

UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE PATENT TRIAL AND APPEAL BOARD

BOE TECHNOLOGY GROUP CO., LTD.,

Petitioner,

v.

138 EAST LCD ADVANCEMENTS LIMITED,

Patent Owner.

DEPOSITION OF E. FRED SCHUBERT

May 28, 2025

9:00 a.m.

Robins Kaplan LLP, 800 LaSalle Avenue, Suite 2800,

Minneapolis, Minnesota 55402

Reported by:

Jonathan Wonnell, RMR

Job No.: 57004

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BOE v. 138 East - IPR2024-00973

1 A P P E A R A N C E S

2

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1 C O N T E N T S

2 WITNESS PAGE

3 E. FRED SCHUBERT

4 By Mr. Rodkey: 4

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9 E X H I B I T S R E F E R R E D T O

10 LABEL PAGE

11 Paper No. 18 - Notice of deposition 7

12 Exhibit 2001 - Curriculum vitae of E. Fred Schubert 9

13 Exhibit 2009 - Declaration of E. Fred Schubert 59

14

15

16 REPORTER'S NOTE: All quotations from exhibits are
17 reflected in the manner in which they were read into
18 the record and do not necessarily reflect exact
quotes from the source documents nor necessarily
match punctuation.

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1 P R O C E E D I N G S

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3 Whereupon,

4 E. FRED SCHUBERT,

5 called as a Witness, was duly sworn by
6 Jonathan Wonnell, a Notary Public in and
7 for the State of Minnesota, and was
8 examined and testified as follows.

9 * * * * *

10 EXAMINATION BY COUNSEL FOR THE PETITIONER

11 BY MR. RODKEY:

12 Q Good morning, Dr. Schubert.

13 A **Good morning.**

14 Q Could you please state your full name, for
15 the record?

16 A **Eric Fred Schubert.**

17 Q And have you ever been deposed before,
18 Dr. Schubert?

19 A **Yes.**

20 Q And how many times?

21 A **More than 30 times.**

22 Q And since you've done this before I know
23 that you generally know how these depositions go, but
24 I'm going to just go over the rules one more times so
25 that we're on the same page as to how this will

1 proceed. And do you understand that you are under
2 oath today to tell the truth?

3 **A Yes.**

4 **Q** And is there any reason that you cannot
5 give true and accurate testimony today?

6 **A No reason.**

7 **Q** And do you understand that you're not
8 allowed to speak with your attorneys about the
9 substance of your deposition during any breaks we
10 have?

11 **A Understood.**

12 **Q** And do you understand that you cannot
13 communicate with anyone else about the substance of
14 your testimony during any breaks?

15 **A Understood.**

16 **Q** And do you understand that counsel may
17 object to one or more of my questions but you still
18 have to answer the question unless it implicates
19 privilege and you are instructed not to answer?

20 **A Understood.**

21 **Q** And if you do not understand a question
22 please ask me to clarify and I may attempt to do so.
23 Is that okay?

24 **A Yes.**

25 **Q** And if I -- if you don't ask for

1 clarification I will assume that you've understood
2 the question. Is that fair?

3 **A** **Yes.**

4 **Q** And because we are having this deposition
5 recorded by written transcript can you please answer
6 verbally with a yes or a no and not gestures such as
7 shaking your head. Is that okay?

8 **A** **Yes.**

9 **Q** And I will try to break about every hour,
10 but if you need a break sooner just let me know. I
11 will try to accommodate you but I may chose to finish
12 a line of questions before we do so. The only thing
13 I ask is that if there's a question pending you need
14 to answer the question before we break. Is that
15 fine?

16 **A** **Yes.**

17 **Q** And I see that you have a laptop in front
18 of you. Can you please confirm that that laptop is
19 not connected to a network?

20 MR. RODKEY: Or counsel, if you can
21 confirm that it's not connected to a network.

22 MR. LINDEN: That was the instruction but
23 let me confirm. Actually it is right now. Let me
24 deactivate. Okay. The laptop has been set to
25 airplane mode.

1 MR. RODKEY: Thank you.

2 BY MR. RODKEY:

3 Q And either Dr. Schubert or Counsel, can
4 you confirm that there are no communication
5 applications our software on that laptop?

6 MR. LINDEN: That is correct. Well, let
7 me -- none that are active. This may have Microsoft
8 Outlook. It has Microsoft Office but it is not open
9 and as noted the laptop should not have connectivity.

10 BY MR. RODKEY:

11 Q Dr. Schubert, I just ask that you do not
12 open that Microsoft Outlook while we're in the
13 deposition. Is that okay?

14 A Yes.

15 Q And I'm going to hand you what has been
16 previously marked in this proceeding as paper number
17 18. It guess petitioner's notice of deposition of
18 Dr. E. Fred Schubert.

19 (Previously marked Paper No. 18 was
20 introduced.)

21 BY MR. RODKEY:

22 Q Dr. Schubert, have you seen this document
23 before?

24 A No.

25 Q Okay. Is it your understanding that you

1 are here to provide testimony in Case Number
2 IPR2024-00973 related to U.S. Patent Number
3 9,184,157?

4 A Yes.

5 Q And are you prepared to testify in this
6 proceeding related to that patent today?

7 A Yes.

8 MR. LINDEN: Kevin, should we announce
9 who's in the room for the record?

10 MR. RODKEY: If you want. It should be
11 recorded, but we can do that if you want.

12 MR. LINDEN: I'll just do that briefly
13 just so the record reflected everybody that's here
14 and listening in. Ben Linden here on behalf of
15 patent owner. Here with me is my colleague Will
16 Jones of Robinson Kaplan.

17 MR. RODKEY: And for petitioner Kevin
18 Rodkey with Finnegan. With me is Qingyu Yin
19 listening in.

20 BY MR. RODKEY:

21 Q Dr. Schubert, I am handing you what was
22 previously marked as Exhibit 2001 pages 54 to 102.

23 MR. RODKEY: Counsel, we can handle this
24 one a few ways. I can either mark it as Exhibit 1018
25 or if you'll accept the representation that it's what

1 patent owner filed as 2001 we can avoid clutter on
2 the record.

3 MR. LINDEN: Could I just take a look at
4 it? Yup. We can stipulate.

5 MR. RODKEY: Actually you can keep that.

6 (Previously marked Exhibit 2001 was
7 introduced.)

8 BY MR. RODKEY:

9 Q Dr. Schubert, have you seen this document
10 before?

11 A Yes.

12 Q And what is this document?

13 A It is my CV.

14 Q And is this CV accurate to the best of
15 your knowledge?

16 A Yes.

17 Q And if you will turn to page 055 -- the
18 page number is on the bottom right-hand corner of
19 each page -- and let me know when you're there.

20 A Yes.

21 Q Do you see the heading that says technical
22 research activities?

23 A Yes.

24 Q And the section technical research
25 activities begins on page 055 and ends on page 056

1 before the heading honors and awards; is that
2 correct?

3 **A Yes.**

4 **Q** And I believe these bullets are in
5 chronological order beginning with the bullet in 1979
6 and ending with a bullet dated 2012. Correct?

7 **A Yes.**

8 **Q** And that first bullet dated 1979, that's
9 the year that you graduated with a Vordiplom degree
10 in electrical engineering from the University of
11 Stuttgart; is that right?

12 **A My degrees and to the year of my degrees**
13 **is found on page 1 of my CV and it indicates that I**
14 **received the equivalent of a BSEE degree in 1978.**

15 **Q** So that first bullet would be the year
16 after you received the equivalent of a BSEE degree?

17 **A Yes.**

18 **Q** And do the bullets listed on page 055 and
19 056 accurately represent all of your technical
20 research activities from 1979 to 2012?

