

Transcript of Ian Galton, Ph.D.

Date: March 12, 2025
Case: Texas Instruments Incorporated -v- Parkervision, Inc. (PTAB)

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WORLDWIDE COURT REPORTING & LITIGATION TECHNOLOGY

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

- - - - - - - - - - - - - - x

TEXAS INSTRUMENTS :

INCORPORATED, and :

NXP USA, INC., : IPR2024-00935 and

Petitioners, : IPR2024-00936

v. :

PARKERVISION, INC., : U.S. Patent 7,865,177 B2

Patent Owner. : and 9,118,528 B2

- - - - - - - - - - - - - - X

Videotaped Deposition of IAN GALTON, Ph.D.

Conducted Virtually

Wednesday, March 12, 2025

12:03 p.m. EDT

Job No.: 572862

Pages 1 - 297

Reported by: Debra A. Whitehead

Videotaped Deposition of IAN GALTON, Ph.D., conducted virtually.

Pursuant to notice, before Debra Ann Whitehead, E-Notary Public in and for the Commonwealth of Virginia.

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TI and NXP v. ParkerVision - IPR2024-00936

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A P P E A R A N C E S C O N T I N U E D

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C O N T E N T S

EXAMINATION OF IAN GALTON, Ph.D. PAGE

By Mr. Charkow 8

E X H I B I T S

(Exhibits 1 - 8 Attached to the Transcript)

(Exhibits 9 and 10 Not Attached)

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E X H I B I T S C O N T I N U E D

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P R O C E E D I N G S

VIDEO SPECIALIST: Begins Media Number 1 in the videotaped deposition of Dr. Ian Galton in the matter of Texas Instruments, Incorporated, versus ParkerVision, Inc.; in the United States Patent and Trademark Office, before the Patent Trial and Appeals Board; Case Number IPR2024-00935 and IPR2024-00936. 12:02:28 12:02:30 12:02:32 12:02:34 12:02:42 12:02:47 12:02:51

Today's date is March 12, 2025. The time on the video monitor is 12:03 eastern time. The remote videographer today is Ken Lauguico, representing Planet Depos. All parties of this video deposition are attending remotely. 12:02:56 12:02:59 12:03:03 12:03:06 12:03:08

Would counsel please voice-identify themselves and state whom they represent. 12:03:10 12:03:14

MR. CHARKOW: Jason Charkow of the Daignault Iyer firm, on behalf of ParkerVision. With me today I have my colleague Stephanie Mandir. 12:03:14 12:03:17 12:03:20 12:03:24

MR. MAGEE: Bobby Magee, Blue Peak Law Group, on behalf of Petitioner Texas Instruments. With me are Josh Griswold and Yao Wang of Fish & 12:03:24 12:03:28 12:03:30

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Richardson, also representing TI. 12:03:36

MR. CRUMBLEY: This is Kit Crumbley from 12:03:38

Bracewell, representing the NXP petitioner. 12:03:42

VIDEO SPECIALIST: Okay. Great. Thank 12:03:42

you so much. 12:03:42

The court reporter today is Debbie 12:03:42

Whitehead, representing Planet Depos. 12:03:42

The witness will now be sworn. 12:03:52

IAN GALTON, Ph.D., 12:03:52

having been duly sworn, testified as follows: 12:03:59

EXAMINATION BY COUNSEL FOR PATENT OWNER 12:03:59

BY MR. CHARKOW: 12:03:59

Q Please state your name. 12:04:00

A Ian Galton. 12:04:02

Q And you're a doctor. Correct? 12:04:04

A I have a Ph.D. 12:04:06

Q And is there any -- oh, sorry. Go ahead. 12:04:08

A No. Go ahead. Sorry. 12:04:11

Q Is there any reason you can't give 12:04:12

truthful and accurate testimony here today? 12:04:13

A There is no reason. 12:04:16

Q You provided two declarations in two 12:04:17

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different IPRs that we're talking about today. 12:04:22
Correct? 12:04:25
A Yes. 12:04:25
Q And one of the IPRs relate to U.S. Patent 7,865,177. 12:04:25
Do you understand that? 12:04:34
A Yes. 12:04:34
Q And if I refer to the '177 patent -- strike that. 12:04:35
If I refer to "the '177 patent," you'll know what I'm talking about. Right? 12:04:40
A I will. 12:04:42
Q And then in another IPR you provided a declaration, and that IPR deals with U.S. Patent Number 9,118,528. Correct? 12:04:44
A Yes. 12:04:47
Q And so if I use the, say -- strike that. 12:04:51
If I say "'528 patent," you'll understand what the '528 patent is. Correct? 12:04:55
A I will. 12:04:58
Q Do you have any documents in front of you today, physical documents or electronic documents, 12:05:00 12:05:02 12:05:02 12:05:07

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sitting on your computer that are open? 12:05:09

A I do not. 12:05:11

Q All right. So let's talk about your 12:05:11

declaration with regards to the '117 patent. 12:05:18

You recall that the '117 -- well, let me 12:05:24

put it in. 12:05:34

MR. CHARKOW: All right. So I'm dropping 12:05:36

into the chat the '117 patent. So just let me 12:05:37

know when you have that. 12:05:40

(Galton Exhibit 1, marked for 12:05:41

identification and is attached to the transcript.) 12:05:41

A Okay. 12:05:46

Q Strike that. I'm putting into -- strike 12:05:47

that. 12:05:50

MR. CHARKOW: I put into the chat the 12:05:51

'177 patent. 12:05:52

A Yes, I have it, and it's open. 12:05:56

Q So the '177 patent is Exhibit 1 to your 12:05:57

deposition. 12:06:00

And have you seen this patent before? 12:06:04

A Yes. 12:06:06

Q And in your declaration -- strike that. 12:06:06

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Can you turn to Claim, let's see -- turn to the claims of the '177 patent, please. 12:06:11 12:06:17

A Give me a second. Okay. Which claim do you want me to go to? 12:06:23 12:06:27

Q Let's go to -- I think it's the only claim that's relevant here, which is claim -- hold on. Fourteen. That's what we're talking about. 12:06:28 12:06:31 12:06:33

A Yep. 12:06:37

Q Sorry, just give me one second. 12:06:37

So if you look at Claim 14, there is this element called the match filtering/correlating module. 12:06:51 12:06:55 12:06:59

Do you see that? 12:06:59

A I do. 12:07:00

Q And you provided some opinions with regards to what the meaning of match filtering/correlating module is. Correct? 12:07:00 12:07:02 12:07:07

Sorry. Did you hear what I said? Sorry. 12:07:18

A I said I did. Can you hear me? 12:07:20

Q No, we couldn't hear the answer. So let me ask it again. Strike that. 12:07:24 12:07:26

You provided some opinions with regards 12:07:27

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to what the meaning of match -- strike that. 12:07:29

You provided some opinions with regards 12:07:34

to what the meaning of a matched 12:07:36

filtering/correlating module is. Correct? 12:07:41

A I did. 12:07:43

Q And according to you, a matched 12:07:44

filtering/correlating module would be a device 12:07:49

with one or more features which are similar to 12:07:53

those of a matched-filter/correlator in the plain 12:07:56

and ordinary meaning of the term, with one of the 12:08:01

similar features is that the aperture window is 12:08:05

periodically nonzero with a phase that is 12:08:08

synchronous with the carrier of the receive 12:08:11

signal. 12:08:14

Do you recall forming that opinion? 12:08:14

A Yeah, but if you wouldn't mind, would you 12:08:17

send me my disclosure so we can focus on the -- on 12:08:19

the exact wording? 12:08:22

I mean, that's -- certainly sounds 12:08:24

similar to what I wrote, but I would just like to 12:08:26

verify that we're literally on the same page. 12:08:28

MR. CHARKOW: So I have just dropped into 12:08:32

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the chat Exhibit 2 to your deposition. 12:08:33

(Galton Deposition Exhibit 2 marked for identification and is attached to the transcript.) 12:08:33 12:08:37

Q Strike that. Exhibit 2 to your deposition is your declaration in this case. If you could please let me know when you have it open. 12:08:37 12:08:39 12:08:41 12:08:43

A It's open. What page would you like me to go to? 12:08:43 12:08:45

Q So it's Paragraph 32. 12:08:45

A All right. And do you have a page? 12:08:50

Q Now you're testing my knowledge. 12:08:54

Yeah. It's Page 22. 12:09:01

A Okay, I'm there. 12:09:08

Q So you're on Page 22 of Exhibit 2. 12:09:09

Correct? 12:09:11

A Yes. 12:09:11

Q Do you see Paragraph 32? 12:09:11

A Yes. 12:09:14

Q And you see it provides a -- I guess your claim construction for what a matched filtering/correlating module would be. Correct? 12:09:14 12:09:16 12:09:20

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A Yes. I see it. 12:09:24

Q And, let's see. All right. So in your definition of a matched filtering/correlating module, you have a definition that includes, "wherein one of the similar features is that the aperture window" -- well, strike that. 12:09:25 12:09:31 12:09:36 12:09:42 12:09:44

So in your definition for matched filtering/correlating module you say, It is a device with one or more features which are similar to those of a matched filter/correlator in the plain and ordinary meaning of the term. 12:09:46 12:09:49 12:09:53 12:09:56 12:10:00

Correct? 12:10:02

A Yes. 12:10:05

Q What do you mean by "similar"? Like, how is one supposed to know what similar means? 12:10:05 12:10:08

A Okay. In order to do that, we have to talk about what -- what is meant by a matched filter/correlator in general. 12:10:12 12:10:14 12:10:19

So if you'd like, I can -- I can explain that first and then come back to answer your question. 12:10:22 12:10:24 12:10:27

Q Yeah, I mean, I don't -- the question is 12:10:28

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what does "similar" mean. I really don't need a discussion of matched filter and -- 12:10:30 12:10:33

A That Thing A and Thing B are similar, we have to know what Thing A is. So Thing A is sort of the textbook matched filter/correlator. And Thing B is what I'm describing here, and I'm saying they're similar. 12:10:36 12:10:39 12:10:42 12:10:49 12:10:52

So in order to describe the similarity, I have to first describe the first thing. So I'm happy to do that if you want. 12:10:54 12:10:56 12:11:01

Q Right. No. Assuming that I know what a matched filter/correlator is in the plain and ordinary meaning, I'm just trying to understand what makes something similar to that. 12:11:02 12:11:04 12:11:07 12:11:09

A So in this case it would be a system which -- or a structure which performs substantially the mathematical operations that a matched filter/correlator would implement. 12:11:11 12:11:13 12:11:18 12:11:23

Q And what are all the similar operations that you're referring to? 12:11:31 12:11:32

A Well, again, if you want me to describe that, we have to first describe the thing we're 12:11:33 12:11:36

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comparing it to. So I'm happy to do that, but I can't answer your first unless you first let me show you what a matched filter correlator does in the textbook sense of the structure. 12:11:39 12:11:45 12:11:48 12:11:51

Q All right. Let me ask you this: In your definition, you say wherein one of -- strike that. 12:11:52 12:12:01

With regards to your definition of matched filtering/correlating module you say, part of the definition is "Where one of the similar features is that the aperture window is periodically nonzero with a phase that is synchronous with the carrier of the receive signal." 12:12:04 12:12:06 12:12:10 12:12:11 12:12:13 12:12:16 12:12:18

Do you see that? 12:12:19

A I do. 12:12:20

Q So you have explained that that is one of the similar features. Correct? 12:12:20 12:12:24

A Uh-huh. 12:12:26

Q I need a verbal yes or no. 12:12:27

A I'm sorry, yes. 12:12:29

Q And so that implies that there's other similar features. Correct? 12:12:30 12:12:33

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A Yes. And I just described one to you, which is -- which is it's a structure which implements the mathematics that are substantially the same as the textbook version of a matched filter/correlator. 12:12:35 12:12:37 12:12:39 12:12:45 12:12:48

Q Why did you pull this one similar feature out and include it in the definition as opposed to all the other similar features you believe there may be? 12:12:49 12:12:53 12:12:55 12:12:57

MR. MAGEE: Objection. Form. 12:12:57

A Well, because I was trying to -- '177 patent and looking at the various embodiments of the invention, I was trying to be as generous as possible in agreeing with the patent specification which said that each of these embodiments implements a matched filter/correlator. And (inaudible.) 12:13:05 12:13:08 12:13:11 12:13:16 12:13:22 12:13:25 12:13:29

(Discussion off the record; technical difficulty.) 12:13:30 12:13:40

MR. CHARKOW: Can we go off the record, please. 12:13:40 12:13:41

VIDEO SPECIALIST: We are going off the 12:13:42

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record at 12:13. 12:13:43

(A recess was taken.) 12:13:45

VIDEO SPECIALIST: We are back on the record at 12:15. 12:15:35

BY MR. CHARKOW: 12:15:38

Q Why did you pull -- well, strike that. 12:15:39

So I'm going to ask the question again because you got cut off. Okay? 12:15:40

A Uh-huh. 12:15:42

Q Strike that. 12:15:43

Why did you pull this one feature out and include it in the definition, as opposed to all the other similar features you believe there may be? 12:15:44

MR. MAGEE: Objection. Form. 12:15:52

A Well, because that is one feature that's consistent among all of the -- mentioned in '177 (inaudible.) 12:15:52

(Discussion off the record; technical difficulty.) 12:15:55

MR. CHARKOW: Could we go off the record. 12:16:00

Let's do this off the record. 12:16:12

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VIDEO SPECIALIST: We are going off the record at 12:16. 12:16:23 12:16:26

(A recess was taken.) 12:16:29

VIDEO SPECIALIST: We are back on the record at 12:18. 12:18:24 12:18:28

BY MR. CHARKOW: 12:18:30

Q Why did you pull this one feature out and include it in the definition as opposed to all the other similar features you believe that there may be? 12:18:31 12:18:34 12:18:36 12:18:38

MR. MAGEE: Objection. Form. 12:18:38

A Because when I looked at the embodiments in -- described in '177 that referred to -- you know, that claimed to be matched filter/correlator, or contained matched filter/correlator blocks, the synchronization was the feature that is absolutely consistent from embodiment to embodiment. 12:18:43 12:18:48 12:18:52 12:18:56 12:18:58 12:19:04 12:19:10

So some of the other features of a matched filter/correlator, such as an integrator and -- and using a so-called symbol waveform that's exactly matched to the input, some of those 12:19:11 12:19:13 12:19:16 12:19:25

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were not met but they were approximately met. 12:19:28

So in '177, you know, definitely mentions 12:19:31

that they approximately implement a matched 12:19:38

filter/correlator in places. So I just pulled out 12:19:42

the one feature that was absolutely consistent and 12:19:45

not approximated in any of the embodiments. 12:19:47

But, you know, aside from all that, this 12:19:49

was just in some sense an aside. I mean, I've 12:19:53

analyzed the claim and -- in '177 carefully for 12:19:56

every definition of matched filter/correlator 12:20:07

that's been proposed. And for ParkerVision's 12:20:10

proposed definition, for the court's proposed 12:20:14

definition and for my sort of modification of what 12:20:16

I think it should be, regardless of which one of 12:20:19

those definitions we take, my conclusion is that 12:20:21

'177, or specifically Claim 14 of '177, is 12:20:28

invalidated regardless. 12:20:31

Q How many similar features do you believe 12:20:33

that a matched filtering/correlating module have? 12:20:36

A You know, I feel like I've answered this 12:20:42

question. I have written clearly in my -- in my 12:20:43

disclosure what I believe the answer to be. I 12:20:46

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feel like I've already answered this question. 12:20:49

Q Is it five similar features, a hundred similar features? I just want to know. 12:20:51 12:20:55

A And I -- like I said, I think I have answered this question already. 12:20:57 12:20:59

Q You haven't. I want to know the number. You haven't given me a number. How many similar features, three, four, ten, a hundred? 12:21:00 12:21:02 12:21:05

A I've pointed out one similar feature that's absolutely consistent. And I've mentioned a few others. And depending on the embodiment that's described in '177, some of the embodiments only approximate those features, whereas some of them are more exact. So it's -- the problem is that the question is kind of ill-posed. Because, you know, whether a feature is approximated or exact makes it hard to say, you know, three or five or ten or 55. 12:21:08 12:21:11 12:21:13 12:21:19 12:21:23 12:21:26 12:21:29 12:21:32 12:21:34 12:21:37

Q Well, sir, you're the one that put in a definition that said one of the similar features, and then you listed one similar feature. And I'm here today trying to understand what are the other 12:21:39 12:21:41 12:21:44 12:21:47

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similar features. Right? 12:21:48

You've said that there are other similar 12:21:50

features. What are those? And if you -- 12:21:51

A And I have -- I have told you some. 12:21:53

MR. MAGEE: Objection. Form. 12:21:56

THE WITNESS: I'm sorry, Bobby. I didn't 12:21:57

mean to cut you off. Say that again? 12:21:59

MR. MAGEE: Just objection, form. 12:22:00

You can answer. 12:22:02

A So I've explained that in -- a matched 12:22:03

filter/correlator implements certain mathematical 12:22:11

operations, and I've offered to show you exactly 12:22:17

what those are, and you turned me down. 12:22:18

But, you know, one of those implement -- 12:22:20

one of those mathematical operations is to perform 12:22:23

integration. And a classical textbook matched 12:22:26

filter/correlator has a very specific variation of 12:22:32

integration. 12:22:35

And as '177 points out, some of their 12:22:38

implementations only implement that approximately. 12:22:43

And so that's why I've taken a slightly more 12:22:46

general few than absolute plain and ordinary 12:22:49

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meaning goes. Because -- or it does, because, you know, I wanted to take what was said in '177 at face value and say they're saying this is a matched filter/correlator. And I agree that in each of their embodiments it does either implement certain features of matched filter/correlators or it can sometimes approximate them. 12:22:54 12:22:59 12:23:03 12:23:05 12:23:08 12:23:14 12:23:17

And so because of that, I pulled out -- I culled out the one feature that's absolutely consistent, and the rest are either implemented or approximated. 12:23:20 12:23:25 12:23:26 12:23:29

And so you're asking me for an absolute, and you're saying is it black or white. And I'm saying, Well, it's gray, you know. So whether a feature is implemented or not implemented exactly is one thing. Whether it's implemented or not implemented approximately is another. And each of the embodiments make approximations to varying degree. 12:23:31 12:23:33 12:23:38 12:23:39 12:23:42 12:23:44 12:23:47 12:23:50

Q So are you saying that your construction is gray; it's not black and white, it's gray? 12:23:51 12:23:54

A No, I'm not saying that at all. I've 12:23:57

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given a very specific construction. You're just asking me to add details to it, which I'm saying if I were to do that, then it would be gray. 12:23:59 12:24:02 12:24:06

Q So why don't you tell me all of the similar features, since you listed one similar feature, why don't you -- strike that. 12:24:08 12:24:10 12:24:13

Why don't you tell me all the similar features that you think would be similar to those with matched filter/correlator. Just go ahead and list them. 12:24:14 12:24:17 12:24:22 12:24:25

MR. MAGEE: Objection. Form. 12:24:25

A We need to go through every one of the embodiments one by one. I am happy to do that if you'd like. 12:24:26 12:24:28 12:24:30

Q Let's just go ahead. Give me what you -- give me what you know. 12:24:31 12:24:33

MR. MAGEE: Same objection. 12:24:34

A When you say, "give me what you know," what does that mean? 12:24:36 12:24:38

Q It means go ahead. 12:24:39

A Go ahead with what? 12:24:41

Q Sir, listen. You asked me -- you said I 12:24:42

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have to go through each of the figures. Okay? 12:24:47
Right? All the embodiments. Right? That's what 12:24:49
you just said. 12:24:52
A Okay. So you would like me to go through 12:24:53
the different embodiments of '177? 12:24:55
Q Yeah. Yes. And tell me what you think 12:24:59
is a similar feature, other than the one you 12:25:01
identified. 12:25:04
A Okay. I need to share my screen. Give 12:25:05
me a second. I'm not used to this computer. 12:25:08
Q You don't have to share your screen. I 12:25:10
have the patent in front of me. 12:25:12
A Okay. Hold on a second. This patent is 12:25:13
so damn long. 12:25:18
MR. MAGEE: I'm just going to object to 12:25:20
form. 12:25:21
Go ahead. 12:25:22
Q I mean, can you explain it to me in the 12:25:32
context of your declaration? 12:25:35
A Well, I have explained it in the context 12:25:36
of the declaration. You want information that's 12:25:37
not in my declaration. 12:25:39

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So let me just find a -- 12:25:41

Q So there are similar features that aren't 12:25:45
in your declaration. Correct? That's what you 12:25:48
just said? I just want to make sure I understand. 12:25:50
That's what you -- 12:25:52

A No. I mean, what I've done is I've said 12:25:53
that there are features similar to -- there are -- 12:25:55
it's similar to a matched filter/correlator in the 12:25:58
plain and ordinary sense of the word. Where -- 12:26:01
where in one of the features is this issue of 12:26:06
synchrony. I'm paraphrasing because I don't have 12:26:09
it in front of me. I'm trying to find a figure 12:26:11
that would be meaningful here. There's like 12:26:14
literally hundreds of pages in this patent, so -- 12:26:16
and this computer is very slow. 12:26:18

Q While you look for that, I just want to 12:26:31
be clear. So there are other similar features 12:26:33
that you are going to point to in the patent that 12:26:39
are not included in your declaration. Correct? 12:26:43
That's what you're doing right now? 12:26:46

MR. MAGEE: Objection. Form. 12:26:47

A I'm going to show a similar feature or 12:26:51

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similar features that are not called out specifically. But I made it clear in the -- in my declaration that it has a similar feature. So could you go to Figure 172, please. 12:26:53 12:26:58 12:27:02 12:27:05

Q Sure. Go ahead. 12:27:07

A Okay. So this architecture where there is a switch which is closed and opened at an aliasing rate in perfect synchrony with the carrier, and then integrated over a -- over the aperture window, and then output, that is -- that has all the features of a matched filter/correlator. So it has a switch that opens and closes with an aperture rate. It's -- the aperture is synchronous with the -- with the carrier of the signal. And the integration is performed over that window. 12:27:16 12:27:18 12:27:22 12:27:24 12:27:31 12:27:37 12:27:46 12:27:48 12:27:51 12:27:54 12:28:01

Now, but even here it's important to point out -- and the '177 specification does point out -- that the application of this matched filter/correlator is not traditional. So whether you call that a difference or a similarity, it's -- you know, it comes down to semantics. 12:28:02 12:28:06 12:28:09 12:28:16 12:28:18 12:28:21

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But the bottom line is that in a traditional matched filter/correlator it operates on a baseband signal. And the aperture window is related to the data symbol, not the carrier. 12:28:23 12:28:26 12:28:31 12:28:37

So again, this is similar to a matched filter/correlator in the sense that it has these similar features, but because its purpose is different and because the aperture has a -- has a different context, it's only similar. So that's 172. And that shows -- 12:28:41 12:28:46 12:28:50 12:28:56 12:29:00 12:29:04

Q Could I stop you there. So Figure 172 shows a similar feature. Correct? 12:29:05 12:29:07

A It shows several similar features. 12:29:12

Q Okay. Next? 12:29:15

A All right. So now I'll show you where things get a little bit gray. 12:29:17 12:29:21

So in Figure 173, now the integration is performed with an RC filter. And -- or with that R and C combination. And so it is performing integration because the RC filter implements a convolution integral. But it's -- it's starting to deviate a bit from the sort of classical 12:29:23 12:29:29 12:29:34 12:29:39 12:29:44 12:29:48

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definition of matched filter/correlator in that the integral is approximate. 12:29:51 12:29:57

So when you were asking me, Oh, tell me all the features, and are there five or 55 or a million, the problem is that the features that are similar depend on your definition of similarity. Right? In the sense that a matched filter/correlator performs the exact integration without any kind of other term inside of the integral. Whereas when we have this type of structure in Figure 173, we've got a -- an impulse response of the filter, you know, being integrated along with the signal. 12:29:59 12:30:00 12:30:03 12:30:08 12:30:14 12:30:17 12:30:20 12:30:23 12:30:26 12:30:32 12:30:34

Q Right. And so -- 12:30:35

A So whether you call this similar or not, you know, it's sort of the wording isn't precise enough to really -- really quantify it. 12:30:36 12:30:39 12:30:43

Q So -- 12:30:45

A I'm not trying to be difficult. I'm just simply trying to point out that -- that depending on what you consider to be an acceptable level of approximation to still consider it a feature of a 12:30:46 12:30:48 12:30:50 12:30:55

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matched filter/correlator, that's somewhat subjective. 12:30:58 12:31:01

But the one thing that is the same across all of the embodiments that include a matched filter/correlator in '177 is that the -- is this concept of synchrony. So that's why I wrote it that way. 12:31:02 12:31:04 12:31:07 12:31:13 12:31:18

Q All right. 12:31:18

A And once again, I would remind you that I've looked at '177 and Claim 14. And in the context of the -- of all three definitions of matched filter/correlator. And in every one of those cases the prior art makes it clear to me that '177 is invalid. 12:31:19 12:31:21 12:31:25 12:31:28 12:31:32 12:31:39

Q Sir, I want you to listen to the question very carefully because you're not answering the question. All I asked you is -- first of all, you're talking about similarities, it's subjective. Okay? We're here to depose you today. Okay? So I want to understand what your view of what's similar -- what's similar. So I don't care about what anybody else's view is. 12:31:46 12:31:48 12:31:50 12:31:52 12:31:55 12:31:57 12:31:59 12:32:01

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Either you have an opinion or you don't have an opinion. So if you could just answer the questions. You don't have to inject, you know, the patent is invalid. That's not the question I asked. I didn't ask that. So you understand, I want your view. I just want to make sure you understand. I want your view of what you believe is a similar feature. 12:32:04 12:32:06 12:32:08 12:32:09 12:32:12 12:32:14 12:32:16 12:32:19

A Right. And I just -- I did answer that that question. 12:32:21 12:32:23

Q You didn't. Because here is the problem. You say, you may consider it similar but I don't know if I -- you know, you won't -- you're not -- I need to know which -- which features specifically you believe are similar. To tell me that there may be -- differences of opinions in terms of what's similar, that's not answering the question. I just want to know what you believe is similar. 12:32:23 12:32:25 12:32:28 12:32:30 12:32:33 12:32:35 12:32:38 12:32:40 12:32:42

I understand there are differing opinions. I may have different opinion from you. I just want to know what you believe is similar. 12:32:43 12:32:45 12:32:47

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So let me ask you the question again. 12:32:50

I want you -- everything that -- all the 12:32:51

answer -- all the answers you're going to provide 12:32:53

to me, I want your view as to terms of what's 12:32:56

similar. Strike that. 12:32:58

So do you understand that what I'm 12:33:00

seeking is your view of what are similar features, 12:33:02

and just walk me through the patent and just say 12:33:05

This is a similar feature, This is a similar 12:33:08

feature. Can you do that? 12:33:10

A The -- 12:33:13

MR. MAGEE: Objection. Form. 12:33:13

THE WITNESS: Oh, sorry, Bobby. 12:33:14

A Yes, I have already described -- I've 12:33:16

already described that a similar feature is that 12:33:20

it's performing integration. It's not exactly the 12:33:21

same because the integration isn't exactly the 12:33:24

same as a -- isn't exactly the same as a textbook 12:33:26

matched filter/correlator, but it is similar in 12:33:34

that it is performing integration. The synchrony 12:33:37

is obviously one. The fact that we're sampling is 12:33:39

one. The fact that the mathematics that are being 12:33:43

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at least approximated by this system are similar to those implemented by a textbook-style matched filter/correlator, they're similar. And the function is similar in the sense that even though it's being applied in a different context, we're still again using the sort of mathematical properties that make a matched filter/correlator useful in baseband, we're using those same properties in '177, and Tayloe for that matter, are using those same properties to achieve a benefit in demodulation. 12:33:46 12:33:50 12:33:54 12:33:56 12:33:59 12:34:03 12:34:06 12:34:10 12:34:13 12:34:15 12:34:20

Q Any other similar features in your view that are similar features that are shown in the '177 patent? 12:34:22 12:34:25 12:34:28

A No. I think -- I think that more or less covers it. It all comes down to details of, you know, how -- to what degree the integration is approximated. But the way I answered that question, it applies to pretty much everything. 12:34:33 12:34:35 12:34:39 12:34:42 12:34:46

Q So why didn't you list all those other similar features? You just -- strike that. 12:34:48 12:34:51

You just listed several similar features, 12:34:52

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but you only identified one in the claim construction. Why? 12:34:55 12:34:57

A Because I wanted to make the claim construction something that was not subjective. 12:35:00 12:35:07

So as I mentioned before, I believe that this approximate integration allows this structure to achieve approximately the same mathematics as are implemented by a matched filter/correlator. However, that's my opinion. And, you know, at some point an approximation breaks down and a reasonable person could say, Well, wait a minute, that's too approximate, you're not doing a good enough job. I don't want to consider that to be a matched filter/correlator. 12:35:11 12:35:15 12:35:18 12:35:22 12:35:26 12:35:30 12:35:33 12:35:35 12:35:37 12:35:40

And just to avoid that ambiguity, I took the most critical feature that every embodiment of '177 that has a matched filter/correlator in it has. And I said, This is the key feature that is never approximated. It's -- it's, you know, indisputable that it could be considered to be not related to a matched filter/correlator. So that's my reasoning. 12:35:41 12:35:43 12:35:47 12:35:51 12:35:55 12:35:59 12:36:02 12:36:06

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Q Right. And you understand that if you put one similar feature into a definition, as opposed to five similar features, you understand you're making the claims much broader. Right? If you have to meet five limitations as opposed to one. You understand that. Right? 12:36:06 12:36:09 12:36:12 12:36:14 12:36:18 12:36:22

A Well, I'm not a lawyer, but that sounds -- certainly sounds reasonable. 12:36:24 12:36:26

Q Right. Because it's harder to prove five similar features than one similar feature. Right? Because you would have to show all of them. Right? So the definition you gave is potentially broader, much broader. 12:36:27 12:36:31 12:36:34 12:36:36 12:36:38

A Well, as -- 12:36:39

MR. MAGEE: Objection. Form. 12:36:40

A As I mentioned, I've also analyzed it in terms of the -- the other definitions, and I came to the same conclusion. So even if you don't like my -- my proposed construction, it's kind of academic anyway since you guys, you know, ParkerVision has a proposed construction, and there's also been a -- you know, a court-proposed, 12:36:41 12:36:45 12:36:50 12:36:53 12:36:57 12:37:00 12:37:02

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I think, construction. Anyway, I've analyzed both of those, too, and came to the same solution. 12:37:09 12:37:13

So I hear what you're saying. But like I said, it's -- it's -- you know, it's kind of irrelevant, because the other two definitions also hold. 12:37:15 12:37:20 12:37:24 12:37:26

Q All right. So just listen to the question that I asked and just -- I just want the answer to the question I asked. So I'll reask the question. And please listen carefully. All right. 12:37:26 12:37:28 12:37:30 12:37:33 12:37:36

I said -- strike that. 12:37:37

Because it's harder to prove five similar features than one similar feature. Right? Because you would have to show all of them? So the definition you gave is potentially broader, much broader. 12:37:38 12:37:40 12:37:43 12:37:45 12:37:48

Did I say it correctly or incorrectly? 12:37:48

MR. MAGEE: Objection to form. 12:37:51

A Let me go look at -- go back and look at exactly what I wrote. Hold on a second. Because I want to make sure I'm answering it properly. 12:37:52 12:37:56 12:37:58

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Oh, what is going on here. 12:38:01

(Discussion off the record with the court reporter.) 12:38:16 12:38:19

A But I'm having trouble opening this. Give me a second. This is not my computer. Hold on. For some reason it's not opening for me. 12:38:20 12:38:23 12:38:33

MR. CHARKOW: Can we go off the record, please, while he figures out the issue. 12:38:35 12:38:37

VIDEO SPECIALIST: Yeah, we are going off the record at 12:38. 12:38:40 12:38:41

(A recess was taken.) 12:38:43

VIDEO SPECIALIST: We are back on the record at 12:39. 12:39:51 12:39:54

A Okay. Do you want to repeat your question? 12:39:59 12:40:02

Q Sure. Strike that. 12:40:03

Because it's harder to prove five similar features than one similar feature, right, because you would have to show all of them, so the definition you gave is potentially broader, much broader. Correct or incorrect? 12:40:13 12:40:16 12:40:18 12:40:20 12:40:27

MR. MAGEE: Objection to form. 12:40:30

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A Yeah, I'm not a lawyer. I mean, I wrote what I wrote. If -- you know, that's up to you guys to decide. I mean, I wrote what I thought was as clear as possible. Like I said, I'm not a lawyer, so I don't know the legal ramifications of it. 12:40:31 12:40:32 12:40:36 12:40:43 12:40:45 12:40:46

But you have what I wrote. You're a lawyer. You know, it's up to you to decide that. 12:40:47 12:40:49

Q So do you believe -- well, strike that. 12:40:52

If you have not addressed all the things that you just identified as similar features of a matched filtering/correlator, you would agree that you're missing some of the claim elements. 12:40:59 12:41:01 12:41:06 12:41:14

Correct? 12:41:17

MR. MAGEE: Objection. Form. 12:41:18

A I mean, missing some of the claim elements? This is just a definition. This is my definition of what I think a matched filter/correlator is. 12:41:24 12:41:28 12:41:29 12:41:31

I mean, the -- I mean, I stand by what I wrote. I don't know what to say. But like I said, the other ones also hold. And for that 12:41:33 12:41:39 12:41:42

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matter, the ParkerVision one has no resemblance to a -- to a matched filter/correlator. It has none of the features of a matched filter/correlator. So, you know, so I don't think I've -- I mean, like I said, I stand by what I wrote. 12:41:46 12:41:49 12:41:51 12:41:54 12:41:59

Q Okay. You listed several similar features. Correct? That we just went through that. Right? 12:42:00 12:42:03 12:42:06

A Yes. 12:42:06

Q If you did not address one of those -- one or more of those similar features in your report, if you did not do that, you would agree that you're missing a portion of the claim element of a matched filtering/correlating module. 12:42:07 12:42:11 12:42:14 12:42:16 12:42:20

Correct? 12:42:27

MR. MAGEE: Objection. Form. 12:42:27

A No. I think -- I mean, my -- again, I'm not a lawyer. But my -- my belief is that if I -- I'm just reading that, what I wrote. My belief is that this is a valid definition of a matched filter/correlator. And -- and that if I -- if it satisfies this, then -- then that's good. 12:42:30 12:42:33 12:42:41 12:42:43 12:42:46 12:42:51

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And like I said, the other definitions of matched filter/correlator I've analyzed, too. So they're -- you know, I guess I don't quite get what -- 12:42:54 12:42:57 12:42:59 12:43:02

Q Okay. Listen. I get it. Just listen very carefully. 12:43:02 12:43:05

So you said your definition on Paragraph 32 is of the matched filtering/correlating module, is a device with one or more features which are similar to those of a matched filter/correlator. Right? That's part of your definition? 12:43:06 12:43:09 12:43:14 12:43:18 12:43:21

A Uh-huh. 12:43:23

Q Okay. Correct? Yes or no. 12:43:23

A Yes. 12:43:26

Q I need -- 12:43:26

A Yes. 12:43:27

Q And if -- you believe that there are other similar features or you have identified other similar features just now. And you're under oath. Correct? 12:43:27 12:43:30 12:43:32 12:43:37

A Yes. 12:43:38

Q And it was more than just the synchronous 12:43:38

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similar feature, correct, that you identified? 12:43:41
You identified more than that. Right? 12:43:43
A I pointed out -- I pointed out features 12:43:46
in some of the embodiments that are similar, yes. 12:43:50
Q Okay. 12:43:54
A But -- yeah, so I did. 12:43:55
Q And if you didn't address for whatever 12:43:56
reason, if you didn't address one of those similar 12:43:59
features, you agree with me that you're missing 12:44:02
part of your own definition. Right? Because it's 12:44:04
one or more features which are similar. Right? 12:44:08
MR. MAGEE: Objection to form. 12:44:11
Q You're missing part of your definition? 12:44:11
A My definition says one or more features, 12:44:13
one of which has to be synchrony. 12:44:16
So -- so, I mean, I feel like I've 12:44:19
answered this question. I don't -- you know, 12:44:23
I've -- it's a very clear definition. And when I 12:44:25
apply this definition to matched 12:44:28
filter/correlator -- slash, correlator, you know, 12:44:31
in the -- in the embodiments of '177, and also in 12:44:35
the prior art, it infringes. And when I apply the 12:44:39

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other definitions it infringes, too. I mean, not infringes, it's invalidated, too. 12:44:43 12:44:46

Q Yeah, I'm not asking for any -- I'm just focusing on your construction. I'm not asking about anybody else's, ParkerVision's, the court's, just your construction. So pay attention to what I'm saying please. Strike that. 12:44:48 12:44:50 12:44:52 12:44:56 12:44:58

So under your construction, you could choose any of those similar features, any one of those similar features, and that would meet -- that would meet the definition of a matched filtering/correlating module. Correct? 12:44:59 12:45:02 12:45:04 12:45:07 12:45:11

MR. MAGEE: Objection. Form. 12:45:15

A I mean, you're kind of oversimplifying. 12:45:18

So let me back up and try to explain. So first of all, the reason why it's called a matched filter/correlator is that you can implement a structure in the textbook sense of the word "matched filter/correlator" as either a matched filter or a correlator. So what matters is what the mathematics it implements is, not how you -- you know, what specific features it has. Okay? 12:45:21 12:45:25 12:45:29 12:45:32 12:45:37 12:45:40 12:45:43 12:45:50

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So you're -- you know, in fact, let me take you -- let me try to make this clear. I mean, I know you think I'm being difficult. And I'm really -- I'm really not trying to be difficult. But I -- 12:45:52 12:45:55 12:45:58 12:46:00 12:46:01

Q I'll withdraw the question. I'm going to -- I'm going to withdraw the question. So there's no need to answer. The question is withdrawn. There is nothing to answer, sir. 12:46:02 12:46:04 12:46:06 12:46:08

A Okay. 12:46:10

Q The question is withdrawn. 12:46:10

A I am happy to answer it, but you have to let me put it in context for it to make sense. 12:46:11 12:46:13

Q Let me ask you this: You identified, with regards to any of the several similar features you identified, is your position that you could use one of those similar features in place of the synchronous feature that you identified in your construction? Meaning that you could -- could you swap one of those similar features out for what you put here? 12:46:15 12:46:21 12:46:23 12:46:26 12:46:28 12:46:32 12:46:35 12:46:38

MR. MAGEE: Objection. Form. 12:46:38

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A I don't follow the question. Can you ask me that again? 12:46:39 12:46:41

Q Right. You identified one similar feature. You said one similar feature, and then you identified the synchronous similar feature in your -- 12:46:42 12:46:43 12:46:46 12:46:48

A I said at least one of those similar features must be that. 12:46:49 12:46:50

Q Okay. At least one of -- right. Which means that you could have chosen randomly another similar feature and said, Well, that could meet the construction because it's a similar feature. 12:46:54 12:46:57 12:46:59 12:47:02

Right? 12:47:04

MR. MAGEE: Objection. Form. 12:47:04

Q You just have to show one? 12:47:05

A Okay. If you -- if you would allow me to put this in context by showing you a matched filter/correlator and show you how, even in the context of the textbook definition, this concept of features is very vague and not applicable, it would help me answer your question in context. 12:47:07 12:47:10 12:47:15 12:47:17 12:47:20 12:47:27

Q Sir, you're saying that these features 12:47:29

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are vague. And you provided a definition based on features. So I'm just trying to understand, from what I'm hearing, is that your definition is vague. Right? 12:47:32 12:47:34 12:47:37 12:47:39

You just said the features are vague, and you tried to give a definition. So your definition -- 12:47:40 12:47:42 12:47:44

A Hold on. It's -- if I -- 12:47:45

MR. MAGEE: Objection. Form. 12:47:54

Q Okay. 12:47:57

A So when we -- let me go back. When we talk about a textbook matched filter/correlator, you can implement it as either a matched filter or a correlator. There are two different forms of it. So what matters is what the mathematics that the structure implements does, as opposed to the specific features of how you do it. 12:47:59 12:48:01 12:48:06 12:48:09 12:48:11 12:48:14 12:48:19

There are many -- like in circuits in general, there are many different circuit topologies that achieve the same function. So when -- the whole reason there's a slash between matched filter/correlator is, even in the textbook 12:48:20 12:48:22 12:48:25 12:48:28 12:48:31

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approach, there are two different ways to do it. 12:48:36

But even in the textbook approach, the 12:48:39

commonality, the common feature, is this issue of 12:48:41

synchrony. Okay? So just like in the textbook 12:48:45

approach, which I'm happy to show you, I've got a 12:48:48

picture of it in my disclosure -- I'm sorry, in my 12:48:50

declaration, just like in the textbook case, there 12:48:54

can be different features of two different -- I 12:49:00

mean two different architectures that implement 12:49:04

the same functionality, can have different 12:49:06

features. 12:49:10

And so you're saying, Oh, well, you must 12:49:11

show me a full list of features that must be there 12:49:13

in order for it to be a -- in order for it to be a 12:49:16

matched filter/correlator. And what I'm saying is 12:49:19

there are many different ways that it can 12:49:22

implemented. And the '177 patent shows many 12:49:25

different implementations. 12:49:29

But the one common feature, just like in 12:49:31

the textbook case, is synchrony. 12:49:34

Q Okay. So the '177 patent discloses many 12:49:36

similar features, but the one that is common 12:49:39

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across all embodiments is the synchronous feature. 12:49:43
Correct? 12:49:46
A Yes. 12:49:48
Q And that's why you chose the synchronous 12:49:48
feature as part of your definition. Correct? 12:49:50
A Yes. 12:49:53
Q Okay. And just to be clear, that you 12:49:53
came up with this definition of having -- the 12:49:56
concept of similar features to define what a 12:50:00
matched filtering/correlating module is. Correct? 12:50:04
MR. MAGEE: Objection. Form. 12:50:08
A Can you give me that again? I didn't 12:50:09
quite follow the question. 12:50:11
Q Yeah. You include this concept of 12:50:11
similar features. Right? You came up with -- 12:50:14
strike that. 12:50:16
You came up with the definition for 12:50:16
matched filtering/correlating module. Correct? 12:50:19
A Yeah. Yes. I mean, based on, you 12:50:24
know -- I didn't just pull it out of the air. 12:50:26
It's based on, you know, the textbook definition. 12:50:28
And so it's -- and also based on how '177 12:50:32

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describes it applies matched filter/correlating to a nontraditional problem. 12:50:36 12:50:39

Q Sir, I just want to know if you came up with the definition, as opposed to -- 12:50:41 12:50:43

A Yeah, I came up with it. I came up with it. 12:50:46 12:50:47

Q Let me ask the question again. 12:50:47

You came up with the definition for matched filtering/correlating module. 12:50:49 12:50:53

Correct or incorrect? 12:50:56

A I did. 12:50:56

Q As part of that definition, you chose to use the language of, you know, similar features. Correct? That's what you chose? 12:50:56 12:50:59 12:51:00

A Yes. 12:51:02

Q Okay. And then from that you chose one similar feature that you believe was common to all embodiments. Correct? 12:51:02 12:51:08 12:51:12

A Yes. 12:51:14

Q And you believe there's other similar features, but they're not necessarily common to all embodiments. Correct? 12:51:14 12:51:16 12:51:19

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A That is correct. 12:51:20

Q And you've identified some of the similar features previously. There's a number of them that you've identified in the patent. Correct? 12:51:21 12:51:24 12:51:27

A Yes; in the context of specific examples, yes. 12:51:30 12:51:32

Q And you believe that the matched filtering/correlating module must use an LO that has the same frequency as the RF. Correct? 12:51:32 12:51:37 12:51:42

A No. 12:51:45

MR. MAGEE: Objection to form. 12:51:45

A It has to be phased synchronous. 12:51:46

Q You believe that the matched filtering/correlating module must use an LO and an RF that is phased synchronous. 12:51:47 12:51:51 12:51:55

A Yes. 12:52:03

So, for example, it could have half the frequency, as long as the apertures occur, for example, when the carrier is positive. 12:52:06 12:52:08 12:52:17

Q So can you turn to Paragraph 44 of your declaration. 12:52:22 12:52:25

A Can you give me a page? 12:52:28

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Q I don't have the page. You're just going to have to scroll down a couple of pages. Sorry. 12:52:29 12:52:31

A That's all right. Hold on. 12:52:33

Yes, I'm there. 12:52:45

Q All right. So Paragraph 44 talks about synchrony. 12:52:45 12:52:49

Do you see that? 12:52:49

A Yes. 12:52:54

Q And synchrony -- strike that. 12:52:54

Why do you believe synchronization is part of a matched filtering/correlating module? 12:52:58 12:53:00

A Well, the idea behind a matched filter/correlating module as used in '177 is, it samples -- it closes a switch, for example, or -- or multiplies by a windowing function, depending on the embodiment. 12:53:05 12:53:10 12:53:18 12:53:24 12:53:26

But anyway, it grabs the input signal only when the phase of the -- or only when the carrier, for example, is always positive or always negative or -- well, yeah, always positive or always negative. 12:53:27 12:53:33 12:53:38 12:53:43 12:53:48

And so as such, what happens is the 12:53:49

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integration process accumulates -- it accumulates power from the desired signal component, namely the modulated signal component. And, you know, it does this in a way that essentially gets rid of the carrier. 12:53:51 12:53:56 12:54:00 12:54:04 12:54:06

And so that can only work if you aren't integrating positively for part of the cycle and then negatively for another part of the cycle. 12:54:07 12:54:13 12:54:15

MR. CHARKOW: Okay. I provided you another exhibit to your deposition. Can you open that up? 12:54:20 12:54:21 12:54:23

(Galton Deposition Exhibit 3 marked for identification and is attached to the transcript.) 12:54:23 12:54:24

Q Strike that. So Exhibit 3 to your deposition is the special master's report and recommendation in a case involving the '177 patent. 12:54:24 12:54:27 12:54:29 12:54:33

Let me know when you have that open, please. 12:54:34 12:54:36

A I have it open. 12:54:36

Q So if you could turn to Page 41 of the opinion. 12:54:37 12:54:40

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By the way, have you seen this opinion before? 12:54:42 12:54:44

A I don't think so. I mean, there have been a lot of documents and we've been doing this for quite a while, but I don't recall seeing it. 12:54:46 12:54:50 12:54:53

Q Okay. 12:54:55

A So what page do you want me to go to? 12:54:55

Q Page 41. Strike that. 12:54:57

Let me ask you this: Are you aware that with regards to the '117 patent there was a Markman hearing in the district court in Texas, a special master provided a claim construction for a matched filtering/correlating module, and the court adopted that construction. 12:55:00 12:55:02 12:55:05 12:55:11 12:55:16 12:55:20

Are you aware of that? 12:55:23

MR. MAGEE: Objection. Form. 12:55:24

A I think it -- I mean, I -- in my -- I mean, it's been a while since I've reviewed this part of it. But in my declaration I believe I did mention the various proposed constructions. And I'd have to check to be sure, but I think -- but I think this is it. 12:55:25 12:55:29 12:55:33 12:55:36 12:55:40 12:55:43

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Q So are you on Page 41 of Exhibit 3 now? 12:55:43
A Yes. 12:55:46
Q All right. And if you could look, it says, "Therefore, for the reasons described above, the undersigned finds that the term should be construed according to its plain and ordinary meaning, wherein the module samples an input signal at an aliasing rate." 12:55:47 12:55:49 12:55:52 12:55:54 12:55:56 12:56:01
Do you see that? 12:56:03
A Hold on. I was looking at the table. 12:56:06
Q It's right above it. Sorry. Do you want me to ask it again? 12:56:08 12:56:10
A Hold on, let me just find it. So -- 12:56:11
Q Well, let's back up. I just want to make -- I don't want you to think I'm not telling you the right stuff. 12:56:19 12:56:20 12:56:23
So let's back up real quick to Page 31, just so you can see what term was being construed. Okay? Page 31? 12:56:24 12:56:26 12:56:28
A Okay. Got it. 12:56:29
Q Now you see -- okay. So on Page 31 of Exhibit 3, you see that matched 12:56:30 12:56:33

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filtering/correlating module is being construed. 12:56:36

Correct? 12:56:40

Do you see that? 12:56:41

A Yes. And I just realized, now this has 12:56:41

jogged my memory, it would be easier if I could 12:56:43

see my own declaration. 12:56:46

But this table on Page 31, this is what I 12:56:47

was aware of. So I -- I was aware of the 12:56:50

plaintiff's proposed construction and the 12:56:56

defendant's proposed construction. And I'd have 12:56:58

to look in my -- in my declaration to see if I 12:57:00

also mentioned the other one. I just -- offhand I 12:57:03

don't remember. 12:57:06

Q So go back down to Page 41 and just make 12:57:06

sure it's the same section, just so you know this 12:57:11

is what the court construed. So right at the top 12:57:14

of 41, before the Section E. Maybe just look at 12:57:16

that. 12:57:21

A "So, therefore, for the reasons described 12:57:21

above, the undersigned finds that the term should 12:57:22

be construed according to its plain and ordinary 12:57:25

meaning, wherein the module samples an input 12:57:27

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signal at an aliasing rate." Okay. 12:57:31

Q Do you agree or disagree that a -- strike that. 12:57:34 12:57:43

Do you agree or disagree that a matched filtering/correlating module must sample an input signal at an aliasing rate? 12:57:48 12:57:52 12:57:58

A I agree with that. 12:58:03

Q All right. You can put that aside. All right. 12:58:04 12:58:10

MR. CHARKOW: So I'm going to hand -- give you another exhibit. 12:58:13 12:58:15

(Galton Deposition Exhibit 4 marked for identification and is attached to the transcript.) 12:58:15 12:58:31

Q So you've been provided with Exhibit 4 to your deposition, which is the Macnally patent. And that's U.S. Patent Number 7,065,327. 12:58:31 12:58:33 12:58:38

A Give me a second. 12:58:44

Got it. 12:59:00

Q Have you seen the Macnally patent before, Exhibit 4? 12:59:00 12:59:04

A I have. 12:59:05

Q So can you turn to Figure 3 of Macnally, 12:59:05

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please. 12:59:08

A Okay. Give me a second. I want to 12:59:15

rotate it so I can see it more clearly. 12:59:17

Okay. Got it. 12:59:19

Q You've seen Figure 3 of Macnally before. 12:59:20

Right? 12:59:22

A I have. 12:59:23

Q So Macnally, on the right side we see it 12:59:23

says, Anti-aliasing filter. 12:59:25

Do you see that? 12:59:28

A I do. 12:59:28

Q And each one of those separate, I don't 12:59:29

know, different -- strike that. 12:59:31

The anti-aliasing filter includes two 12:59:32

differential amplifiers. Correct? 12:59:36

MR. MAGEE: Objection. Form. 12:59:38

A Yes, there -- there -- the name for those 12:59:39

two identical structures are called biquads, so it 12:59:42

has two biquads. And each biquad performs not 12:59:46

only differential amplification but also 12:59:50

differential -- but also filtering. 12:59:52

Q So the biquads, another name for biquads 12:59:56

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are differential amplifiers. Correct? 13:00:00

MR. MAGEE: Objection. Form. 13:00:03

A A biquad typically does more than simply amplifying it. It performs low-pass filtering -- or filtering as well as amplifying. 13:00:04 13:00:09 13:00:13

Q So there are two structures shown in the anti-alias filter. Correct? 13:00:15 13:00:18

A Yes. 13:00:20

Q And each of those structures is a differential amplifier, and you say also acts as a low-pass filter. Correct? 13:00:20 13:00:25 13:00:29

MR. MAGEE: Objection. Form. 13:00:30

A Yes. 13:00:32

THE WITNESS: Sorry. 13:00:33

Q Correct? 13:00:35

A Correct. 13:00:36

Q And Macnally, on the left-hand side we see what is a mixer. Correct? 13:00:36 13:00:41

A Correct. 13:00:47

Q And Macnally shows a traditional Gilbert cell mixer. Correct? 13:00:47 13:00:53

MR. MAGEE: Objection. Form. 13:00:54

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A It is a Gilbert cell mixer, yes. 13:00:57

Q And Figure 3 of Macnally more 13:00:59

specifically shows a double-balanced mixer. 13:01:02

Correct? 13:01:06

A Correct. 13:01:07

Q And Macnally uses a 50-percent duty cycle 13:01:07

LO. Correct? 13:01:12

A It's actually slightly less than 50 13:01:18

percent. Because when you implement these things, 13:01:22

you typically want to -- you don't want both -- 13:01:25

you don't want any two transistors -- like, let me 13:01:31

back up. 13:01:35

So let's look at M5 and M6 for example. 13:01:35

So M5 in principle turns on when M6 turns off, and 13:01:39

vice versa. However, you don't want them to turn 13:01:44

on at the same time even briefly, because that -- 13:01:47

that is problematic as far as, you know, the 13:01:52

mixer's functionality. 13:01:58

So what's typically done is the -- the 13:01:59

crossing points of the LO are chosen in this case 13:02:03

to be relatively low so that one transistor turns 13:02:08

off before the other transistor turns on ever so 13:02:12

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slightly. So it's almost 50 percent but not quite. 13:02:16 13:02:19

Q Macnally uses a nominal 50-percent duty cycle. Correct? 13:02:19 13:02:23

MR. MAGEE: Objection. Form. 13:02:23

A I've given you my answer. I mean, it's designed such that the switches turn on for slightly less than 50 percent. 13:02:26 13:02:28 13:02:32

Q So you're telling me -- have you ever heard of a Gilbert cell mixer using 50-percent duty cycle? 13:02:34 13:02:40 13:02:43

A Yes, I have. But what I'm telling you is when you design them, you design it to be slightly less than 50 percent so that you don't have transistors turning on at the same time that you don't want to turn on at the same time. 13:02:45 13:02:47 13:02:51 13:02:54 13:02:57

Q Macnally -- so what percentage does Macnally use in a duty cycle, 49.9 percent? 13:02:58 13:03:01

MR. MAGEE: Objection. Form. 13:03:06

A It would be different based on how fast the transistors are, you know, what technology you're using. The -- it's not like you pick a 13:03:07 13:03:09 13:03:11

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percent and always choose that. You design the circuit such that you guarantee that one transistor turns off before the other. And you'd want to get as close to 50 percent as possible, subject to that constraint. And that constraint always puts you slightly below 50 percent. 13:03:14 13:03:17 13:03:21 13:03:23 13:03:26 13:03:28

Q So Macnally uses a duty cycle that is as close to 50 percent as possible. Correct? 13:03:30 13:03:33

A Subject -- 13:03:37

MR. MAGEE: Objection to the form. 13:03:38

A Subject to the constraint I just described. 13:03:39 13:03:41

Q So the answer is yes, subject to the constraint you just described. Correct? 13:03:41 13:03:44

A Yes -- 13:03:47

MR. MAGEE: Objects to form. 13:03:48

A Sorry. I'll try to add more delay. I'm sorry, I'm not good at that. 13:03:50 13:03:52

When you design these things you always try to design it -- or you always do design it so that one switch turns off before the other turns on. And that implicitly requires that the 13:03:58 13:04:00 13:04:03 13:04:05

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switches turn on for slightly less than 50 percent of the duty cycle. So I don't know how to answer it any more clearly than that. 13:04:09 13:04:11 13:04:14

Q Yeah, so I just -- I'm just seeking a yes or no, if you can answer yes or no or I don't know. Strike that. 13:04:16 13:04:31 13:04:33

So Macnally uses a duty cycle that is as close to 50 percent as possible. 13:04:33 13:04:37

Correct or incorrect? 13:04:39

MR. MAGEE: Objection. Form. Asked and answered. 13:04:41 13:04:42

A Yeah, I feel like I've answered this question. 13:04:44 13:04:46

Q You can answer it again. Go ahead. 13:04:46

A Okay. I'll give you the same answer. 13:04:48

The answer is that that is -- it is always going to turn on each switch for slightly less than 50 percent of the -- slightly less than 50 percent of the cycle because you want to prevent the two switches from ever being open -- closed at the same time. 13:04:50 13:04:54 13:04:58 13:05:01 13:05:04 13:05:08

And so -- so because of that, it's never 13:05:09

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50 percent, it's always a little less than 50 percent. And the percentage that we are below 50 percent is implementation-dependent. It depends on how fast the transistors are, and, you know, what the frequencies are and so forth. 13:05:12 13:05:15 13:05:18 13:05:21 13:05:24

Q I get it. But for Macnally, you're trying -- the point is you're trying to use a duty cycle that is as close to 50 percent as possible. 13:05:26 13:05:28 13:05:31

Correct? 13:05:34

MR. MAGEE: Objection. Form. 13:05:34

Q Given the restrictions that you mentioned? 13:05:36 13:05:38

MR. MAGEE: Objection. 13:05:39

A What do you mean by "as possible"? I mean, that's what I don't understand about your question. 13:05:40 13:05:42 13:05:43

I've told you -- I've given you a very specific answer, and it seems like you're trying to put words in my mouth. 13:05:43 13:05:46 13:05:48

I mean, if we wanted to make the duty cycle of -- if we wanted to make the duty cycle 50 percent, we could. It's just that in that case 13:05:50 13:05:52 13:05:55

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the circuit wouldn't function as well. And so -- 13:05:57

Q Right. You're saying how to implement it. And so I'm talking from an implementation point of view. 13:06:00 13:06:02 13:06:04

If you're the circuit designer, the point is, you're trying to get as close to 50 percent as possible. You're not trying to get close to zero percent or 5 percent. You're trying to get as close to 50 percent as possible, understanding you're not going to hit 50 percent. Right? 13:06:05 13:06:07 13:06:10 13:06:14 13:06:17 13:06:20

MR. MAGEE: Objection to form. 13:06:22

A So like I said, you want -- I mean, you would like to have the switch closed for as long as possible. The -- you know, in a perfect world, if the switches were ideal, which they're not, then you could -- you could get right up to 50 percent. 13:06:23 13:06:23 13:06:25 13:06:29 13:06:32 13:06:34

But -- but in order to design this and have it work well, you know, a designer would dial back a little bit from that, and it would be less than that. I don't know how to answer it more clearly than that. 13:06:36 13:06:39 13:06:45 13:06:47 13:06:49

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Q But the point being is that if you have an option between 5 percent duty cycle or 50 percent, you're trying to get as close as possible to 50 percent. You're not trying to get as close as possible to 5 percent. Right? 13:06:49 13:06:51 13:06:55 13:06:57 13:06:59

MR. MAGEE: Objection. Form. Asked and answered. 13:07:01 13:07:02

A Yeah, I feel like I've answered it. It's -- the problem with your question that I'm having, that is what the definition of "as possible" is. 13:07:03 13:07:06 13:07:08 13:07:12

Q Okay. 13:07:13

A And I've tried to answer that question by defining what "as possible" means by telling you what is actually done. And then you keep trying to back out and say, Well, generally we're trying to make it as close as possible. And whether the answer to that question is yes or no depends on how you define "as possible." 13:07:14 13:07:17 13:07:21 13:07:23 13:07:25 13:07:28 13:07:30

So I've tried to define "as possible" in the context of my answer. 13:07:32 13:07:34

Q Okay. That's fine. You can ask me to 13:07:35

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clarify and I'll clarify. 13:07:38

So you want -- with regards to Macnally, 13:07:39

you want the duty cycle to approach 50 percent. 13:07:41

Correct? 13:07:46

MR. MAGEE: Objection. Form. 13:07:46

A Again, what does approach mean? I 13:07:49

mean -- 13:07:53

Q It's plain English language. This is 13:07:53

plain English language. If I say I'm approaching 13:07:56

you, right, I'm coming up to you, I'm approaching 13:07:58

you, I'm getting closer to you. You understand 13:08:01

what "approach" means, right, in the plain English 13:08:03

language? 13:08:06

A And how close is approach? What's the 13:08:07

percentage? 13:08:09

Q Well, as a circuit designer, that's what 13:08:09

I'm asking you. You're trying to approach, you're 13:08:12

going towards 50 percent. I'm not putting a 13:08:14

specific percentage. I'm saying you're not 13:08:17

backing up; you're going towards it. Strike that. 13:08:20

With regards to Macnally, you're trying 13:08:22

to approach a 50-percent duty cycle. Right? 13:08:24

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That's -- you're trying to move towards that. 13:08:26
Right? 13:08:28
MR. MAGEE: Objection. Form. 13:08:28
A That's true, but you stop -- 13:08:29
THE WITNESS: Sorry, Bobby. Go ahead. 13:08:31
MR. MAGEE: Objection. Form. 13:08:33
A That's true. But as you approach it, you 13:08:37
stop at the point where if you went any further 13:08:39
you would have the possibility that the switches 13:08:41
would turn on simultaneously. 13:08:43
So it's true that you would like to have 13:08:45
the switches on, you know -- having the switches 13:08:47
on longer is beneficial. But you have to -- and 13:08:54
so, therefore, you would like to, in your words, 13:08:59
approach 50 percent. But you are forced to stop 13:09:02
short because you don't want those switches to 13:09:06
turn on at the same time. 13:09:08
Q The differential amplifiers shown in 13:09:09
Figure 3 of Macnally have matching input 13:09:12
impedances at their terminals. Correct? 13:09:17
MR. MAGEE: Objection to form. 13:09:19
A So can you hit me with that one more 13:09:22

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time? 13:09:26

Q Sure. Strike that. 13:09:26

The differential amplifiers shown in 13:09:28

Figure 3 of Macnally have matching input 13:09:30

impedances at their terminals? 13:09:33

MR. MAGEE: Objection to form. 13:09:35

A Can you define what you mean by 13:09:36

differential amplifier? 13:09:37

Q Sir, you've been doing circuits for a 13:09:41

long time. You can look at this diagram and know 13:09:43

what a differential amplifier is in the circuit. 13:09:45

You're telling me -- just to be clear, 13:09:47

because I read your declaration, you're telling me 13:09:49

you can't -- and this is a claim term in a patent. 13:09:52

And that's fine. If you say you don't know, 13:09:55

that's great, that's good for me. 13:09:56

You're telling me, looking at Figure 3, 13:09:59

you do not see any differential amplifiers? 13:10:01

MR. MAGEE: Objection to form. 13:10:04

A I do. But the problem is, I see multiple 13:10:05

things that could legitimately be called 13:10:07

differential amplifiers. 13:10:11

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I'm just trying to get you to pin down your question. So the op amps, the triangles, are differential amplifiers. Each biquad performs differential amplification. 13:10:11 13:10:13 13:10:16 13:10:17

So I don't know whether you're talking about the input to the differential operational amplifiers or whether you're talking about the input to the first biquad or whether you're talking about the input to the second biquad. 13:10:19 13:10:20 13:10:23 13:10:26 13:10:29

So all I'm asking you to do is just ask me clearly what your question is, and I'll do my best to answer it. I'm really not trying to be difficult; I'm just trying to be precise. 13:10:31 13:10:33 13:10:35 13:10:37

Q Okay. It's probably the same thing. All right. Strike that. 13:10:39 13:10:43

So with regards to the op amp, the triangle that has the plus and minus, the one on the left. Okay? 13:10:43 13:10:46 13:10:49

A Uh-huh. Yes. 13:10:50

Q Okay. The plus and minuses have matching input impedances. Correct? 13:10:52 13:10:56

MR. MAGEE: Objection. Form. 13:10:58

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A Okay. At the risk of upsetting you, I want to ask you to clarify it more. 13:11:00 13:11:03

So if we -- that triangle represents a circuit that isn't -- you know, that's implied by the triangle but not shown explicitly. 13:11:05 13:11:07 13:11:09

So if we take that -- you know, the circuit within that triangle in isolation and we look at its input impedance, the answer to your question is yes. 13:11:12 13:11:14 13:11:17 13:11:20

Q And the same answer with regards to the triangle on the right, I'll call it the second triangle, the plus and minus, the input impedances of the -- of the plus and minus terminals will be the same. Correct? They'll be matched? 13:11:24 13:11:25 13:11:28 13:11:32 13:11:38

A Again, it's exactly what I said before. So take my answer verbatim for that one as well. 13:11:40 13:11:45

Q And so why is the plus and minus of the op amp circuit, why are the input impedances matched? 13:11:47 13:11:55 13:11:59

MR. MAGEE: Objection to form. 13:11:59

A Because -- so again, the triangle represents a circuit. And that circuit is a fully 13:12:03 13:12:07

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differential circuit. And so it's designed to be symmetrical. It's designed to be symmetrical, you know, from -- on both -- with respect to both inputs and outputs. 13:12:10 13:12:14 13:12:21 13:12:25

May I just ask a clarifying question, though. When you said "matched," I assume you meant in this context equal to each other. Is that -- is that what you meant? 13:12:26 13:12:29 13:12:32 13:12:36

Q Correct. 13:12:37

A Okay. Then my answers stand. 13:12:38

Q So with regards to the triangle -- so just to be clear, the triangle, there's all sorts of circuitry inside of the triangle. Right? 13:12:40 13:12:44 13:12:46

A Yes. 13:12:49

Q And with regards to the plus and minus inputs, the input impedances are matched on those inputs. Correct? 13:12:49 13:12:51 13:12:58

A The -- the input impedances, looking into those input terminals, are equal to each other. 13:13:00 13:13:03

Q And the input -- so that the input is going to go into the gate of a MOSFET. Correct? 13:13:06 13:13:16

A That is correct. 13:13:19

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MR. MAGEE: Object to form. 13:13:20

Q And the gate of a MOSFET has a very high impedance. Correct? 13:13:20 13:13:25

A It has a very high resistance, and it's capacitive. So whether it's high or not depends on the frequency. But it's very high resistance. 13:13:27 13:13:32 13:13:36

Q So the gate of a MOSFET, which would be in that triangle shown in Figure 3, in both triangles, that would have a very high resistance. Correct? 13:13:40 13:13:44 13:13:49 13:13:51

A It would, when you take that triangle out of the circuit and look at it in isolation. 13:13:51 13:13:54

Q Okay. 13:13:59

A However, when you wrap it inside a feedback the way it's wrapped here, then the impedance at those nodes, the differential -- actually, the differential resistance of those nodes goes from being very, very high to very, very low. 13:14:00 13:14:02 13:14:04 13:14:08 13:14:09 13:14:12

Q So the let's just talk about the triangle itself without talking about the feedback. 13:14:13 13:14:19

A Can we make the stipulation that for the 13:14:20

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questions you're asking me we're talking about the op amp, the circuitry within the triangle, removed from the circuit and looked at in isolation? 13:14:23 13:14:25 13:14:28

Q I'll ask the questions like that. I'm going to ask the question specifically. Okay? To capture that. 13:14:30 13:14:32 13:14:36

A Okay. Sure. 13:14:37

Q All right. Strike that. 13:14:37

So the triangle, which is an op amp, has a plus and minus terminal. And there are -- there are gates of a MOSFET at those inputs. Correct? 13:14:40 13:14:45 13:14:51

MR. MAGEE: Objection to form. 13:14:55

A Usually that is the case. 13:14:57

Q And just looking at the op amp circuit itself, the gates of a MOSFET have a very, very high resistance. Correct? 13:14:58 13:15:01 13:15:05

MR. MAGEE: Objection to form. 13:15:07

A Yes. 13:15:09

THE WITNESS: Sorry, Bobby. 13:15:10

A Yes. But again, subject to the -- you know, the precondition that we're taking the op amp out of the circuit and looking at it in 13:15:11 13:15:15 13:15:17

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isolation. 13:15:20

Q Correct. 13:15:20

So my answer -- the answer is I'm correct 13:15:21

if we're taking the op amp and looking at it 13:15:23

outside of the rest of the circuit. Correct? 13:15:27

A Yes. 13:15:29

MR. MAGEE: Objection to form. 13:15:29

Q And then when you add the feedback 13:15:30

capacitor resistor, you're saying that that 13:15:34

reduces the resistance. Correct? Of the whole 13:15:40

circuit? 13:15:43

MR. MAGEE: Objection to form. 13:15:44

A It reduces the differential resistance. 13:15:46

Q And it's -- and what is -- is it the 13:15:51

resistor, the feedback resistor, that reduces the 13:15:57

resistance that would otherwise be there, or is it 13:15:59

the feedback capacitor that does that, or both? 13:16:03

MR. MAGEE: Objection to form. 13:16:07

A It's both, in that the act of introducing 13:16:08

feedback causes the differential resistance to -- 13:16:12

to go way down. So it's not that it's a resistor 13:16:16

or a capacitor; it's the fact that we've wrapped 13:16:21

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this high-gain amplifier inside of a feedback system. 13:16:24 13:16:27

Q If the input impedance at the plus and minus terminals of the op amp did not match, there would be an IQ imbalance. Correct? 13:16:32 13:16:37 13:16:43

MR. MAGEE: Objection to form. 13:16:47

A No, that's not correct. 13:16:54

Q So if you didn't match the plus and minus terminals of the op amp, you're saying there wouldn't be an IQ imbalance? 13:16:57 13:16:59 13:17:02

MR. MAGEE: Objection to form. 13:17:04

A Hit me with that question one more time. I want to make sure I'm fully understanding it. 13:17:11 13:17:13

Q So if you don't match the plus and minus terminals of the op amp in terms of their input impedance, you're saying there wouldn't be an IQ imbalance? 13:17:15 13:17:18 13:17:22 13:17:25

MR. MAGEE: Objection to form. 13:17:26

A No, there wouldn't, because each -- each one of these mixers works on either I or Q. They don't work on -- they don't simultaneously work on I and Q. 13:17:28 13:17:32 13:17:35 13:17:39

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So -- so if you had a mismatch between those impedances, that wouldn't necessarily give rise to an IQ imbalance. 13:17:40 13:17:46 13:17:52

Q If you had a mismatch between the impedances of the plus and minus inputs of the op amp, what problems would that cause, if any? 13:17:55 13:17:57 13:18:00

MR. MAGEE: Objection. 13:18:09

A It would -- 13:18:10

THE WITNESS: Sorry, Bobby. Go ahead. 13:18:11

MR. MAGEE: Objection to form. 13:18:13

You can answer. 13:18:14

A So it would have very little effect. Because as I mentioned, the feedback lowers that impedance a great deal. 13:18:16 13:18:22 13:18:25

So -- so it wouldn't -- it wouldn't cause a huge problem. 13:18:28 13:18:31

Q Would it cause any problems, not having the plus and minus -- strike that. 13:18:34 13:18:37

Would it cause any problems -- strike that. 13:18:38 13:18:40

Would any problems result by not matching the impedances of the plus and minus inputs to the 13:18:40 13:18:45

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op amp? 13:18:48

MR. MAGEE: Objection to form. 13:18:50

A You could -- you could get some 13:18:56

differential to common mode conversion and common 13:19:02

mode to differential conversion, you know, 13:19:07

which -- which would slightly degrade the 13:19:09

signal-to-noise ratio or signal-to-noise and 13:19:16

interference ratio of the system. But it wouldn't 13:19:19

be significant with -- you know, for the types of 13:19:22

mismatches we would expect in these kinds of 13:19:24

circuits. 13:19:28

MR. CHARKOW: All right. I think we've 13:19:28

been going for an hour. We can take a break. 13:19:29

Let's go off the record, please. 13:19:31

VIDEO SPECIALIST: We are going off the 13:19:33

record at 1:19. 13:19:34

(A recess was taken.) 13:19:36

VIDEO SPECIALIST: We are back on the 13:30:25

record at 1:30. 13:30:30

BY MR. CHARKOW: 13:30:33

Q A mixed -- strike that. 13:30:34

A mismatch of the input impedances of 13:30:36

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the -- of the plus and minus inputs of the op amp could result in signal distortion. Correct? 13:30:43 13:30:47

MR. MAGEE: Objection. Form. 13:30:51

A Result in signal distortion? 13:30:55

Do you mean nonlinear distortion, or what do you mean by "distortion"? 13:31:02 13:31:05

Q Any distortion, any signal distortion. 13:31:06

A I mean, it would be extremely minimal. But you could have -- so if the -- okay. Let me back up. 13:31:13 13:31:18 13:31:23

So again we're talking about a mismatch of the impedances at the terminals of the op amp when the op amp is taken out of the circuit. So if that -- if the answer to that is yes, then a mismatch between -- between the impedances of those plus and minus terminals would have extremely little effect. 13:31:25 13:31:28 13:31:33 13:31:36 13:31:41 13:31:43 13:31:46

But to the extent that it does have an effect, it could cause some common mode to differential mode conversion, which could cause the output to have some noise or interference coupled into it from, say, the supplies. 13:31:48 13:31:50 13:31:55 13:31:57 13:32:03

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And so -- so it -- we wouldn't normally call that distortion, but it would be a form of corruption. But in this type of circuit it would be extremely minor. 13:32:06 13:32:09 13:32:15 13:32:17

Q Okay. A mismatch of the input impedances of the plus and minus terminals of the op amp signal can degrade accuracy. Correct? 13:32:18 13:32:21 13:32:24

MR. MAGEE: Objection to form. 13:32:27

A Isn't that the same question you just asked me? 13:32:31 13:32:32

Q No. 13:32:33

A Can you -- can you read it -- can you ask me again, then. 13:32:35 13:32:37

Q Strike that. 13:32:38

A mismatch of the input impedances of the plus and minus terminals of the op amp can degrade accuracy. Correct? 13:32:39 13:32:42 13:32:46

MR. MAGEE: Objection to form. 13:32:48

A And are we considering the op amp, when you're talking about those -- those impedance mismatches, are we talking about the op amp taken out of the circuit and measured in isolation? 13:32:49 13:32:53 13:32:56 13:32:59

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Q Yes. 13:33:02

A Okay. In that case, it can cause a very minor reduction in accuracy. 13:33:03 13:33:09