21 **MR. LINDEN: Object to form.**

22 **A The list is accurate, but probably not**
23 **comprehensive.**

24 **BY MR. RODKEY:**

25 **Q** Are you aware of any technical research

1 activities that you conducted between 1979 and 2012
2 that are not reflected in this list?

3 **A Yes.**

4 **Q** What is not reflected in this list?

5 **A For example, I had a research project that**
6 **related to ITO electrodes in an LCD display. And I**
7 **can be more detailed on the ITO research project. I**
8 **can think also of other research activities that I**
9 **conducted that are not mentioned in this list.**

10 **Q** What is an ITO electrode?

11 **A An indium tin oxide ITO electrode.**

12 **Q** And what was the purpose of that ITO
13 electrode that you were researching?

14 **A The ITO electrode is used in LCD display**
15 **and the research project had the goal of reducing the**
16 **optical reflectivity of the ITO electrode.**

17 **Q** And since you mentioned reducing the
18 optical reflectivity of the ITO electrode was the ITO
19 electrode intended to used in the display pixel of
20 the LCD display?

21 **A Yes.**

22 **Q** And you mentioned other research
23 activities that you could think of that are not
24 reflected on pages 055 and 056 of Exhibit 2001. What
25 were those other projects?

1 **A** **On these pages I mention my activities in**
2 **the field of light emitting diodes. What is not**
3 **mentioned is that these light emitting diodes have**
4 **been applied as backlighting systems or backlighting**
5 **units for LCD displays.**

6 **Q** And when you say backlighting systems or
7 backlighting units for LCD displays that would be the
8 lighting unit for the optical pixels; is that
9 correct?

10 **A** **The lighting unit that makes the display**
11 **emit light.**

12 **Q** So it provides the light that would allow
13 a user to see the display pixels on the display
14 screen? Is that a fair characterization?

15 **A** **Yes.**

16 **Q** Returning to pages 055 and 056, a large
17 number of the research activities listed refer to,
18 for example, in bullet three doped aluminum gallium
19 arsenide/gallium arsenide heterostructures, bullet
20 four, aluminum gallium arsenide/gallium arsenide
21 heterostructures and other references to gallium
22 arsenide throughout. And then in bullet 22 you have
23 a reference to p-type doping gallium nitride and
24 additional references to gallium nitride throughout.

25 Is it fair to say that between 1979 and

1 2012 many of the research if not all of the research
2 activities listed on pages 055 and 056 related to
3 gallium nitride or its compounds or gallium arsenide
4 and its compounds?

5 MR. LINDEN: Object to form.

6 A No.

7 BY MR. RODKEY:

8 Q Why do you say that's not a fair
9 characterization?

10 MR. LINDEN: Object to form.

11 A Because there are some bullets that do not
12 relate to gallium arsenide and gallium nitride.

13 BY MR. RODKEY:

14 Q Okay. So we can go bullet by bullet.
15 Well, maybe we can make this simple. Would you say
16 that many of the bullets relate to gallium nitride or
17 gallium arsenide?

18 MR. LINDEN: Object to form.

19 A Well, I look at the first bullet and the
20 first bullet is not related to gallium arsenide or
21 gallium nitride. I look at the second bullet and the
22 second bullet is not related to gallium arsenide or
23 gallium nitride.

24 BY MR. RODKEY:

25 Q Okay. So we can go sort of bullet by

1 bullet. The first bullet refers to a silicon
2 pressure sensor; is that correct?

3 **A Yes.**

4 Q What was the purpose of the research for
5 that silicon pressure sensor?

6 **A To fabricate a pressure sensor to**
7 **understand how it works and to relate the pressure**
8 **sensor's characteristics to the silicon material that**
9 **it is made of.**

10 Q And was that pressure sensor for use in
11 LCD displays?

12 **A So 1979 and 1980 is a long time ago. And**
13 **at that time the dominant display was a CRT display**
14 **and not a LCD display.**

15 Q When you say CRT display are you referring
16 to cathode ray tubes?

17 **A Yes.**

18 Q And the second bullet relates to design of
19 an opto -- of an electro-optic Mach-Zehnder
20 interference modulator based on lithium niobate; is
21 that right?

22 **A Yes.**

23 Q And what was the purpose of the design of
24 that electro-optic Mach-Zehnder interference
25 modulator?

1 **A The purpose was to modulate the intensity**
2 **of light that is injected into the modulator.**

3 Q And that modulator, does that relate to a
4 laser?

5 **A Yes.**

6 Q And the third bullet, "first study of hot
7 electron effects in selectively doped aluminum
8 gallium arsenide heterostructures." Do you see that
9 one?

10 **A Yes.**

11 Q Are those gallium arsenide
12 heterostructures also related to lasers?

13 MR. LINDEN: Object to form.

14 **A No.**

15 BY MR. RODKEY:

16 Q What were they related to?

17 **A They are related to transistors.**

18 Q And what were those transistors used for?

19 **A Transistors are used for many**
20 **applications. And this particular project was**
21 **focused on the transistors themselves.**

22 Q And are gallium arsenide transistors
23 typically used for display pixels?

24 **A I think the most common material used for**
25 **the switching transistor associated with a display**

1 pixel is silicon, but potentially other materials can
2 be used as well. But silicon is the most common
3 material for that purpose.

4 Q So what was the purpose of the gallium
5 arsenide transistors listed in that third bullet?

6 A The study concerned more the transistors
7 themselves rather than specific application areas of
8 the transistor.

9 Q Did you have an intended use for those
10 transistors?

11 A I don't recall.

12 Q And the fourth bullet, was that related to
13 the same project as the third bullet?

14 A Yes.

15 Q And do you recall the intended use of that
16 fourth bullet?

17 A Can I get the question again?

18 Q Do you recall the intended use of that
19 fourth bullet?

20 A You mean the intended use of the
21 transistors mentioned in the fourth bullet?

22 Q Yes.

23 A I do not recall.

24 Q And the fifth bullet refers to a "first
25 analysis of semiconductors doped with simultaneously

1 shallow and deep donors." Do you see that?

2 **A Yes.**

3 Q Can you further explain the research that
4 you were working on in that fifth bullet?

5 **A The research concerned the doping of**
6 **semiconductors.**

7 Q Did those semiconductors have any intended
8 use?

9 **A I don't recall.**

10 Q And the sixth bullet point refers to
11 "development and use of thyristor circuits (including
12 GTO thyristor circuits) for the control of a lamp
13 heating system." Do you see that one?

14 **A Yes.**

15 Q What was the lamp heating system that you
16 refer to?

17 **A I'm not certain at this time, but I'm**
18 **happy to speculate.**

19 Q The next bullet refers to the "proposal
20 and demonstration of a" -- I believe that's
21 "delta-doped field-effect transistor." Do you see
22 that?

23 **A Yes.**

24 Q What was the purpose of the delta-doped
25 field-effect transistor that you were researching?

1 **A The purpose was to make a better**
2 **transistor.**

3 **Q Did that transistor have any intended use?**

4 **A The transistor could be used for any**
5 **application.**

6 **Q Was it a transistor for fluorescing or**
7 **emitting photons such as in the pixel?**

8 **A In general these transistors can be used**
9 **for any applications, but I do not recall which**
10 **applications we had in mind in 1985 or if we had any**
11 **applications in mind at that time.**

12 **Q And the next bullet refers to "development**
13 **of the theory of alloy broadening in luminescence**
14 **spectra of alloy semiconductors such aluminum gallium**
15 **arsenide." Do you see that?**

16 **A Yes.**

17 **Q Why do you refer to luminescence spectra?**

18 **A Some semiconductors emit light and the**
19 **light emission can be characterized by the emission**
20 **spectrum.**

21 **Q Why were you interested in the**
22 **luminescence spectra of this aluminum gallium**
23 **arsenide semiconductor?**

24 **A I don't recall.**

25 **Q In LCD displays are the luminescence**

1 spectra typically for the pixels in the display
2 screen?

3 MR. LINDEN: Object to form.

4 A In an LCD display there are several
5 optical spectra. For example, the backlighting unit
6 has an emission spectrum. As another example, the
7 color filters have a transmission spectrum.

8 BY MR. RODKEY:

9 Q And was the luminescence spectra that you
10 were interested in in the eighth bullet related to
11 either of those two?

12 A Yes.

13 Q Which one?

14 A The backlighting unit of an LCD typically
15 has LEDs light-emitting diodes. The light-emitting
16 diodes are made of semiconductors. And my research
17 conducted at that time is relevant to the emission
18 spectrum of LEDs used in backlighting units.

19 Q And the next bullet, which I believe is
20 number nine, says "first demonstration of a
21 light-emitting diode with a doping superlattice
22 active region." Do you see that?

23 A Yes.

24 Q Was that also a light-emitting diode for a
25 backlight unit?

1 **A I do not recall a specific application**
2 **area, but in general light-emitting diodes such as**
3 **the one mentioned here can be used in the**
4 **backlighting unit of an LCD display.**

5 Q And I'll just try to speed this up. The
6 remaining bullets on page 55 and 56, were they also
7 generally directed to the topics that we just talked
8 about such as color filters for LCD display pixels,
9 backlighting units for LCDs or light-emitting diodes
10 for the backlight unit of an LCD?

11 MR. LINDEN: Object to form.

12 **A Can I hear the question again?**

13 BY MR. RODKEY:

14 Q The remaining bullets on page 55 and 56,
15 were they also generally directed to the topics that
16 we just talked about such as color filters for LCD
17 display pixels, backlighting units for LCDs or
18 light-emitting diodes for the backlight unit of an
19 LCD?

20 MR. LINDEN: Same objection.

21 **A I wouldn't characterize the remaining**
22 **bullets in this manner.**

23 BY MR. RODKEY:

24 Q For the ones that were not related to
25 color filters for LCD display pixels, backlighting

1 units for LCDs or light-emitting diodes for the
2 backlight unit of an LCD, what were they related to?

3 **A They are generally related to**
4 **microelectronics technology, optoelectronic**
5 **technologies, semiconductors, semiconductor devices**
6 **semiconductor systems, integrated circuit technology**
7 **and displays.**

8 Q So the 11th bullet under your technical
9 research activities says a "demonstration of
10 delta-doped non-alloyed ohmic contacts with very low
11 contact resistance and subsequent demonstration of
12 self-aligned field-effect transistor with delta-doped
13 non-alloyed ohmic contacts." What did that relate
14 to?

15 **A It related to field-effect transistors and**
16 **the ohmic contacts for field-effect transistors.**

17 Q What was the intended use of those
18 field-effect transistors?

19 **A They can be used for any application, but**
20 **I do not recall the specific application that we had**
21 **in mind.**

22 Q And the 12th bullet, again, refers to near
23 the end of that first line "doping elements in
24 delta-doped semiconductors such as gallium arsenide
25 and silicon for MESFET and lightly-doped drain MESFET

1 applications." Do you recall the intended use of
2 that research?

3 **A The transistors can be used for multiple**
4 **applications, but I do not recall the specific**
5 **applications we had in mind.**

6 Q And the next bullet refers to "significant
7 improvement of the optical properties of doping
8 superlattices by employment of delta doping." What
9 was the intended use of the improvement of optical
10 properties of doping superlattices?

11 **A The purpose was to improve the optical**
12 **properties of semiconductors that emit light.**

13 Q Were they for the purpose of the doping
14 superlattice laser mentioned in the next bullet?

15 **A That is a possibility but I do not recall.**

16 Q And what is a doping superlattice laser
17 used for?

18 **A Does your question relate to the present**
19 **time or to the time frame mentioned here in my CV?**

20 Q Let's start with the 1989 time frame.
21 Well, let's specifically refer to the purpose of the
22 tuneable doping superlattice laser mentioned in the
23 14th bullet.

24 **A I do not recall.**

25 Q And the 15th bullet refers to a "first

1 quantitative analysis of a capacitance-voltage
2 profiling technique in semiconductors with
3 quantum-confined carriers." What was the purpose of
4 that research?

5 **A The purpose was to better understand the**
6 **properties of semiconductors.**

7 **Q** And what was your reason for wanting to
8 better understand the properties of those
9 semiconductors?

10 **A Understanding semiconductors in a more**
11 **detailed manner allows one to build better devices**
12 **and systems.**

13 **Q** Did you have an intended use that you were
14 studying for those particular semiconductors?

15 **A The semiconductors can be used for**
16 **multiple or many applications. But I do not recall**
17 **the specific application areas we had in mind.**

18 **Q** Okay. And the 17th bullet refers to
19 "invention and first demonstration of resonant cavity
20 light-emitting diode (RCLED)." Do you see that?

21 **A Can I hear the question again?**

22 **Q** Yes. The 17th bullet refers to "invention
23 and first demonstration of resonant cavity
24 light-emitting diode (RCLED)." Do you see that
25 bullet?

1 **A Yes.**

2 **Q What is a resonant cavity?**

3 **A It is an optical resonator.**

4 **Q Is it an optical resonator typically used**
5 **for lasers?**

6 **A Yes, but the use is not limited to lasers.**

7 **Q What was the use that you were**
8 **investigating in the 17th bullet?**

9 **A Any use.**

10 **Q Are those resonant cavities used in LCD**
11 **displays?**

12 **A Possibly yes, but I'm not certain.**

13 **Q Are you aware of those resonant cavities**
14 **ever being used in LCD displays?**

15 **A I'm pretty certain that they have been**
16 **used in the research area. I'm pretty certain about**
17 **that.**

18 **Q Have you ever conducted that research?**

19 **A I have conducted research in the field of**
20 **resonant cavity LEDs used in conjunction with**
21 **displays.**

22 **Q Were they LCD displays?**

23 **A They were LED displays.**

24 **Q Just to be clear, LED as in light-emitting**
25 **diode displays?**

1 **A Correct.**

2 Q What part of the LED displays were they
3 related to?

4 **A Where the resonant cavity LED is used as**
5 **the emitter for a pixel.**

6 Q The 18th bullet refers to "demonstration
7 of giant enhancement of luminescence intensity for
8 Er-doped silicon silica microcavities." Do you see
9 that?

10 **A Yes.**

11 Q What was the purpose of that research?

12 **A To tailor the intensity and spectrum of**
13 **optically active elements.**

14 Q What do you mean by optically active
15 elements?

16 **A Light emitting elements.**

17 Q Would those be light-emitting diodes?

18 **A The elements refers to chemical elements.**
19 **They can be used in light-emitting diodes but the**
20 **chemical elements are not light-emitting diodes.**

21 Q Since they are light emitting are they for
22 the display pixels?

23 **A They can be used for light emitting**
24 **pixels.**

25 Q Are you aware of any other use for them?

1 **A Yes. They can also be used in application**
2 **areas unrelated to displays.**

3 Q And we've been going about an hour. If
4 it's okay with you I just want to finish out page 55
5 and then we'll take a break. Is that fine?

6 **A Sure.**

7 Q The 18th bullet refers to a "first
8 demonstration of a resonant cavity detector which is
9 useful for wavelength selective detection." Do you
10 see that?

11 **A Yes.**

12 Q Being a resonant cavity, does that also
13 relate to a light emitting element such as an LED?

14 **A It can relate to a light emitting**
15 **semiconductor or to a light absorbing semiconductor.**

16 Q And would those be used for the pixels of
17 the display?

18 **A A detector would not be used for a pixel**
19 **of a display.**

20 Q Would it be used in an LCD display at all?
21 I can rephrase. Are you aware of it being
22 used in an LCD display?

23 **A I'm aware of detectors being used in an**
24 **LCD display and I can be more detailed if you wish.**

25 Q Are you aware of the resonant cavity

1 detector that you refer to in the 19th bullet on page
2 55 being used in an LCD display?