Q Okay. A mismatch of the -- strike that. 13:33:11

A mismatch of the input impedances of the plus and minus terminals of the op amp can introduce gain error. Correct? 13:33:14 13:33:16 13:33:20

MR. MAGEE: Objection to form. 13:33:25

A Not necessarily. And to the extent that it did, it would be exceedingly minor. 13:33:29 13:33:32

Q A mismatch of the input impedances of the plus and minus terminals of the op amp can introduce phase error. Correct? 13:33:36 13:33:39 13:33:42

MR. MAGEE: Objection to form. 13:33:45

A What do you mean by "phase error"? 13:33:49

Q Anything that you understand to be phase error. 13:33:51 13:33:53

A Well, this is a baseband signal. And so there's no concept of -- well, the problem is I don't know how to -- how to interpret that question. 13:33:53 13:33:59 13:34:08 13:34:09

So any filter has a magnitude response 13:34:10

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and a phase response. And so any time you change the circuit by either altering components or changing -- you know, changing attributes such as going from perfect matching to imperfect matching, you are changing the phase response of the filter. 13:34:16 13:34:21 13:34:26 13:34:29 13:34:32

But it would be such a nonissue in this type of circuit that for all practical purposes and for the types of mismatches you would expect, it's just really a nonissue. 13:34:36 13:34:39 13:34:42 13:34:46

Q A mismatch of the -- strike that. 13:34:48

A mismatch of the input impedances of the plus and minus terminals of an op amp can degrade the ability to reject common mode signals. 13:34:55 13:34:57 13:35:02

Correct? 13:35:05

MR. MAGEE: Objection to form. 13:35:07

A That is true. But once again, we're talking about the impedance of the -- seen at the plus and minus terminals when the op amp is taken out of the circuit and looked at in isolation. And what you're saying is true, but it would be quite a negligible contributor to that problem. 13:35:12 13:35:15 13:35:19 13:35:23 13:35:25 13:35:29

Q A mismatch of the input impedances of the 13:35:31

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plus and minus terminals of an op amp can increase noise. Correct? 13:35:35 13:35:39

MR. MAGEE: Objection to form. 13:35:42

A I get that it's a different question, but my answer is still the same. 13:35:49 13:35:50

The answer is, in principle yes. But for the types -- you know, this is an integrated circuit where you -- where it's designed to match well. So that the level of mismatch that you get is typically well under a percent. And -- of the various properties of the transistors. And because of that, the effect you're describing, while could sometimes be there, is -- is pretty negligible. 13:35:51 13:35:57 13:36:00 13:36:02 13:36:06 13:36:11 13:36:13 13:36:17 13:36:20

Q Let me ask -- let me ask it a different way. I think this may help. Strike that. 13:36:21 13:36:24

A mismatch of the input impedances of the plus and minus terminals such that one terminal was a low resistance and one terminal was a very high resistance, can increase noise. Correct? 13:36:25 13:36:30 13:36:32 13:36:37

MR. MAGEE: Objection to form. 13:36:40

A Can you define "very low" and "very 13:36:41

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high"? 13:36:44

Q As you understand low and high in the 13:36:44

context of circuits. 13:36:46

A Well, in the context of this circuit, the 13:36:48

input resistance would be very high in both cases. 13:36:52

And, therefore, a slight mismatch in -- you know, 13:36:56

the level of mismatch that we would expect in this 13:37:00

type of circuit for resistance would have 13:37:03

essentially no effect. And the capacitive 13:37:05

component of the -- of the impedance would still 13:37:08

match quite well. 13:37:13

So because of that, when one is low and 13:37:15

one is high in the context of mismatches we would 13:37:18

expect in this context, what you're saying is 13:37:21

true; but the effect is usually negligible. 13:37:25

Q If the -- if -- strike that. 13:37:29

If there is a mismatch in input impedance 13:37:37

such that the negative terminal was in the order 13:37:39

of kilohms and the positive terminal was in the 13:37:47

order of megohms, would that introduce gain error? 13:37:50

MR. MAGEE: Objection to form. 13:38:04

A It would introduce gain error. Well, so 13:38:09

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let me back up for a second. 13:38:12

First of all, that would never happen in 13:38:14

this circuit. Those numbers would just -- just 13:38:17

would not happen the way we build these circuits. 13:38:20

So keep in mind that I am answering the question, 13:38:23

but I'm answering it with respect to a 13:38:25

hypothetical which isn't valid. 13:38:28

But with that as a preamble, the answer 13:38:30

to your question would depend on how much open 13:38:34

loop gain the op amp has. So if it has a very 13:38:38

high open loop gain, then that would mitigate the 13:38:44

effect. So I could make that gain in principle 13:38:46

high enough, you know, that it would -- it would 13:38:49

make that effect not significant. 13:38:54

But if you took Macnally's circuit as 13:38:58

designed, and you -- and you made such an 13:39:03

egregious change to it where you not only made 13:39:07

those resistances mismatched but you also made 13:39:11

both of them lower than the designed values for 13:39:15

the circuit, then it would not surprise me if it 13:39:18

reduced the gain and increased noise and so forth, 13:39:23

all the things you've been asking. 13:39:26

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But this is just something that would truly never happen for this type of circuit unless it was burned out or something. 13:39:27 13:39:29 13:39:32

Q Okay. If there was a mismatch in input impedances of the op amp circuit -- or the op amp such that the negative terminal was in the order of kilohms and the positive terminal was in the order of megohms, would this increase noise? 13:39:34 13:39:36 13:39:40 13:39:42 13:39:45

MR. MAGEE: Objection to form. 13:39:53

A Honestly, I'd have to sit down and analyze it. I mean, it wouldn't surprise me if it did. It wouldn't surprise me if it didn't. I would have to -- I would have to look at a specific circuit and perform a specific analysis, and I just haven't done that. And again, this is just something that literally would never happen. 13:39:54 13:39:56 13:39:59 13:40:03 13:40:04 13:40:07 13:40:09

Q So why would it literally never happen that you would have a mismatch, a significant mismatch, between the plus and the minus input terminals of an op amp? 13:40:11 13:40:13 13:40:15 13:40:20

A Well, what I said would never happen is your scenario of those -- of those numbers. 13:40:23 13:40:25

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The -- when you look into the -- in a typical op amp that you build in a CMOS process, what you said before, of it -- of the inputs feeding into the gates of MOSFETs is true. And gates of MOSFETs are almost purely capacitive, meaning they've got an exceedingly high resistive component. And so the impedance is almost entirely capacitive. 13:40:28 13:40:32 13:40:37 13:40:43 13:40:45 13:40:49 13:40:52 13:40:54

Especially in the process used by Macnally. In later IC technologies sometimes you can have gate leakage, in which case you can have a resistive component as well. 13:40:57 13:40:59 13:41:04 13:41:07

But anyway, in the context of Macnally, the -- the input impedance would be mostly capacitive. The resistive component would be very high. Excuse me. 13:41:09 13:41:14 13:41:18 13:41:21

So -- and, also, you build these circuits to be as symmetrical as possible and you lay them out to be as symmetrical as possible. So while you can have capacitive differences at those two inputs, you're really talking about differences that are typically less than a percent. 13:41:24 13:41:27 13:41:30 13:41:33 13:41:35 13:41:39

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And in the context of this circuit, again I haven't analyzed this specific question, but my belief -- and I could analyze it if I were asked to do so -- is that -- is that it would have a negligible effect on performance. 13:41:42 13:41:45 13:41:49 13:41:51 13:41:54

Q If you -- strike that. 13:41:55

If you -- strike that. 13:41:59

Would you ever design a circuit -- strike that. 13:42:01 13:42:04

Would you ever design a differential amplifier that had a, you know, an ohm or maybe even several kilohms on the negative input and, you know, in megohms in the positive input? 13:42:05 13:42:06 13:42:12 13:42:19

MR. MAGEE: Objection. Form. 13:42:30

A So can you stipulate whether we're talking about an op amp removed from the circuit, or are we looking at now the op amp within the circuit? 13:42:31 13:42:35 13:42:37 13:42:39

Q So let's start with the op amp removed from the circuit. Well, strike that. I'm talking about a differential amplifier. I'm talking about with circuit stuff around it. I'm not sure. 13:42:40 13:42:44 13:42:45 13:42:48

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You're saying a differential amplifier is just the op amp? I'm not sure we're on the same page there. So let me strike that. Let me ask it this way. 13:42:50 13:42:52 13:42:54 13:42:56

So just, if you're just looking at an op amp, the triangle, would you ever design an op amp that had a, you know, an input impedance or resistance of a few ohms or even up to, you know, kilohms, and then a positive input that has an input impedance of, you know, in the order of megohms? 13:42:56 13:43:02 13:43:05 13:43:13 13:43:19 13:43:24 13:43:27

A You would not do that. 13:43:29

Q And why wouldn't you do that? 13:43:30

A Because for this type of op amp you want everything above the center line to be as matched as possible to everything below the center line. And so when you design these op amps, you -- you design them with that in mind. You lay them out very symmetrically, and you try to make it so that the only mismatches you have are mismatches incurred during fabrication. Okay? 13:43:33 13:43:40 13:43:43 13:43:46 13:43:51 13:43:55 13:43:58 13:44:02

Now, additionally, you gave examples with 13:44:05

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resistances at the inputs. And the point that I made before is that when you take the op amp out of the circuit and treat it in isolation, you would like to have those resistances to be as high as possible. So you would never intentionally design an op amp to have low input resistances. 13:44:07 13:44:11 13:44:15 13:44:17 13:44:20 13:44:23

Q Now let's put the op amp in the context of the circuit that's shown in Macnally, as shown. Okay? 13:44:28 13:44:33 13:44:39

A Okay. 13:44:41

Q Would you ever design that circuit where the minus input was in the order of ohms or kilohms and the plus input was in the order of megohms? 13:44:41 13:44:46 13:44:55 13:44:59

A Okay. I'm a little worried you're going to get mad at me again, but I want to pin this down a little bit more. 13:45:01 13:45:03 13:45:06

So we're -- we're looking at the Macnally circuit. And let's take the first biquad. 13:45:07 13:45:13

And you're saying -- well, let's take the whole thing. But let's say we're looking at the -- at the resistance between the plus terminal 13:45:19 13:45:22 13:45:24

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and the minus terminal. Or are we looking at the resistance between the plus terminal at ground and the minus terminal at ground? 13:45:27 13:45:30 13:45:32

Yeah, so which is that? 13:45:35

Q Looking at the resistance of the gate of the MOSFET. 13:45:36 13:45:40

A With -- resistance has to be measured with respect to some -- to some -- any resistance has two terminals. So I need to know which terminals you want me to tell you about the impedance between. 13:45:41 13:45:43 13:45:47 13:45:50 13:45:54

Q Okay. Why don't you go -- why don't you do -- why don't you break it out and tell me for both. 13:45:55 13:45:57 13:46:00

MR. MAGEE: Objection to form. 13:46:00

A Okay. So we -- you're kind of asking me to ask myself the question and then answer it. So I'll -- why don't I start with asking myself the question, make sure you agree with that, and then I'll answer it. 13:46:06 13:46:10 13:46:12 13:46:15 13:46:17

Okay. So you said "do both." So one of your questions is, we're going to take the 13:46:18 13:46:20

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biquad -- I'm sorry, the anti-alias filter as shown in Macnally, running in normal operation, and we're -- and then the question is, what is the impedance between the positive terminal and ground and what is the impedance between the negative terminal and ground. And -- yeah, I think that was your first question. 13:46:24 13:46:29 13:46:32 13:46:39 13:46:42 13:46:45 13:46:48

Is that true? 13:46:49

Q Yeah. And if you make one really high, like one like an ohm or kilohm and the other one a megohm. 13:46:51 13:46:53 13:46:56

A Hold on a second. I asked a very specific question, and then you added stuff to it. 13:46:57 13:46:59

I tell you what. This isn't working. Why don't you just ask me specifically the question you want me to answer, and I'll be happy to answer. I know it sounds like I'm trying to be difficult. I swear I'm not. But the problem is, you know, circuit design is a very precise field. And so if you ask an imprecise question, it's very hard to answer. 13:47:02 13:47:03 13:47:05 13:47:08 13:47:10 13:47:12 13:47:15 13:47:18

Q Right. How many depositions have you 13:47:19

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given? 13:47:20

A I don't know the exact number, like four or five, maybe. 13:47:22 13:47:24

Q How many trials have you been to? 13:47:25

A Two, I think. 13:47:28

Q All right. So the -- if I'm looking at the first biquad. Okay? The first one. 13:47:28 13:47:35

A Uh-huh. Yes. 13:47:38

Q That's the one on the left. Right? 13:47:39

A Yeah. 13:47:41

Q Okay. The resistance that you see looking into the plus, okay, I want you to -- would you design a circuit where the input -- the resistance looking into the plus is in the order of kilohm or ohms or kilohms, and the resistance looking into the minus input is megohms. 13:47:42 13:47:44 13:47:48 13:47:50 13:47:53 13:47:58

A Okay. Again, I swear I'm not trying to be difficult. But the word "looking into" has a very specific meaning to it. So if you -- if you're talking about the impedance at that node with respect to ground, that's a different question than when you ask if you're looking at 13:48:02 13:48:06 13:48:08 13:48:11 13:48:13 13:48:15

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the impedance looking into that plus terminal. So I need to know which of those two you are asking about. 13:48:18 13:48:21 13:48:23

Q I just said looking into the terminals. I didn't say anything about ground. So why don't you start -- right? So I don't understand what the problem is. I didn't say anything about ground. 13:48:27 13:48:29 13:48:31 13:48:33 13:48:34

A Whenever you measure impedance, it's always with respect to two terminals. Okay? So I can look at the impedance looking into the positive terminal with respect to ground, or I can look at the impedance looking into the positive terminal with respect to the node at the minus terminal, or any other node, for that matter. But you have to tell me which two nodes you want me to talk about the impedance on. And then on top of that, when you talk about the impedance at a node with respect to ground, that is a different question than the impedance looking into some terminal with respect to ground. 13:48:35 13:48:41 13:48:43 13:48:45 13:48:49 13:48:51 13:48:56 13:48:59 13:49:01 13:49:04 13:49:07 13:49:09 13:49:13

Q Okay. So I would like you to tell me 13:49:15

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with regards to the first triangle on the left, 13:49:18
the op amp in Macnally, if you're -- would you 13:49:23
ever design a circuit looking -- where the 13:49:30
resistance looking into the plus is in the order 13:49:37
of kilohms relative to ground, and the resistance 13:49:40
of the negative input looking into it is in the 13:49:46
order of megohms relative to ground? 13:49:50
MR. MAGEE: Objection to form. 13:49:54
A If I were designing a fully differential 13:49:58
op amp for this purpose, there is no way I would 13:50:02
ever do that. 13:50:04
Q Okay. And the vice versa is true. If 13:50:05
you made the minus the ohms, you know, the 13:50:08
resistance ohms and the plus the megohms, you 13:50:14
would -- same answer. Right? 13:50:18
A Yes. 13:50:20
Q Okay. Now if I -- let's change it up. 13:50:20
Let's do that second scenario you said. Just get 13:50:26
this right. 13:50:31
A May I interject something here? 13:50:34
Q Not right now. Let me just finish this 13:50:36
before I lose my train of thought. 13:50:41

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A Okay.
Q I would like you to tell me, with regards to the first triangle on the left, so the op amp of Macnally, would you ever design a circuit where the resistance looking into the plus is in the order of kilohms relative to the minus, and the resistance of the negative input looking into it is in the order of megohms relative to the plus input?
MR. MAGEE: Objection to form.
A So when you -- when you measure resistance or impedance, you're always measuring between two terminals. So the question that you asked me before made sense because we were looking at the impedance looking into the plus terminal with respect to ground and the impedance looking into the minus terminal with respect to ground. And then you said, Well, would you make -- you know, would you ever make these different and you gave me numbers and I gave you the answer.
The problem that I am having now is that you are -- you are asking me if I look into the

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plus terminal with respect to looking into the minus terminal, and the minus terminal with respect to looking into the plus terminal, would I ever design it to be different. 13:52:04 13:52:05 13:52:07 13:52:10

And by definition, just mathematically, those are the same. Because -- because regardless, when you measure impedance between two terminals, which you always do, it's the same, you know, whether or not you swap the terminals. 13:52:13 13:52:16 13:52:20 13:52:22 13:52:26

So the answer, if I'm understanding your question correctly, is that not only would I not do that, but it would be impossible to do that, because you're -- the things that you're asking me -- or asking if I would ever make different are the same by mathematical law. 13:52:29 13:52:32 13:52:35 13:52:37 13:52:39 13:52:42

Q Okay. With regards to the circuit again on the left side shown in Macnally where you have that first op amp, the triangle there, would you ever design a circuit where the resistance looking into the plus is in the order of ohms or kilohms relative to any node, and the resistance of the negative input looking into it is in the order of 13:52:46 13:52:49 13:52:51 13:52:55 13:52:59 13:53:04 13:53:07

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megohms relative to any node? 13:53:10

MR. MAGEE: Objection to form. 13:53:14

Q Would you ever do that? 13:53:15

A I would have to analyze the circuit. 13:53:20

Because now you're -- now you're talking about the 13:53:22

circuit in situ. And -- well, actually, let me 13:53:24

think for one second. Give me one second. 13:53:29

I think I actually can answer it, but 13:53:35

just to be sure I answer the right question, can 13:53:37

you hit me with it one more time. 13:53:39

Q With regards to the circuit on the left 13:53:41

side shown in Macnally where you have that first 13:53:45

op amp, the triangle there, would you ever design 13:53:48

a circuit where the resistance looking into the 13:53:51

plus input is in the order of ohms or kilohms 13:53:53

relative to any node, and the resistance of the 13:53:58

negative input looking into it is in the order of 13:54:01

megohms relative -- also relative to any node? 13:54:04

MR. MAGEE: Objection to form. 13:54:10

A I'd have to analyze it carefully to be 13:54:18

sure, but I believe the answer is no. 13:54:20

Q Because it's poor circuit design. Right? 13:54:27

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MR. MAGEE: Objection to form. 13:54:30

A No, not because it's poor circuit design, but because I would -- there are a lot of nodes in this circuit. And to make sure -- to make sure of my answer, I literally would have to write out the equations and do the analysis. 13:54:33 13:54:37 13:54:39 13:54:42 13:54:44

So -- so my gut feeling is no. But I -- I'm leaving it somewhat tentative because -- because it's not something I've analyzed. And I would have to -- I'd have to analyze it carefully to be sure. 13:54:47 13:54:50 13:54:54 13:54:56 13:54:58

Q Your whole 30-plus year -- you've been working in this industry for probably 30 -- 25, 30 years. Right? 13:54:59 13:55:02 13:55:05

A Yeah, I'm an old guy. 13:55:06

Q So how long have you been working in this industry? 13:55:07 13:55:09

A Since -- well, depending on how you define it, since '92. 13:55:10 13:55:12

Q Have you ever designed an op amp circuit, meaning some circuit that has an op amp in it that's like shown in Macnally, where you would 13:55:14 13:55:18 13:55:22

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have a resistance looking into the plus in the order of ohms or kilohms relative to any node, and the resistance of the negative input looking into it in the order of megohms relevant to -- relative to any node? 13:55:27 13:55:30 13:55:33 13:55:36 13:55:39

Have you ever done that? 13:55:41

A Not intentionally. But the thing is, this is -- the question you're asking isn't a question that normally comes up during design because you're usually interested in impedance between specific nodes. And so you're asking me a question that is something I -- for this type of circuit I've never analyzed. 13:55:45 13:55:48 13:55:51 13:55:54 13:55:57 13:55:59 13:56:02

So my gut feeling is the answer to your question is no. But like I said, you know, to be absolutely sure, I would -- I would need to do the calculation. 13:56:04 13:56:07 13:56:09 13:56:14

So it's true I've worked on this type of circuit many, many times. And it's not that I'm not familiar with the circuit. I know exactly how to analyze it. It's just that the question you're asking from a -- and I don't mean this critically, 13:56:15 13:56:17 13:56:20 13:56:22 13:56:25

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but from an engineering point of view is so weird that it's not a question that a circuit designer would normally ask themselves, and I've never asked myself that. 13:56:30 13:56:32 13:56:34 13:56:37

So my gut feeling is the answer to your question is no. But to be absolutely sure, I would have to sit down and do a lengthy analysis and calculate the impedance from those points, looking into those points to every other node. 13:56:38 13:56:40 13:56:42 13:56:45 13:56:49

So my gut feeling is no, but I'm just not a hundred percent certain. 13:56:51 13:56:54

Q Sorry, sir. That wasn't my question. I asked have you ever designed a circuit like that, in your whole career. Not you have to analyze stuff or go back. But to your knowledge, sitting here today, in 30 years or longer, have you ever designed a circuit as I just described? 13:56:55 13:56:57 13:56:59 13:57:02 13:57:04 13:57:06

MR. MAGEE: Objection. Form. 13:57:08

A And my answer -- and again, I'm really not trying to be difficult. My answer is, to my knowledge, no. But because of the circuits I've designed -- I mean, I've designed, you know, 13:57:10 13:57:15 13:57:17 13:57:22

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literally this same type of circuit before. 13:57:24

And so your question presupposes that, 13:57:29

well, if you designed it, you would know the 13:57:33

answer. And my answer to you is, I wouldn't know 13:57:35

the answer because that's a question I would -- I 13:57:37

would not have asked myself, and -- during the 13:57:39

design process, and would not have verified. 13:57:42

So I have not intentionally designed 13:57:45

something to have that property. But in order to 13:57:47

see whether this circuit or other circuits that 13:57:48

I've designed happen to have that property, I 13:57:51

would need to sit down and -- and carefully 13:57:52

calculate the impedance or simulate the impedances 13:57:56

that you described. 13:57:59

Q All right. 13:58:00

A So it's just we -- as circuit designers 13:58:01

we never say, Okay, what's the impedance looking 13:58:03

into this terminal from every other node in the 13:58:06

circuit. It's just not something we do. So I 13:58:10

just don't have the answer for you without doing 13:58:13

calculations. I'm sorry. 13:58:16

Q Let me ask you this question. Strike 13:58:17

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that. 13:58:19

Have you ever designed a circuit 13:58:19

intentionally where you have an op amp in the 13:58:22

circuit like shown in Macnally, and where the 13:58:26

resistance looking into the plus side is in the 13:58:30

order of ohms or kilohms and the resistance of the 13:58:33

negative input looking into it is in the order of 13:58:36

megohms? 13:58:40

MR. MAGEE: Objection. Form. 13:58:41

A With respect -- 13:58:43

THE WITNESS: Sorry, Bobby. 13:58:45

Q Intentionally. 13:58:46

A So again, when you talk about impedance, 13:58:47

you have to specify two terminals. Are you 13:58:49

talking about impedance with respect to ground? 13:58:51

Q Yes. 13:58:53

A Okay. I think you asked that question 13:58:53

already and I have answered it. And the question 13:58:55

is, no, I would never -- I would never 13:58:57

intentionally do that for a circuit like this. 13:58:59

Q Okay. Tayloe is a sampling mixer. 13:59:01

Correct? 13:59:04

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Strike that. 13:59:04

You're familiar with Tayloe. Correct? 13:59:05

A I am. 13:59:07

Q And Tayloe has sampling -- is a sampling mixer. Correct? 13:59:07 13:59:09

A It performs sampling. 13:59:11

Q Right. Well, okay. Tayloe has a mixer that performs sampling. Correct? 13:59:13 13:59:15

A Yes. 13:59:17

Q And Tayloe -- strike that. 13:59:17

Tayloe does not disclose the use of a Gilbert cell mixer. Correct? 13:59:22 13:59:24

MR. MAGEE: Objection. Form. 13:59:26

A That is correct. 13:59:28

Q And Tayloe doesn't disclose the use of a double-balanced mixer. Correct? 13:59:28 13:59:31

MR. MAGEE: Objection. Form. 13:59:34

A Let me just -- let me just go to Tayloe. Let's -- 13:59:36 13:59:40

Q I can -- I don't know if I gave you that. Oh, I gave you that already. So let's mark that as Exhibit 5. So strike that. 13:59:40 13:59:43 13:59:46

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You've been provided with Exhibit 5 to your deposition, and that's the patent to Tayloe. 13:59:53 13:59:55

(Galton Deposition Exhibit 5 marked for identification and is attached to the transcript.) 13:59:55 13:59:58

Q And that's U.S. Patent Number 7, -- strike that. 13:59:58 14:00:03

You've been provided with Exhibit 5 to your deposition, which is U.S. Patent Number 6,230,000, to Tayloe. 14:00:03 14:00:05 14:00:08

Do you have that in front of you? 14:00:11

A I do. 14:00:13

Q Okay. So strike that. 14:00:13

Tayloe is not a -- strike that. 14:00:19

Tayloe does not use double-balanced mixers. Correct? 14:00:22 14:00:26

A Their preferred embodiments do not. I shouldn't say "preferred." Their embodiments do not in the specification. But -- but that doesn't -- but that doesn't mean the -- that you couldn't do that and satisfy the claim. It's just that their specific embodiments do not. 14:00:28 14:00:30 14:00:32 14:00:34 14:00:39 14:00:41

Q Sir, listen to my question. I just need 14:00:45

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you to answer the question asked. I don't -- I know you're a super smart guy. You've been doing this for a long time. I'm sure you could think of all sorts of ways to make things work or not work. Just listen to the question, and just answer the question that I asked. Strike that. 14:00:47 14:00:50 14:00:50 14:00:55 14:00:57 14:00:58

Tayloe does not use double-balanced mixers. Correct or incorrect? 14:00:59 14:01:01

MR. MAGEE: Objection to form. 14:01:02

A The embodiments shown do not use double-balanced mixers. 14:01:04 14:01:07

Q And nowhere in Tayloe is there any disclosure of the use of double-balanced mixers. 14:01:09 14:01:11

Correct? 14:01:14

MR. MAGEE: Objection. Form. 14:01:14

A The specification in its description of the embodiments does not mention double-balanced mixers one way or the other. 14:01:17 14:01:21 14:01:25

Q Tayloe uses 25-percent duty cycle. 14:01:26

Correct? Strike that. 14:01:31

Tayloe uses an LO with a 25 percent duty cycle. Correct? 14:01:33 14:01:37

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MR. MAGEE: Object to form. 14:01:38

A Some of the embodiments -- yeah, it does. 14:01:39

Yes. 14:01:41

Q Did you perform any simulations of the 14:01:41

Tayloe circuit ever? 14:01:45

A I did not. 14:01:48

Q Did you perform any simulations of Figure 14:01:48

3 of Tayloe? 14:01:52

A Well, I think that's subsumed by my 14:01:56

previous answer. But no, I have not simulated 14:01:57

Tayloe. 14:02:00

Q Just bear with me. 14:02:00

Did you perform any simulations of Figure 14:02:02

6 of Tayloe? 14:02:04

A Give me a second to look at Figure 6. 14:02:08

No. 14:02:16

Q If you look at -- so if you look at 14:02:16

Figure 3 of Tayloe, please. Let me know when 14:02:19

you're there. 14:02:24

A I'm there. 14:02:25

Q All right. You see the elements marked 14:02:25

50 and 52? 14:02:29

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Do you see that? 14:02:30

A Let me just rotate. I thought I just 14:02:31

accidentally clicked my screen and it went away. 14:02:34

Let me just rotate it so I can see it more 14:02:38

clearly. 14:02:41

Okay. Go ahead. 14:02:42

Q Okay. You see the elements 50 and 52? 14:02:43

They're dashed boxes? 14:02:47

A I do. 14:02:48

Q Okay. And 50 and 52 are amplifiers. 14:02:49

Correct? 14:02:52

A They are. 14:02:52

Q And what type of amplifiers are 50 and 14:02:53

52? What would you call them? 14:02:56

A I would call them -- well, the -- the 14:02:59

terminology for this type of circuit is a 14:03:05

little -- a little fuzzy in the literature. 14:03:09

They -- they differentially amplify their inputs. 14:03:12

I mean, they amplify the difference between their 14:03:17

inputs. So some people call them a differential 14:03:20

amplifier. 14:03:20

But that's to be distinguished from a 14:03:20

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fully differential amplifier, where the input impedances are matched, and there are two of them, like this -- but this doesn't have matched input impedances -- and the output is fully differential, meaning the output signal is represented as -- you know, via two wires, voltages on two wires. 14:03:21 14:03:25 14:03:29 14:03:32 14:03:35 14:03:38 14:03:42

Q All right. So is it fair to say that the amplifiers 50 and 52 in Tayloe are not fully differential amplifiers? 14:03:43 14:03:45 14:03:48

A That is correct. 14:03:49

Q And but it's also fair to say that the amplifiers 50 and 52 are a type of differential amplifier, in your opinion? 14:03:50 14:03:54 14:03:58

MR. MAGEE: Objection to form. 14:04:00

A Yeah. I mean, in that it amplifies the difference between the two inputs, you could say it's a differential amplifier; it's just not fully differential. 14:04:06 14:04:11 14:04:14 14:04:18

Q Okay. So in Tayloe there is -- Tayloe references -- discusses voltages. Can you point me to anywhere in Tayloe that it refers 14:04:18 14:04:24 14:04:27

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specifically to energy or current? 14:04:29

MR. MAGEE: Objection. Form. 14:04:37

A I'd have to -- I mean, I'd have to read through it carefully. Do you want me to do that? I don't -- I don't have a word-for-word memory of what's in the patent. 14:04:38 14:04:41 14:04:43 14:04:45

Do you want me to take the time to read the patent? 14:04:47 14:04:48

Q I would like to you tell me what you know based on, you know, your extensive analysis of Tayloe across at least two cases. I would like you to tell me, are you aware, sitting here, if there's any mention whatsoever of energy or current in Tayloe? 14:04:49 14:04:51 14:04:54 14:04:58 14:05:00 14:05:04

MR. MAGEE: Objection. Form. 14:05:06

A Well, definitely -- it definitely talks about current charging up those capacitors. And any time you charge a capacitor, you're storing energy on that capacitor. 14:05:07 14:05:09 14:05:13 14:05:18

So I -- the question you just asked me now is different than what you asked before. You said is there any mention. And I would have to go 14:05:19 14:05:21 14:05:23

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look and look at the exact wording to give that you answer. 14:05:25 14:05:27

But in terms of what's disclosed in the patent, for sure it talks about, either directly or indirectly, energy being stored on those capacitors because it talks about the capacitors charging and discharging. And it talks about, you know, the integration effect. And that all involves storing energy on a capacitor. 14:05:27 14:05:30 14:05:32 14:05:35 14:05:38 14:05:41 14:05:43

Q Are you aware of the term -- the terms "energy" or "current," those words, being used anywhere in Tayloe? 14:05:45 14:05:49 14:05:52

MR. MAGEE: Objection to form. 14:05:54

A I would have to go through and read it carefully to tell you whether those words are literally mentioned. 14:05:56 14:05:58 14:06:01

But they talk about quantities, you know -- you know, current. You know, they talk about current, and they talk about the current going into the capacitors. And, also, they talk about those capacitors and that our filter resistor in this case forming an RC filter. And 14:06:03 14:06:07 14:06:09 14:06:12 14:06:15 14:06:22

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the only way any of that happens is if energy is stored on those capacitors. 14:06:25 14:06:28

The only purpose of a capacitor at the end of the day is to store energy. And that property is used to achieve a lot of functions. But if you don't allow a capacitor to store energy, it might as well not be there. 14:06:29 14:06:31 14:06:36 14:06:39 14:06:43

Q Sir, I move to strike as nonresponsive. Listen my question very carefully. All I said, simply, is, are you aware, sitting here right now, of whether the terms "energy" or "current" are actually used in Tayloe, yes or no? 14:06:45 14:06:47 14:06:50 14:06:52 14:06:56

MR. MAGEE: Objection to form. 14:06:58

A I've answered you. 14:06:59

THE WITNESS: Sorry, Bobby. 14:07:00

Q Show me where the term "current" is used. You said -- you're under oath. You said those words are used. 14:07:01 14:07:03 14:07:06

A I didn't say those words were used. 14:07:07

Q Okay. 14:07:09

A What I told you -- what I told you -- 14:07:09

Q That's what I asked. That's my question. 14:07:11

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Listen to my question, answer my question. That's it. I withdraw the previous question. 14:07:12 14:07:14

MR. CHARKOW: Whatever, Bobby. It's withdrawn. There's nothing else. 14:07:16 14:07:17

MR. MAGEE: Please not talk over each other, and let the witness finish his answer. 14:07:18 14:07:20

MR. CHARKOW: Well, I could say the same thing about the witness. 14:07:22 14:07:24

A I'll do my best. 14:07:25

Q So I'll start over. Okay. 14:07:26

Are you aware -- it's a yes-or-no question. Are you aware if there's anywhere in Tayloe where the words "current" or "energy" are used, yes or no? 14:07:29 14:07:31 14:07:33 14:07:37

MR. MAGEE: Objection. Form. 14:07:39

A I do not -- I am not aware, but I could -- I would have to reread the patent and do a -- do a search on those words. So I'm not aware, but I -- but that doesn't mean it's not there. I just -- I just -- you know, I'm just not aware. 14:07:40 14:07:44 14:07:46 14:07:50 14:07:52 14:07:55

Q Are you aware that Tayloe talks and uses 14:07:55

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the term "voltage" a lot? 14:08:00

MR. MAGEE: Objection to form. 14:08:03

A My answer is the same. I -- in order to tell you what specific words are used in Tayloe, I would have to go through and reread it. It's -- the voltages and currents, you know, are certainly described. I just don't know exactly what words they use. 14:08:09 14:08:12 14:08:16 14:08:19 14:08:24 14:08:26

So, you know, when they talk about a low-pass filter that operates, you know, with a voltage across it and a current going through it, these things are implied. I just don't remember the exact wording of the patent. And I'm happy to go back and read it and answer your question specifically. But I just -- you know, I just don't have the text of the patent burned into my brain. 14:08:27 14:08:30 14:08:35 14:08:38 14:08:40 14:08:42 14:08:45 14:08:48 14:08:52

I understand how it works and I can answer any question about how it functions. But I just can't remember specifically the wording of the patent in every respect. 14:08:52 14:08:55 14:08:57 14:09:00

Q Are you finished? 14:09:01

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A Yes. 14:09:03

Q Okay. Great. Strike that. 14:09:03

What is signal-to-noise ratio? 14:09:05

MR. MAGEE: Objection to form. 14:09:10

A Well, like many of your questions, we need to put it in context. But if you're talking about the output of a circuit, typically there's some desired signal component, and there's -- there are unwanted signal components. And loosely speaking, signal-to-noise ratio is often defined as the power of the desired component over the bandwidth of interest divided by the power of everything else over the band of interest. 14:09:12 14:09:14 14:09:16 14:09:21 14:09:24 14:09:28 14:09:32 14:09:37 14:09:41

Now, there is some variability in meaning. Sometimes we talk about noise and distortion. So then sometimes you will have signal-to-noise ratio referring to just the noise portion of the unwanted component. And then signal to noise in distortion ratio refers to both the unwanted noise and distortion components. 14:09:44 14:09:49 14:09:51 14:09:54 14:09:57 14:10:02 14:10:07

So -- so purely speaking, you would say signal-to-noise ratio is the power of the desired 14:10:11 14:10:13

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signal, divided by the power of the noise component of the unwanted part over the bandwidth of interest. 14:10:16 14:10:21 14:10:23

Q So signal-to-noise ratio is a power of the desired signal divided by the power of the noise component of the unwanted part over the bandwidth of interest. Correct? 14:10:25 14:10:28 14:10:32 14:10:34

A That is -- that is one of two ways the term is used. 14:10:35 14:10:38

Q Okay. 14:10:39

A So I described both ways. 14:10:40

Q How it -- and how would you explain the other way to an undergrad student that was taking your course for the first time? 14:10:42 14:10:45 14:10:50

MR. MAGEE: Objection to form. 14:10:51

A I just described it. 14:10:53

Q That's how you would describe is it to an undergrad student? 14:10:54 14:10:56

A I gave you two definitions that are widely used. And I gave them in the form that I would tell an undergraduate circuit student. 14:10:58 14:10:59 14:11:02

Q Okay. Strike that. 14:11:05

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Did you calculate the signal-to-noise ratio of Tayloe's circuit? 14:11:09 14:11:11

A No. 14:11:18

Q Have you ever calculated the signal-to-noise ratio of Tayloe's circuit, any of the circuits shown? 14:11:18 14:11:20 14:11:22

A It is not possible to do so because no values have been given and no frequencies have been specified. 14:11:23 14:11:26 14:11:30

And so -- so without knowing the power of the signal, and without knowing the values of the components, there is simply no way to do what you're asking. 14:11:31 14:11:36 14:11:40 14:11:43

Q Do you believe it's possible to simulate Tayloe or it's not possible because you don't have the necessary values? 14:11:43 14:11:46 14:11:49

A It's certainly possible. 14:11:50

MR. MAGEE: Objection. Form. 14:11:51

THE WITNESS: Sorry. 14:11:52

MR. MAGEE: Objection. Form. 14:11:54

You can answer. 14:11:55

A It's -- if I make design decisions and 14:11:57

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choose values for the components, and I choose an input power for the signal, then, yes, I can calculate it. 14:12:02 14:12:06 14:12:09

Q But just using Tayloe, what's disclosed in Tayloe, it's not possible to simulate Tayloe. 14:12:10 14:12:13

Correct? 14:12:17

MR. MAGEE: Objection to form. 14:12:21

A Can you hit me with that again? I just want to make sure I'm answering it right. 14:12:23 14:12:25

Q Just using what's in Tayloe, only using what's -- the information provided with Tayloe. You're not making any other assumptions or putting anything else in there. It's not possible to simulate Tayloe. Correct? 14:12:27 14:12:29 14:12:31 14:12:33 14:12:35

A That is correct. 14:12:37

Q Okay. 14:12:37

A May I add something to that, though? 14:12:43

Q Not right now. 14:12:45

Let's go to the amplifier circuit in Tayloe. Okay? So this is the -- strike that. And we're still on Figure 3. And we're talking about, let's look at the triangles that are in 14:12:48 14:12:54 14:13:06 14:13:09

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Boxes 50 and 52. Okay? 14:13:14

A Okay. 14:13:17

Q Okay. The op amp circuits by themselves are high-impedance loads. Correct? 14:13:17 14:13:26

A Again, we've got to nail down your question a little bit more to be precise. What do you mean by a high-impedance load? 14:13:31 14:13:33 14:13:36

Q Well, what do you understand -- okay. What do you understand a high-impedance load versus a low-impedance load to be? 14:13:38 14:13:40 14:13:42

MR. MAGEE: Objection to form. 14:13:44

A Well, a load -- a load is something we're driving. So are you asking me whether if we take the op amp out of the circuit and we look at the impedance with respect to -- of the minus terminal with respect to ground and we get a certain impedance and we look at the impedance with the positive terminal with respect to ground we get another certain impedance, and are you asking me whether I would expect those impedances to be high? 14:13:45 14:13:48 14:13:50 14:13:52 14:13:56 14:13:58 14:14:00 14:14:03 14:14:04 14:14:06

Q Yes. 14:14:06

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A So the resistance would be very high, typically. And the -- and the impedance would be mostly capacitive. So -- so the impedance would change as a function of frequency. And at low frequencies it would be very high, and at high frequencies it would be lower. 14:14:07 14:14:09 14:14:12 14:14:17 14:14:19 14:14:21

Q But even at low frequencies it would still be a high impedance load. Right? 14:14:23 14:14:25

A Typically yes. 14:14:28

Q So regardless of what frequencies you use with that op amp circuit that's shown in Box 50 and 52, which is that triangle, if you pulled that out, regardless of what frequency you use, you would have a high-impedance load. Correct? 14:14:28 14:14:31 14:14:34 14:14:38 14:14:41

MR. MAGEE: Objection to form. 14:14:43

A I mean, I've answered this question. And your wording is too loose for my taste. So I can -- you can either refer back to my previous answer or I'll give it again if you'd like. 14:14:47 14:14:53 14:14:56 14:14:58

Q Yeah, I just want to know if it's high impedance or not high impedance. Strike that. 14:15:00 14:15:03

I just want to know if those -- what's 14:15:05

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shown in Tayloe, if you pulled those op amp circuits out and regardless of what frequency you put, used, they would be high impedance? 14:15:08 14:15:12 14:15:16

MR. MAGEE: Objection to form. 14:15:18

A Not -- not regardless of what frequency you use it. If you used a high frequency they would -- they could be very low -- low impedance. 14:15:20 14:15:21 14:15:24

And again, we're talking about impedance with respect to ground. So if you put a very high frequency signal into the -- into either of those terminals, those capacitors would start looking like shorts, and it would be low impedance. So at low frequencies the impedance -- impedances of those two terminals with respect to ground when the -- when the circuit is taken -- when the triangle is taken out of the circuit and evaluated in isolation, they would be high at low frequencies, and the -- and the impedance would go down as the frequency is increased. 14:15:29 14:15:30 14:15:33 14:15:37 14:15:40 14:15:43 14:15:46 14:15:50 14:15:53 14:15:56 14:15:58 14:16:00

Q What's the frequencies that's used in Tayloe? 14:16:04 14:16:07

A They don't -- they don't specify 14:16:08

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frequencies.
Q What frequency would you use if you wanted to model Tayloe?
MR. MAGEE: Objection. Form.
A Well, I haven't -- I haven't modeled Tayloe, so I don't -- I'd have to think about it.
But what I would do is I would -- I would -- you know, Tayloe is directed toward -- look, it can be used generally, but they mention single side band modulation.
And so I guess what I would do is I'd look at single side band modulation applications, and I'd pick a frequency range which is consistent with that. You know, just if I had no other guidance. And then I would look at the bandwidth, you know, look at what RF frequencies are at, what the bandwidth of the signal is, and then I would -- you know, that would determine it.
But you know, again, I haven't done what you're asking. So I'd really need to think about what exactly I would do. But that's the starting point I would -- I would take.