3 **A It's a possibility but I'm not aware of a**
4 **specific employment of a resonant cavity detector for**
5 **this application.**

6 Q And then just three more. The 20th bullet
7 says a "demonstration of resonant cavity
8 light-emitting diode (RCLED)." Was that related to
9 the same resonant cavity light-emitting diode in the
10 17th bullet?

11 **A Yes.**

12 Q And so it was also intended for the pixels
13 of a display for an LED display?

14 **A That is a potential use, but it was not**
15 **limited to that application.**

16 Q Were your other applications other than an
17 LED display?

18 **A Yes. And I can be more detailed if you**
19 **wish.**

20 Q Sure. What are you referring to?

21 **A One example of another application is**
22 **using LEDs for the purpose of optical communication.**

23 Q And that optical communication would be
24 different from a display device; is that correct?

25 **A Yes. Correct.**

1 Q The 21st bullet refers to "Demonstration
2 of delta doping in silicon for fabrication of shallow
3 junctions in scaled-down silicon lightly-doped drain
4 (LOD) MESFETs for integrated circuits (SI ICs)." Do
5 you see that?

6 A **Yes.**

7 Q What was the intended purpose of that
8 research?

9 A **The purpose was to make better MESFETs,**
10 **M-E-S-F-E-T-s.**

11 Q And did you have any particular MESFET
12 application in mind when conducting that research?

13 A **Integrated circuits.**

14 Q What do you mean by integrated circuit?

15 A **An integrated circuit is an electrical**
16 **circuit consisting of multiple transistors that are**
17 **integrated on a silicon substrate.**

18 Q And did you have a particular application
19 in mind for those integrated circuits?

20 A **They can be used for any application.**

21 Q But you didn't have any particular
22 application in mind; is that right?

23 A **The application was silicon integrated**
24 **circuits and those circuits can be used for whichever**
25 **purpose you wish.**

1 Q And then the last one before we break, the
2 last bullet on that page, which just to keep the
3 numbering is the 22nd bullet, refers to the
4 "invention of a new concept, superlattice doping, for
5 enhanced p-type doping of gallium nitride." Do you
6 see that?

7 A Yes.

8 Q What was the intended use of that
9 research?

10 A **The intended use was to make better LEDs.**

11 Q And were those LEDs for the purpose of a
12 display pixel?

13 A **The application of these LEDs includes
14 backlighting units for LCDs as well as light-emitting
15 pixels, but is not limited to these applications.**

16 Q And the -- just to be clear, the
17 backlighting unit of an LCD provides light for the
18 display pixels that serve as the color filters for
19 the various colors. Is that accurate?

20 A **I would express it in the following
21 manner. The backlighting unit provides light that is
22 transmitted through the LCD panel so that the display
23 image is a light-emitting image.**

24 Q So if I understand what you just said
25 correctly, the backlighting unit is behind the LCD

1 pixels in the LCD screen and shines through those
2 pixels to provide an image?

3 **A Yes.**

4 MR. RODKEY: I said we would break there
5 and if that's fine with you we'll take a short break.

6 (Recess from 10:16 a.m. to 10:29 a.m.)

7 BY MR. RODKEY:

8 Q Welcome back, Dr. Schubert. If you will
9 turn to page 56 of Exhibit 2001, and by my count
10 there are 16 bullets on page 56. Counsel, feel free
11 to tell me if I got those wrong. Looking at these
12 bullets with the exception of the fourth, fifth,
13 seventh and 16th bullets I believe each of them refer
14 to a light-emitting diode or a laser. Is that
15 correct?

16 MR. LINDEN: Object to form.

17 **A I would be happy to go bullet by bullet,**
18 **but --**

19 BY MR. RODKEY:

20 Q Okay. Sure. I'm trying to make this an
21 efficient process. I'm not trying to trick you. I'm
22 just trying to understand your background. So the
23 first bullet refers to "yellow luminescence in
24 gallium nitride and its use in microcavity effects,"
25 correct?

1 **A Yes.**

2 **Q And I believe previously we talked about**
3 luminescence and microcavity effects being used for
4 an LED. Did I understand that correctly?

5 **A Yes.**

6 **Q And the second bullet refers to the "first**
7 gallium nitride/gallium indium nitride double
8 heterostructure laser." So that specifically refers
9 to a laser, correct?

10 **A Yes.**

11 **Q And the third bullet refers to**
12 "co-inventor of photonic-crystal light-emitting
13 diode, PC-LED." So that specifically refers to a
14 light-emitting diode, right?

15 **A Correct.**

16 **Q And I'm going to skip the fourth and the**
17 fifth bullets and move on to the sixth one which near
18 the end of that line specifically refers to a
19 "photon-recycling semiconductor light-emitting diode
20 (PRS-LED)." So that also specifically refers to a
21 light-emitting diode, right?

22 **A Correct.**

23 **Q And I will skip the seventh bullet. The**
24 eighth bullet refers to an aluminum gallium indium
25 phosphorous light-emitting diode. Did I get that

1 correct?

2 **A Yes.**

3 Q So it specifically refers to an LED,
4 right?

5 **A Yes.**

6 Q And the ninth bullet, if you go near the
7 end of that line refers to a UV LED which I believe
8 is an ultraviolet LED. Is that right?

9 **A Yes.**

10 Q And actually I'm going to skip the tenth
11 bullet. The 11th bullet near the end of that line
12 refers to "light-emitting diodes, particularly UV
13 light-emitting diodes." So that also specifically
14 refers to light-emitting diodes, correct?

15 **A Yes.**

16 Q The 12th bullet, about two-thirds of the
17 way through the first line refers to white
18 light-emitting diodes. Do you see that?

19 **A Yes.**

20 Q So that specifically refers to LEDs?
21 Correct.

22 **A It refers to LEDs. It also has a
23 reference to collaboration with Samsung.**

24 Q Okay.

25 **A And I recall that project also included**

1 **work or research on LCDs.**

2 Q Is that because I believe you said earlier
3 white LEDs can be used as the backlight for an LCD
4 display?

5 A **I'm not sure if that's the reason, but I**
6 **do recall that for a period of time my research was**
7 **funded by Samsung --**

8 Q Okay.

9 A **-- and associated research activities**
10 **concerned various aspects of the LCD displays.**

11 Q Is any of your current research being
12 funded by Samsung?

13 A **No.**

14 Q The 13th bullet right below that, about
15 halfway across it refers to white LEDs with remote
16 phosphors. So that one also specifically refers to
17 LEDs, correct?

18 A **Yes.**

19 Q The 14th bullet refers to graded index
20 anti-reflective coatings. Do you see that?

21 A **Yes.**

22 Q Was that intended as a coating for the
23 screen of an LED or LCD display?

24 A **The applications that we had in mind**
25 **included the ITO contacts of LCD devices as well as**

1 **solar cells.**

2 Q And then the next bullet, the 15th bullet
3 refers to "efficiency droop-reducing gallium indium
4 nitride/gallium indium nitride and gallium indium
5 nitride/aluminum gallium nitride LED active regions."
6 Do you see that?

7 A **Yes.**

8 Q And so that also refers to LED technology,
9 right?

10 A **Yes.**

11 Q And for each of the bullets that we just
12 talked about were the LED technologies intended for
13 use in LED displays?

14 A **That is one application area but the use
15 of LEDs is not limited to that application area.**

16 Q For those that -- well, were you intending
17 them for use in LED displays?

18 A **Yes. That was one of the application
19 areas.**

20 Q Okay. What was -- did you have any other
21 application areas?

22 A **Yes.**

23 Q What were those?

24 A **One other application area is lighting
25 applications, room lighting applications.**

1 Q Did you have any other applications in
2 mind?

3 A Yes. Another application area is the
4 communication of information with room lighting
5 sources.

6 Q What do you mean by the communication of
7 information with room lighting sources?

8 A It's an area of engineering where
9 information is transmitted by modulating the
10 intensity of room lighting sources such as light
11 bulbs. The area is also known by the acronym LIFI,
12 L-I-F-I.

13 Q Okay. Let's return to the bullets we
14 haven't discussed yet, so beginning with the fourth
15 bullet on page 56. And that refers to "the first
16 demonstration of crystallographic etching of gallium
17 nitride." Do you see that?

18 A Yes.

19 Q And then the last sentence of that bullet
20 refers to the LED industry, LED chips and LED light
21 bulbs, correct?

22 A Yes.

23 Q So is this fourth bullet also related to
24 LED technology?

25 A Yes.

1 Q All right. And the fifth bullet
2 "experimental demonstration of a tenfold enhancement
3 of p-type doping activation in aluminum gallium
4 nitride/gallium nitride doped superlattices." Do you
5 see that?

6 A Yes.

7 Q Although it doesn't refer to LED
8 specifically, was your research related to LEDs?

9 A Based on my recollection that research was
10 for both optoelectronic devices and electronic
11 devices such as transistors.

12 Q Did those transistors have any specific
13 use?

14 I'll rephrase that. Did those transistors
15 have any specific intended use?

16 A Any use would be possible for those
17 transistors.

18 Q In the industry is there a common use for
19 aluminum gallium nitride or gallium nitride
20 transistors?

21 A The specific transistors that we had in
22 mind at that time were bi-polar transistors. And
23 based on my knowledge those transistors are not used
24 at the present time.

25 Q What were they being used for at the time?

1 **A The intended use was not specific. Any**
2 **use would have been fine.**

3 Q The seventh bullet refers to the
4 "invention and demonstration of polarization-enhanced
5 ohmic contacts in p-type and n-type gallium nitride."
6 Do you see that one?

7 **A Yes.**

8 Q Was that related to the gallium nitride
9 LEDs discussed in the other bullets on this page?

10 **A To some degree, yes, but the ohmic contact**
11 **technology is also being used for transistors.**

12 Q Would those be transistors in
13 light-emitting sources?

14 **A The potential application of these**
15 **transistors is switching applications and these**
16 **switching application transistors can be used to**
17 **regulate the intensity of LED backlighting units.**

18 Q All right. If you go down three bullets
19 to the tenth bullet it refers to "developed new class
20 of materials, low-refractive index materials, or low
21 n materials, with an unprecedented low refractive
22 index of N less than 1.10." Do you see that?

23 **A Yes.**

24 Q What did that research -- what was the
25 intended use of that research?

1 **A** We had two applications in mind. One of
2 them was the employment of these materials in solar
3 cells and the other application was the use of these
4 materials in LCD displays.

5 **Q** Where would these materials be used in LCD
6 displays?

7 **A** They are used in LCD displays to reduce
8 the optical reflection of certain films or certain
9 materials.

10 **Q** Those films and materials, would they be
11 on the display screen with the pixels?

12 **A** They would be located on the LCD panel.

13 **Q** What do you mean by the LCD panel?

14 **A** The LCD glass panel including the TFT
15 substrate, the color filter substrate and the liquid
16 crystal material between those two substrates.

17 **Q** And that would be the optical screen
18 portion of the LCD display?

19 MR. LINDEN: Object to form.

20 BY MR. RODKEY:

21 **Q** Correct?

22 **A** I'm not sure if I understand the question.

23 **Q** Sure. I'll try to rephrase. When you say
24 the LCD glass panel including the TFT substrate, the
25 color filter substrate and the liquid crystal

1 material between those two substrates, are you
2 referring to the portion of an LCD display that has
3 the optical pixels with the liquid crystals in it?

4 MR. LINDEN: Object to form.

5 A I'm not sure if I understand the question.
6 But when I say LCD panel I'm referring to an LCD
7 display, the part or the unit that provides an image
8 like a still image or still picture or motion
9 picture. And so it's an LCD panel or LCD device that
10 I'm referring to.

11 BY MR. RODKEY:

12 Q All right. Thank you for the
13 clarification. That helps. Just so that I
14 understand you right, when you're referring to the
15 portion that provides an image, that's the portion
16 that has the pixels on it to display the image,
17 right?

18 A The LCD panel has pixels, but I'm not
19 exactly sure what portion you're referring to.

20 Q I'm trying to understand what you mean by
21 the LCD panel between the two substrates. I'm just
22 trying to figure out what part of the device you're
23 referring to. It sounds like you're referring to,
24 for example, the screen portion that has the LCD
25 crystals and the backlight and the color filters that

1 are powered or driven to provide an image. Is that
2 correct?

3 MR. LINDEN: Object to form.

4 A When I say LCD panel I wouldn't include
5 the backlight.

6 BY MR. RODKEY:

7 Q Okay. That's helpful. Thank you.

8 So let's move on to what should be the
9 last bullet here, the 16th bullet on page 56. It
10 refers to "developed analytic model for efficiency
11 droop based on drift-induced reduction of a
12 carrier-injection efficiency." Do you see that
13 bullet?

14 A Yes.

15 Q Can you describe that research further?

16 A The research concerned physical mechanisms
17 that reduce the efficiency of semiconductor light
18 emitters.

19 Q And I believe that's the last bullet.
20 It's dated 2012. Why are there no further bullets
21 after 2012?

22 A It looks like that I have not included
23 research activities that are relatively recent or, to
24 be fair, research activities I engaged in during the
25 last ten years.

1 Q Do your research activities since 2012
2 relate to the same type of research activities as the
3 bullets listed on pages 55 and 56?

4 MR. LINDEN: Object to form.

5 A **Not only to those topics, but also going**
6 **beyond those topics.**

7 BY MR. RODKEY:

8 Q Beyond those topics what are your other
9 research activities since 2012?

10 A **We can go to the list of patents that I**
11 **have included in my CV.**

12 Q What page are you on?

13 A **Page 84. Patent number 35, the title of**
14 **this patent is liquid crystal display with refractive**
15 **index matched electrodes issued in 2012. This is an**
16 **example --**

17 Q I'm sorry. Did you say patent number 35?

18 A **Correct.**

19 Q On page 86?

20 A **84.**

21 Q Ah. Thank you. Okay. I'm sorry. Go
22 ahead.

23 A **Patent number 35 relates to liquid crystal**
24 **displays specifically the electrodes of pixels of the**
25 **display.**

1 Q Okay. Any other research activities since
2 2012 that would not fall under the same topics as the
3 research activities we discussed on pages 55 or 56 or
4 the subject of patent number 35?

5 A Yes. Patent number 38 relates to a
6 tuneable nanoporous film on polymer substrates. I
7 would say that this particular topic is somewhat
8 different than the topics we talked about. I would
9 also say that patent number 39 issued in 2021 is a
10 newer topic. And if we go to the list of
11 publications, just as an example page 102, you see
12 publication number 348 which is a book on
13 light-emitting diodes. And in this book I have a
14 chapter or maybe a section of this book that relates
15 directly to LCDs and LCD displays.

16 I also have collaborated with industry on
17 various topics. For example, I recall one research
18 project on the topic of yield.

19 Q I'm sorry. Did you say yield?

20 A Yield.

21 Q Y-i-e-l-d?

22 A Correct.

23 I also recall a research project on AMOLED
24 displays, AMOLED displays. This is a type of display
25 that does not use a liquid crystal but nevertheless

1 is a flat panel display. I'm sure there are
2 additional topics that I have worked on or that I
3 conducted research in and if you wish I can think
4 more of the activities during the last years.