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Q So if you look at Box 50, which is the amplifier circuit, and you look at that feedback resistor. 14:17:20 14:17:23 14:17:27

Do you see that? 14:17:27

A I do. 14:17:28

Q And so when I was talking about the feedback resistor, that's the resistor that kind of loops over the top of the op amp. Correct? 14:17:28 14:17:30 14:17:32

A Yes. 14:17:35

Q Okay. And that's known as a compensation resistor. Correct? 14:17:35 14:17:38

A Known as a what? 14:17:40

Q Compensation resistor? 14:17:41

A No, it's not known as a compensation resistor. 14:17:43 14:17:45

Q Okay. Is it used as a compensation resistor in this circuit? 14:17:45 14:17:47

A No. 14:17:48

Q No. Okay. 14:17:48

Did you ever hear of a 741 series op amp? 14:17:52

A I have. 14:17:55

Q And you're aware that a 741 series op amp 14:17:55

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was one of the most widely used op amps at the time of the, you know, late '90s? 14:17:58 14:18:03

You're aware of that. Right? 14:18:07

MR. MAGEE: Objection. Form. 14:18:08

A I'm not aware of that. It was certainly a widely used op amp when I was in the college in the early '80s. But I can't speak to how widely it was used. But certainly by the time of the priority date and certainly by the time of this patent there were much better op amps available than the 741. 14:18:09 14:18:11 14:18:13 14:18:19 14:18:22 14:18:27 14:18:31

The 741 was like one of the first op amps that was -- you know, that had -- that worked well as an op amp. But by the time this came along it was really outdated. I mean, it's possible that it was still widely used. I can't speak to that, but it was certainly outdated by that time. 14:18:32 14:18:35 14:18:37 14:18:42 14:18:44 14:18:47

Q So let's look again in the box that's labeled 50 and 52 and the op amp component of it, the triangle. 14:18:49 14:18:52 14:18:58

Do you see that? 14:18:58

A Yes. 14:18:59

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Q There is no feedback resistor on the bottom around the plus terminal. Correct? 14:19:00 14:19:05

A That is correct. 14:19:09

Q And so the plus terminal will have high resistance or high impedance. Correct? 14:19:10 14:19:16

MR. MAGEE: Objection. Form. 14:19:18

A To the extent -- 14:19:19

THE WITNESS: Sorry, Bobby. 14:19:20

A To the extent that the op amp's positive terminal has high impedance, then that is true. 14:19:23 14:19:29

Q Well, let's just be clear. The op amp circuit in the circuit will have a MOSFET -- strike that. 14:19:33 14:19:35 14:19:39

The input into the positive terminal will be to the gate of a MOSFET. Correct? 14:19:39 14:19:44

MR. MAGEE: Objection to form. 14:19:47

A So generally, yes. But for the 741 example you gave, I think they used bipolar junction transistors. So, you know, at the time of Tayloe it's not necessarily true. 14:19:51 14:19:53 14:19:56 14:19:59

Q The one you said you're not sure if it's used or you're not sure if it was used at that 14:20:02 14:20:06

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time, now you're relying on it. Right? 14:20:08

A No, I'm not. 14:20:11

MR. MAGEE: Objection to form. 14:20:11

A I'm just -- I'm just trying to be precise. And, you know, I know you seem to think I'm being difficult. And I'm really not trying to be difficult. But I want to be -- 14:20:13 14:20:15 14:20:18 14:20:20

Q You don't have to keep saying those words. 14:20:23 14:20:24

A What's that? 14:20:25

Q You don't have to keep saying those words. Did you ever hear when someone says something a lot it's kind of an indication of actually what's going on? So what I'm saying is maybe you don't have to give me the reason and say, I'm trying to not be difficult. To me that's kind of telling. But people usually don't have to say it when they're not being something. So why don't we just stick with, you know, just answer my questions and that's it. I don't need a whole -- 14:20:25 14:20:27 14:20:30 14:20:32 14:20:33 14:20:35 14:20:38 14:20:40 14:20:42 14:20:45

A Although, with respect, I would ask that you stop trying to read my mind or psychoanalyze 14:20:47 14:20:50

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me. 14:20:53

Q Okay. 14:20:53

A But in any case, you asked me whether the input would be going into -- into the gate of a MOSFET. And what I told you was that not all op amps that you buy off -- or what I meant was, not all op amps that you buy off the shelf, especially at the time of Tayloe, were CMOS op amps. And as an example, the 741, which I don't know whether it was widely used at the time but I'm sure it was still used, although there were better options available, that as an example has bipolar junction transistors that you would be looking into the base of. Excuse me. So -- 14:20:54 14:20:57 14:21:00 14:21:06 14:21:09 14:21:13 14:21:18 14:21:21 14:21:23 14:21:26 14:21:29 14:21:32

Q Are you aware that the 741 has -- typically uses 2 million ohms, or 2 megohms? Are you aware of that? 14:21:35 14:21:38 14:21:44

MR. MAGEE: Objection. Form. 14:21:45

A Not offhand. But it wouldn't surprise me, just because the -- you're not looking into a MOS transistor. I mean, I'd have to look at it to be sure. But I'm -- you know, like I'm -- the 14:21:47 14:21:50 14:21:56 14:21:59

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last time I used the 741 op amp I was a young guy, I was in college. But I'm about 95 percent sure that it was a bipolar junction transistor IC technology. And if that's the case, then it would not surprise me if -- if the impedance was in the megohm range. 14:22:02 14:22:06 14:22:10 14:22:17 14:22:19 14:22:25

Q Okay. So let me ask you this: With regards to the op amp shown in Figure -- in the boxes 50 and 52, so as part of the amplifier, that plus input would be very high impedance. Correct? 14:22:26 14:22:29 14:22:32 14:22:37

MR. MAGEE: Objection to form. 14:22:42

A I feel like I've answered this question so many times. 14:22:44 14:22:46

At -- for a typical op amp, the resistive component of the impedance would be generally as high as they can make it, subject to the constraints of the technology they're using. And similarly for the capacitive component. 14:22:47 14:22:52 14:22:56 14:22:59 14:23:01

However, once you get to a high-enough frequency the capacitor starts looking like a short, and so you end up having a low impedance at high frequencies. So that's the answer I gave you 14:23:05 14:23:07 14:23:11 14:23:13

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before, and that's the answer I'm giving you now. 14:23:16

Q The inverted and noninverted pin-ups of the op amps -- strike that. 14:23:18 14:23:22

So in the case of the plus input in the -- in Box 50 and 52, the input would go right into -- right into the gates of a transistor. 14:23:38 14:23:43 14:23:48

Correct? 14:23:53

MR. MAGEE: Objection to form. 14:23:53

A I'm sorry, can you hit me with that question one more time? 14:24:02 14:24:03

Q So in the case of the plus input in the box 50 and 52, the input would go right into the gates of a transistor. Correct? 14:24:04 14:24:08 14:24:12

MR. MAGEE: Objection to form. 14:24:14

A If it's a CMOS or BiCMOS integrated circuit technology that the op amp was implemented in, yes. If it's a bipolar technology, it would go into the base of a transistor, one or more transistors. 14:24:16 14:24:24 14:24:27 14:24:31 14:24:35

Q And are you aware that the 741 has -- uses -- has an input impedance of 2 kilohms? Sorry. Strike that. 14:24:35 14:24:37 14:24:42

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Are you aware that the 741 op amp has an input impedance of 2 megohm? 14:24:42 14:24:47

A I feel like -- 14:24:49

MR. MAGEE: Objection to form. 14:24:49

A I feel like I've answered that question. Well, I know I've answered that question already. 14:24:50 14:24:52

What I told you before, and my answer still is, that I haven't looked at the specifications of the 741 op amp for, like, something like 40 -- 40-something years, because it's something that I looked at in college and used I think as a summer intern, you know, at some place. 14:24:54 14:24:56 14:25:00 14:25:03 14:25:07 14:25:10 14:25:13

So even by the time I graduated, there were more advanced op amps available, so the 741 was not considered to be a state-of-the-art op amp. 14:25:13 14:25:17 14:25:19 14:25:23

That said, my vague memory of the 741 is it's a bipolar junction transistor op amp. And because of that, I -- it wouldn't surprise me if the input impedance was what you -- input resistance was what you quoted. But -- but I 14:25:23 14:25:26 14:25:29 14:25:32 14:25:35

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just, you know, without looking up the details, I can't say absolutely yes or no. But what you're saying does not -- would not surprise me, based on what I remember. 14:25:38 14:25:40 14:25:43 14:25:45

Q When you model the gate of a transistor, it is ideally infinite impedance. Correct? 14:25:46 14:25:49

A No. 14:25:52

Q Okay. If you model the gate of an ideal MOSFET, it would have infinite impedance, an ideal MOSFET? 14:25:52 14:25:57 14:26:01

A Define what you mean by "an ideal MOSFET." 14:26:02 14:26:04

Q Sir, you know what an ideal -- you've heard of the word -- okay. In your 40-year career, you've heard of an ideal MOSFET. Correct? 14:26:05 14:26:07 14:26:10

A So I'm resisting the urge to say I'm really not trying to piss you off, but let me explain why what you're asking is ambiguous. 14:26:13 14:26:16 14:26:19

So a MOSFET can be used as a switch, in which case an ideal MOSFET would literally be a switch that gets turned off and on. Or you can say that I'm going to model the MOSFET as having 14:26:22 14:26:24 14:26:28 14:26:31

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the DC behavior of an op amp but neglecting all capacitances. In which case, that would be a type of idealization. 14:26:40 14:26:45 14:26:48

And for both of those levels of idealization, then what you're saying is true. However, we also model transistors. We have what's called a hand analysis models, which are idealizations of MOS transistors where we include the idealizations of the capacitors and we include idealizations of the dependent current sources and idealizations of the resistances. And that model is an idealization because we're taking this highly nonlinear circuit and we're looking at only its ideal linear behavior. 14:26:49 14:26:52 14:26:55 14:26:59 14:27:03 14:27:08 14:27:12 14:27:15 14:27:18 14:27:21 14:27:25

So -- so once again, you're asking me this completely ambiguous question, and I'm simply trying to explain to you why I can't answer it unless you pin it down more. 14:27:27 14:27:29 14:27:33 14:27:35

Q So with regards to Tayloe, what is your opinion in terms of the type of FET that's used at the plus and the minus terminals of the op amp? 14:27:37 14:27:40 14:27:48

MR. MAGEE: Objection. Form. 14:27:51

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A It's not specified. 14:27:52

Q Did you provide any opinion in this case on that issue? 14:27:57 14:27:58

MR. MAGEE: Objection. Form. 14:28:01

A I did not -- I did not provide an opinion as to what type of transistors are used inside of that -- of those triangles. So if that's your question, my answer is no. 14:28:04 14:28:07 14:28:10 14:28:13

Q Then there is resistors. Before that op amp there's resistors. Do you see that, before each positive and minus terminal? 14:28:14 14:28:18 14:28:20

A I do. 14:28:22

Q Okay. And those resistors before the op amps, that simply adds more resistance. Correct? 14:28:22 14:28:25

MR. MAGEE: Objection. Form. 14:28:28

A That is true. 14:28:29

Q Right. Because the -- 14:28:30

A Actually, let's stop. 14:28:32

We're talking about to the positive terminals only. Right? 14:28:34 14:28:36

Q Yes, for the positive terminals only, sure. 14:28:38 14:28:41

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A Okay. So if your question is do the resistors driving the -- you know, preceding the positive terminals of those op amps add additional resistance to the resistances seen looking into the positive terminals, then the answer is yes. 14:28:41 14:28:44 14:28:47 14:28:50 14:28:52

Q Okay. What about for the negative terminals; does the resistor that's in series with whatever is in -- whatever is at that negative terminal, does that add more resistance because it's in series? 14:28:54 14:28:56 14:29:01 14:29:03 14:29:07

A Okay. Once again, I need to -- I need to ask you for clarification. 14:29:09 14:29:12

So if we talk about the resistance to ground at the node where the negative terminal is, that resistance is very low. In which case the resistor preceding it would increase that resistance. 14:29:14 14:29:18 14:29:22 14:29:26 14:29:29

However, if you talk about the resistance looking into the negative terminal, then the resistance looking into that resistor would actually be significantly lower than the resistor looking into the negative terminal. 14:29:30 14:29:32 14:29:37 14:29:39 14:29:41

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Q Okay. Is it true in general that resistors in series adds more resistance? 14:29:43 14:29:49

A If you have a circuit that could be represented as a resistance, and you put another resistor in series with it, then yes, the total resistance of that series combination is larger than -- than the first resistor by itself. 14:30:02 14:30:03 14:30:06 14:30:09 14:30:12

Q Have you ever heard of a compensation resistor in your whole career? 14:30:16 14:30:19

A I have. 14:30:20

Q What is a compensation resistor? 14:30:20

A Okay. So if you were to -- okay. So first of all, the -- the act of compensation refers to modifying a circuit, a feedback circuit, to make it more stable. So if you have a feedback circuit that oscillates or just rings when it's disturbed, those are usually, unless you're trying to build an oscillator, which we're not here, that's usually a very undesirable characteristic. 14:30:23 14:30:26 14:30:33 14:30:39 14:30:42 14:30:45 14:30:48 14:30:50

So the act of performing compensation is adding or changing components to make that undesirable property go away. 14:30:53 14:30:56 14:30:59

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So in the case -- so compensation resistors are very rarely used. But an example of a compensation resistor would be to take a resistor and tie it from that negative terminal to ground. And the -- the effect of that is to improve the so-called phase margin of the feedback system or gain margin in such a way that the system has improved marginal stability. 14:31:02 14:31:03 14:31:07 14:31:11 14:31:14 14:31:19 14:31:22 14:31:27

Q Can you go to your declaration, Page 62. 14:31:31

A Declaration for '177? 14:31:40

Q That's the only one I gave you, yes, for '177. 14:31:42 14:31:45

A Okay. 14:31:45

Q Page 62. 14:31:45

A Sixty-two. Hold on a second. 14:31:47

Q And particularly Paragraph 111? 14:31:58

A Okay, I am there. 14:32:00

Q Do you see the circuit in Paragraph 111 on Page 62? 14:32:01 14:32:03

A I do. 14:32:04

Q Did you ever simulate that circuit? 14:32:05

A Again, I feel like -- or I have answered 14:32:10

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this question. I have not simulated any circuits with respect to Tayloe. 14:32:12 14:32:14

Q Right. Well, just to be clear, this has a TI data sheet, you know, combined with Tayloe. So it's not Tayloe. Right? You understand that? 14:32:15 14:32:17 14:32:21

A Right. 14:32:23

MR. MAGEE: Objection. 14:32:23

A If I hadn't simulated anything to do with Tayloe, I wouldn't have simulated this circuit either. But the answer is no, I have not simulated. 14:32:24 14:32:27 14:32:29 14:32:30

Q And why haven't you simulated this circuit that's shown on Page 62 under Paragraph 111? 14:32:31 14:32:32 14:32:36

MR. MAGEE: Objection to form. 14:32:36

A I don't -- I did not need to simulate it to understand how it works. 14:32:39 14:32:41

MR. CHARKOW: Okay. Let's take a break. I think we've been going for an hour. 14:32:44 14:32:46

THE WITNESS: Should we stop for lunch? 14:32:48

MR. CHARKOW: Yeah. Let's go off the record. 14:32:51 14:32:52

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VIDEO SPECIALIST: Going off the record at 2:32. 14:32:54 14:32:55

(A recess was taken.) 14:32:57

VIDEO SPECIALIST: We are back on the record at 2:40. 14:40:48 14:40:57

BY MR. CHARKOW: 14:40:59

Q So can you go to the Tayloe patent, please, Column 5. 14:40:59 14:41:01

A Sure. Give me a second. 14:41:04

Okay. 14:41:21

Q So if you look at Column 5, there's a section called Experimental Results. 14:41:21 14:41:23

Do you see that? 14:41:26

A I do. 14:41:27

Q Remember earlier you said you didn't have frequencies so you couldn't model it? 14:41:27 14:41:30

A Oh, yeah. I forgot about -- I forgot about this. I'm sorry. So I'm not sure if this provides everything, but it certainly provides an example that I could have used. 14:41:32 14:41:35 14:41:38 14:41:40

Q Okay. So just to be clear, if you wanted to, you could have modeled Tayloe, but you didn't? 14:41:42 14:41:45

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MR. MAGEE: Objection. Form. 14:41:49

A So give me one second, because I want to see if all of the components are here. 14:41:54 14:41:56

I mean, first of all, what I said before, I did not mean to imply I couldn't have modeled Tayloe if I wanted to. I just simply said I would have had to chose components that weren't specified. So give me a moment to read through this and see if there are any components that aren't specified. Okay? 14:41:59 14:42:01 14:42:03 14:42:06 14:42:07 14:42:10 14:42:12

Q Well, just to be clear, you said you didn't have -- one of the things you said, there was no frequency in Tayloe. Right? That you said under oath. Right? 14:42:13 14:42:14 14:42:16 14:42:19

A And I stand by what I said. And that was just one of many parameters that I would have had to have chosen for myself. 14:42:20 14:42:22 14:42:24

But I stand corrected, because you pointed out that there are experimental results, which I had forgotten about. I read this quite a while ago. And so for sure I could have used these frequencies. 14:42:26 14:42:27 14:42:29 14:42:32 14:42:34

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And if you want, I'll read through this and see if there are any components that aren't specified. I suspect there are. Like, I don't think they give the capacitor values. But I misspoke when I said I didn't -- I had no indication of what frequency to use. I could have, indeed, used these frequencies; I just forgot about that. 14:42:36 14:42:37 14:42:39 14:42:42 14:42:45 14:42:47 14:42:51 14:42:52

But I don't think that the capacitor values and the resistor values are specified, just scanning over this. And so given that, my earlier answer still stands, at least in principle, which is that in order to simulate Tayloe, I would have had to chose some values which weren't provided. 14:42:53 14:42:56 14:43:01 14:43:04 14:43:06 14:43:10

And I was wrong to say that frequency was one of those values. Because as you've pointed out, an example frequency is specified in the experimental results. 14:43:13 14:43:15 14:43:19 14:43:21

Q And just to be clear, a frequency is specified in Column 5 of Tayloe, Line 50. 14:43:22 14:43:25

Correct? 14:43:30

A Yeah. Give me one second. 14:43:32

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So I said that I would need to know the center frequency and the bandwidth. I don't see offhand that bandwidth is specified. Oh, no, it is. Bandwidth of roughly 1 kilohertz. So yeah, I could -- I could have used a 7 megahertz carrier and a 1 kilohertz bandwidth. And, yeah, so that -- of the various things I would have to pick out myself, I could -- I could use these numbers along with those. 14:43:37 14:43:39 14:43:42 14:43:45 14:43:48 14:43:52 14:44:01 14:44:03 14:44:07

Q In another IPR you simulated a circuit by a gentleman named Macnally. Correct? 14:44:09 14:44:19

A Macnally, yes. 14:44:25

Q And there were no values in -- there were a lot of missing values in Macnally. Correct? 14:44:25 14:44:28

A That is correct. 14:44:30

MR. MAGEE: Object to form. 14:44:31

Q But you still simulated the circuit. Right? 14:44:32 14:44:35

A Yes. And, I mean, I want to make sure that my previous answer was clear. I at no time said I could not simulate the circuit. I said, in response to you asking about, you know, specific 14:44:35 14:44:40 14:44:44 14:44:46

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properties, that in order to simulate the circuit and get those specific properties, I would have to choose values. I would have to essentially make some design decisions. Which is what I would do in Tayloe if I were to simulate it, and that's what I did when I simulated Macnally. 14:44:48 14:44:49 14:44:52 14:44:54 14:44:57 14:44:59

Q And going back to Tayloe and whether or not it's a low frequency, high frequency, Tayloe uses low frequency. And certainly the down-converted signal going into the amplifiers would be low frequency. Correct? 14:45:01 14:45:05 14:45:09 14:45:12 14:45:16

MR. MAGEE: Objection to form. 14:45:18

A So the mixing operation ends up -- you know, just the commutating operation, which is a -- a type of mixing operation, generates a frequency. It moves the signal to DC, but it also creates higher-frequency components. And those higher-frequency components are not at DC. And depending on the type of op amp used, the impedance of those higher frequencies, you know, would be lower. 14:45:21 14:45:28 14:45:32 14:45:35 14:45:38 14:45:41 14:45:45 14:45:51 14:45:53

I can't say specifically how much lower 14:45:55

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because I don't know specifically what op amp we're talking about. And if you say, Oh, well, what about the 741, I'd say, Well, I'd have to look at its specs and perform an analysis. So offhand I do not know the answer. 14:45:58 14:46:00 14:46:03 14:46:06 14:46:09

Q Because you didn't -- strike that. 14:46:11

When you did your analysis of Tayloe, you didn't consider the op amp that was being used in the actual -- the type of op amp that was being used in Tayloe's circuit. Correct? 14:46:14 14:46:16 14:46:18 14:46:22

A That's not correct. 14:46:23

Q Okay. You didn't consider the type of FET that was being used in the op amp in Tayloe's circuit. Correct? 14:46:25 14:46:28 14:46:31

A Also not correct. 14:46:32

MR. MAGEE: Objection to form. 14:46:33

Q You considered -- I'm sorry, your report has an analysis of the type of FET that was used in the op amp of Tayloe? 14:46:34 14:46:37 14:46:42

MR. MAGEE: Objection to form. 14:46:43

A Yeah, the -- 14:46:45

THE WITNESS: Sorry, Bobby. I keep 14:46:45

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talking over you. 14:46:47

A Macnally specified a .6 micron CMOS 14:46:50

technology. And that nails down the type of 14:46:54

spec -- type of transistor that's used. 14:47:00

Q In Tayloe. 14:47:03

A No, not Tayloe. Did I say Tayloe? I'm 14:47:05

sorry. I meant -- you said Macnally. 14:47:07

Q I said Tayloe. I have the transcript in 14:47:09

front of me, sir. 14:47:10

A Can you read back your question then, 14:47:12

from the transcript? Because maybe I wildly 14:47:13

misheard it. 14:47:15

Q I will read the exact question from the 14:47:16

transcript. All right. 14:47:18

You didn't consider the type of FET that 14:47:20

was being used in the op amp of Tayloe's circuit. 14:47:22

Correct? 14:47:25

MR. MAGEE: Objection to form. 14:47:25

A Yeah, so first of all, I apologize. I 14:47:29

thought when you said Tayloe, I mistook it for 14:47:30

Macnally. 14:47:33

No; because I -- I just considered the 14:47:38

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normal behavior of an op amp. So at -- you know, until -- until you start wanting to simulate or come up with, you know, precise answers to the questions you're asking me, that's sufficient. But as soon as you start saying, Well, exactly what was the impedance looking into this node of the circuit, then I need actual component values. 14:47:41 14:47:46 14:47:51 14:47:53 14:47:57 14:47:59 14:48:01

But for the analysis I did on Tayloe I didn't need that information, and so I didn't -- I didn't essentially design those values in what I thought would be a reasonable engineering optimization process. 14:48:03 14:48:08 14:48:10 14:48:15 14:48:18

Q Can you answer the following question just with a yes or no: You didn't consider the type of FET that was being used in the op amp of Tayloe, yes or no? 14:48:19 14:48:21 14:48:24 14:48:27

MR. MAGEE: Objection to form. 14:48:29

A It's not really a yes-or-no answer. The answer is, I -- it's true I didn't -- I didn't evaluate whether it was a bipolar junction transistor or a -- or a MOSFET transistor. But I assumed that whatever technology was being used, 14:48:33 14:48:36 14:48:41 14:48:44 14:48:47

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that -- to implement that op amp, that a good enough job was done that it functions properly as an op amp. 14:48:50 14:48:54 14:48:56

So implicitly, you know, I mean, explicitly, no, I didn't -- I didn't say, Oh, this is a bipolar junction transistor input or a MOS transistor input. I didn't do that. But I assumed that a technology that was good enough to implement an op amp that would be appropriate for this circuit was used, and that does to some extent nail things down a bit. 14:48:57 14:49:00 14:49:03 14:49:07 14:49:10 14:49:13 14:49:15 14:49:18

Q All right. So go to Column 3 of Tayloe, particularly Line 21. 14:49:21 14:49:29

A Okay, I am at -- hold on. Column 4. Line 21 of Column 3. 14:49:37 14:49:41

Okay. I'm there. 14:49:42

Q All right. So it says, "Another advantage of the Tayloe product detector is its narrowband detection characteristics. Resistor 32 and each capacitors 72 to 78 form low-pass filters." 14:49:43 14:49:45 14:49:49 14:49:53 14:49:57

Do you see that? 14:49:57

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A I do. 14:49:58

Q So one advantage of Tayloe's circuit 14:49:58

configuration was that the resistor, 32, which he 14:50:02

refers to as R filter, and each of the capacitors 14:50:06

is forming a low-pass filter. Correct? 14:50:11

A Yes. 14:50:13

Q So Tayloe disclosed a circuit with a 14:50:13

low-pass filter in it. Correct? 14:50:15

A That's true. 14:50:18

Q And if you can go back to -- back to Page 14:50:18

62 and Paragraph 111 of your declaration, please. 14:50:24

A Sixty-two, and Paragraph 111. 14:50:31

Okay. I'm there. 14:50:33

Q There's a diagram there. 14:50:34

Do you see that? 14:50:35

A Yes. 14:50:36

Q So that diagram on Page 62, you've 14:50:36

combined the TI data sheet, in particular you 14:50:39

replaced Tayloe's commutating switch -- strike 14:50:45

that. 14:50:52

So on Page 62 you have Figure 3 of 14:50:52

Tayloe, and you've replaced Tayloe's commutating 14:50:56

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switch in Figure 3 with the -- with the TI circuit. Correct? 14:51:00 14:51:06

A I have. 14:51:07

Q And I noticed that when you did that, you removed the R filter and you removed the bias circuitry. Correct? 14:51:07 14:51:12 14:51:19

A That's what the figure shows. But let me just go back and look. I mean so, yeah, I did not mean to imply that either the resistor or the bias circuitry weren't there. 14:51:20 14:51:23 14:51:26 14:51:31

But let me just look at exactly in Tayloe what they're calling f1. This may just -- this may be a typo, or a figure error. Just give me a moment here. Where the hell did this go? 14:51:32 14:51:35 14:51:39 14:51:44

Yeah, so that is a mistake. So f1 should go into a resistor prior to the analog MUX. So I apologize. 14:51:52 14:51:56 14:52:02

What this figure should have said is, is that the input to the analog MUX was the output of the resistor. So that is -- I apologize. That's a misprint that I didn't catch. 14:52:03 14:52:04 14:52:08 14:52:10

Q But it's a misprint that's throughout 14:52:12

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your declaration. It's, like, every diagram. 14:52:14
It's, you know, throughout in pages and pages, 14:52:16
your whole analysis excluded, you know, Page 60 -- 14:52:20
let's see. I'll go through this. Page 64, Page 14:52:24
67, Page 70 -- 14:52:28
A Hold on. Hold on. Hold on. Not so 14:52:32
fast. 14:52:35
So it's absolutely labeled incorrectly in 14:52:35
the figure on 62. In the figure in -- on Page 64, 14:52:40
it's not labeled and so it's not incorrect. It 14:52:49
just talks about, you know, the input 1A. So -- 14:52:53
and what other -- what other pages do you want me 14:52:59
to look at? 14:53:01
Q Sir, just to be clear, 64 does not -- you 14:53:02
showed all the other stuff of Tayloe in Figure 3, 14:53:05
and you specifically excluded from that figure, 14:53:09
right, the R filter and the bias circuitry. 14:53:12
Correct? It's not shown, factually? 14:53:15
MR. MAGEE: Object to form. 14:53:17
A I answered that question. It's not 14:53:20
shown, and it was a mistake not to show it. And 14:53:22
until this very moment I honestly didn't notice 14:53:24

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it. The other figures at least to which you referred don't show that label as input f1. So what we should have said is just input, meaning the input to the -- the MUX. So it was a mistake. And it's my declaration, so it's my fault. But, you know, we -- 14:53:26 14:53:29 14:53:33 14:53:35 14:53:40 14:53:43

Q So Page 67, just to be clear, Page 67 is another example where there's a mistake. Right? This wasn't just an isolated incident. Every diagram, as far as I'm aware, that you put in here has no reference whatsoever to R filter or bias circuitry. Just taken out. 14:53:44 14:53:47 14:53:50 14:53:52 14:53:55 14:54:01

MR. MAGEE: Objection to form. 14:54:03

A So in the case of -- of the thing on Figure 7, it's not incorrect in the sense that we're not -- we're not saying that that input is input f1. But -- but I agree, it's -- you know, if you look at it in the context of the other figure, the resistor is missing. And I don't know how to say it any differently. It was a -- it was a mistake. 14:54:05 14:54:08 14:54:11 14:54:14 14:54:20 14:54:24 14:54:31 14:54:33

Q And the bias circuitry is missing, too. 14:54:34

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Right? Not just the resistor or the filter, but the bias circuitry? 14:54:36 14:54:39

MR. MAGEE: Objection to form. 14:54:40

A I mean, that is true. But even in Tayloe they show, for example Figure 7 without the bias circuitry. So in electronic circuits we often don't show the bias circuitry explicitly. So it's certainly there in Tayloe's Fig 7, even though it is not shown. Whereas in Fig 3 it's shown. 14:54:42 14:54:44 14:54:46 14:54:50 14:54:54 14:54:58

So the -- not showing the bias I don't view as a mistake, because any circuit designer would understand that there needs to be a bias circuit there, whether you explicitly show it or not. However, not including the resistor was absolutely a mistake. The mistake was my fault, it was a typo. And as far as I know, you know, the only actual explicit typo was in labeling that particular figure on Figure 62 as input f1. If it had just said "input" that would have been fine, because then it would have meant the input to the multiplexer. 14:55:00 14:55:03 14:55:07 14:55:10 14:55:13 14:55:14 14:55:17 14:55:24 14:55:30 14:55:34 14:55:36 14:55:39

So, but, you know -- 14:55:40

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Q Sir, just to be clear, you included all the other pieces of Figure 3, even on the other diagrams where it doesn't say FN or whatever you said, all the other pieces of Figure 3 are there; but you specifically chopped out and did not include the R filter. Specifically took it out, not there. 14:55:42 14:55:44 14:55:47 14:55:50 14:55:53 14:55:55 14:55:58

A I specifically didn't notice that it wasn't in the diagram. 14:55:59 14:56:02

MR. MAGEE: Objection. Form. 14:56:02

A I don't know how to answer this any differently. It was a mistake. It should be there. And no matter how many times you ask me this question or a semantically different but logically equivalent question, my answer is going to be the same. It was meant to be there. I screwed up. I didn't put it there. It was an oversight. 14:56:03 14:56:04 14:56:07 14:56:09 14:56:15 14:56:16 14:56:17 14:56:19

Q Okay. Let's go to Paragraph 130 of your declaration, please. 14:56:21 14:56:26

A Okay. Give me a second. 14:56:30

Q That's on Page 74. 14:56:37

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A Okay, I am there. 14:56:39