5 Q Let's start with the ones that you
6 mentioned. Turning back to page 84, patent number
7 38, why do you say that that's different from the
8 previous research and activities that we've been
9 discussing?

10 A Patent number 38 relates to tuneable
11 nanoporous films on polymer substrates and does not
12 relate to semiconductors. And for that reason I
13 indicated that this particular patent is on a
14 somewhat different subject.

15 Q So what is the tuneable nanoporous film
16 intended to be used for in the patent?

17 A I believe the applications are optical
18 thin-film coatings.

19 Q Okay. And why do you say patent number 39
20 is different from the research activities that we had
21 discussed previously?

22 A It also refers to or is related to optical
23 coating technology. So not directly related to a
24 semiconductor material or a semiconductor device.
25 And for that reason I would put it in a somewhat

1 **different category.**

2 Q Okay. Going back to what you had
3 mentioned related to the publications, you mentioned
4 collaboration on the topic of yield. What was that
5 research intended for?

6 A **As a first point I worked for ten years in**
7 **industry and in industry yield of integrated circuits**
8 **is an important figure of merit. And integrated**
9 **circuits when they are fabricated have a certain**
10 **yield. When scaling down the spatial dimensions of**
11 **semiconductor devices the yield generally drops but**
12 **the number of integrated circuit chips on a wafer**
13 **generally increases.**

14 So you have these two counteracting
15 trends. Scaling down the spatial dimension has a
16 negative effect, reduction of yield, but it also has
17 a positive effect, more chips on a wafer. And my
18 work or my research related to the question where do
19 we want to be positioned in that tradeoff.

20 Q And just so we're clear, what does the
21 yield measure?

22 A **Yield can refer to a specific process step**
23 **or it can refer to a product, a finished product.**
24 **And I'm happy to talk on either topic.**

25 Q Yeah. I'm just trying to understand when

1 you refer to yield is that the number of chips or
2 products that are successively manufactured or how do
3 you determine what the yield is? What are the
4 criteria that you are looking for?

5 MR. LINDEN: Object to form.

6 A I'm happy to consider any criteria you
7 propose. I can give an example of yield. And yield
8 in the context of silicon integrated circuits can
9 mean the number of working integrated circuit chips
10 over the total number of integrated circuit chips.

11 BY MR. RODKEY:

12 Q So if, to use your example, you're trying
13 to manufacture a ten-by-ten array of IC chips, so a
14 hundred chips, and 90 of those are functional, you
15 would have a yield of 90 percent?

16 A Yes. That is one example.

17 Q What were the chips that you were
18 working -- or that you were researching when you were
19 collaborating with industry on this yield study?

20 A At the time I was working in industry and
21 it related to silicon integrated circuits.

22 Q What was the use of those circuits?

23 A I do not recall.

24 Q Regarding LCD displays are you familiar
25 with the term driver circuit?

1 **A Yes.**

2 Q And have you heard the term scanning line
3 driver circuit or scanning line driving circuit?

4 **A Yes.**

5 Q And have you also heard the term gate
6 driver or gate driving circuit?

7 **A Yes.**

8 Q Is it your understanding that a gate
9 driver or a scanning line driving circuit refers to
10 the same circuit in an LCD display?

11 **A Yes.**

12 Q And have you heard the term source driver
13 or source driving circuit for an LCD display?

14 **A Yes.**

15 Q And have you heard the term data driver or
16 data-line driving circuit for an LCD display?

17 **A Yes.**

18 Q And is it your understanding that a data
19 driver and the source driver typically refer to the
20 same circuit but are interchangeable terms?

21 **A Yes, but I just want to use the full term,
22 so data-line driver circuit and source-line driver
23 circuit describe the same driver circuit.**

24 Q Okay. Do you have any experience
25 analyzing, developing or designing scan-line driving

1 circuits or data-line driving circuits for LCD
2 devices?

3 **A I have had research activities in the**
4 **field of LCD displays and also in the field of**
5 **driving the display.**

6 **Q Did your research in the field of LCD**
7 **displays include analyzing a scanning line driving**
8 **circuit or a data-line driving circuit?**

9 **A My work activity -- and this includes**
10 **research, teaching, consulting and service --**
11 **included various aspects of the display devices**
12 **including analysis and the functioning and the design**
13 **of display drivers.**

14 **Q What was a project you were working on**
15 **that involved the analysis or functioning or design**
16 **of display drivers?**

17 **A I have analyzed and worked on various**
18 **aspects of the drivers. For example, the mounting of**
19 **driver circuits in displays.**

20 **Q What do you mean by the mounting of driver**
21 **circuits in displays?**

22 **A For example, the mounting technology that**
23 **is referred to as COF, chip on flex or chip on film.**

24 **Q Have you ever worked with chip on glass?**

25 **A I have certainly come across that**

1 **technology in the past.**

2 Q Have you ever worked with chip on glass
3 technology?

4 A **I'm not exactly sure what you mean, but as**
5 **I said before I have been involved in that type of**
6 **technology in the past.**

7 Q So you mentioned that you worked on the
8 mounting of the drivers, mounting of the driver
9 circuits and displays. Have you ever worked on
10 analyzing the actual driver circuit itself?

11 MR. LINDEN: Object to form.

12 A **You mean the electrical functionality of**
13 **driver circuits?**

14 BY MR. RODKEY:

15 Q I'm just trying to understand if you're
16 done any other work related to driver circuits other
17 than the mounting of the circuits, for example, chip
18 on flex.

19 A **Yes. I have worked on the architecture of**
20 **those drivers.**

21 Q What do you mean by the architecture?

22 A **The architecture relates to the**
23 **organization of a driver circuit. At the top you**
24 **have a block and that block is a specific driver**
25 **circuit. If you go downward you have various**

1 **subblocks. Those subblocks have various functions.**
2 **And if you go further down you're at the circuit**
3 **level, at the transistor level. And I would describe**
4 **this as the architecture of a driver circuit.**

5 Q When you say at the top you have a block
6 and that block is a specific driver circuit, are you
7 referring to essentially a conceptual block like you
8 would see in a block diagram?

9 MR. LINDEN: Object to form.

10 A **I'm referring to a box, to a block, to a**
11 **functional unit, and one might describe this block or**
12 **this box or this functional unit by using the term**
13 **scanning line driver circuit.**

14 BY MR. RODKEY:

15 Q So what architecture of a driver circuit
16 did you work on?

17 A **For example, scanning line driver circuit**
18 **architecture, its location, its implementation and**
19 **its function.**

20 Q What do you mean by the location of the
21 scanning line driver circuit?

22 A **The physical location of that circuit.**

23 Q Do you mean the physical location within a
24 display device?

25 MR. LINDEN: Object to form.

1 **A** **I can give you an example. If we look at**
2 **the '157 patent figure 1 we can identify a scanning**
3 **line driver circuit. And in this particular case the**
4 **scanning line driver circuit is located on the LCD**
5 **TFT glass substrate.**

6 BY MR. RODKEY:

7 **Q** **So is that you mean when you say you**
8 **worked on the location of a driver circuit?**

9 MR. LINDEN: Object to form.

10 **A** **No, I wouldn't say it this way. I would**
11 **say that my work activities included various aspects**
12 **such as the physical location, the technological**
13 **implementation and the architecture of driver**
14 **circuits such as the scanning line driver circuit.**

15 BY MR. RODKEY:

16 **Q** **What do you mean by the technological**
17 **implementation?**

18 **A** **It can be implemented in various ways such**
19 **as a TFT thin-film transistor circuit that is located**
20 **on the TFT glass substrate or as a conventional CMOS,**
21 **C-M-O-S, integrated circuit as an IC chip on a**
22 **silicon wafer.**

23 **Q** **And so what was your work related to those**
24 **topics you just mentioned?**

25 **A** **What are the benefits, what are the**

1 **drawbacks, what type of properties do we need for a**
2 **TFT. I have conducted studies on the electron**
3 **mobility in TFTs thin-film transistors that are made**
4 **of either amorphous silicon or polycrystalline**
5 **silicon.**

6 MR. RODKEY: We've been going just a
7 little bit over an hour. Is now a good time for a
8 break?

9 THE WITNESS: Sure.

10 (Recess from 11:32 a.m. to 11:43 a.m.)