Q All right. So you're taking about 14:56:39

Tayloe's discussion of 6 to 7 dB conversion loss. 14:56:41

Correct? 14:56:47

A Yes. 14:56:47

Q Are you aware whether that conversion 14:56:47

loss refers to a voltage conversion loss or a 14:56:52

power conversion loss? 14:56:54

MR. MAGEE: Objection to form. 14:56:57

A Usually it's -- when it is specified in 14:57:02

dB, you know, like this and it's called conversion 14:57:05

loss, it's power. 14:57:08

Q Okay. Did you run any calculations to 14:57:10

make a determination that the 6 to 7 dB conversion 14:57:12

loss is a power conversion loss, as opposed to 14:57:18

a -- a -- sorry, I lost the question. Strike 14:57:22

that. 14:57:30

Did you run any calculations to determine 14:57:30

that the 6 to 7 dB conversion loss is a power 14:57:31

conversion loss, as opposed to a voltage 14:57:34

conversion loss? Like, did you run the 14:57:37

calculation to figure out if that's what you would 14:57:39

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get? 14:57:42

MR. MAGEE: Objection to form. 14:57:43

A I did not, but I didn't have to. 14:57:45

First of all, it would be, you know, 14:57:48

standard to assume it's power. And even if it 14:57:50

weren't power, even if it were voltage, it would 14:57:55

just change the numbers. But it wouldn't change 14:57:57

the disclosure in Tayloe, which says that there's 14:57:59

an improvement that's achieved by doing it this 14:58:03

way. 14:58:05

So the -- you know, the dB numbers would 14:58:06

change, if for some weird reason they were using 14:58:10

voltage, which I don't think they are. But I 14:58:14

didn't bother simulating, I didn't have to 14:58:16

simulate it, because an improvement is an 14:58:17

improvement. And the difference you're talking 14:58:19

about would simply change the magnitude of the 14:58:22

improvement. 14:58:24

Q Do you agree that current always flows 14:58:25

from the higher potential to a lower potential? 14:58:36

A Absolute current, yes. Signal current, 14:58:42

not necessarily. 14:58:44

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Q What do you mean "signal current, not necessarily"? 14:58:45 14:58:48

A Well, in any kind of amplifier, let's say a MOS transistor amplifier, the simplest one you can come up, say a common source amplifier, there's always current flowing from VDD to ground. Right? But the signal is superimposed on that. 14:58:48 14:58:53 14:58:56 14:59:00 14:59:03

So sometimes there's more current flowing, sometimes there's less current flowing, and so we as circuit designers consider the variation to be the signal. 14:59:07 14:59:09 14:59:13 14:59:18

And so the variation in that signal can be positive or negative, even though the absolute current flowing is positive. 14:59:20 14:59:25 14:59:29

Q In circuit design, VDD is the source of current. Correct? 14:59:31 14:59:36

A The source of current? 14:59:38

MR. MAGEE: Objection to form. 14:59:39

A I mean, the current -- so, I mean, the reason we call it circuit -- a circuit, is because current flows in a circle. Right? 14:59:40 14:59:47 14:59:50

So the VDD, all of the various places 14:59:53

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where we -- where we attach the circuit to VDD, in a typical transistor where we have one supply VDD and -- one positive supply and one ground, then if you add up all of the currents that are supplied by VDD, that same current comes out of ground. 14:59:59 15:00:04 15:00:09 15:00:14 15:00:18

And so in that scenario, if that's what you're defining as the current, the answer is yes. I'm just trying to -- 15:00:23 15:00:25 15:00:31

Q You can't answer my question with a yes-or-no answer. You have to give -- is this how you describe things to your, like, first-year circuit students? Like, is this how you -- I'm just curious. 15:00:33 15:00:34 15:00:37 15:00:38 15:00:41

MR. MAGEE: Objection to form. 15:00:42

A Yes. 15:00:43

Q Okay. 15:00:44

A It is. And the reason is, because this is a precise field. And, you know, how you -- how you phrase things makes a difference. 15:00:44 15:00:45 15:00:50

Now, if you asked my wife she'll say, Yes, he does that all the time and it drives me crazy. And perhaps in a marriage that's not such 15:00:51 15:00:54 15:00:56

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a good way to respond. But when we're talking about technical stuff, the details matter. The devil is in the details and God is in the details. 15:00:59 15:01:01 15:01:04

And if you ask fuzzy questions where you don't define things well, then I can't give you a clear answer unless I take it upon myself to correct you and, you know, make the question go from being ill-posed to well-posed. 15:01:09 15:01:11 15:01:13 15:01:16 15:01:21

Q Okay. So just to be clear, I have ill-posed questions? I am just curious. 15:01:25 15:01:27

MR. MAGEE: Objection. 15:01:31

Q I am just trying to make better questions. I am just trying to make better questions. 15:01:31 15:01:33 15:01:35

A Are you ready for me to answer? 15:01:35

Q Yes. 15:01:36

A Several of my -- several of the questions you've asked me have been ill-posed. And in those cases I have said, Wait a minute, we need to back up, is this what you mean, and we go down a path. 15:01:37 15:01:39 15:01:43 15:01:45

And then once I've gotten sufficient information to be able to give you an unequivocal 15:01:48 15:01:49

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answer, then I give you an unequivocal answer. I can't even say it. Unequivocal answer. 15:01:52 15:01:56

Q Okay. VDD is power supply voltage. Correct? 15:01:59 15:02:01

MR. MAGEE: Objection to form. 15:02:02

A So a voltage -- this is another case of where it's an ill-posed question. So a voltage is always measured between two points. And so if you have one VDD and one ground, then the -- then the difference between VDD and ground is called the power supply voltage. 15:02:04 15:02:07 15:02:13 15:02:16 15:02:20 15:02:23

Q So the difference between VDD and ground is the power supply voltage. Correct? 15:02:24 15:02:27

A In the case where you only have one supply, yes. 15:02:30 15:02:32

Q VDD is the highest potential point in a circuit relative to ground. Correct? 15:02:32 15:02:37

A No. 15:02:40

MR. MAGEE: Objection. Form. 15:02:40

Q In a circuit, what's higher than VDD as the potential point? What's the highest potential point? 15:02:41 15:02:45 15:02:48

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A Well, so for example, if you were to look at the LNA in the Macnally circuit, it's connected -- if you want, we can go to a specific example and I will show you. Or I can just continue trying to explain it in the air. 15:02:49 15:02:53 15:02:59 15:03:01 15:03:04

Q No, that's okay. I'll withdraw the question. I don't really care. All right. 15:03:06 15:03:08

MR. CHARKOW: So I've given you another exhibit to your deposition. 15:03:12 15:03:14

Debbie, are we up to Exhibit 6 now? 15:03:15

Exhibit 6 to your deposition is a paper by Dr. Razavi. 15:03:24 15:03:26

Q Let me know when you have that open, please. 15:03:30 15:03:31

(Galton Deposition Exhibit 6 marked for identification and is attached to the transcript.) 15:03:31 15:03:31

A Okay, it's open. 15:03:36

Q You have seen this paper before by Dr. Razavi. Correct? 15:03:37 15:03:41

A I have. 15:03:42

Q Did you perform any simulations of the Razavi circuits in this document? 15:03:42 15:03:47

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A I have not. 15:03:49

Q So if you could turn to the second page, 15:03:50

and let's look at Figure 1. 15:03:55

A Okay. 15:04:01

Q Okay. You see amplifier A1? There are 15:04:01

two amplifiers A1? 15:04:05

A I do. 15:04:06

Q Those are high impedance. Correct? 15:04:06

A Since he hasn't specified the details of 15:04:14

the amplifier, it's not clear. 15:04:16

Q If Dr. Razavi said that A1 were high 15:04:18

impedance, would you disagree with him? 15:04:21

A No. 15:04:23

Q Let me put it this way: If Dr. Razavi 15:04:23

testified or had any comments about any of this 15:04:27

circuitry, would you dispute what he had to say 15:04:29

with regards to his paper? 15:04:32

A I mean, I'd have to -- I'd have to look 15:04:36

at the specifics of what he's saying. I mean, you 15:04:40

know, just like you found out that I had a mistake 15:04:42

in my -- in my disclosure by not having that 15:04:45

resistor, you know, most papers contain, you know, 15:04:49

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some slight errors. So I'm not going to say, you know, just as a blanket statement, If Razavi says it, it's absolutely true. 15:04:54 15:04:57 15:05:00

But -- but I would be inclined to believe what he says, subject to my verification. 15:05:02 15:05:05

Q Right. Well, if Dr. Razavi explained how the various circuits were supposed to work, you wouldn't disagree with him. Right? 15:05:08 15:05:11 15:05:14

MR. MAGEE: Objection to form. 15:05:16

A I mean, I've answered that question already. 15:05:18 15:05:19

Q Okay. You understand that when I ask a question, "I answered the question already" is not an answer. Just answer the question again. My questions may be different. You may have not heard it. So please, instead of saying "I've answered the question already," that's not an answer. It's either yes, no, I don't know, or provide an explanation. Okay? So I'll. 15:05:22 15:05:25 15:05:27 15:05:30 15:05:32 15:05:34 15:05:36 15:05:38

Ask it again. Strike that? 15:05:40

If Dr. Razavi explained the various circuits -- strike that. 15:05:41 15:05:43

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If Dr. Razavi explained how the various circuits in his paper were supposed to work, you wouldn't disagree with him. Right? 15:05:44 15:05:47 15:05:50

MR. MAGEE: Objection. Form. 15:05:51

A As I said before, when -- I'm not going to give a blanket statement about that because, you know, a lot of papers have statements which are incorrect for a variety of reasons. Razavi, I have a great respect for Razavi, and I would be inclined to believe what he says. But I won't believe anything anybody says without verifying it for myself. 15:05:52 15:05:55 15:05:57 15:05:59 15:06:03 15:06:05 15:06:08 15:06:10

So while I would be inclined to believe anything he says, I would always verify it for myself. 15:06:11 15:06:13 15:06:16

Q But what you're required to do when looking at Razavi, you're required to use the disclosure of Razavi and use what's actually said in that. Right? Correct? You can't make stuff up. You've got to use what he says? 15:06:16 15:06:19 15:06:22 15:06:23 15:06:26

MR. MAGEE: Objection to form. 15:06:28

A I mean, if we could -- if you could point 15:06:30

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to someplace in my disclosure where you feel I haven't done that, I've -- I mean, that's a very general question. 15:06:34 15:06:36 15:06:39

Q We'll get to that. That's fine. We'll get to it. All right. So strike that. 15:06:40 15:06:43

VOUT. So if you look at Figure 2 of Razavi? 15:06:46 15:06:48

A Yes. 15:06:48

Q Strike that. If you look at Figure 2 of Razavi, VOUT is -- stands for voltage out. 15:06:52 15:06:53

Correct? 15:06:57

A Yes. 15:06:58

Q So in the circuit, the mixer of Figure 2, there was a voltage at the output of Razavi's mixer. Correct? 15:06:58 15:07:03 15:07:05

A Yes. 15:07:07

MR. MAGEE: Objection. Form. 15:07:07

Q Okay. The LO and the RF signal affects how much power from VDD is converted to VOUT. 15:07:08 15:07:15

Correct? 15:07:18

MR. MAGEE: Objection to form. 15:07:21

A I mean, so this is another example of an 15:07:28

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ill-posed question. 15:07:30

Power is -- refers to, you know, energy per unit second that's dissipated by some component like by that R. VOUT is just a voltage. That if you -- if one knows what VOUT is and nothing else, you have no idea what the power is. 15:07:33 15:07:39 15:07:41 15:07:45 15:07:48

So, for example, a high voltage going into an infinite impedance delivers no power to that -- to that impedance. So I -- I just don't have a way to answer your question the way you want me to. 15:07:51 15:07:54 15:07:57 15:08:02 15:08:04

Q Okay. Does the LO and RF signal affect in any way the VOUT? 15:08:05 15:08:08

A Yes. 15:08:11

Q How? 15:08:11

MR. MAGEE: Objection to form. 15:08:13

A So hit me with the question one more time. I just want to make sure I'm fully understanding the question. 15:08:21 15:08:23 15:08:25

Q Does the LO and the RF signal affect in any way the VOUT? And I said, how. 15:08:26 15:08:29

A Okay. So that's a very -- 15:08:34

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MR. MAGEE: Objection. Form. 15:08:35

A -- general question. 15:08:36

But, for example, if I were to make the 15:08:38
RF signal be very small in amplitude, then VOUT 15:08:40
would correspondingly get small in amplitude. 15:08:47

If I were to change the duty cycle of the 15:08:51
local oscillator, then that would -- that would 15:08:56
cause an -- excuse me, an imbalance, which would 15:08:58
cause -- so VOUT is a differential signal. And if 15:09:01
the duty cycle of the local oscillator were to 15:09:07
change, then you would end up changing the common 15:09:09
mode voltage of that differential signal. 15:09:16

Q And if the RF signal was very -- had a 15:09:20
very large amplitude, you would agree that VOUT 15:09:23
would be also larger in amplitude. Correct? 15:09:28

MR. MAGEE: Objection to form. 15:09:33

A So mixers have a -- have a usable range. 15:09:37
And if you make -- if you drive the mixer with a 15:09:41
signal that's too large, then the mixer will go 15:09:45
through a process called compression, where 15:09:48
further increases in the input voltage won't 15:09:52
have -- yield significant further increases in the 15:09:54

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output voltage. 15:09:56

So if -- I'd modify your question to say 15:09:57

if you are within the sort of linear range or the 15:10:03

usable range of the mixer for two input signal 15:10:06

amplitudes, then the larger of the two input 15:10:10

signal amplitudes will give a larger VOUT swing. 15:10:15

Q So if you're within the linear range or 15:10:18

usable range of a mixer for two input signal 15:10:20

amplitudes, then the larger of the two input 15:10:24

signals will give a larger VOUT swing. Correct? 15:10:26

A Yes. And when I say -- when we say 15:10:29

"larger," what I mean is larger swing. 15:10:30

Q Okay. So the current -- the current, the 15:10:33

absolute current, flows downward from VDD through 15:10:42

Resistors R1 and R2, and into transistors, and then 15:10:45

to ground. Correct? 15:10:48

A The absolute current does, yes. 15:10:50

Q And -- 15:10:51

A Actually, can I -- can I amend that? I 15:10:56

spoke too quickly. Some of that current can also 15:10:58

flow through C2. 15:11:02

Q Okay. But the absolute current is 15:11:06

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flowing down in Figure 2. Correct? 15:11:11

MR. MAGEE: Objection to form. 15:11:14

A The absolute current is flowing down? I mean, the absolute current through the resistors is certainly flowing down. Some of that current can be -- you know, get siphoned off through the capacitors. So not all of it goes down through M5 and M6. And then some of it, you know, a non-DC portion of it, but some of it goes through C2. So what's left over goes through M7. 15:11:16 15:11:19 15:11:21 15:11:26 15:11:30 15:11:36 15:11:41 15:11:43

Q Okay. And current in Figure 2 moves in the direction down, and it's going downwards to the capacitors to the left and right of VOUT. 15:11:46 15:11:54 15:11:59

Correct? 15:12:03

MR. MAGEE: Objection to form. 15:12:04

A Can you hit me with that again? I want to make sure I'm understanding. 15:12:06 15:12:08

Q Capacitors to the left and right of VOUT. 15:12:09

Do you see that? 15:12:12

A I do. 15:12:13

Q The absolute current that's moving through Figure 2 moves down through R1, R2, and 15:12:13 15:12:15

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then some of that potentially goes into the capacitors around VOUT, and then some of that goes down to M6 and M5. Correct? 15:12:21 15:12:24 15:12:26

A Yes. But so that is yes. But I want to make absolutely clear that we're talking about the total current, not the signal -- not the signal that's riding on top of the current. 15:12:29 15:12:32 15:12:34 15:12:36

Q Okay. The current is -- in Figure 2 is not flowing from the RF input. Correct? 15:12:38 15:12:46

MR. MAGEE: Objection. Form. 15:12:48

A No, that's not true. Because there is a path for the current to flow through C2. And current that flows through -- the M7 and the inductor below it act as a constant current source. 15:12:53 15:12:59 15:13:04 15:13:07 15:13:12

And so any current that flows through C2, at least to a good approximation, let's say current flows from left to right through C2, that will cause less current to flow through M5 and M6, and therefore that will affect the current through those resistors and capacitors above it. 15:13:12 15:13:15 15:13:19 15:13:23 15:13:28 15:13:31

And so that's -- this is that distinction 15:13:33

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between absolute current versus signal current. From a signal current point of view, you know, the signal component, when we analyze these circuits, we view it as a component that has -- can go positive and negative. Which means you can have -- you can have signal current flowing upward as well as downward. So the absolute current is flowing downward. But if you view the absolute current as a bias current upon which the signal rides, then the signal can be -- the signal current can be positive and negative, meaning it can flow upward or downward. 15:13:36 15:13:38 15:13:42 15:13:44 15:13:47 15:13:49 15:13:51 15:13:57 15:14:00 15:14:03 15:14:06 15:14:08

Q The current flowing from VDD downwards is dictated by the switches. Correct? Switches M5 and M6? Well, strike that. 15:14:10 15:14:14 15:14:18

The current flowing from VDD downwards is dictated by the transistors M5 and M6. Correct? 15:14:20 15:14:23

MR. MAGEE: Objection. Form. 15:14:27

A It is not dictated. It is affected by. 15:14:29

Q The current flowing from VDD downwards is affected by the transistors M5 and M6. Correct? 15:14:32 15:14:37

A Yes. 15:14:41

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Q All right. And AC current that's in the capacitors around the VOUT will discharge to ground. Correct? 15:14:41 15:14:47 15:14:50

MR. MAGEE: Objection to form. 15:14:51

A No, that's not correct. 15:14:55

Q Okay. The current of the capacitors around VOUT will discharge towards the transistors. Correct? The transistors being M5 and M6? 15:14:57 15:15:12 15:15:15

MR. MAGEE: Objection to form. 15:15:19

A I'm trying to think how to answer your question. So are we talking about signal current, or are we talking about total current? 15:15:29 15:15:32 15:15:34

Q Whatever is in the capacitors. 15:15:35

MR. MAGEE: Objection. Form. 15:15:40

Q Strike that. 15:15:41

The current of the capacitors would discharge towards Transistors M5 and M6. Correct? 15:15:41 15:15:43

MR. MAGEE: Objection. Form. 15:15:46

A Yeah, so first of all, the capacitors are constantly charging and discharge. They charge and they discharge, they charge and they discharge. So when -- when we look at the -- let 15:15:50 15:15:53 15:15:55 15:15:57

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me think how to say this. 15:16:03

From a signal point of view, what you're 15:16:04

saying is not true. When you look at the total 15:16:08

current, I think that's true. But for sure when 15:16:12

we're talking about the signal that we -- the 15:16:16

signal component, then it's -- it's -- it just 15:16:18

depends. 15:16:23

Q The total current of the capacitor will 15:16:24

discharge towards the Transistors M5 and M6. 15:16:29

Correct? 15:16:32

MR. MAGEE: Objection to form. 15:16:33

A So -- 15:16:40

Q Let me ask it again. Strike that. 15:16:41

With regards to total current, current of 15:16:43

the capacitors will discharge towards Transistors 15:16:45

M5 and M6. Correct? 15:16:47

MR. MAGEE: Objection to form. 15:16:49

A I'm having -- I'm struggling with the -- 15:16:53

with the question. 15:16:56

So give me a second. 15:16:58

Q I'm just taking your words and trying to 15:16:59

put it in questions. So I'm using your words from 15:17:01

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the transcript. 15:17:03

A Right. So when -- when the capacitor is 15:17:05

discharging, okay, and we look at the -- we look 15:17:14

at the total charge that's stored on the 15:17:20

capacitor, and then we -- and let's suppose that 15:17:23

the -- actually, no. It isn't true, and here's 15:17:28

why. 15:17:31

So sometimes -- there's a certain -- 15:17:32

okay. Let me back up. And it's just a little 15:17:40

complicated to explain in the air, but, so there's 15:17:43

a certain nominal current that flows when the 15:17:46

switch is on -- switches are on. And that nominal 15:17:50

current determines the nominal voltage across that 15:17:53

capacitor. 15:17:59

So, for example, when M5 is on, there is 15:18:00

a certain nominal current flowing through M5 and 15:18:03

through R1. And it's -- if it weren't for the RF 15:18:07

signal, it would be DC. Okay? 15:18:11

Now, when M5 -- when M5 turns off, then 15:18:14

we -- we slowly charge up to VDD, although we never 15:18:26

get there because it's not turned off for that 15:18:31

long. 15:18:34

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But the point is, the voltage on the capacitor can be above or below its bias point value, depending on what the RF signal is. And so -- I'm just -- let me just think about this a little bit more. I don't usually think about it in terms of total current, so I just want to make sure I'm giving you the right answer. 15:18:34 15:18:37 15:18:41 15:18:46 15:18:49 15:18:51 15:18:54

Okay. So it isn't correct, and this is why. So when -- when the RF signal is such that at a given point in time the capacitor is at a lower voltage than -- than its bias point, then when the switch turns off the charge will equalize through R1, or start to equalize through R1. So it will actually -- it will actually start -- well, hold on. 15:19:05 15:19:07 15:19:16 15:19:22 15:19:30 15:19:33 15:19:39 15:19:43

Q It's hard to explain, I think, because I'm not sure this is -- you know, I think you're having a hard time explaining it because you're searching for words. Right? 15:19:58 15:20:00 15:20:02 15:20:04

I mean, it seems like the reason you're having a hard time explaining it is because it doesn't work the way you're saying. Right? 15:20:06 15:20:09 15:20:11

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A That certainly is not my testimony. What I'm -- what I'm trying to do is -- 15:20:13 15:20:15

Q You're having a very hard time explaining something which is a fairly simple circuit concept. So I'm just curious why it's taking five minutes to explain a simple circuit concept. 15:20:17 15:20:20 15:20:24 15:20:26

A Okay. I will tell you why, and I'll tell you what my answer would be if this were -- 15:20:30 15:20:31

Q I am going to withdraw the question. There is nothing to answer. 15:20:32 15:20:33

A I am ready to answer it. 15:20:35

Q I'm withdrawing it. Sir, there's nothing to answer. It's a withdrawn question, so you're not answering anything. It's not going to go on the record. There's no question pending. 15:20:36 15:20:37 15:20:39 15:20:41

A Okay. 15:20:43

Q So the capacitors to the left and right of VOUT, where do they discharge to? 15:20:43 15:20:45

MR. MAGEE: Objection to form. 15:20:49

A Well, they're constantly -- you know, they're continually charging and discharging. 15:20:53 15:20:55

This is a similar question to what you asked me 15:20:59

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before. And my answer was going to be that in terms -- in terms of where they discharge to from a signal point of view depends whether they're below their bias point or above their bias points. So the capacitors never fully discharge on an absolute sense because they're always going back and forth above this bias point. And this bias point is always above DC. 15:21:01 15:21:03 15:21:08 15:21:11 15:21:17 15:21:20 15:21:23 15:21:25

So in that sense from an absolute scale, you could argue that it -- that the absolute current eventually, when it does discharge, eventually goes to ground. 15:21:28 15:21:32 15:21:34 15:21:37

But from a signal point of view -- and this is what I was struggling with to try to explain. From a signal point of view, when -- when the bias voltage -- sorry, when the -- when the voltage say on the left side of VOUT, the left differential terminal of VOUT, when it is lower than the quiescent point from a signal point of view we consider that discharging in the upward direction. And because of that, from a signal flow point of view, it can go either up or down. 15:21:40 15:21:41 15:21:44 15:21:47 15:21:51 15:21:56 15:21:59 15:22:02 15:22:05 15:22:08

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Right? 15:22:11

The thing I was having trouble explaining 15:22:12

was trying to figure out a way to put that into 15:22:15

words. So we don't consider the signal to be the 15:22:17

total current. We consider the signal to be the 15:22:22

set of voltages -- sorry, we don't consider the 15:22:25

signal to be either the total voltage or the total 15:22:28

current. We consider the signal in applications 15:22:32

like this to be the variations riding about the 15:22:35

bias. And because of that, a circuit designer 15:22:39

would consider that discharge path to be variable 15:22:43

either down or up, depending on whether that 15:22:46

offset were positive or negative. 15:22:48

And what I was trying to do was put that 15:22:51

in terms that would be -- that would be clear. 15:22:52

And hopefully I've succeeded. But if not you can 15:22:55

ask me more questions about it. 15:22:59

Q Yeah. All right. The signal that you're 15:23:00

referring to is a voltage. Right? The signal 15:23:07

that goes up and down, that's the voltage. Right? 15:23:11

MR. MAGEE: Objection to form. 15:23:13

A Well, I've talked about multiple signals. 15:23:14

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VOUT is -- 15:23:17

Q Sorry, sir. Strike the -- withdraw the 15:23:19

question. Strike the answer as nonresponsive. 15:23:23

Listen to the question carefully. 15:23:25

You just referred to signals being 15:23:27

discharged from the capacitor going up or down. 15:23:29

Do you recall that testimony under oath that you 15:23:32

just gave? 15:23:34

MR. MAGEE: Objection. Form. 15:23:34

A I do. 15:23:35

Q Is that signal is a voltage. Correct? 15:23:36

A Now that you've said "that signal," yes, 15:23:38

that signal is a voltage. Before you just said 15:23:40

"signal," so I didn't know what signal you were 15:23:46

referring to. 15:23:48

Q All right. So current, absolute 15:23:49

current -- well, strike that. 15:24:03

And the only other place that capacitor 15:24:20

would discharge to would be to ground, correct, 15:24:23

other than the voltage signals, the only other 15:24:25

place it could discharge to is ground. Correct? 15:24:27

MR. MAGEE: Objection to form. 15:24:31

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A As I said before, the signal -- the signal component of the charge that's stored on that capacitor at any given time could discharge upward or downward. The absolute charge ultimately flows downward. But as circuit designers, we're interested in the signal component. So, you know, that is my answer. 15:24:32 15:24:39 15:24:44 15:24:48 15:24:51 15:24:56 15:24:58

Q And the transistors -- strike that. Right. Strike it. 15:25:01 15:25:16

All right. So let's look at Figure 4A through C of Razavi. Okay? 15:25:22 15:25:25

A Okay. Although you had said I should suggest when I'd like a break. I'm getting hungry. I don't know about you. 15:25:30 15:25:33 15:25:35

MR. CHARKOW: Oh, sure. Go ahead. We can take a break. Yeah. Yeah. That's fine. Take a break. Just nobody reminded me. That's fine. We can stop right now. 15:25:37 15:25:38 15:25:40 15:25:42

THE WITNESS: Okay. When do you want to come back? 15:25:45 15:25:46

MR. CHARKOW: Off the record, please. 15:25:47

VIDEO SPECIALIST: Off the record at 15:25:48

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3:25. 15:25:50

(A recess was taken.) 15:25:53

VIDEO SPECIALIST: We are back on the 15:52:14

record at 3:53. 15:53:03

BY MR. CHARKOW: 15:53:05

Q All right. The current that flows -- 15:53:05

okay. Strike that. 15:53:07

So going back to Razavi, Figure 2 again. 15:53:09

A Can you point me to where we're looking 15:53:12

specifically? 15:53:14

Q Razavi, Figure 2. 15:53:15

A All right. So hold on, let me -- let me 15:53:17

go back to the -- so you're talking about in the 15:53:19

Razavi paper. Okay. 15:53:23

Q It's the last figure we were discussing. 15:53:24

Razavi Figure 2. You're there? 15:53:28

A Yeah. 15:53:31

Q Okay. Strike that. 15:53:31

So Razavi Figure 2, the -- all right. 15:53:32

With regards to Razavi and Figure 2, the current 15:53:39

that flows through M5 and M6 does not come from the 15:53:42

VRF, but it comes from the VDD. Correct? 15:53:49

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MR. MAGEE: Objection to form. 15:53:52

A The signal -- for the signal current, 15:54:01
that's not true. Because some of the signal 15:54:03
current is flowing through C2, that's how the 15:54:05
signal gets into the mixer. And the current that 15:54:10
flows into C2 causes more or less current to flow 15:54:14
through M5 based on that signal. 15:54:19

And so the amount of current that flows 15:54:22
from the supply ends up getting controlled by that 15:54:24
signal. And so -- so it's true that if you look 15:54:30
at the total current flowing from VDD to ground 15:54:33
through that mixer circuit, then at any given time 15:54:37
the total current is from VDD to ground. But from 15:54:40
a signal current point of view, that is not 15:54:43
correct. 15:54:44

Q What's signal current? I've never 15:54:45
heard -- maybe I'm just ignorant. You have this 15:54:49
term, "signal current." Is that a determine of 15:54:52
art, or is that something you just made up? 15:54:54

MR. MAGEE: Objection to form. 15:54:55

A It's a term of art. 15:54:56

So I explained this earlier. So in any 15:54:58

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kind of amplifier, like, say, you know, a single transistor amplifier, just to make it really simple, the current is always flowing from VDD to ground. However, in -- the signal rides on top of that current. 15:55:00 15:55:04 15:55:06 15:55:11 15:55:19

So if the current is in the form -- sorry, if the signal is in the form of a current, then it's a variation in current about that bias current. And that's -- not only is it, you know, a standard term, but it's one of the first things we teach in circuits classes. 15:55:19 15:55:22 15:55:24 15:55:27 15:55:30 15:55:32

So when we -- when we convert a circuit to a so-called small signal model diagram, which is how we analyze it, now the -- we're looking at signals, whether they be currents or voltages or charge even, we're looking at them as variations about their bias. 15:55:34 15:55:42 15:55:46 15:55:50 15:55:53 15:55:55

This is completely standard. I'm not making it up. There's nothing unusual about this way of looking at it. 15:55:56 15:55:58 15:56:02

Q Where -- sorry. VDD is the power source that's providing the energy to M5 and M6. Correct? 15:56:03 15:56:07

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MR. MAGEE: Objection to form. 15:56:11

Q Or incorrect? 15:56:13

A Energy? I mean, not necessarily. The -- some of that -- I mean, see, it's a vague question, that's the problem. Some of the energy is supplied by VLO. 15:56:19 15:56:25 15:56:27 15:56:29

And then on top of that, the amount of energy that goes -- well, it's energy per unit second is power that we talk about. So the amount of energy per unit second that flows through M5 and M6 is also controlled by the signal current that flows through C2. 15:56:31 15:56:34 15:56:37 15:56:39 15:56:42 15:56:49

So it's -- it's true that the absolute current, that is the bias current plus the signal, is flowing from VDD to ground. But when we analyze circuits and when we think about circuits, when we describe circuits that operate on signals, it's understood that the small signal component, that's another term for it, but the signal component often called the small signal component, is the component that represents the information is a variation that rides on top of that. 15:56:51 15:56:56 15:57:00 15:57:04 15:57:07 15:57:11 15:57:16 15:57:18 15:57:21 15:57:24

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So I'll give you an analogy. Like I like to surf. And when I look at the surf report, I look at -- I get a report of how big the waves are. They're not telling me how deep the ocean is at the point where I catch the wave. It's just telling me what the variation of the thing I care about is on top of that -- on top of that total water height. 15:57:25 15:57:28 15:57:31 15:57:34 15:57:36 15:57:39 15:57:40 15:57:46

So the signal of interest is the variation about the bias point. 15:57:47 15:57:49

Q Okay. I'm going to move to strike as nonresponsive. 15:57:51 15:57:54

Sir, listen to the question. I didn't say anything about current. Okay? I asked about energy. All right? I said -- so listen to the question and please answer the question. Otherwise we'll just go to the Board and they'll make you answer the question. So I think it's pretty clear you're not answering the question because I'm talking about energy and you're going into current, and you're, like, answering the questions that I asked five questions ago. So 15:57:54 15:57:56 15:57:58 15:58:01 15:58:02 15:58:04 15:58:07 15:58:09 15:58:11 15:58:13

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strike that. 15:58:15

VDD is the power source that's providing 15:58:15

the energy to M5 and M6. Correct or incorrect? 15:58:19

MR. MAGEE: Objection to form. 15:58:22

Q You know what, either I'm right or wrong. 15:58:24

A No, there's a third option which, is -- 15:58:26

which is, it depends. And it depends on where the 15:58:28

power for the -- for LO is. 15:58:31

And also -- and, you know, I wasn't being 15:58:34

nonresponsive. You asked me whether the use of a 15:58:37

signal component or a signal current was standard 15:58:43

art. And I answered it truthfully and correctly. 15:58:47

Q I asked you that question -- sir, 15:58:50

respectfully, that's not the question I asked. 15:58:52

That was, like, three questions ago. Listen to 15:58:55

the question carefully. Strike as nonresponsive. 15:58:57

Listen to the question carefully. Don't answer a 15:58:59

question that I didn't ask. Please answer a 15:59:03

question that I did ask. 15:59:04

You even just admitted that, yeah, three 15:59:06

questions ago you asked me something and I was 15:59:07

responding to that. I'm not talking about that. 15:59:10

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So strike it. Strike it. Listen to the question. 15:59:12
Answer it. And if you can't answer it, great. I 15:59:14
don't care. Either I'm right or wrong. And if I 15:59:17
am wrong, say, You're wrong and here is why. All 15:59:20
right? Let's try this. Strike that. 15:59:22
VDD is a power source that's providing 15:59:25
the energy to M5 and M6. Correct or incorrect? 15:59:27
MR. MAGEE: Objection. Form. 15:59:31
Q And please explain. 15:59:33
MR. MAGEE: Objection. Form. 15:59:34
Argumentative. Just let the witness finish his 15:59:36
answers. 15:59:38
Q Go ahead. 15:59:38
A The question just -- I mean, energy -- 15:59:41
energy can be delivered to a capacitor because the 15:59:43
capacitor stores the energy. Energy can be 15:59:46
delivered to a resistor because the resistor 15:59:48
dissipates it. But, I mean, energy delivered to a 15:59:50
MOS transistor doesn't make a lot of sense. 15:59:57
But if I try to answer your question in 15:59:59
the most general form, then the answer is, it 16:00:02
depends. Because some of the energy that would 16:00:04

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pass through M5 would also come from the local oscillator. And therefore, it would depend on whether the local oscillator is driven by the same VDD, which often it isn't. And, also, the amount of energy which flows through M5 and M6 is also modulated by the RF signal that comes in through C2. 16:00:07 16:00:09 16:00:13 16:00:15 16:00:18 16:00:23 16:00:27

So you're insisting like, you know, answer this yes or no, and it's not a yes-or-no question because it's not fully posed. 16:00:28 16:00:30 16:00:32

Q So the energy that's moving through M5 and M6 is moving downwards. Correct? 16:00:35 16:00:38

MR. MAGEE: Objection to form. 16:00:41

A Energy -- I mean, again, it's an ill-posed question. Energy doesn't have a direction in this case. But -- 16:00:45 16:00:48 16:00:50

Q It doesn't have a direction? That's a fine question. Energy does not have a direction in this case? If that's your answer, I'm fine with that. 16:00:52 16:00:54 16:00:56 16:00:57

MR. MAGEE: Let him finish his answer. You literally interrupted it. 16:00:58 16:00:59

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Q Okay. 16:01:01

A So it's not that it doesn't have a 16:01:02

direction, but in the context -- in the context of 16:01:04

this circuit, it just doesn't make a lot of sense. 16:01:09

So we've got energy that can flow in 16:01:11

through the gate. We've got energy that can flow 16:01:14

from the drain to the source. And we've got a 16:01:17

modulation of that energy that's not only 16:01:20

controlled by the local oscillator but is also 16:01:23

controlled by the amount of current that flows in 16:01:25

through C2. 16:01:29

So if you were to measure, for example, 16:01:32

the amount of energy that is flowing per unit time 16:01:34

from the -- you know, between the gate and the 16:01:40

source, then the absolute value of that -- of that 16:01:42

energy you -- you -- I mean, even this doesn't 16:01:49

make sense. 16:01:53

Because -- 16:01:54

Q The whole case is how energy is 16:01:56

transferred. And if you're saying in Razavi you 16:01:58

can't tell if it's transferring energy or flowing 16:02:00

energy, and you can't tell which direction, I'm 16:02:02

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fine with that answer. So if you want to say -- and I think I have it already on the record. 16:02:04 16:02:06

But if you want to continue down this road and say you can't figure out which way energy goes or doesn't flow or it's not clear, that's a fine answer. I'll take it. 16:02:08 16:02:09 16:02:12 16:02:15

MR. MAGEE: So stop interrupting him. He was in the middle of his question when you interjected that. 16:02:17 16:02:19 16:02:21

A So current flows. And then -- and then current gives rise to energy storage or energy dissipation. So we can certainly say which way the absolute current flows. But, you know, as current flows from VDD to ground through these resistors, the resistors are dissipating power, and power is energy per unit time. 16:02:23 16:02:26 16:02:28 16:02:32 16:02:36 16:02:39 16:02:42

So the problem is your question is so vague I don't have a clear way to answer it. 16:02:45 16:02:47

Q Okay. I don't think my question is vague, but that's okay. Strike that. 16:02:50 16:02:53

Does current flow from M5 up to R1? 16:02:56

MR. MAGEE: Objection. 16:03:04

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A In the signal -- in the -- the signal component can flow in both directions because it can be positive or negative. If you're talking about the absolute current, then -- then the absolute current flows from VDD to ground. But when you're talking about the signal component that rides on top of that absolute bias current -- or the bias current component of that absolute current, then it can flow positively or negatively. And -- 16:03:05 16:03:07 16:03:09 16:03:11 16:03:15 16:03:19 16:03:21 16:03:24 16:03:27 16:03:29

Q There is -- okay. Go ahead. 16:03:30

A No. Go ahead. I'm sorry. 16:03:32

Q Does the signal component, does that have current, or is that current flowing up? 16:03:33 16:03:38

A It can flow -- 16:03:42

MR. MAGEE: Objection. 16:03:42

A It can flow both up and down, depending on its sine. And its sine is sometimes positive or negative. So sometimes it flows up, sometimes it flows down. 16:03:43 16:03:45 16:03:48 16:03:50

Q And is that signal a voltage? 16:03:52

MR. MAGEE: Objection. Form. 16:03:55

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A Well, you just asked about the current. And so in that sense the signal would be the signal current. If that signal current gives rise to a -- to a voltage measured at the output, or the two outputs shown there, and so in that sense, you know, the concepts of signal current and signal voltage both apply, depending on what quantity you're interested in, what quantity you're asking about. And you asked specifically about current, so my answer was in terms of current. 16:03:57 16:04:00 16:04:02 16:04:06 16:04:10 16:04:12 16:04:14 16:04:17 16:04:19 16:04:21 16:04:24

Q So -- sorry, give me a minute. The current -- strike that. 16:04:24 16:05:01

The current from the VRF does not flow through Transistor M5. Correct? 16:05:03 16:05:06

MR. MAGEE: Objection to form. 16:05:08

A What in Figure -- what in Figure 2 are you referring to as VRF? I don't see a label for it anywhere. 16:05:14 16:05:20 16:05:22

Q It's the RF signal. 16:05:23

A Okay. But the RF signal. 16:05:29

Q It's VIN. 16:05:35

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A I'm sorry? 16:05:36
Q It's VIN. 16:05:37
MR. MAGEE: Objection to form. 16:05:38
A Well, I can interpret it as VIN. But 16:05:39
that block called LNA generates an amplitude 16:05:41
version -- amplified version of the RF input 16:05:44
signal. So I can certainly consider the gate -- 16:05:46
the voltage at the gate of M4 going into the mixer 16:05:48
as the RF signal. And then M4 creates an RF signal 16:05:51
in the form of a current that goes through C2. 16:05:58
So, you know -- so if you ask me, you 16:06:02
know -- I mean, I would consider the -- you know, 16:06:06
since the mixer operates on an RF signal and 16:06:09
converts it to a different frequency, in the 16:06:12
context of your question I would interpret the 16:06:16
current going through C2 as my RF signal. 16:06:18
And as I've explained previously, that 16:06:23
when we look at it in terms of the signal current, 16:06:25
it can flow up and it can flow down. 16:06:28
Q Sir, are you aware that in your 16:06:30
declaration in the '528 patent you used VRF, you 16:06:33
certainly knew what it was? 16:06:37

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MR. MAGEE: Objection. Form. 16:06:39

A I mean, you would have to point me 16:06:43

specifically to where it is. I know what the RF 16:06:45

signal is. 16:06:47

It's just my point is simply that, 16:06:48

depending on which part of the circuit we're 16:06:50

looking at, you know, it's an RF signal until it 16:06:52

gets down-converted. So we can -- we can 16:06:55

considered the antenna jack to have an RF signal. 16:06:57

We can consider the output of the LNA to be an RF 16:07:00

signal. And, you know, until it gets 16:07:03

down-converted it's an RF signal. And so -- 16:07:04

Q Sir -- I'm sorry. Go ahead. 16:07:07

A So, I mean, I'm trying to answer your 16:07:09

question. It's -- 16:07:13

Q You're misstating. You're saying you 16:07:14

don't know what VRF is, but it's in your 16:07:16

declaration. That's where I'm having a problem. 16:07:21

A I didn't say I didn't know what VRF was. 16:07:22

I said, what do you consider VRF in this circuit? 16:07:24

Q What you consider the VRF is, exactly 16:07:28

what you consider it to be. 16:07:30

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A But, you know, it seems like we're just arguing in the air. Why don't you point me to my declaration. 16:07:30 16:07:32 16:07:35

Q All right. Exhibit -- 16:07:35

(Galton Deposition Exhibit 7 marked for identification and is attached to the transcript.) 16:07:35 16:07:40

Q You've been provided with Exhibit 7 to your deposition. And that's -- 16:07:40 16:07:42

A With my declaration, you mean? 16:07:44

Q Yeah, Exhibit 7 -- strike that. 16:07:44

Exhibit 7 is your declaration in the -- for the '528 patent case. 16:07:46 16:07:48

A And where do you want me to go to? 16:07:50

Q Paragraph 232. 16:07:52

A Hold on. 230. Do you happen to know what page that's on? 16:07:59 16:08:02

Q 126, 128. 16:08:04

A All right. Give me a second. 16:08:06

128 you said? 16:08:14

Q Page 127, Paragraph 232. 16:08:16

A Oh, I'm looking at the PDF pages. Hold on. Wait. I don't -- 16:08:20 16:08:22

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Q Sir, it's the same thing. PDF Page 127, actual Page 127. It's the same exact thing. 16:08:24 16:08:28

A Well, when I look at Page 127, I see my CV in the document you gave me. Am I looking at the wrong -- hold on a second. I'm looking at -- oh, shoot, shoot, shoot. I'm sorry. What's going on here? I'm looking at my declaration for 177 -- 16:08:31 16:08:35 16:08:39 16:08:51 16:08:52

Q I said on the '528. I dropped a new exhibit. 16:08:57 16:08:59

MR. CHARKOW: Can we go off the record? Off the record, please. 16:09:00 16:09:01

VIDEO SPECIALIST: We are going off the record at 4:09. 16:09:05 16:09:06

(A recess was taken.) 16:09:10

VIDEO SPECIALIST: We are back on the record at 4:10. 16:10:12 16:10:13

BY MR. CHARKOW: 16:10:15

Q Okay. Are you in Exhibit 7 to your deposition, which is your declaration for the '528 patent? 16:10:15 16:10:17 16:10:19

A I am. 16:10:20

Q So, actually, go one page up to 126, 16:10:21

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please. 16:10:24

A Okay. 16:10:25

Q Okay. Do you see all that purple in there? 16:10:25

A I do. 16:10:27

Q Now go to Page 127. 16:10:28

A Okay. 16:10:32

Q Do you see the third line, and it says, VRF (purple)? 16:10:32

Do you see that? 16:10:36

A Yes. 16:10:38

Q So you know what VRF is in the context of Razavi. I'm not saying anything that you don't know? 16:10:39

A And it's exactly what I told you I was interpreting it to be; namely, the current going through that capacitor. That's exactly what I told you. What I was asking you is, what were you referring to about VRF? Because you have had a history of asking me very vague questions, and I'm just trying to pin it down so I can give you a truthful, clear answer. 16:10:40 16:10:42 16:10:45 16:10:45 16:10:48 16:10:50 16:10:53 16:10:56 16:10:58 16:11:01 16:11:03

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Q Sir, you're being very -- just for the record, you're trying to pretend like you're being helpful, but you're actually being very obstructionist. So if we are going to put stuff on the record I will make that clear. Strike that. 16:11:04 16:11:06 16:11:09 16:11:11 16:11:14 16:11:16

So does -- my question was, let's go back to my question. Let's find my question. Strike that. 16:11:16 16:11:19 16:11:33

Current from VRF does not flow through Transistor M5 or M6. Correct? 16:11:35 16:11:38

MR. MAGEE: Objection. Form. 16:11:41

A Okay. As I've said before, the signal component that flows -- the signal -- the current which represents the RF signal flowing into the mixer through C2, it does, it can flow either up or down, depending on the polarity. 16:11:43 16:11:47 16:11:49 16:11:52 16:11:57

So the answer is that it can flow up or down, depending on the polarity. It's the same answer I've been giving you in multiple ways that you've asked this question. 16:12:01 16:12:05 16:12:07 16:12:09

Q Yeah, so I just want to know, does the 16:12:11

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current from VRF, does that flow through the Transistors M5 and M6, through the transistors, yes or no? 16:12:14 16:12:18 16:12:21

MR. MAGEE: Objection. Form. Asked and answered. 16:12:22 16:12:23

A Yeah, it -- it's -- the absolute current flows from VDD to ground at any given time. However, the variation of that current about the bias point can be positive or negative. And as circuit designers, we represent that variation as the actual signal. We subtract out the bias. And when viewed in that way, it flows up and down, depending -- I should say up or down, depending on whether the polarity is positive or negative. 16:12:24 16:12:30 16:12:34 16:12:35 16:12:40 16:12:44 16:12:48 16:12:50 16:12:53

Q All right. You're talking about variation in current. I'm not talking about variation in current. All I want to know is if actual current, real current, not variations based on moving stuff around or whatever you're talking about, does it go from VRF through the transistors? It's very simple. It either does or doesn't. There is either current going through it or there 16:12:55 16:12:57 16:12:59 16:13:01 16:13:05 16:13:07 16:13:10 16:13:13

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is not. You're basically saying it's affecting what's -- at the transistor is affecting things. I'm not asking it's affecting things. I'm literally asking does current, physical electrons, go through the transistors. So let me ask the question. Strike that. 16:13:15 16:13:18 16:13:21 16:13:24 16:13:27 16:13:28

Do electrons, okay, do current, do the flow of electrons, does it pass from the VRF through M5 up towards Resistor R1? 16:13:29 16:13:32 16:13:38

MR. MAGEE: Objection. Form. 16:13:42

A Actually, the answer to that question is yes. 16:13:43 16:13:45

Q Electrons pass. 16:13:45

A Electrons flow from C2 up to VDD, yes. 16:13:48

Q Okay. All right. So go back to Razavi, please. 16:13:52 16:14:03

A Okay. Hold on. Oh, I got it. Okay. 16:14:09

Q All right. So Razavi, Figure 4 says "baseband processing." 16:14:13 16:14:17

Do you see that? 16:14:18

A Yes. 16:14:20

Q And if you go to Page 1 of Razavi, and 16:14:20

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let's look what it says about Figure 4. Okay? 16:14:26
And so that's going to be the fourth paragraph on 16:14:29
the right side, starting with, "The down-converted 16:14:31
signal." 16:14:36
A So Page 1, the fourth paragraph. 16:14:37
Q Right side. 16:14:39
A Right side. Okay. "The down-converted 16:14:40
signal can be further processed by one of the 16:14:41
three permutations." Yeah. 16:14:43
Q Then it says in Figure 4A, "A low-pass 16:14:45
filter suppresses out-of-channel interferes, 16:14:48
allowing A1 to be a nonlinear, high gain amplifier 16:14:51
and the analog-to-digital converter (ADC) to have 16:14:54
a moderate dynamic range." 16:14:56
Sorry. I take that back. Let's go down 16:14:59
a little further. Sorry. Yeah. Then it says, 16:15:02
"However, the low-pass filter design entails 16:15:13
severe noise-linearity-power tradeoffs. The 16:15:16
second permutation, shown in 4B, relaxes the LPF 16:15:20
noise requirement, while demanding a higher 16:15:24
performance in the amplifier. The difficulty here 16:15:26
is that the signals are quite small and the 16:15:29

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interferers quite large. Thus, A1 must exhibit both low noise and high linearity. The present design is intended for permutations in Figures 4B and C." 16:15:31 16:15:35 16:15:38 16:15:40

Do you see that? 16:15:41

A I do. 16:15:42

Q So what Dr. Razavi is saying is that don't use Figure 4A in my design, use Figure 4B and Figure 4C. Correct? 16:15:43 16:15:45 16:15:50

MR. MAGEE: Objection. Form. 16:15:52

A I mean, he's -- he's simply saying it's intended for permutations in Figures 4A, 4B, and 4C. 16:15:54 16:15:56 16:16:01

But I would like to point out something. There is a typo in my declaration where we -- there's a reference that accidentally narrows it to 4A. And what I intended and I think what my -- the wording in my declaration says is that it's -- it's in line with Figure 4. It actually applies to all three cases. 16:16:02 16:16:03 16:16:07 16:16:13 16:16:16 16:16:19 16:16:21

Q Okay. Dr. Razavi said that Figure 4A was not his implementation, but it was 4B and 4C. 16:16:22 16:16:26

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Do you disagree with him? Would you disagree with him? 16:16:31 16:16:33

A He didn't implement it. He said, The present design is intended for permutations 4B and 4C. 16:16:34 16:16:34 16:16:40

Q Right. 16:16:40

A And I agree that that's -- that that's a reasonable -- you know, that that's a reasonable position to take. And yeah, I mean, I see that statement. He didn't -- he didn't design it, but he -- but he intended it for that. 16:16:41 16:16:42 16:16:46 16:16:51 16:16:53

Q Right. So Dr. Razavi, when he was designing his circuit, he showed Figure 1, which was something that existed in the field, Figure 1 was a receiver architecture that existed prior to his work. Correct? 16:16:55 16:16:58 16:17:00 16:17:02 16:17:05

MR. MAGEE: Objection. Form. 16:17:07

A Figure 1? Yes. Okay. 16:17:09

Q Okay. Correct? That existed prior to his work? 16:17:11 16:17:13

A Uh-huh. Yes. 16:17:14

Q And he said in his implementation, I'm 16:17:15

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not going to do 4A, which is already shown in Figure 1. I'm going to do 4B and 4C. Correct? That's what he said? 16:17:17 16:17:20 16:17:25

MR. MAGEE: Objection. 16:17:26

A He said that it's intended for implementation with Figure 4B and C. He didn't do it. So he's saying it's intended for it, but -- 16:17:27 16:17:29 16:17:32

Q Which means his intent when he -- when he was describing what his kind of concept was, was to use 4A and 4B, not -- sorry, strike that. 16:17:34 16:17:37 16:17:41

When Dr. Razavi was explaining the concept for his down-converter that he was explaining and providing diagrams for, he was saying that what I have come up with, I want to use 4B and 4C, not 4A. Correct? 16:17:45 16:17:48 16:17:50 16:17:52 16:17:57

A I think that's fair. 16:18:01

Q Okay. And if you use 4B and C and you put it into Figure 1, you wind up with an amplifier after the mixer. Correct? 16:18:01 16:18:07 16:18:10

MR. MAGEE: Objection to form. 16:18:15

A Yes, you have an amplifier followed by a -- an amplifier followed by a filter in part -- 16:18:15 16:18:20

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in B. That's what you are asking about, 4B? 16:18:25

Q Yes. 16:18:28

A Yes. So in 4B there's an amplifier followed by a filter. 16:18:28 16:18:31

Q All I want to know is, if you put 4B and 4C into Figure 1, what's going to happen in either of those embodiments is you're going to put an amplifier A1 immediately after the mixer, which is the circle with the X. Correct? 16:18:33 16:18:36 16:18:40 16:18:43 16:18:46

MR. MAGEE: Objection to form. 16:18:48

A Yes. 16:18:49

THE WITNESS: Sorry, Bobby. 16:18:49

Q All right. And so what would happen if you put an amplifier of Figure 4B and 4C next to the mixer, how would that affect how the mixer operates and what it outputs? 16:18:53 16:19:00 16:19:06 16:19:08

MR. MAGEE: Objection. Form. 16:19:09

A If you're asking what would happen if you put an amplifier following the mixer? That's your -- that's your question? 16:19:13 16:19:14 16:19:18

Q Yeah. Of Figure 4B and 4C, what would happen if you put those amplifiers right after the 16:19:19 16:19:22

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mixer? 16:19:24

A The output of the amplifier would be an amplified version of the signal coming out of the mixer. 16:19:26 16:19:28 16:19:32

Q No. What would -- what would happen to what comes out of the mixer? How would having an amplifier right after the mixer affect the signal coming out of the mixer? 16:19:32 16:19:35 16:19:39 16:19:42

MR. MAGEE: Objection to form. 16:19:43

A It would depend on what kind of amplifier you used. If it's -- if it's -- if it's a high-impedance amplifier, then it would -- it would have a relatively small effect. And if it -- if it's a lower impedance amplifier, it would have a different effect with respect to amplitude and also noise performance. 16:19:46 16:19:48 16:19:54 16:19:56 16:19:59 16:20:04 16:20:06

Q If A1 was a high-impedance amplifier, current would not flow from the mixers. Correct? 16:20:08 16:20:12

MR. MAGEE: Objection to form. 16:20:16

Q Very high impedance. 16:20:17

A Well, to the -- if the impedance is high enough, that's true. In reality it's going to be 16:20:20 16:20:22

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capacitive, some current is going to flow. But -- 16:20:24
but if you -- if you make the impedance of the 16:20:27
amplifier sufficiently high, then what you're 16:20:31
saying becomes sufficiently better and better of 16:20:33
an approximation, so yes. 16:20:36
Q All right. So back to -- strike that. 16:20:38
So back to Figure 5 of -- sorry. Strike 16:20:56
that. 16:20:58
Back to Figure 2 of Razavi. 16:20:59
A Okay. 16:21:03
Q M5 and M6 are NMOS transistors. Correct? 16:21:03
A Yes. 16:21:09
Q And current always flows from drain to 16:21:10
the source when turned on, since VDD is at the 16:21:12
drain and VRF is at the source. Correct? 16:21:16
MR. MAGEE: Objection. 16:21:21
A Again, we're talking about absolute 16:21:22
current, yes. If we're talking about signal 16:21:24
current, no. 16:21:25
Q Is signal current actual current? What's 16:21:26
the difference -- what's the difference between 16:21:33
signal current and total current? 16:21:35

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A Signal current -- 16:21:39

Q Strike that. 16:21:40

What's the difference between absolute 16:21:41

current and signal current? 16:21:43

A Absolute current is the -- if you put an 16:21:44

amp meter from the, you know, from the bottom 16:21:47

terminal of R1 and then connected it back to the 16:21:50

rest of the terminal, the total current would be 16:21:54

on that amp meter. The signal current is -- is 16:21:56

the portion of that current that is superimposed 16:22:02

about what we consider to be the bias current. 16:22:05

And, you know, so it's -- you know, it's as if 16:22:08

we're -- we're adding water to a cup. Right? 16:22:11

If the -- if the amount we add is 16:22:14

distinguishable from the amount in the cup before 16:22:17

we add it, after it's indistinguishable. So we 16:22:21

have a bias current, and we've got a variation 16:22:24

about that bias current. 16:22:26

And circuit designers, when they're 16:22:27

analyzing the signal flow through the -- through 16:22:29

the circuit, we -- we analyze the signal current 16:22:33

and signal voltage and signal charge as opposed to 16:22:37

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the absolute voltage, absolute current, and absolute charge. 16:22:40 16:22:44

Q R1 and R2 in Figure 2 are load resistors for M5 and M6. Correct? 16:22:44 16:22:49

MR. MAGEE: Objection. Form. 16:22:51

A I mean, they're -- they are resistors attached to the drain of M5 and M6. There may also be additional resistances elsewhere. And so we would normally consider the total resistance -- well, it depends. What we consider to be our load depends on what -- what resistor we consider to take the voltage from. So it -- the answer is, it depends. 16:22:54 16:22:56 16:22:59 16:23:03 16:23:07 16:23:11 16:23:13 16:23:17

Q Sir, I just want to know what Razavi shows, that's all I want to know. There is no, it depends. Razavi shows whatever it shows. Okay? So can you please answer the question. Strike that. 16:23:18 16:23:20 16:23:22 16:23:25 16:23:27

R1 and R2 are load resistors of M5 and M6. Correct or incorrect? Either I'm right or wrong. 16:23:27 16:23:32

MR. MAGEE: Objection. 16:23:34

A Once again, the question is somewhat 16:23:35

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ill-posed. 16:23:38

If you don't attach anything to the 16:23:40

output of this circuit, then yes, R1 and R2 are 16:23:41

considered to be the load resistors. If, on the 16:23:44

other hand, you connect something else to it, 16:23:46

that's not necessarily true. 16:23:48

Q Okay. Razavi doesn't disclose connecting 16:23:50

anything else to it. So I'm just saying, within 16:23:52

the bounds of Razavi, okay -- strike that. 16:23:54

Within what Razavi discloses, R1 and R2 16:23:57

are load resistors of M5 and M6. Correct or 16:24:01

incorrect? Assuming you're not adding anything 16:24:04

else that's not disclosed in Razavi. 16:24:07

MR. MAGEE: Objection to form. 16:24:08

A Now your question is not ill-posed, but 16:24:09

it's actually not correct. 16:24:11

Razavi does disclose connecting the 16:24:12

output of that mixer to additional circuits 16:24:14

downstream. And we don't know, you know, what 16:24:19

those additional circuits' properties are. And so 16:24:21

like I said, I -- you know, if you allow -- if you 16:24:25

say what's the load resistance for the case where 16:24:28

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we don't attach the output to anything, if all we have is Figure 2 and there's nothing else connected to the output, then the answer to your question is yes. 16:24:32 16:24:34 16:24:36 16:24:38

If you -- if we do what Razavi intended and attached -- and attached something to the output of this mixer, then the answer is, it depends. 16:24:38 16:24:42 16:24:46 16:24:49

Q Right. So the answer is, either R1 and R2 are load resistors of M5 or M6, or you don't know. Correct? 16:24:49 16:24:53 16:24:57

A That's not what I -- that's not what I said. 16:24:57 16:24:59

MR. MAGEE: Objection. 16:24:59

Q You literally just said that. You're like, I don't -- it's not known, right, the answer is it depends. Right? Which means you don't know. Because you don't know what's outside of Razavi. Right? Yes, there's something out there, but you don't know what else is out there. Right? 16:25:00 16:25:02 16:25:04 16:25:07 16:25:09 16:25:11

MR. MAGEE: Objection. Form. Misstates testimony. 16:25:13 16:25:15

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A I mean, saying "I don't know" means it may be, maybe not. What I'm saying is that, once we look at a circuit I will know. But in lieu of seeing what it's connected to, it's impossible to say. 16:25:21 16:25:23 16:25:28 16:25:31 16:25:34

So, I mean, I guess you could say I -- 16:25:35

Q Impossible to say is the same as saying you don't know? 16:25:35 16:25:35

A I'm sorry? 16:25:38

Q Impossible to say means you don't know. Like, it's okay to say you don't know something. I don't know a lot of things. 16:25:39 16:25:41 16:25:43

But you literally just said, It's impossible to say, which means you don't know by definition. Right? Am I missing something -- 16:25:44 16:25:46 16:25:49

MR. MAGEE: Objection. Let him finish his answer and stop putting words in his mouth. 16:25:51 16:25:54

MR. CHARKOW: Please stop. Please stop coaching the witness, Bobby. Put your objection in, however you want to put it in. 16:25:57 16:25:57 16:26:00

MR. MAGEE: I am not going to let you just talk over the witness and interrupt his 16:26:01 16:26:03

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answers. He's entitled to give his complete answer. 16:26:03 16:26:04

MR. CHARKOW: He is interrupting my questions. He's been interrupting your objections. And it's just how he responds and how we're dealing with the situation. 16:26:04 16:26:05 16:26:08 16:26:11

MR. MAGEE: Please don't interrupt him, that's the point. I don't interrupt you. We don't interrupt him. 16:26:14 16:26:15 16:26:17

If he doesn't know how to behave at a deposition, that's not our invitation to just interrupt his answers. 16:26:18 16:26:20 16:26:22

MR. CHARKOW: Right. Okay. Thank you for the advice. 16:26:23 16:26:24

Q All right. So let me ask you -- strike that, wherever I was. Move to strike as nonresponsive. 16:26:28 16:26:30 16:26:33

Let me ask you this: If something is -- let's see, what did you say. When you say -- when you say it's impossible to say in lieu of seeing what's connected impossible to say, that means you don't know. Correct? That's usually a pretty 16:26:33 16:26:38 16:26:40 16:26:43 16:26:46

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good way of saying I don't know. 16:26:48

MR. MAGEE: Objection. Form. 16:26:49

A I mean, yes. But the distinction I was trying to make, which, you know, maybe is irrelevant, is simply that it's not that the answer is maybe, maybe not because I have no idea how the circuit works. It's that maybe, maybe not because we don't know what this -- what this is going to be attached to, the specifics of it. 16:26:53 16:26:56 16:26:58 16:27:01 16:27:04 16:27:08 16:27:11

So I'm not saying that you know, golly, you know, somebody else might be able to give you an answer, but I can't. What I'm trying to explain is that the information isn't available in the document to give you an answer. That's what I meant by it's impossible to say. 16:27:15 16:27:17 16:27:18 16:27:22 16:27:25 16:27:28

So it's true that in this case I don't know. But what I was trying to make clear is it's not that it's a case of, you know, me not having an answer for you, even though the information is -- is available. I'm simply saying that it's possible to know only when more information is provided. 16:27:30 16:27:33 16:27:36 16:27:40 16:27:43 16:27:47 16:27:49

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MR. CHARKOW: Move to strike as nonresponsive. 16:27:50 16:27:51

Q That means if you need more information, if you need more information to figure something out, that means you don't know. But whatever. Move to strike as nonresponsive. Strike. Strike that. 16:27:52 16:27:54 16:27:56 16:27:59 16:28:02

VDD is at the drain. Correct? Strike that. 16:28:03 16:28:06

VDD is at the drain of M5 and M6. Correct? 16:28:06 16:28:10

MR. MAGEE: Objection. Form. 16:28:10

A No. 16:28:12

Q No? 16:28:12

A No. 16:28:12

Q Okay. So what's at the drain of M5 and M6? 16:28:13 16:28:21

MR. MAGEE: Objection to form. 16:28:23

A Well, if you're asking what voltage is at the drain of M5 and M6, it's the left voltage -- you know, the left side of the differential voltage VOUT is at the drain of M5 and the left -- 16:28:25 16:28:27 16:28:36 16:28:38

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and the right voltage of VOUT is at the drain of M6. 16:28:42

Q Did you perform any simulations of any 16:28:48

circuits in Razavi? 16:29:01

A No. 16:29:03

Q Ever? 16:29:03

A Oh, no. 16:29:08

Q Did you perform -- okay. Strike that. 16:29:13

Can you look at Figure 3 of Razavi, which 16:29:18

is the LO divider circuit. 16:29:20

A Okay. 16:29:23

Q Did you model that to determine the shape 16:29:23

of the LO signal that would come -- 16:29:26

A No, I did not model it. But I don't need 16:29:30

to model it to know the shape. 16:29:32

Q Okay. All right. So you rely on another 16:29:34

reference in the '177 patent, called Uzunoglu. 16:29:46

A Yes. 16:29:53

Q Do you know the reference? 16:29:53

A Yes. 16:29:54

Q What is Razavi missing that required you 16:29:55

to use Uzunoglu? 16:29:57

A So it comes back to that concept. We're 16:30:06

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talking about now the '177 patent, I believe. 16:30:08

Q Yes. 16:30:10

A And the Razavi doesn't stipulate that the LO frequency is exactly the same as the RF frequency and, therefore, he doesn't guarantee phase synchrony. 16:30:14 16:30:21 16:30:26 16:30:29

And it's common in receivers, especially older receivers, to use a technique called carrier synchronization, where basically you have a circuit which generates a local oscillator signal that has exactly the same frequency and the same phase as the carrier of the RF signal. 16:30:31 16:30:34 16:30:40 16:30:42 16:30:46 16:30:48

And so in synchronous receivers where that is done, you can then get away without using a quadrature path, you can just use an in-phase path, and that has the potential to save you hardware. 16:30:53 16:30:56 16:31:01 16:31:04 16:31:08

And so to use the Razavi mixer in that synchronous way, a POSITA would have known that they could have used a circuit such as Uzunoglu to generate that synchronous carrier. 16:31:09 16:31:19 16:31:21 16:31:26

Q So if you go back to Figure -- go back -- 16:31:30

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okay. Strike that. 16:31:37

Can you go back to Figure 2 of Razavi? 16:31:38

A I'm there. 16:31:41

Q The drains of M5 and M6 are connected to VDD through Resistors R1 and R2. 16:31:42

Is that correct? 16:31:45

A Yes. 16:31:48

Q And the VRF, is that the source? 16:31:49

Correct? 16:31:49

MR. MAGEE: Objection. Form. 16:31:58

A The signal is introduced to the mixer through a current that is -- that we consider in this case to be the -- not VRF in this case, but IRF. So VRF appears across that C2 and delivers current, RF current, to the mixer. 16:31:58 16:32:05 16:32:07 16:32:12 16:32:19 16:32:24

Q I'm sorry, so let's -- if you go back to your declaration for the '528 patent, Page 126. It looks to me what you call VRF, which is purple, is at the source of -- 16:32:29 16:32:33 16:32:41 16:32:44

A Just give me a second to get there. One second. 16:32:46 16:32:48

So let me read what I said. Hold on. 16:32:50

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I'm trying to find where I've -- where I've described that purple input. Give me a second. 16:33:28 16:33:31

Q Right below. 16:33:33

A Right -- tell me exactly where you are so -- 16:33:37 16:33:39

Q Paragraph 232, right below the diagram. 16:33:39

A 232. Hold on. I'm looking for where I used the word "purple." I'm just going to do a search on the word, here we go, purple. 16:33:43 16:34:02 16:34:10

Q It's where I pointed you to. 16:34:14

A So it's saying that a portion of the energy that is distinguishable from noise is transferred from the modulated carrier signal VRF purple as the output. 16:34:22 16:34:23 16:34:26 16:34:30

So the -- the purple line is showing the path that the energy -- through which energy is delivered from the voltage. 16:34:31 16:34:38 16:34:42

So -- so the -- I mean, when we talk about voltages, we're talking about voltage from one node usually to ground. So whenever he's talking about voltages, there is -- it's a voltage difference always. Whenever we don't say it 16:34:48 16:34:53 16:34:55 16:34:58 16:35:00

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explicitly is a difference, it's the difference at that node with respect to ground. 16:35:03 16:35:10

And this purple line shows -- crosses three nodes. So what we're showing is the -- where the energy is delivered in response to VRF. So it's -- it's delivered in the form of a current. And that current is proportional to the VRF input voltage. 16:35:10 16:35:12 16:35:13 16:35:18 16:35:22 16:35:26

Q So VRF is at the source of the transistors M5 and M6. Correct or incorrect? 16:35:27 16:35:31

MR. MAGEE: Objection. Form. 16:35:34

A No; what I said is correct. I mean, the -- there is a voltage at the sources in M5 and M6 that's related to -- to VRF. But the actual -- the thing that's actually proportional to VRF is the current that flows through C2. 16:35:36 16:35:40 16:35:45 16:35:52 16:35:55

Q In NMOS transistors generally, the current flows from the drain to the source when the transistor is on. Correct? 16:35:57 16:36:05 16:36:06

MR. MAGEE: Objection to form. 16:36:07

A That is not generally correct, no. 16:36:08

Q That's not correct, that current flows -- 16:36:10

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so if I look at like a textbook, it wouldn't say that in an NMOS transistors current flows from the drain to the source when the transistor is on? 16:36:13 16:36:16 16:36:21

MR. MAGEE: Objection. Form. 16:36:23

A So the answer is it depends. So when you use a transistor as a switch, the current can go in either directions. And it actually becomes somewhat ambiguous as to what you even consider to be the source. 16:36:24 16:36:27 16:36:30 16:36:32 16:36:35

In this circuit, the -- as I've said many times to your many questions about it, the absolute current through these switches when they are conductive flows from drain to source. But the signal component can go in either direction. 16:36:36 16:36:39 16:36:43 16:36:47 16:36:49

Q Okay. 16:36:53

A So I've said that many, many times to you. And every time you ask me, the answer will be the same. 16:36:53 16:36:56 16:36:58

Q Razavi does not disclose synchronization. Correct? 16:36:59 16:37:06

A That is correct. 16:37:07

Q All right. Are you familiar with the 16:37:07

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maximum power transfer theorem? 16:37:11

A Yes. 16:37:13

Q And the maximum -- strike that. 16:37:13

The maximum power transfer theorem is 16:37:16

when a source, a voltage or a current source, is 16:37:18

connected to a load, and the maximum power is 16:37:21

delivered to the load, when the load resistance is 16:37:23

equal to the internal source resistance, meaning 16:37:26

the resistance of the voltage current source. 16:37:29

Correct? 16:37:31

A Yes. 16:37:32

Q All right. Let's go -- all right. So 16:37:32

you can put all that aside. Let's go to the '528 16:37:40

patent. I'll hand that to you in a second. Give 16:37:43

me a second. I haven't given it to you. 16:37:53

A Yeah, I was going to say I didn't want to 16:37:55

get yelled at again so I didn't want to say I 16:37:57

didn't have it before I -- 16:38:00

Q Okay. You've been provided with Exhibit 16:38:01

8 to your deposition, which is the '528 patent. 16:38:02

(Galton Deposition Exhibit 8 marked for 16:38:02

identification and is attached to the transcript.) 16:38:02

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A Okay. Hold on. It's downloading. 16:38:07

Okay, I'm there. 16:38:18

Q Can you go to the Claim 1 of the '528 patent, please. 16:38:19 16:38:22

A Yeah. Hold on. 16:38:23

Q It's the last page, second-to-last page, I guess I should say. 16:38:24 16:38:26

A Okay, I'm there. 16:38:33

Q All right. Do you see the limitation that says, "a first switch"? 16:38:34 16:38:35

A "A first switch coupled to a first control signal," yes. 16:38:39 16:38:41

Q And if you keep reading down on the third line, it says, "A portion of energy that is distinguishable from noise, it's transferred from the modulated carrier signal as an output of the first switch during the sampling aperture of the first control signal." 16:38:42 16:38:44 16:38:46 16:38:48 16:38:51 16:38:55

Do you see that? 16:38:56

A Yes. 16:38:59

Q Did you perform any simulation or analysis of Tayloe to determine if energy is 16:38:59 16:39:03

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distinguishable from noise is being transferred from the modulated carrier signal during the sampling aperture? 16:39:06 16:39:11 16:39:14

MR. MAGEE: Objection. Form. 16:39:15

A No. 16:39:17

THE WITNESS: Sorry. 16:39:17

A No. And I didn't need to. 16:39:18

Q And did you perform any simulations or calculations to determine if energy is distinguishable from noise with regards to Razavi? 16:39:19 16:39:24 16:39:25

MR. MAGEE: Objection to form. 16:39:31

A No. And I didn't n e e d to. 16:39:33

Q So let's go to your declaration for the '528 patent. So this was exhibit -- 16:39:34 16:39:48

A Have you given that to me? 16:39:51

Q Yes, that's the one you didn't know where it was. And I said -- 16:39:52 16:39:55

A Give me a second. Let me just -- 16:39:57

Q Exhibit -- 16:39:59

A Okay. I've got it. Where do you want me to go? 16:40:01 16:40:02

Q Let's start with -- strike that. 16:40:03

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So I want to see how you built a circuit using Tayloe that you say invalidates the '528 patent. Okay? 16:40:09 16:40:12 16:40:16

A Okay. 16:40:16

Q So let's look at your declaration on Page 71. 16:40:16 16:40:19

A Okay. 16:40:22

Q All right. So Page 71 of your declaration shows kind of how you built a circuit. 16:40:22 16:40:36

Correct? 16:40:39

MR. MAGEE: Objection to form. 16:40:41

A I didn't build a circuit. I'm just -- I'm just showing figures from Tayloe that have been annotated, and in one case where we've expanded the commutator to the circuit diagram we would have used to implement the commutator. 16:40:43 16:40:46 16:40:51 16:40:54 16:40:59

Q Just to be clear, you're taking figures from all over the place. Let's just go through exactly what's happening here. 16:41:01 16:41:03 16:41:06

A Point me to wherever you want me to go. 16:41:08

MR. MAGEE: Hang on. 16:41:11

Q Sure. 16:41:11

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MR. CHARKOW: Sorry. Did somebody say hang on? 16:41:11 16:41:13

MR. MAGEE: Go ahead. We're ready. Move on. 16:41:13 16:41:17

Q All right. So for -- okay. Strike that. 16:41:17

Why did you take Figure 6 -- strike that. Why did you take Figure 3 of Tayloe, combine that with Figure 6 of Tayloe, and then -- and then use the op amp circuit of Figure 3? So you basically put Figure 6 in the middle of Figure 3. That's the center diagram on the page. 16:41:25 16:41:29 16:41:35 16:41:38 16:41:42 16:41:47

MR. MAGEE: Objection. Form. 16:41:51

A Okay. So first of all, what you're saying isn't true. I didn't put Figure 6 in the middle of Figure 3. That's absolutely incorrect, and I did not do it. 16:41:56 16:41:58 16:42:03 16:42:06

What I did do in the case of the combined teachings of Tayloe is I took Figure 6 and replaced the -- or implemented the commutator -- I'm sorry. Let me make sure I'm -- which figures are you talking about? You're talking about Figure 6, Figure 3, and what was the -- what was 16:42:08 16:42:12 16:42:18 16:42:25 16:42:27 16:42:29

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the third figure? 16:42:31

Q Let me just be clear. Because what you 16:42:32

just said is not correct. So I want to -- I think 16:42:34

you're missing a very important piece here. All 16:42:36

right. 16:42:39

So look at the middle diagram. So this 16:42:39

says, "Combined teachings of Tayloe." 16:42:42

Do you see that? 16:42:43

A Yep. 16:42:44

Q So on the left side we see the bias 16:42:44

network and R filter. 16:42:47

Do you see that? 16:42:48

A Yep. 16:42:50

Q That's Figure 3. Right? 16:42:50

A Uh-huh. Yes. 16:42:52

Q Then you see the commutating switch in 16:42:52

the -- in the middle. Right? 16:42:57

A Yes. 16:42:58

Q Okay. Now, if you look to Figure 6, 16:42:58

Figure 6 does not have -- Figure 6 does not have 16:43:03

an R filter, nor does it have a bias network. 16:43:07

That came from Figure 3. Right? 16:43:10

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MR. MAGEE: Objection to form. 16:43:12