11 BY MR. RODKEY:

12 Q Welcome back, Dr. Schubert. Have you
13 heard the term electrostatic discharge or ESD before?

14 A **Yes.**

15 Q And if I use the term ESD you'll
16 understand that I'm referring to electrostatic
17 discharge?

18 A **Yes.**

19 Q And ESD is discussed in the '157 patent
20 that is at issue in this proceeding; is that right?

21 A **Yes.**

22 Q Just generally can you explain what ESD
23 is?

24 A **Yes. ESD stands for electrostatic**
25 **discharge and it is the accumulation of static charge**

1 **and an associated voltage. The accumulated charge**
2 **can discharge, can neutralize, can find the opposing**
3 **charge, and that can be described as an ESD event.**
4 **The voltage that is associated with such a discharge**
5 **is typically several hundred volts, and such voltage**
6 **can damage or destroy a TFT thin-film transistor.**
7 **Specifically the gate insulating film of a TFT.**

8 **Electrostatic discharge is somewhat**
9 **related to the phenomenon of lightning. The voltage**
10 **associated with lightning is in the million volts**
11 **range, sometimes more than a hundred million volts.**
12 **And we have in the phenomenon of lightning a**
13 **discharge event that we all know of.**

14 Q You mentioned that ESD can damage or
15 destroy transistors. What happens if an ESD event
16 destroys the transistors in a scanning line driving
17 circuit?

18 A **If the transistors of a circuit are**
19 **destroyed then the circuit becomes nonfunctional.**

20 Q Okay. I guess we can do this however you
21 want. I have the '157 patent which was previously
22 marked as Exhibit 1001. I'm going to hand that to
23 you. I understand you also have a copy on your
24 computer.

25 Dr. Schubert, have you seen Exhibit 1001

1 before?

2 **A Yes.**

3 Q And I just want to be clear. I understand
4 you have a copy on your computer. Does that copy
5 have any notes or annotations on it?

6 **A I don't know.**

7 Q If you decide to open that please let me
8 know and then we can revisit the question. Otherwise
9 I think we can probably work with the paper version.
10 Could you please turn to figure 11 which is on
11 page 10 of 18? And under the heading figure 11 at
12 the top it says "related art." Right?

13 **A Yes.**

14 Q And the '157 patent describes figure 11 as
15 conventional art. Do you recall that?

16 **A Yes.**

17 Q And in figure 11 on the bottom left side
18 do you see the boxes that are labeled ESD1, ESD2,
19 ESD3 and ESD4?

20 **A Yes.**

21 Q And is it your understanding that those
22 are ESD protection circuits?

23 **A Yes.**

24 Q What is an ESD protection circuit?

25 **A An ESD protection circuit has the function**

1 **of protecting another device or circuit in case an**
2 **ESD discharge event occurs.**

3 Q Okay. And could you turn to figure 4 of
4 the '157 patent? And is it your understanding that
5 figure 4 is a representation of an ESD protection
6 circuit that would appear in, for example, ESD1 in
7 figure 11?

8 A **Yes.**

9 Q And so just laying the understanding here.
10 The in, i-n, side of figure 4 where there's resistor
11 503, that would be the side of ESD1, the side of the
12 box that's closest to the terminal VS, 650? Is that
13 right?

14 A **Yes.**

15 Q And the out, o-u-t, of figure 4 would be
16 the side of ESD1 in figure 11 that is on the side of,
17 for example, box 800 which is the dashed lines above
18 ESD1; is that correct?

19 A **Generally, yes. I just would like to make**
20 **one addition.**

21 Q Okay.

22 A **And that is the resistor 503 is more**
23 **typically used with signal lines, not with power**
24 **lines. And I think the terminal that you're**
25 **referring to was VS. And so that's the only addition**

1 **I would like to make.**

2 Q Okay. And the ESD protection circuit in
3 figure 4, is it your understanding that the way that
4 circuit functions is when there's an ESD event on the
5 in side of that circuit one of the two transistors
6 504 or 502 divert the ESD away from the out side to
7 either VH or VL in order to protect what's on the out
8 side?

9 A I think you can express it that way. I
10 would probably use slightly different words, but I
11 think the way you said it is fine.

12 Q Okay. Are you familiar with the term
13 ground terminal in a circuit?

14 A Generally, yes. I mean, there are
15 slightly different meanings. Sometimes ground is
16 used to indicate a literal ground connection grounded
17 to the earth and sometimes ground connection is
18 referred to as a line that has zero voltage. So
19 generally I'm familiar with what is known as
20 electrical ground.

21 Q What does it mean to shunt to ground,
22 s-h-u-n-t?

23 A Are you referring to a specific place
24 where this wording is used?

25 Q I'm just asking the question. If I shunt

1 an electrical circuit to ground, what does that mean?

2 **A** If we have an electrical line and we have
3 an excessive voltage on that line and we have an ESD
4 protection circuit connected between that line and
5 ground and the ESD protection circuit opens up at a
6 specific voltage -- for example, 25 volts -- then the
7 hundred volts that I mentioned earlier are prevented
8 from propagating on that line. And this protection
9 mechanism can be expressed by using the words the
10 voltage is shunted to ground.

11 **Q** And so the shunting to ground diverts that
12 excess voltage off of the line being protected to the
13 ground, correct?

14 **A** Yeah. You can express it in different
15 ways. For example, the protection circuit prevents
16 the line from propagating excessive ESD voltages and
17 you can say that the energy is shunted to ground. I
18 think those are acceptable ways of expressing what is
19 going on from an electrical point of view.

20 **Q** Okay. And returning to figure 11 of the
21 '157 patent, if we just start at the left which is
22 the CLK terminal 601, that line 701 has only one ESD
23 protection circuit on it and that's ESD3, correct?

24 **A** Correct.

25 **Q** And then moving to the right terminal 650

1 which is the VS terminal line 750, that line has only
2 one ESD protection circuit on it and that's ESD1; is
3 that right?

4 **A Sorry. Can I hear the question again?**

5 Q So the terminal 650 which is marked VS has
6 a line coming out of it 750, and that line has only
7 one ESD protection circuit on it and that's
8 protection circuit ESD1, right?

9 **A Correct.**

10 Q Then the next terminal to the right, 602,
11 is the SP terminal, and that connected to line 702
12 and that line has only one ESD protection circuit on
13 it which is ESD4, correct?

14 **A Yes, with just one qualification. And if**
15 **we go back to figure 4 each of the two transistors in**
16 **figure 4 provide some protection. So what I'm saying**
17 **is 502 in isolation fulfills a protection function**
18 **and 504 by itself fulfills a protection function.**
19 **And you can consider each transistor to be part of a**
20 **circuit or a circuit and you can consider the whole**
21 **circuit that is shown in figure 4 also as a**
22 **protection circuit.**

23 Q Is it your understanding that the
24 protection circuit in figure 4 is the box ESD4 on
25 line 702?

1 **A Yes. It can serve in that function.**

2 Q And then for terminal 651 labeled VD, it's
3 connected to line 751, that line has only one ESD
4 protection circuit labeled which is ESD2; is that
5 correct?