Q See f1? 16:43:17

A Oh, I see what you're saying. Okay, I apologize. So let me address it one at a time. 16:43:19 16:43:21

So first of all, this is another misprint. That R filter shouldn't be there. It doesn't hurt it to be there. It still works with it there, but that R filter we shouldn't have included. 16:43:23 16:43:27 16:43:30 16:43:32 16:43:36

But as far as the rest of it goes, Tayloe discloses Figure 6. And I believe he then says that the zero, 90 degrees, 180 degrees and 270 degrees outputs can then be processed subsequently as shown in Figure 3. Or something to that effect. 16:43:38 16:43:42 16:43:46 16:43:50 16:43:53 16:43:57

And so the bottom line is that the portion of Figure 3 prior to the amplifiers 50 and 52 can be implemented equivalently as shown in Figure 6. And it turns out that if we had a resistor where -- if we had an R filter in there, it would still work. It's just that some of the R would be coming before the multiplexer and some 16:43:57 16:44:01 16:44:08 16:44:13 16:44:17 16:44:21 16:44:23

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would be coming after. 16:44:26

But in the combined teachings of Tayloe, it was a misprint to show that R filter there. So that was another mistake that I was not aware of until now. 16:44:28 16:44:31 16:44:36 16:44:37

Q Well, so I don't know how you're not aware of it. It's your report. How are you not aware of that? 16:44:38 16:44:41 16:44:43

A Well, if you're able to write documents that have zero misprints all the time, then you're better than I am. You know, when I write stuff, sometimes it has misprints. And I'm human, I make mistakes. 16:44:44 16:44:46 16:44:49 16:44:52 16:44:55

Q Sir, that's not a misprint. You literally put Figure 6 in the middle of Figure 3. There are times when you didn't do that. And then if you go down to the next one you, like, completely took out R filter. That's what I'm trying to understand. One time you have R filter and bias network, then you take it out. This isn't misprints, this is what you meant to do. Now you're saying I it's misprints but -- strike 16:44:56 16:44:58 16:45:02 16:45:05 16:45:08 16:45:10 16:45:13 16:45:16 16:45:18

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that. 16:45:21

SO just to be clear, just for the record, 16:45:21

mistake or no mistake. Strike that. 16:45:23

The center diagram, the combined teaching 16:45:26

of Tayloe, you put Figure 6 in the middle of 16:45:28

components of Figure 3. Factually that's what you 16:45:31

did. Right? 16:45:34

MR. MAGEE: Objection. Form. 16:45:35

A That is -- that is correct. And the only 16:45:36

mistake here is that R filter should not have been 16:45:39

there. Everything else about -- about the 16:45:44

combined teaching of Tayloe is completely 16:45:48

consistent with the patent. And it was just a 16:45:49

mistake to leave R filter there. We were cutting 16:45:53

and pasting stuff, and it was just an oversight. 16:45:56

That said, even if that R filter is 16:45:58

there, it doesn't change fundamentally the 16:46:00

properties of -- of Tayloe in terms of the -- of 16:46:04

the -- of what the invention describes. So it 16:46:08

shouldn't have been there. If I could go back and 16:46:12

redo it I certainly would have deleted R filter 16:46:14

there. But everything else is as intended. And 16:46:17

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if you go down to the combined system, that is what we intended without the misprint. So yeah -- I'm sorry? 16:46:21 16:46:27 16:46:32

Q You kept saying "we." Who is "we"? 16:46:33

A Well, I meant me. The we -- the attorneys helped me with these figures in the sense that I told them what -- what figures I wanted, and they created them for me. So it's on me because I didn't notice the misprint, but I had help with the -- with the preparation of the figures. 16:46:37 16:46:42 16:46:44 16:46:47 16:46:52 16:46:55 16:46:57

So, for example, I described how the -- I created the text and -- and then I requested help with the figures because there was a lot of work went into creating these documents. And I wanted some clerical help, so to speak, in generating figures. So I told them what I wanted, and they created them. And the reason -- that's the reason for the word "we." 16:46:57 16:47:03 16:47:07 16:47:10 16:47:16 16:47:19 16:47:21 16:47:24

And but the mistake is mine because I should have been able to look at it and see this mistake. And I just didn't notice it. 16:47:26 16:47:28 16:47:31

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Q Did you simulate the circuit that says Combined teachings of Tayloe? 16:47:33 16:47:36

A As I told you before, I have not simulated Tayloe in any way. 16:47:38 16:47:40

Q Why didn't you simulate this circuit on the combined teachings of Tayloe? 16:47:41 16:47:48

MR. MAGEE: Objection. Form. 16:47:50

A Because I didn't need to to understand how it works. 16:47:52 16:47:53

Q Underneath that, the last diagram on Page 71 says Combined System. 16:47:53 16:47:56

Do you see that? 16:47:58

A I do. 16:47:58

Q So here we have the TI data sheet which has been substituted in place of the commutating switch. You have Figure 6 from Tayloe, and then at the right side you have Figure 3 of Tayloe. 16:47:59 16:48:02 16:48:07 16:48:11

Correct? 16:48:14

A No, that's not correct. As I said a moment ago -- there are different pieces of this, so let me answer this. Be patient with me. 16:48:15 16:48:18 16:48:21

So first of all, Tayloe discloses Figure 16:48:24

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6 and points out that from the output of Figure 6, you build the rest of the circuit as shown in Figure 3, namely with 50, 52, and then the components following 50 and 52. It just didn't repeat that in the figure, but it makes it clear in the text that's what it's supposed to do. 16:48:26 16:48:32 16:48:35 16:48:39 16:48:41 16:48:44

So the only difference between what Tayloe teaches explicitly and what's shown in the combined system is that we didn't, like you said, put the data sheet of the -- of the MUX into this thing. We used a circuit diagram that's disclosed in the data sheet to show how on a chip we would implement the -- the commutator. 16:48:46 16:48:47 16:48:50 16:48:55 16:49:01 16:49:05 16:49:10

Q Okay. Just to be clear, Figure 6 does not show any of the differential amplifier circuitry. Correct? Just factually. It doesn't show it? 16:49:16 16:49:18 16:49:23 16:49:25

MR. MAGEE: Objection. Form. 16:49:26

A That is true. But in combination with the text, it makes it clear that that was the intent. 16:49:27 16:49:29 16:49:31

Q And you didn't simulate that circuit at 16:49:32

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the bottom, the combination system. Correct? 16:49:34

A As I've told you many times, I have not 16:49:37

simulated any part of Tayloe. 16:49:39

Q Sir, telling me many times doesn't make a 16:49:41

difference. I have to go through each piece 16:49:44

because I don't know -- I don't know what you 16:49:45

mean. I don't know if you mean Tayloe or when you 16:49:48

combine Tayloe. So I know you just want to say I 16:49:51

repeat myself, but I have to repeat myself. So I 16:49:54

apologize. But you don't have to add it. I get 16:49:57

it. I understand what I'm doing. So thank you. 16:49:59

Strike that. 16:50:02

All right. So just to be clear, you 16:50:03

removed the bias network and R filter from -- from 16:50:07

the diagram, from Tayloe -- strike that. 16:50:14

So in the combined system, you removed 16:50:18

the bias network and R filter. Correct? That's 16:50:20

not in there? 16:50:23

MR. MAGEE: Objection to form. 16:50:24

A So we're combining Figure 6 with -- when 16:50:27

we're talking about Figure 6 and we're -- and 16:50:33

we're putting it into the combined system, the 16:50:35

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figure at the bottom of that page, we have not removed the bias network, because Figure 6 does not show the bias network. So all we've done in going from Figure 6 to the bottom figure is we've expanded what the commutator would be in terms of a -- of a circuit design based on MOS transistors. And we've added the downstream amplifiers which are not shown in Figure 6 but are disclosed as being what Figure 6 would drive in the Tayloe specification. 16:50:40 16:50:42 16:50:46 16:50:50 16:50:54 16:50:58 16:51:03 16:51:06 16:51:09 16:51:15

Q So why not use Figure 3 which you started with using in the middle diagram, and why did you get rid of R filter and bias network? Why didn't you use Figure 3? Why did you use Figure 6 instead? 16:51:16 16:51:20 16:51:25 16:51:29 16:51:32

A We could have used Figure 3. I don't remember exactly why we used Figure 6. Either one of them would work. 16:51:33 16:51:35 16:51:40

I think -- yeah, so either one would work. So regard -- the only difference between figure -- so let's back up for a second. 16:51:41 16:51:44 16:51:48

Figure 6 shows what -- shows a block that 16:51:50

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performs the functionality of what R filter and the commutator and the capacitors do in Fig 3. So those two blocks are essentially equivalent from the operation -- in terms of the mathematical operations they implement. 16:51:53 16:51:57 16:52:03 16:52:06 16:52:08

And so those two things are interchangeable in terms of functionality. And I agree it would have been clearer if we had simply gone directly from Fig 6 to the combination system using switch -- using the switch of TI-1005. 16:52:09 16:52:12 16:52:14 16:52:17 16:52:23

Yeah, so certainly would have been clearer if we had done that. But the result stands. 16:52:30 16:52:32 16:52:35

Q Okay. 16:52:35

MR. CHARKOW: Let's take a break. We've been going about an hour. 16:52:36 16:52:38

THE WITNESS: Okay. 16:52:39

MR. CHARKOW: Go off the record, please. 16:52:40

VIDEO SPECIALIST: Going off the record at 4:52. 16:52:41 16:52:42

(A recess was taken.) 16:52:44

VIDEO SPECIALIST: We are back on the 17:01:37

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record at 5:01. 17:01:40

BY MR. CHARKOW: 17:01:43

Q All right. I just want to turn back to 17:01:43

Razavi for a second and the M5 and M6 transistors. 17:01:46

You referred to -- you referred to -- I 17:01:54

think you referred to signal components when you 17:01:58

were referring to what was going on in the Razavi 17:02:01

circuit. Right? 17:02:03

MR. MAGEE: Objection. Form. 17:02:07

A I did mention -- I did mention signal 17:02:08

components, yes. 17:02:10

Q And the -- it's -- when you're referring 17:02:11

to signal components, you're referring to voltage 17:02:17

fluctuations at the source. Correct? 17:02:19

MR. MAGEE: Objection to form. 17:02:22

A Well, in any part of the circuit, that 17:02:28

signal will be represented as variations. So 17:02:35

certainly there are variations related to the 17:02:38

signal at the sources. 17:02:41

But when we were talking specifically 17:02:44

about it, I was saying that the signal is 17:02:46

delivered to the mixer as in the form of a 17:02:49

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small -- of a signal current pass through C2. 17:02:54

Q Right. But you referred to the signal component and said there's a signal component that, you know, moves up or whatever. What you were referring to is a voltage fluctuation at the source. Correct? That's -- when you're referring to a signal component, that's what you're referring to. Right? I just want to know if I'm right or wrong. 17:03:00 17:03:02 17:03:04 17:03:06 17:03:09 17:03:11 17:03:13 17:03:15

A Yeah, so when I -- when we discussed this, I was -- I was -- in that particular instance I was referring to a fluctuation -- a signal -- a signal -- a signal component of a current that gets passed through C2. That does cause a voltage variation related to the signal at the sources of M5 and M6. But when I was -- when I was answering your question I was specifically talking about the signal current pass through C2. Because that's how -- that's how the signal gets delivered to the mixer. 17:03:16 17:03:17 17:03:19 17:03:24 17:03:28 17:03:31 17:03:37 17:03:40 17:03:42 17:03:47 17:03:49

Q Can you go to Page 81 of your declaration in the '528 patent, please. Page 81. 17:03:51 17:03:55

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A Okay. Hold on. 17:04:02

I'm there. 17:04:06

Q All right. So now you're taking -- now you're further building a circuit. You're taking the -- at the top of the page we see you have the TI data sheet transistors. You have the diagram from Figure 6 in the middle. And then you put the differential amplifier circuit from Macnally on the right. Correct? 17:04:06 17:04:10 17:04:13 17:04:16 17:04:22 17:04:29 17:04:36

MR. MAGEE: Objection. Form. 17:04:38

A Yes. Yes. 17:04:39

Q So what you did is, you took the differential amplifier that existed, that you previously had, and now you're replacing it with a different differential amplifier of Macnally. 17:04:45 17:04:54 17:04:58 17:05:00

Correct? Right? 17:05:03

You had the differential amplifier for Tayloe, you pulled that out now, and you put Macnally in its place. Right? 17:05:05 17:05:06 17:05:08

MR. MAGEE: Objection to form. 17:05:10

A So there were a few questions in there. So it's true that I replaced the amplifiers in 50 17:05:13 17:05:15

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and 52, or in this case just 50, with the structure shown in the blue box. That's certainly true. 17:05:19 17:05:22 17:05:24

Fifty is not a fully differential amplifier, and this is. So that's one benefit of this. And then, also, 50 is not -- does not provide additional low-pass filtering, and this does. 17:05:24 17:05:27 17:05:29 17:05:33 17:05:35

And so my point was that a POSITA would have understood at the time of the priority date that if you're going to implement this thing on a single chip, or on a chip at all, it would be highly advisable to use a fully differential circuit, which this is. And a POSITA would also know that while the resistors and capacitors shown in the figure you mentioned in Tayloe do, indeed, provide filtering, they only provide one pole of filtering. And this blue box would provide additional low-pass filtering, which a POSITA would recognize is -- is necessary in most receiver applications. 17:05:36 17:05:39 17:05:42 17:05:44 17:05:49 17:05:52 17:05:55 17:06:00 17:06:05 17:06:09 17:06:14 17:06:17 17:06:21

Q Did you simulate the circuit shown on the 17:06:22

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top of Page 81 of your declaration? 17:06:25

A The whole -- the whole circuit? Well, I 17:06:30

didn't simulate any part of it. So the answer is 17:06:32

no. 17:06:34

Q So basically you are just building a 17:06:34

circuit to show -- to get to the claims. Right? 17:06:38

You're just kind of building the circuit to show 17:06:41

the claimed invention. Right? 17:06:43

MR. MAGEE: Objection. Form. 17:06:45

A No. No, that's not the case. I'm -- I 17:06:46

am explaining how a POSITA would read Tayloe and 17:06:49

recognize that if he or she wanted to put it on a 17:06:54

chip, that it would be inadvisable to use the 17:06:57

amplifier shown in Tayloe because it's not really 17:07:02

ideal. It's not ideal for chip implementation. 17:07:05

And a POSITA would have also recognized that 17:07:07

additional low-pass filtering would be necessary 17:07:10

in most applications. So a POSITA would -- would 17:07:13

use a structure like this to achieve those 17:07:17

benefits. 17:07:20

So, you know, you're saying did I -- did 17:07:21

I purposely construe this just to satisfy the 17:07:24

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claims, and that's absolutely not the case. 17:07:26

Q Let's just back up and see what you did. 17:07:28

You used the -- you used a portion of the 17:07:31

TI data sheet. You combined it with a portion of 17:07:36

Tayloe, and then you combined that with a portion 17:07:40

of Macnally. 17:07:43

So you're taking circuit components from 17:07:45

three different references and putting them 17:07:48

together. And you don't think you are building a 17:07:50

circuit here? 17:07:52

I mean, you're a smart guy, but you're 17:07:53

building a circuit. 17:07:54

A I didn't say -- 17:07:55

MR. MAGEE: Objection. 17:07:57

A I didn't say -- you asked me whether I 17:07:57

was constructing the circuit to explicitly try to 17:08:01

hit every element of the claim. And the answer 17:08:04

is, I was -- we don't call this building a 17:08:07

circuit. We call it, you know, designing a 17:08:11

circuit, I guess you could say. 17:08:13

I was -- I was showing how a POSITA would 17:08:16

design the circuit in the case of a -- if you were 17:08:18

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going to put it on an integrated circuit. 17:08:23

And it's not that I'm combining the data 17:08:26

sheet of TI. I'm simply taking the information 17:08:28

that the schematic diagram that is shown in the TI 17:08:32

circuit, which is completely an easily 17:08:36

implementable on an IC. So I'm not changing 17:08:39

Tayloe's circuit. I'm simply showing how I would 17:08:43

implement it and how a POSITA would have known to 17:08:45

implement it. 17:08:47

Q Listen to what I'm saying. I'm only 17:08:48

saying that just factually you have -- you have 17:08:50

transistors from the TI data sheet, combined with 17:08:54

a portion of Figure 6 of Tayloe, combined with a 17:08:57

portion of Macnally. Correct or incorrect? Just 17:09:02

factually. 17:09:06

A That part is correct. 17:09:07

Q So you're designing a circuit here. 17:09:07

Correct? 17:09:12

MR. MAGEE: Objection. Form. 17:09:13

A I'm showing a -- I'm showing a design, 17:09:15

yes. 17:09:17

Q That you put together. Right? This 17:09:17

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didn't exist anywhere else you know in the world until you put this together. Right? 17:09:21 17:09:24

MR. MAGEE: Objection to form. 17:09:25

A Well, let's take it in pieces. 17:09:28

I know -- I know that since I'm using the same circuit for the commutator that Tayloe's specification recommended I use, I don't view that as changing the circuit. I'm simply expanding what's in that box. 17:09:31 17:09:35 17:09:43 17:09:46 17:09:48

So as far as -- as far as the first part of your question goes, no, that's not the case. 17:09:51 17:09:54

And for the second part, I'm making a change to Tayloe to Tayloe's Box 50 that would be advantageous in the case where we plan to implement this thing on a -- on a chip. 17:09:57 17:10:01 17:10:07 17:10:09

Q Okay. You could say that -- you could literally say any circuit component. You're a smart guy. You could say any circuit component is advantageous if you wanted to say it. Right? 17:10:11 17:10:13 17:10:17 17:10:20

I mean, you're taking random pieces of circuits from various places and just throwing them on, you know, on a diagram. Right? 17:10:23 17:10:25 17:10:27

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A So if I were willing to lie under oath, I could say anything I wanted. But I'm not willing to lie under oath. And so I'm not taking random circuits. I'm taking -- I'm taking well-established, well -- I'm taking well-established, well-known circuits. 17:10:30 17:10:32 17:10:35 17:10:39 17:10:42 17:10:45

In the case of the commutator, it's literally the circuit that is -- that is described in the specification of Tayloe. So I'm not changing anything at all there. 17:10:46 17:10:50 17:10:52 17:10:54

And as far as the blue circuit is concerned, it's a -- it's a circuit that has been around probably for as long as you and I have been around. It is well-known and still used. And it's -- it serves a purpose that is very useful with respect to Tayloe's design, but geared more toward single chip implementation. 17:10:56 17:10:57 17:10:59 17:11:02 17:11:04 17:11:12 17:11:17

Q Let me ask you a question: When Tayloe designed his circuit, this Macnally circuit shown in blue on the top of Page 81, that was known in the art. Right? 17:11:19 17:11:23 17:11:27 17:11:30

A Yes. 17:11:31

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Q So Tayloe decided he wanted to use something different. He used a different circuit. Correct? Factually. 17:11:31 17:11:34 17:11:36

A Yes. Yes. 17:11:38

Q And so he decided not to use the Macnally circuit that was probably years and years before he came up with his invention. Correct? 17:11:38 17:11:42 17:11:45

MR. MAGEE: Objection. Form. 17:11:47

A Yes. Yes. And the reason is, because for a board design, not a -- not an integrated circuit design, this would not have made sense. 17:11:49 17:11:54 17:11:59

Q Do you know Mr. Tayloe? Do you know how he thinks and why he did what he did? 17:12:01 17:12:04

A No. But I don't need to know -- I don't need to know him or what his reasoning was to know that this circuit, this blue circuit, would not be a good circuit to use in a -- at the board level. 17:12:07 17:12:10 17:12:14 17:12:17

In fact, I don't even think at the time of Tayloe you could buy an op amp that is fully differential. I'm not a hundred percent sure of that, but I've never seen one. And it's very, very uncommon even nowadays to use a fully 17:12:21 17:12:23 17:12:26 17:12:28 17:12:31

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differential op amp at the board level. 17:12:34

Q Sorry, you're saying -- sorry, you said that at the time of Tayloe they didn't have the Macnally circuit? 17:12:38 17:12:41 17:12:47

A No, that's not what I'm saying. What I'm saying is that at the time of Tayloe -- so Tayloe was building this thing on a -- on a circuit board. And the reason I know that is because they -- they talk about, you know, components they're using, one of which is the -- is the commutator circuit. So this is not a single chip solution. 17:12:48 17:12:50 17:12:53 17:12:55 17:12:58 17:13:02 17:13:07 17:13:10

So what I'm saying is that when you're implementing a circuit on a chip, it's advisable to be fully differential, like as shown in that blue box. However, since Tayloe was building the circuit at the board level, it would be really not a good idea to use this circuit because it's not on a chip. And then I added to that that I don't believe, I'm not a hundred percent sure of this but I would be surprised if you could have at the time of Tayloe even bought a standalone op amp 17:13:10 17:13:15 17:13:18 17:13:20 17:13:27 17:13:30 17:13:33 17:13:37 17:13:39 17:13:40

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that is fully differential. 17:13:45

I don't know that, that's just a guess. 17:13:46

But it would be very, very rare and inadvisable to 17:13:48

use a fully differential op amp on -- at -- you 17:13:51

know, on a -- at the board level. Because the 17:13:55

advantages that you get from going fully 17:13:58

differential are very significant on chips, and 17:14:00

less so at the board level. 17:14:06

Q Do you have any books? Have you written 17:14:07

any books on circuits or anything like that? 17:14:11

MR. MAGEE: Objection. Form. 17:14:12

A No. 17:14:13

Q Did you write any articles about circuit 17:14:14

design or any publications on circuit designs, any 17:14:16

patents on circuit designs? 17:14:19

A Yes. 17:14:21

Q You have patents on circuit designs? 17:14:22

A I have patents on -- on circuit blocks. 17:14:26

I mean, every one of my patents, it relates to 17:14:30

circuits. 17:14:32

Q Okay. Do you have -- have you written 17:14:33

papers on circuits? 17:14:35

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A Yes. 17:14:36

Q Do you ever talk about NMOS transistors 17:14:37

in any of your papers or patents? 17:14:42

A Yes. 17:14:44

Q Would it surprise you that, you know, the 17:14:44

physics of NMOS transistors don't allow for 17:14:48

bidirectional current flow? 17:14:51

MR. MAGEE: Objection to form. 17:14:53

Q Are you aware of that? Like, I don't 17:14:54

even think the physics allow that. 17:14:57

A No; it does. If you use a -- if you use 17:14:58

an NMOS transistor as a -- as a transconductor and 17:15:03

you put it across the differential outputs of a 17:15:08

circuit, current can absolutely flow in both 17:15:11

directions. 17:15:13

Q You performed simulations from Macnally 17:15:14

in another IPR. Correct? 17:15:19

You performed simulations of Macnally 17:15:21

previously. Correct? 17:15:24

A Yes. 17:15:25

Q And you didn't perform any simulations of 17:15:25

Macnally with regards to this IPR. Correct? 17:15:27

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A I did not. 17:15:29

Q And I'm talking about with the -- with 17:15:30

regard to the '528 patent IPR. Correct? 17:15:31

A I assumed that. And the answer is I did 17:15:34

not. 17:15:37

Q So let's go to Page 73 of your report, 17:15:38

that's the '528 patent. 17:15:41

A Seventy-three of the '528. Hold on a 17:15:45

second. 17:15:47

Q Yeah, top of Page 73. 17:15:48

A Got it. 17:15:49

Q So what's shown here on the top of Page 17:15:50

73 is you identified a differential amplifier, a 17:15:54

nonfully differential amplifier of Tayloe. And 17:16:00

you said, Okay, I'm going to replace that 17:16:04

Amplifier 50 of Tayloe with the fully differential 17:16:09

amplifier of Macnally. Correct? 17:16:12

A Yes. 17:16:16

Q All right. And so you're combining the 17:16:16

fully differential amplifier of Macnally with 17:16:20

Tayloe. Correct? 17:16:22

A Yes. 17:16:26

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Q And to your knowledge, you built the circuit, are you aware if that circuit has ever existed anywhere before, the configuration of Tayloe with Macnally, before you did it? 17:16:26 17:16:32 17:16:34 17:16:37

MR. MAGEE: Objection to form. 17:16:40

A You're asking me whether I know of anybody who has implemented Tayloe's circuit with 50 replaced by the block I'm showing? 17:16:41 17:16:43 17:16:46

Q Yes. 17:16:48

A I'm not aware of it, no. 17:16:49

Q Are you aware of anybody in the history of the universe ever took Tayloe or a circuit like Tayloe and replaced -- replaced a nonfully differential amplifier with a fully differential amplifier? 17:16:50 17:16:52 17:16:56 17:17:03 17:17:06

MR. MAGEE: Objection. Form. 17:17:08

A That's two questions. There were two questions there. One is did I know this with respect to Tayloe, no. Did I know this with respect to -- with respect to circuits like Tayloe, yeah. I mean, any time you go from a board implementation to a -- to a chip 17:17:09 17:17:10 17:17:12 17:17:15 17:17:20 17:17:24

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implementation, board implementations are almost always done with single-ended, not fully differential structures. And chip implementations are almost always done with fully differential structures. 17:17:28 17:17:32 17:17:34 17:17:36 17:17:39

So the answer to your -- to the second part of your compound question is yes. 17:17:40 17:17:42

Q So what's wrong -- so what's wrong with Tayloe's differential amplifier after the -- strike that. 17:17:43 17:17:47 17:17:54

Tayloe's differential amplifier, what's wrong with it? Why take -- kind of reject what Tayloe did, you know, ignore it, take it out, and put something else in its place? 17:17:54 17:17:58 17:18:01 17:18:04

MR. MAGEE: Objection to form. 17:18:06

Q It's a perfectly good amplifier circuit. It works. Right? 17:18:08 17:18:10

A You ready for my answer? 17:18:12

MR. MAGEE: Objection to form. 17:18:12

Q Yeah. 17:18:12

A So there's nothing wrong with this amplifier when implemented at the board level on a 17:18:17 17:18:19

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circuit board. But when you implement it on an integrated circuit, the components are much more tightly packed and there's -- there's -- and our power supply connections aren't as solid, so to speak. And so we have a lot of potential for coupling unwanted signals into the various nodes of the circuit. 17:18:21 17:18:24 17:18:26 17:18:30 17:18:34 17:18:36 17:18:40

And so in a fully differential circuit, like shown on the right here in this figure, any -- we lay these things out so that the symmetric components are very close to each other and the wires are close to each other. And so any energy that's coupled into -- or any charge, I should say, that's coupled into one node. Gets coupled into the corresponding node almost equally. 17:18:41 17:18:43 17:18:47 17:18:50 17:18:53 17:18:55 17:18:59 17:19:03 17:19:06

And since we're always interested -- since our signal is always defined to be the difference between any two of these corresponding nodes, then because of this, that unwanted junk that gets coupled in equally to both of those nodes goes away when we subtract it. 17:19:07 17:19:09 17:19:13 17:19:17 17:19:22 17:19:24

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And not only that, but even though the input to 50 is differential in the sense that we've got, you know, a voltage that's going up, and, you know, the signal part of the voltage is going up in one case and down in the other case, so it's differential in that respect, the impedances at these two nodes are different because the circuit is asymmetrical. And therefore, junk that gets coupled in will get coupled in asymmetrically. And when the differencing occurs, you still get that junk to be at the output, and it's indistinguishable from the signal. 17:19:27 17:19:32 17:19:38 17:19:41 17:19:43 17:19:45 17:19:48 17:19:50 17:19:53 17:19:56 17:19:59 17:20:01 17:20:04

So when we move to a chip, this problem of coupling junk in is exacerbated. But when we move to a chip, we have the ability to put these things very close together and match them very well. And because of that, junk that gets coupled in tends to get differenced out when we're looking at the signal. 17:20:04 17:20:06 17:20:12 17:20:17 17:20:19 17:20:22 17:20:25

So it's a very, very standard procedure to, when going from a board design to a chip 17:20:26 17:20:28

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design, to move from non -- not fully differential to fully differential. 17:20:31 17:20:34

Q Has anybody in the history of the universe that you've known tried to put Tayloe's circuit on a board -- strike that. 17:20:35 17:20:37 17:20:40

Has anybody in the history of universe, to your knowledge, tried to put Tayloe on a chip? 17:20:41 17:20:43

MR. MAGEE: Objection. 17:20:47

A I'm not aware of one. 17:20:48

Q Let me go back to Razavi and M5 and M6. Okay? We were talking about those earlier. 17:20:49 17:20:53

A Okay. 17:20:56

Q Okay. Are M5, M6 used as transconductors? 17:20:56 17:21:03

A No. 17:21:03

Q All right. So you would agree -- back to Tayloe. You would agree that Tayloe discloses using R filter with the capacitors to create a low-pass filter. Correct? 17:21:04 17:21:16 17:21:19 17:21:21

A Just to make sure we're literally on the same page, can you point me to what you want me to look at? 17:21:24 17:21:27 17:21:30

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Q I'm back at Tayloe. Back at Figure 3. Remember our conversation we had about Tayloe? And we looked at Tayloe and it talked about, if you use R filter with the capacitors it forms a low-pass filter? 17:21:30 17:21:33 17:21:35 17:21:37 17:21:40

A Yes. 17:21:41

Q That's what I'm talking about. 17:21:41

A Okay. 17:21:41

Q So are we on the same page? 17:21:43

A Yeah. And so hit me with the question now? 17:21:44 17:21:47

Q So you agree that Tayloe discloses using R filter and the Capacitors 72, 74, 76, and 78 to create low-pass filters. Correct? 17:21:47 17:21:49 17:21:56

A Tayloe does disclose that, yes. 17:22:01

Q So you have -- so in Tayloe you have a circuit that discloses low-pass filters, and you have a circuit that discloses differential amplifier. But you decided to change it. And you dumped out the R filter. Right? And you got rid of the low-pass filter that Tayloe talked about, and you created a filter instead with Macnally. 17:22:02 17:22:05 17:22:11 17:22:14 17:22:18 17:22:23 17:22:25

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Correct? 17:22:28

MR. MAGEE: Objection. 17:22:29

A No, that's not correct. As I told you before, that removal of R filter was a typo. It was -- it was not intended. And so at least not in the Figure 3 version. In the Figure 6 version there is no R filter there. But it was a mistake to not show R filter there. And so that was not intentional to remove it. 17:22:30 17:22:31 17:22:36 17:22:41 17:22:44 17:22:47 17:22:49

Q Sir, let's just go back through this for a second. Look at top of Page -- let's see. So your declaration, top of Page 73. 17:22:50 17:22:53 17:22:57

Do you see that? 17:22:59

A I do. 17:23:00

Q See how that's Figure 3 on the left? 17:23:00

A Yeah. 17:23:04

Q And you see how you said, I could swap out the differential amplifier 50 of Tayloe with the differential amplifier of Macnally? 17:23:05 17:23:10 17:23:15

Do you see that? 17:23:18

A I do. 17:23:18

Q Was that a mistake too, that you didn't 17:23:19

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mean to put Figure 3 in there? 17:23:21

A No. No. No. But the mistake -- you said a minute ago, part of your question was, you took out R filter and you -- and then you made other changes to the circuit. 17:23:23 17:23:26 17:23:28 17:23:32

And what I'm saying is that R filter is shown here, and it hasn't been taken out. But I just assumed you were referring back to that other figure we were talking about earlier, where R filter was left out by accident. 17:23:34 17:23:37 17:23:40 17:23:42 17:23:44

So R filter is still there in this circuit. And R filter in conjunction with those capacitors do, indeed, implement some low-pass filtering. 17:23:45 17:23:48 17:23:51 17:23:55

Q So let me just make sure it's clear. 17:23:55

So Tayloe discloses low-pass filter, like a way to create a low-pass filter. Correct? 17:23:58 17:24:01

A Uh-huh. Yes. Sorry. Yes, it does. 17:24:04

Q And Macnally discloses a way to create a low-pass filter. Correct? 17:24:07 17:24:09

A Yes. 17:24:11

Q And, actually, you used the differential 17:24:11

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amplifier of Macnally to create a low-pass filter. 17:24:16
Correct? 17:24:19
A That is correct. 17:24:20
Q So you decided to basically go with a 17:24:21
diagram that, you know, basically Figure 6, which 17:24:26
doesn't talk about a low-pass filter. And you 17:24:30
decided to then-- and even though Tayloe talks 17:24:33
about a low-pass filter. And then you decided to 17:24:35
create the low-pass filter using Macnally. 17:24:38
Correct? 17:24:41
MR. MAGEE: Objection to form. 17:24:41
A No. 17:24:42
THE WITNESS: Sorry, Bobby. 17:24:42
A No, that is not correct. 17:24:44
What -- I left the low-pass filter in 17:24:46
place as disclosed in Tayloe. But I pointed out 17:24:49
that a POSITA would recognize that the low-pass 17:24:53
filtering introduced by that R and that C is 17:24:58
usually, in most cases, would not be sufficient. 17:25:04
And so, and in technical terms that low-pass 17:25:06
filter is a so-called one-pole low-pass filter, 17:25:10
which is a very, very weak low-pass filter. 17:25:14

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And so I pointed out that a POSITA would recognize that more low-pass filtering would be necessary and, therefore, would be motivated to replace 50 with a combined amplifier and low-pass filter. 17:25:16 17:25:20 17:25:23 17:25:30 17:25:33

And Tayloe actually discloses this, albeit indirectly. They point out -- or the Tayloe specification points out that the RC filter reduces the need for filtering but doesn't necessarily eliminate it. 17:25:34 17:25:37 17:25:43 17:25:47 17:25:50

Q All right. Tayloe, the amplifier in Tayloe would have a higher impedance than the amplifier in Macnally. Correct? 17:25:53 17:25:58 17:26:01

MR. MAGEE: Objection to form. 17:26:03

A When you say "impedance," I mean, there are two inputs. 17:26:05 17:26:09

So -- so in general the answer to your question is no. 17:26:10 17:26:12

Q Would any portion of Tayloe's amplifier circuit have a higher input impedance than Macnally? 17:26:14 17:26:21 17:26:26

MR. MAGEE: Objection to form. 17:26:27

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A The bottom input, so the bottom left input to 50, would generally have a higher impedance than -- than either of the inputs of the -- of the Macnally circuit. 17:26:29 17:26:33 17:26:37 17:26:41

Q So in Figure 3 of Tayloe the -- the input to the plus of the op amp in 50 and 52 would be much higher impedance than either of the inputs, the positive or the minus, in Macnally's differential amplifier. Correct? 17:26:43 17:26:51 17:26:59 17:27:05 17:27:07

MR. MAGEE: Objection to form. 17:27:09

A Yeah, I want to -- I want to tighten that question a bit. 17:27:11 17:27:13

So first of all, we're talking about not the impedance at the plus and minus terminals. We're talking at the impedance looking into the top left and bottom left of Macnally. And we're looking at the impedance in the top left and bottom left of 50. 17:27:14 17:27:15 17:27:17 17:27:20 17:27:25 17:27:27

And so if your question is would the impedance looking into the bottom left input of 50 be higher than that looking into the bottom left input of the Macnally circuit, then the answer is 17:27:29 17:27:33 17:27:38 17:27:41

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yes. 17:27:45

Q Sorry, are you talking, like, before the 17:27:47

resistor? I'm just trying to understand. 17:27:49

So if you look at -- I'm confused. When 17:27:50

you look at Tayloe, when you say "the bottom 17:27:53

left," are you talking -- and you're looking at 17:27:55

50, are you talking about the input into the 17:27:57

resistor coming into the blue box? Are you 17:27:59

talking about the input coming into the plus sign 17:28:01

on the op amp? 17:28:04

A Well, which do you want me to comment on, 17:28:05

and I'll comment on it. 17:28:07

Q I asked you which one were you commenting 17:28:08

on. You gave me an answer. Which one were you 17:28:10

pointing to I just want to know. 17:28:12

A It's literally what I said. The bottom 17:28:14

left input to 50 has a higher impedance looking 17:28:16

into it than the bottom left input of the Macnally 17:28:19

circuit as shown in that blue box. 17:28:22

Q Bottom -- the input to 50. That's what's 17:28:24

coming into the -- there is -- you see there's a 17:28:27

resistor? So 50 on the bottom left there is a 17:28:32

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resistor. Correct? 17:28:33

A Yeah. 17:28:34

Q Is the input you're referring to before or after that resistor? 17:28:35 17:28:37

A It's before. Because I'm saying -- 17:28:39

Q All right. 17:28:40

A We're talking about 50 as a blue box. We're talking about Macnally as a blue box. Both blue boxes have two left-side inputs. And I'm talking about the bottom input to 50, which, therefore, is the bottom -- is the input into the bottom resistor. 17:28:41 17:28:43 17:28:46 17:28:49 17:28:52 17:28:54

Q All right. So the -- strike that. 17:28:55

In Tayloe, in the amplifier shown in 50, the bottom left input before the resistor on the bottom left has a much higher impedance than either of the inputs into the Macnally circuit shown on the right. Correct? 17:28:59 17:29:05 17:29:10 17:29:17 17:29:23

MR. MAGEE: Objection. Form. 17:29:24

A Yeah. And this is -- and this is one of the reasons why a POSITA would have -- would have opted on a chip to swap 50 with a circuit along 17:29:25 17:29:27 17:29:30

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the lines of the Macnally circuit. 17:29:34

Q Right. But you're changing impedance. 17:29:36

When you change impedance, you're changing a 17:29:38

circuit. Right? Like, you're not just like 17:29:40

swapping things that are kind of equivalent; 17:29:44

you're actually changing the circuit. 17:29:46

Right? If you have a high impedance and 17:29:48

a low impedance, that changes how the circuit 17:29:50

operates. Right? 17:29:51

MR. MAGEE: Objection to form. 17:29:52

A If I just change any of the values, the 17:29:53

same -- the same can be said. 17:29:55

Q Yeah. 17:29:56

A But I'm not changing the inventive aspect 17:29:57

of Tayloe. I'm just -- I'm just modifying it in a 17:30:00

way that would preserve the invention but 17:30:02

implement it in a way that's -- that's better 17:30:04

suited to single-chip implementation. 17:30:06

Q So you don't think -- so your opinion is 17:30:08

that if you take a low-impedance load and swap it 17:30:12

in place of a high-impedance load, you don't think 17:30:18

that's changing the circuit? You don't think 17:30:20

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that's changing how a circuit operates at all? 17:30:23

MR. MAGEE: Objection. 17:30:25

A That circuit, that resistor is not the load. The load is 50. I'm sorry, the load is the -- is the top-most resistor in 50. And -- and both -- the difference between -- an amplified version of the difference between the two inputs appears as a voltage across 50, so that's our load. 17:30:25 17:30:27 17:30:30 17:30:36 17:30:40 17:30:47 17:30:50

So -- 17:30:51

Q Why in the lower left-hand corner, why isn't that a load? Why isn't what's on the high impedance on the lower left-hand corner of 50, why isn't that a high-impedance load? 17:30:51 17:30:55 17:30:58 17:31:00

It is. Right? You just said it. You testified -- 17:31:03 17:31:05

A It is a high impedance -- it's a high-impedance resistance. 17:31:06 17:31:07

MR. MAGEE: Objection. 17:31:08

A But it's not the -- it's not the dominant -- that resistance looking in there is -- looking into that node is negligible compared to 17:31:09 17:31:12 17:31:16

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the -- compared to the resistance that would be seen through the commutator and through our filter. 17:31:21 17:31:24 17:31:27

So it's just terminology. We just don't think of that as the load. 17:31:27 17:31:32

Q So your answer is, I change a circuit, it's just terminology, that's your testimony? 17:31:33 17:31:37

MR. MAGEE: Objection to form. 17:31:39

A No. You're twisting my words. I meant what I said. If there's any part of what I said that is confusing let me know and I'll be happy to address it. 17:31:40 17:31:43 17:31:45 17:31:48

Q I think I got the testimony I need. Thank you. Strike that. 17:31:49 17:31:51

All right. So if you can go to Paragraph -- strike that. If you can go to Page 126 of your declaration in the '528 patent. 17:31:54 17:31:57 17:31:59

A 126. Give me a second. Okay, I'm there. 17:32:12

Q Where did you get, you see the pink VLOs? 17:32:14

A Yes. 17:32:18

Q Where did you get that from? 17:32:18

MR. MAGEE: Objection to form. 17:32:20

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A What do you mean, where did I get that from? 17:32:23 17:32:25

Q Where did you get it from? It's not -- they're just there. There's no explanation. They're just there. 17:32:25 17:32:27 17:32:29

A Where did I get what from? You're saying how do I know the waveforms? Is that what you're asking? 17:32:31 17:32:33 17:32:36

Q Yeah. 17:32:36

A Oh. 17:32:37

MR. MAGEE: Objection. 17:32:38

A Well, two -- a few reasons. First of all, in mixers of this type, you -- you would -- it's -- you want the local oscillator edges to be as sharp as possible. So you want them to approximate square waves. And the reason for that is because we're very sensitive to jitter. That is, we're very sensitive to the exact timing of those edges. 17:32:39 17:32:41 17:32:48 17:32:52 17:32:55 17:33:00 17:33:04 17:33:07

And the problem is, transistors add noise in -- you know, they'll add variations in amplitude. And so if you have a very straight 17:33:08 17:33:14 17:33:19

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up-and-down edge, adding noise doesn't change where it crosses zero, where it crosses the midpoint. 17:33:21 17:33:23 17:33:25

Whereas, if it's -- if it's a, like, sinusoidal or a highly -- you know, a slanted edge with the most slope, changing the amplitude actually moves where the zero crossing occurs and introduces more jitter. 17:33:26 17:33:28 17:33:32 17:33:35 17:33:37

So Reason 1 is that, in this type of circuit we want -- we want the edges to be as square-wave-like as possible. And, actually, I referenced in my -- in my declaration I referenced an invited tutorial paper, paper I wrote on exactly this topic. Which -- which supports what I'm saying, and it's also just extremely well-known. 17:33:39 17:33:42 17:33:50 17:33:52 17:33:56 17:33:59 17:34:03 17:34:06

And, also, let's -- if we could go back to Razavi. If we look at the LO divider circuit, this type of circuit, you can see those cross-coupled transistors at the output. And that cross-coupling is introducing positive feedback. 17:34:06 17:34:10 17:34:15 17:34:19 17:34:24

And so what happens is, it causes the 17:34:28

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circuit to slam to one -- to VDD and ground or ground and VDD as fast as possible. So that's a -- that's a kind of squaring-up circuit that helps make these edges as sharp as possible. 17:34:32 17:34:35 17:34:39 17:34:41

Q If Razavi said that's not what that shows, would you disagree with him? 17:34:43 17:34:45

A Well, it depends what he said exactly. If you want to point that -- point me to it, I'd be happy to look at it. 17:34:47 17:34:49 17:34:52

Q I'm just curious, if he stated that that's not what it shows and that it is sine wave or, you know, would you disagree with him? 17:34:53 17:34:56 17:34:59

MR. MAGEE: Objection. Form. 17:35:02

A I would have -- 17:35:04

Q Or would he have no basis to say that? 17:35:04

MR. MAGEE: Objection. Form. 17:35:06

A I would have to see the context in which he said it. I mean, I've given you my testimony. 17:35:07 17:35:09

Q It's -- if he's looking at Figure 3 and he says that generates a sine wave, would you disagree with him? Would you say that there is no way that could be? 17:35:11 17:35:14 17:35:17 17:35:19

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MR. MAGEE: Objection to form. 17:35:19

Q Based on what you're seeing here. That's the circuit. That's what you and him are left with, that's what you're looking at? 17:35:22 17:35:23 17:35:26

MR. MAGEE: Objection to form. 17:35:27

A So I would have to see what he says. 17:35:30

I mean, very often we call -- we call the I side of the -- we call the in-phase local oscillator signal a sine -- I'm sorry, a cosine and the Q a sine. But what we really mean by that is a squared-up version of a cosine and a squared-up version of a sine. 17:35:32 17:35:35 17:35:40 17:35:45 17:35:48 17:35:51

And the reason why there's often some ambiguity in the wording is because when you look at a square wave, it consists of sine waves at multiples of the local oscillator frequency. And so -- so the -- what's called the fundamental of that square wave is sinusoidal. 17:35:52 17:35:54 17:35:56 17:36:00 17:36:04 17:36:10

So it's often -- it's common to call it a sine. But I guarantee you -- and I'm sure Behzad Razavi would agree with me -- that this circuit does not produce a sine wave. It produces a 17:36:13 17:36:15 17:36:20 17:36:22

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squared-up local oscillator signal, the fundamental of which is a sine wave. But that's different than saying it is a sine wave. And yet people often just out of slang, you know, or, you know -- well, "slang" is a good word, will call it sine wave, even though it's not, actually, a sine wave. 17:36:26 17:36:30 17:36:32 17:36:34 17:36:42 17:36:48 17:36:52

Q Okay. 17:36:52

A And this happens in -- 17:36:53

Q You're saying a squared-up sine wave. You're like a sine wave that's been squared up? 17:36:55 17:36:58

A Yes. 17:37:00

Q So it's a sine wave, just that you think it's squared up. Okay. 17:37:01 17:37:03

A Hold on. No. No. No. You're twisting my words. 17:37:04 17:37:07

As soon as you -- a sine wave is a sine wave. It's got a mathematical definition. As soon as you square it up, it's no longer a sine wave; it's a -- it's a signal that contains many sine waves. And the lowest frequency sine wave that it contains is equal to -- you know, it's the 17:37:07 17:37:10 17:37:12 17:37:16 17:37:18 17:37:21

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local -- it's a sine wave local oscillator signal at the local oscillator frequency. But as soon as you add these other components to it, it doesn't become a sine wave. 17:37:25 17:37:28 17:37:31 17:37:33

Q So, but you showed a pulse. You didn't show a squared-up sine wave; you showed a pulse. 17:37:34 17:37:37

A Well, that's what a square -- squared-up sine wave looks like. 17:37:40 17:37:41

Q Okay. Sure. Okay. Then why would -- so all pulses are sine waves, basically. Right? 17:37:42 17:37:47

MR. MAGEE: Objection. Form. 17:37:51

Q They're all squared up sine waves, is that what you're saying? 17:37:51 17:37:55

MR. MAGEE: Objection to form. 17:37:56

Q Strike that. Withdraw the question. 17:37:58

You just said that if you square up a sine wave, that's a pulse. Which means that, like, all pulses, right, just basically could be squared-up sine waves or sine waves that have been squared up? 17:38:00 17:38:03 17:38:05 17:38:10 17:38:14

MR. MAGEE: Objection to form. Misstates testimony. 17:38:14 17:38:17

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A So, first of all, a pulse, if we take this, its meaning is just a single pulse. 17:38:17 17:38:19

So if you square up a sine wave, you get a sequence of pulses or what we often call a square wave. And in real life you don't get a perfect square wave, because nothing in nature is super abrupt. But we try to make those edges, as I testified, as sharp as possible. 17:38:23 17:38:26 17:38:29 17:38:32 17:38:35 17:38:37

So we square up a sine wave, with the goal of creating a signal that's as close to a square wave as possible. 17:38:39 17:38:41 17:38:44

Q Yeah, but a squared-up sine wave does not look like what you showed in your diagram. That's not -- 17:38:45 17:38:48 17:38:48

A It absolutely does. 17:38:50

Q That's a squared-up sine wave, a perfect up and down, perfect flat top, perfect flat bottom? That's a squared-up sine wave? 17:38:51 17:38:54 17:38:58

MR. MAGEE: Objection to form. 17:39:00

Q Ninety degree angles? 17:39:03

A It is in the sense that the way you square up a sine wave is you -- is you -- how to 17:39:03 17:39:05

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describe this. 17:39:12

Q Well, I'll withdraw the question. I'll withdraw the question. Let me ask you this. The question is withdrawn. 17:39:13 17:39:14 17:39:16

A Okay. 17:39:17

Q So just to be clear, if you square up a sine wave, it has perfect 90-degree angles up and down, and perfect flat tops and bottoms, that's your testimony under oath? 17:39:17 17:39:22 17:39:26 17:39:28

MR. MAGEE: Objection to form. 17:39:29

A Okay. Again, you're twisting my words. 17:39:31

Q I'm just going what's in the diagram you drew. It's -- 17:39:33 17:39:36

A If you let me answer, I will answer. Okay? If you want to -- if you want to testify, go ahead. But I'm testifying. And you've asked me a question, and I would appreciate it if you would let me answer it. 17:39:37 17:39:38 17:39:41 17:39:42 17:39:45

What I said and what I stand by is that what we would like is to create a local oscillator signal that's as close to a square wave as possible. 17:39:46 17:39:48 17:39:51 17:39:54

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Now, the way that is achieved in practice is you take a -- you drive a sine wave or something that's close to a sine wave into an amplifier that's got high gain, and you purposely overload it. 17:39:54 17:39:57 17:40:01 17:40:04 17:40:08

So the rise and fall edges are very, very sharp. And, you know, if the amplifier has enough gain, they actually look vertical. And when it saturates, it flattens out. So it won't be a perfect square wave. But the goal is to make it as close to a square wave as possible. 17:40:10 17:40:13 17:40:17 17:40:20 17:40:22 17:40:25

Q Did you remember in Figure 3 to take a look at the resistors in the LO divider circuit? 17:40:29 17:40:31

MR. MAGEE: Objection to form. 17:40:35

Q And how that -- those -- how that would affect the flip-flop and what it outputs through -- 17:40:37 17:40:40 17:40:45

MR. MAGEE: Objection. 17:40:45

Q -- to M5 and M5 to M6? 17:40:46

MR. MAGEE: Objection to form. 17:40:50

A So, yes. But the -- the positive feedback latches there introduce -- well, they 17:40:53 17:40:56

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introduce positive feedback, which has the goal of making those edges as sharp as possible. 17:41:00 17:41:03

So it won't be a perfect square wave, but it is -- the intent is to make those edges as sharp as possible. 17:41:05 17:41:07 17:41:11

And so if you were to plot the output of the circuit, depending on how you sized the transistors relative to those resistors, it would look like an approximate square wave. And like I said, the goal, period, is to make the edges of those LOs as sharp as possible. 17:41:12 17:41:13 17:41:19 17:41:22 17:41:24 17:41:27

And because this positive feedback circuit tends to latch -- cause things to hit the rails, it has the effect of flattening at the top and the bottom. 17:41:32 17:41:34 17:41:43 17:41:46

Q Right. And the size will be all sorts of like -- like sine waves, like bowed. Right? It's like a -- it's like a sine wave with, like, the top and bottom is a little flat. Right? That's what it actually looks like. Not what you drew, which is perfect 90-degree angles. Right? 17:41:47 17:41:50 17:41:54 17:41:56 17:41:59 17:42:01

A So what I drew isn't -- is an 17:42:04

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idealization. Just like when you draw a sine wave, it's an idealization. Nothing that we build is perfect. 17:42:06 17:42:09 17:42:11

But it's -- if you provide enough amplification to a sine wave and then you clip it, those -- what -- while what you said is true, the edges will be a portion of a sine wave or related to that, because you've provided so much amplification it looks very much like a sharp edge. 17:42:12 17:42:16 17:42:19 17:42:22 17:42:25 17:42:30 17:42:32

So I've said over and over again that the square wave is an idealization, and our goal is to come as close to that as possible to minimize noise. 17:42:33 17:42:36 17:42:39 17:42:41

Q Sir, you talked about intent. How can you talk about -- where did you get intent from? Did you talk to Dr. Razavi? Where is the intent to make this a perfect square wave or pulse, pulses that you showed on Page 126? You're talking about intent. Point me in Razavi where he talks about intent. 17:42:41 17:42:44 17:42:48 17:42:50 17:42:53 17:42:56 17:42:59

MR. MAGEE: Objection. 17:43:00

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A Well, the goal, whenever you're designing a circuit you want it to have as little noise as possible for the power consumption, you know, for the power it's consuming. Right? Otherwise -- otherwise you're just wasting power. Okay? So we always want to minimize the noise subject to how much power we're consuming. And it's just a fundamental concept in circuit design that if you want to minimize the noise of a resistor, you should make those edges as sharp as possible. 17:43:00 17:43:02 17:43:05 17:43:08 17:43:11 17:43:15 17:43:18 17:43:23 17:43:26 17:43:29

And I earlier in my testimony I explained the reason for it. And I have a reference in my -- in my declaration, which is a highly cited invited paper that I wrote, and it's a tutorial paper so it's not something I invented. It's -- you know, I'm just explaining the reason for this. 17:43:33 17:43:36 17:43:39 17:43:44 17:43:48 17:43:50

I go into great detail to explain why that is the case. 17:43:53 17:43:56

Q Sir, I just want to know what you drew in 126, the pink. Okay? Is that exactly, exactly, perfectly what comes out of the Razavi circuit shown in Figure 3? Is that exactly how it looks, 17:43:57 17:44:00 17:44:03 17:44:07

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perfectly? 17:44:12

A No. It's an idealization of what it 17:44:13

would look like. But it -- but it would look 17:44:15

reasonably close to that. 17:44:17

Any -- any waveform you draw by hand 17:44:19

is -- is an approximate version. When you say a 17:44:22

sine wave comes out, it's never a sine wave even 17:44:25

if when you're trying to design a sine wave. It's 17:44:27

something that approximates a sine wave. And yet, 17:44:30

we model it as a sine wave, if that's what we're 17:44:32

doing, we would model it as an exact sine wave 17:44:35

with the understanding that's an idealization of 17:44:38

it. 17:44:40

So in the case of the square wave, it's 17:44:40

an idealization. It is what we would have liked 17:44:43

to have created if possible. And we come close to 17:44:45

it depending on how well we design this circuit. 17:44:47

Q Just to be clear, just yes or no, what 17:44:51

you drew on Page 126 in pink is not exactly what 17:44:53

comes out of Figure 3. Correct or incorrect? I 17:44:58

just want to know. 17:45:02

MR. MAGEE: Objection. Form. 17:45:03

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A It's an idealization, and it's a representation of it. But it's not exactly the same. 17:45:04 17:45:06 17:45:08

Q Okay. Do you have a piece of paper with you anywhere in your room? 17:45:09 17:45:11

A No. 17:45:13

Q You don't have a piece of paper nowhere? 17:45:14

MR. CHARKOW: Can we take a break? I would like you to grab a piece of paper. Can we take a break, please. 17:45:17 17:45:20 17:45:23

VIDEO SPECIALIST: We are going off the record at 5:45. 17:45:24 17:45:25

(A recess was taken.) 17:45:30

VIDEO SPECIALIST: We are back on the record at 5:46. 17:45:58 17:46:35

BY MR. CHARKOW: 17:46:37

Q Okay. So in front of you you have a blank piece of paper. And on it you have written Exhibit 9. Correct? 17:46:38 17:46:40 17:46:43

A Yes. 17:46:44

(Galton Deposition Exhibit 9 marked for identification.) 17:46:44 17:46:45

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Q So just to clear, after this deposition don't destroy that. Okay? Keep it, give it to your counsel. Okay? 17:46:45 17:46:48 17:46:51

A Okay. May I ask you a quick question first? I have a proposal that might be more efficient than this. I referenced that paper I described. I imagine you're going to ask me to draw a local oscillator signal, and I have a paper that discusses this in detail. I could share it and point to you. 17:46:52 17:46:53 17:46:55 17:46:59 17:47:03 17:47:05 17:47:07

Q That's okay. I don't want that. 17:47:08

A Okay. 17:47:08

Q So okay. So you have Exhibit 9 in front of you, which is currently a blank piece of paper. Correct? 17:47:10 17:47:12 17:47:15

A Uh-huh. 17:47:15

Q With Exhibit 9 on it? 17:47:15

A Yes. 17:47:17

Q I would like you to draw exactly, as best you can, exactly the shape of the waveform that will come out of the circuit shown in Figure 3 of Razavi. 17:47:17 17:47:20 17:47:25 17:47:29

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A Let me look at Figure 3. I mean, it's going to be a -- it's going to be -- 17:47:31 17:47:33

Q Just draw it. Whatever it is, just draw it. 17:47:36 17:47:38

A All right. Give me a second. 17:47:39

So it's going to be something that -- let me draw it and then I'll explain it. 17:47:41 17:47:43

Q Okay. 17:47:44

A Okay. Its a he going to be something that looks like this. Can you see it? 17:48:01 17:48:02

Q Yep. 17:48:05

A It's not going to look exactly like that because we need to run a simulation to show it. 17:48:05 17:48:08

But the point is that we want these edges to be as sharp as possible. And usually what happens is, when you don't get a perfect clipping, usually there's some ringing and stuff. But these edges tend to look like this. 17:48:11 17:48:15 17:48:18 17:48:21 17:48:23

Q Okay. Sorry, can you redraw Number 9, because I don't want all these -- all I asked for was you to draw what you would see. And you put circles around it. So rip off that piece of 17:48:25 17:48:27 17:48:31 17:48:34

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paper, rip it up. And start again. I don't want anything on it -- 17:48:37 17:48:39

MR. MAGEE: For the record, we should make it Exhibit 10. We shouldn't destroy it. 17:48:41 17:48:42

MR. CHARKOW: That's fine. Keep it Exhibit 9. Make Exhibit 10. 17:48:45 17:48:47

(Galton Deposition Exhibit 10 marked for identification and is attached to the transcript.) 17:48:47 17:48:50

Q Let me know when you're done. And put Exhibit 10. 17:48:50 17:48:55

A Okay. 17:48:56

Q Are you done? 17:48:56

A Not yet. Give me a second. 17:48:57

Q I just wanted to know if you're done putting Exhibit 10 on it, not if you were done drawing completely. 17:48:58 17:49:01 17:49:04

A I'm done putting Exhibit 10 on it. Now I'm drawing. 17:49:05 17:49:08

Okay. It would look something like this, where, as I mentioned, the goal of the circuit is to make those edges as sharp as possible. And but they're not going to be perfect. 17:49:13 17:49:16 17:49:19 17:49:22

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Q So Exhibit 10 is what you believe would come out of the circuit of Figure 3 of Razavi. Correct? 17:49:24 17:49:28 17:49:31

A Well, each -- each of those -- when we look at the local oscillator outputs, there are four outputs, ILO and QLO, and they each have two outputs. This would be what I expect the voltage swing at those nodes to look like. 17:49:35 17:49:37 17:49:41 17:49:45 17:49:48

Q Okay. So -- and just to be clear, what you drew on Figure 10 looks different than what you put on Page 126, just factually, of your report. Correct? 17:49:52 17:49:59 17:50:03 17:50:08

MR. MAGEE: Objection. 17:50:08

A Slightly. 17:50:10

THE WITNESS: Sorry, Bobby. 17:50:10

A Slightly. But this is very common. We -- we -- it's what we draw -- what I drew on Figure 10 is what we're striving to achieve. And what we achieve in reality is going to be -- deviate from that somewhat because no circuits are perfect. And it's the same -- in the old days we often used -- or we -- in the very old days people 17:50:12 17:50:14 17:50:18 17:50:24 17:50:27 17:50:30 17:50:33

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tended to use sinusoidal LOs. And they would show the sinusoidal LO as a perfect sine wave. But circuits would not generate perfect sine wave. They generate sine-wave-like waveforms, just like this is a square-wave-like waveform. So it is very common that we draw the idealization of what we're trying to do as opposed to the actual waveform. 17:50:36 17:50:42 17:50:46 17:50:50 17:50:53 17:50:57 17:51:01 17:51:04

And this is -- this is very common. In '177, for instance, the carrier signal is shown, you know -- everything is very idealized to show the concept and to show the objective. But in reality there are other impairments that aren't shown, such as noise and distortion and so forth. 17:51:04 17:51:08 17:51:12 17:51:14 17:51:18 17:51:21

Q Are you finished? 17:51:24

A I am. 17:51:26

MR. MAGEE: All right. Counsel, can we just go off the record for one second? I'm sorry. 17:51:27 17:51:29

MR. CHARKOW: Sure. 17:51:31

Off the record, please. 17:51:32

VIDEO SPECIALIST: We are going off the record at 5:51. 17:51:33 17:51:34

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(A recess was taken.) 17:51:36

VIDEO SPECIALIST: We are back on at 17:51:59

5:52. 17:52:09

BY MR. CHARKOW: 17:52:09

Q All right. So I'm just asking you a very 17:52:10

simple question. I just want a simple answer, to 17:52:12

the extent you can. Just -- strike that. 17:52:14

What you drew on Figure 10, factually it 17:52:16

looks different than what you put on Page 126. 17:52:20

Correct or incorrect? 17:52:23

A It -- it is -- it does look different, 17:52:25

yes. 17:52:28

Q Okay. 17:52:28

A And I've explained why. 17:52:29

Q And let me -- okay. So let's go back. 17:52:30

And when you drew that diagram you just drew, did 17:52:33

you consider the resistors that I mentioned in 17:52:36

Figure 3 and how those would affect the signal 17:52:38

that would come out? 17:52:41

A Yes. In the sense that -- that the 17:52:43

positive feedback of those cross-coupled 17:52:46

components, I am treating as being strong relative 17:52:49

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to the -- you know, to the effect of those resistors. 17:52:53 17:52:58

But, you know, I am not a human simulator. So if you were to simulate this, it would qualitatively look like what I drew. But, you know, things where I put little bumps and stuff, you know, that's going to be very specific in a circuit. And I can't say exactly what it would be. But what I'm telling you and what I have been telling you multiple times is that the objective is to make the edges as sharp as possible. And this circuit approximates that. 17:52:58 17:53:01 17:53:02 17:53:05 17:53:08 17:53:10 17:53:13 17:53:15 17:53:16 17:53:19

Q Right. So can you look at Page 1 of Razavi, please. And I'm on the right-hand side, Page 1, third paragraph that starts with, Figure 3 illustrates. 17:53:24 17:53:26 17:53:30 17:53:34

A Hold on I've got to find it. One second. Where the hell did Razavi go? Oh, here it is. Okay. So Page 1. And what? 17:53:35 17:53:39 17:53:49

Q Page 1, third paragraph, starts with, "Figure 3." 17:53:51 17:53:53

A Page 1, third paragraph. Starts with -- 17:53:54

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Figure 3, you mean? 17:53:58

Q "Figure 3 illustrates." First page, 17:53:59

right-hand side -- right-hand side, third 17:54:02

paragraph. 17:54:04

A Oh, right-hand side. I'm sorry. 17:54:04

Q "Figure 3 illustrates." 17:54:07

A Yeah, I see that. 17:54:08

Q So I would like you to look at Razavi 17:54:09

Page 1, right-hand side, third paragraph, last 17:54:11

sentence. And it says, "Resistors R5 and R6 17:54:14

shift." 17:54:17

Do you see that? 17:54:17

A Yes. 17:54:18

Q It says, "Resistors R5 and R6 shift the 17:54:18

high level of ILO and QLO down to avoid driving the 17:54:23

mixer switching pairs into the triode region." 17:54:28

Do you see that? 17:54:31

A I do. 17:54:32

Q Did you consider that when you drew your 17:54:32

diagram? 17:54:34

A Yes. That's not relevant to my diagram. 17:54:35

Q Not relevant to your diagram? Okay. 17:54:37

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A I can explain it further, if you'd like. 17:54:51
Q No. That's fine. I'll have my expert 17:54:53
explain it. All right. Strike that. 17:54:57
All right. If you could go to Figure 5 17:55:02
of Razavi. So Figure 5 of Razavi says, Baseband 17:55:04
Amplifier. 17:55:07
Do you see that? 17:55:07
A Give me a second. Figure -- yeah, I see 17:55:08
it. 17:55:10
Q And do you see the VIN on the left side? 17:55:10
A I do. 17:55:13
Q And those VINs go directly into the gates 17:55:13
of the transistors, with no intervening circuitry. 17:55:19
Right? 17:55:21
MR. MAGEE: Objection to form. 17:55:22
A So you're asking whether VIN, VIN wires go 17:55:27
directly into the gates of the transistors? 17:55:31
Q Yeah. 17:55:33
A Yes, that's what the figure shows. 17:55:34
Q All right. And that would be high 17:55:35
impedance. Right, for NMOS Transistors M1 and M2, 17:55:37
that would be a high impedance. Correct? 17:55:41

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A It would be very high resistance, and the capacitance would have an impedance which starts out very high and decreases with frequency. 17:55:42 17:55:45 17:55:48

Q Sure. Okay. Strike that. All right. 17:55:52

So if you could turn to Paragraph 58 of your declaration. And this is on -- sorry. Sorry. Paragraph 111, Page 58 of your declaration in the '528 case. 17:55:58 17:56:02 17:56:05 17:56:09

A Page 111, you said? 17:56:13

Q I messed it up. It's Paragraph 58, Paragraph 111. 17:56:18 17:56:20

A Oh, Page 58. Hold on a second. 17:56:21

Got it. 17:56:32

Q So on Page 58 of your declaration in the '528 case, on the top of that page you see the Macnally circuit with red and blue boxes drawn? 17:56:32 17:56:35 17:56:42

A I do. 17:56:45

Q The anti-alias as -- strike that. 17:56:45

The anti-alias filter is a low-pass filter in Macnally, what's shown in the blue box. 17:56:50 17:56:55

Correct? 17:56:59

A Yes. 17:56:59

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Q And as a matter of fact, each differential amplifier circuit shown in that blue box is a low-pass filter. Correct? 17:56:59 17:57:01 17:57:04

MR. MAGEE: Objection to form. 17:57:05

A Each biquad is a low-pass filter. The triangle as an op amp isn't a low-pass filter by itself. But when you -- when you draw a subbox that divides the blue box in half, then -- then each half of that bigger blue box is a low-pass filter. 17:57:08 17:57:11 17:57:14 17:57:18 17:57:21 17:57:25

Q Isn't each half of that blue box a differential amplifier circuit? 17:57:25 17:57:28

MR. MAGEE: Objection. Form. 17:57:30

A It performs differential amplification and low-pass filtering. 17:57:30 17:57:35

Q Okay. But you would call that a differential amplifier? I understand it performs other functions. But you're saying that a person in your field will not call one of those biquads or whatever you called it a differential amplifier? I mean, you call it that in your report. 17:57:36 17:57:38 17:57:40 17:57:42 17:57:46 17:57:48 17:57:50

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A Yeah, I mean, it -- the sort of formal, correct name for it would be a differential biquad. But because it performs amplification, it would not be incorrect to also call it a differential amplifier or a differential low-pass filter. 17:57:51 17:57:55 17:57:58 17:58:01 17:58:03 17:58:06

Q So if you divide -- all right. So if you look in the blue box of -- strike that. 17:58:06 17:58:09

If you look in Macnally, the diagram that you put on Page 58 of your report at the top in the blue box, there are two differential amplifier circuits. Correct? 17:58:12 17:58:15 17:58:18 17:58:21

A There are two differential, fully differential biquad circuits, yes. 17:58:22 17:58:23

Q And each circuit can perform or act as a low-pass filter. Correct? 17:58:25 17:58:30

A That's correct. 17:58:32

Q Can you go to Page 75 of your declaration, please? 17:58:32 17:58:35

A Sure. 17:58:36

Okay. 17:58:41

Q So Page 75, Paragraph 143 in particular. 17:58:44

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All right? 17:58:50

A Okay. 17:58:53

Q And in Paragraph 143 you express that 17:58:53

Macnally would be beneficial as a low-pass filter. 17:58:56

Correct? 17:58:59

A That's what I say. Can I just zoom out a 17:59:01

bit? I just want to make -- are we talking -- is 17:59:03

this the part where I talk about it connecting 17:59:06

with Razavi or with Tayloe? 17:59:08

Q Do whatever you want. I don't know what 17:59:09

to tell you. You can do whatever you want. 17:59:12

A You are dumping me into the middle. Let 17:59:15

me just look at the context. Tayloe. So yes, go 17:59:17

on. 17:59:22

Q Strike that. 17:59:22

In Paragraph 143 of your report on the 17:59:23

'528 patent, you discuss how Macnally would be 17:59:26

beneficial as a low-pass filter. Correct? 17:59:29

A Yes. 17:59:31

Q And Tayloe specifically touts that it has 17:59:31

a filter that uses R filter to create -- strike 17:59:40

that. 17:59:43

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Tayloe specifically touts its low-pass filter using R filter and the capacitors. Correct? 17:59:43 17:59:47 17:59:51

MR. MAGEE: Objection. Form. 17:59:51

A It is correct. But as I testified earlier, it only provides a one-pole low-pass filter, which a POSITA would have recognized is generally insufficient. And even in the Tayloe specification they point out that it isn't necessarily sufficient and acknowledge the need for potential -- sorry, for the potential for the -- the need for additional filtering. 17:59:52 17:59:54 17:59:58 18:00:01 18:00:03 18:00:06 18:00:10 18:00:13

Q All right. So can we go to Page 132 of your declaration, please? This is the '528 patent declaration. 18:00:17 18:00:26 18:00:33

A Got it. 18:00:43

Q All right. So you see on -- strike that. 18:00:44

On Page 133 -- sorry. Go to Page 133. I'm sorry. I think I gave you the wrong page. There's a diagram on the top. 18:00:48 18:00:56 18:00:58

A Yes. 18:01:00

Q So you're on Page 133 of your '528 patent 18:01:00

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declaration. Correct? 18:01:05

A Yes. 18:01:06

Q And you see there is a diagram that says 18:01:06

Combination Receiver. 18:01:10

Do you see that? 18:01:12

A I do. 18:01:13

Q And that's a combination of the mixer 18:01:13

circuit of Razavi and the differential amplifier 18:01:15

of Macnally. Correct? 18:01:19

MR. MAGEE: Objection. Form. 18:01:22

A Yes. 18:01:23

Q So did you perform any circuit 18:01:23

simulations on this circuit shown on Page -- on 18:01:27

the top of Page 133? 18:01:30

A Not in the context of Razavi. 18:01:33

Q Do you perform any circuit circulations 18:01:37

in any other contexts with regards to what's shown 18:01:40

on the top of Page 133? 18:01:43

A Well, as you pointed out earlier, for 18:01:45

another document I simulated Macnally's circuit in 18:01:50

conjunction with the rest of Macnally. So I 18:01:58

have -- I have simulated the blue box, just not 18:02:01

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the blue box attached to Razavi's circuit. 18:02:06

Q So what's shown on Page 133, just the 18:02:08

exact circuit that you've drawn out on Page 133, 18:02:12

you have not simulated that circuit ever? 18:02:16

A That is correct. 18:02:18

Q And so basically what you're showing here 18:02:19

is, on the top of Page 133 of your declaration, is 18:02:26

combining the low-pass filter of Macnally or the 18:02:33

differential amplifier of Macnally immediately 18:02:36

after Razavi's mixer. 18:02:38

That's what you're showing. Right? 18:02:39

A Yes. Although I want to remind you that 18:02:41

this is both a low-pass filter and an amplifier 18:02:45

operating simultaneously. 18:02:48

Q Okay. Do you recall in Figure 4A and 4B 18:02:50

and 4C, do you remember our discussion about that 18:02:58

in Razavi? 18:03:00

A Yes. 18:03:01

Q And you remember how we said put it -- 18:03:02

use the amplifiers and put that at the output of 18:03:05

the mixer? Do you remember that? 18:03:07

A Yes. 18:03:09

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Q And here you're putting something which is I guess an amplifier and a low-pass filter at the output of the mixer. Correct? 18:03:10 18:03:14 18:03:18

A Yes. So -- so it combines the operation of amplification and filtering. 18:03:20 18:03:24

MR. CHARKOW: Can we take a break. I may be getting close. Let's go off the record, please. 18:03:27 18:03:28 18:03:30

VIDEO SPECIALIST: We are going off the record at 6:03. 18:03:31 18:03:32

(A recess was taken.) 18:03:34

VIDEO SPECIALIST: We are back on the record at 6:15. 18:15:18 18:15:31

MR. CHARKOW: No further questions at this time. 18:15:33 18:15:34

MR. MAGEE: Okay. We have no questions. 18:15:35

We're going to read and sign. 18:15:39

MR. CHARKOW: Okay. We can go off the record. 18:15:41 18:15:42

Thank you very much. 18:15:42

VIDEO SPECIALIST: This marks the end of the deposition of Dr. Ian Galton. 18:15:43 18:15:45

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We are going off the record at 6:15 p.m. 18:15:58

(Off the record at 6:15 p.m. EDT.)

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ACKNOWLEDGMENT OF DEPONENT

I, IAN GALTON, Ph.D., do hereby acknowledge that I have read and examined the foregoing testimony, and the same is a true, correct and complete transcription of the testimony given by me, and any corrections appear on the attached Errata sheet signed by me.

_____ _____

(DATE) (SIGNATURE)

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C E R T I F I C A T E

I, Debra Ann Whitehead, E-Notary Public in and for the Commonwealth of Virginia, do hereby certify:

That IAN GALTON, Ph.D., the witness whose deposition is hereinbefore set forth, was duly sworn by me before the commencement of such deposition and that such deposition was taken virtually and is a true record of the testimony given by such witness.

I further certify that the adverse parties, TEXAS INSTRUMENTS INCORPORATED and NXP USA, INC., were represented by counsel at the deposition.

I further certify that the deposition of IAN GALTON, Ph.D., occurred virtually, on Wednesday, March 12, 2025, from 12:03 p.m. to 6:15 p.m. EDT.

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I further certify that I am not related to any of the parties to this action by blood or marriage, I am not employed by or an attorney to any of the parties to this action, and that I am in no way interested, financially or otherwise, in the outcome of this matter.

IN WITNESS WHEREOF, I have hereunto set my hand this 14th day of March, 2025.

My commission expires:

October 31, 2027



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a1
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