6 **A Yes.**

7 Q And ESD1, ESD2, ESD3 and ESD4 are the only
8 protection circuits shown in figure 11, right?

9 **A Correct.**

10 Q And if you look at figure 1 of the '157
11 patent at the top left-hand corner of figure 1 do you
12 see the ESD protection circuits ESD11, ESD12 and
13 ESD13?

14 **A Yes, I do.**

15 Q And the addition of ESD protection
16 circuits ESD11, ESD12 and ESD13 are the only
17 difference between figure 1 and figure 11, correct?

18 **A I think that's a fair characterization.**

19 Q Okay. Let's look at figure 2. And if we
20 take figure 2 and compare it to figure 1, figure 2 is
21 basically what's in the box labeled A in figure 1
22 except figure 2 adds in the middle ESD protection
23 circuits ESD21, ESD22 and ESD23. Is that right?

24 **A Yes.**

25 Q And in figures 1 and 2 the line 702 for

1 terminal SP602 still only has one ESD protection
2 circuit on it which is ESD4; is that right?

3 **A Can I hear the question again?**

4 **Q** In figure 1 and figure 2 the line 702
5 which is connected to the input terminal 602 labeled
6 SP, that line has only one ESD protection circuit on
7 it which is ESD4 like in figure 1, right?

8 **A Yes.**

9 **Q** What is line SP?

10 **A I think I know the answer, but I would**
11 **like to check if the '157 patent includes a statement**
12 **on the SP line.**

13 **Q** Okay.

14 **A (Reviewing document.)**

15 **Q** I'm just going to try to help you out
16 here. You might look in column 5 lines 20 to 50.

17 **A (Reviewing document.) It is characterized**
18 **as the SP line. It is typically a start frame line**
19 **or start picture line and is used to indicate that a**
20 **new image, a new picture, is being written.**

21 **(Previously marked Exhibit 2009 was**
22 **introduced.)**

23 **BY MR. RODKEY:**

24 **Q** Dr. Schubert, I'm handing you what was
25 previously marked as Exhibit 2009 in this proceeding.

1 And if you'll review that document and let me know
2 when you're finished.

3 **A (Reviewing document.) Yes. I've**
4 **finished.**

5 Q Do you recognize this as your declaration
6 in this proceeding?

7 **A As one of my declarations, yes.**

8 Q The one that you signed on March 14th,
9 2025 according to page 83?

10 **A Yes.**

11 Q And that is your signature on page 83,
12 correct?

13 **A Yes.**

14 Q Would you turn to paragraph 47, please?
15 And if you'll review paragraph 47 and let me know
16 when you're finished.

17 **A (Reviewing document.) Yes, I've finished.**

18 Q The last sentence of paragraph 47 says "I
19 have offered opinions in that case regarding the
20 validity of the '157 patent claims," correct?

21 **A Correct.**

22 Q Did you also offer opinions regarding
23 infringement of the '157 patent in the related
24 District Court litigation?

25 **A Yes.**

1 Q Did you offer any opinions regarding claim
2 construction of the '157 patent in the related
3 District Court litigation?

4 A **Possibly yes, possibly no. I would need**
5 **to check my records.**

6 Q Sitting here now do you recall offering
7 the claim construction positions for the '157 patent
8 in the related District Court litigation?

9 A **That is very possible.**

10 Q Did you apply the same meaning for the
11 claims of the '157 patent in both your declaration in
12 this proceeding and your infringement analysis of the
13 '157 patent in the related District Court litigation?

14 MR. LINDEN: I'm just going to object to
15 scope for the record.

16 A **Your question related to infringement.**
17 **Did I hear that correctly?**

18 BY MR. RODKEY:

19 Q It relates to your declaration in this
20 proceeding and I'm asking did you apply the same
21 meaning of the claim terms of the '157 patent in this
22 declaration, Exhibit 2009, that you applied when
23 analyzing infringement in the '157 patent in the
24 related District Court litigation?

25 MR. LINDEN: Same objection.

1 **A Based on my understanding, in the IPR**
2 **proceeding the plain and ordinary meaning of claim**
3 **terms is being used. And in the District Court my**
4 **use of the term is subject to a claim construction**
5 **order but I do not recall the details of that claim**
6 **construction order. I'm happy to look at the claim**
7 **construction order if you wish me to do so.**

8 BY MR. RODKEY:

9 **Q Do you recall any terms in the claim**
10 **construction order of the District Court that would**
11 **have been different than the plain and ordinary**
12 **meaning as they relate to the '157 patent?**

13 **A It would be helpful for me to have the**
14 **claim construction order in hand.**

15 **Q If no terms of the '157 patent were**
16 **construed in the claim construction order of the**
17 **District Court, would you have applied your**
18 **understanding of the plain and ordinary meaning of**
19 **the terms in both this proceeding and the District**
20 **Court?**

21 **A In the IPR proceedings I used the plain**
22 **and ordinary meaning of claim terms. In the District**
23 **Court proceedings I used the meaning found in the**
24 **claim construction order. I used the meaning ordered**
25 **by the judge. But I do not recall off the top of my**

1 head all the constructions that were ordered by the
2 judge. It would be helpful to have in my hands the
3 claim construction order.

4 Q If a judge did not provide a meaning of a
5 particular term for the '157 patent how did you
6 interpret that term?

7 A Can I hear the question again?

8 Q If the judge did not provide a meaning of
9 a term of the 157 patent how did you interpret that
10 term in the District Court?

11 MR. LINDEN: I'll object to form.

12 A In the absence of a claim construction
13 order I would use the plain and ordinary meaning in
14 light of the respective patent as understood by a
15 POSITA at the time of the invention.

16 BY MR. RODKEY:

17 Q And POSITA do you mean person of ordinary
18 skill in the art?

19 A Yes.

20 Q And is it your understanding that the
21 plain and ordinary meaning of a term in the District
22 Court should be interpreted the same as the plain and
23 ordinary meaning of a term in this IPR proceeding?

24 A Based on my understanding there can be a
25 difference. In the District Court we have a claim

1 **construction order and in the IPR I do not recall any**
2 **claim construction order. I don't think there was**
3 **one.**

4 Q For a term in the District Court that is
5 not subject to the claim construction order, meaning
6 the judge did not provide a construction, in which
7 you said you applied the plain and ordinary meaning,
8 is it your understanding that you should apply your
9 same understanding of the plain and ordinary meaning
10 in this proceeding?

11 A **Yes. In absence of a claim construction**
12 **order I would use the plain and ordinary meaning in**
13 **light of the patent, the respective patent, for a**
14 **POSITA at the time of the invention.**

15 Q And you look at you might be reading off
16 that screen. Do you have a document open on that
17 laptop?

18 A **I do not.**

19 Q So just to be clear, for a term that you
20 applied the plain and ordinary meaning, or your
21 understanding of the plain and ordinary meaning in
22 the District Court, did you apply the same
23 understanding of the plain and ordinary meaning in
24 your declaration 2009 in this proceeding?

25 A **To the extent that the claim term is**

1 affected by the claim construction order, I followed
2 the claim construction order. In the IPR I followed
3 the plain and ordinary meaning as perceived by a
4 POSITA at the time of the invention and given the
5 context of the respective patent.

6 Q Okay. My question wasn't about those that
7 are subject to the claim construction order. My
8 question was about terms that are not subject to the
9 claim construction order for which you said you
10 applied the plain and ordinary meaning in the
11 District Court. Did you apply the same plain and
12 ordinary meaning in District Court for those terms
13 not subject to the claim construction order as you
14 did for the terms of the '157 patent in Exhibit-- in
15 your opinions in Exhibit 2009?

16 A I'm just thinking the different
17 definitions of the POSITA in the IPR proceeding and
18 in the District Court. Based on my understanding
19 petitioner has proposed a POSITA having in my opinion
20 a relatively low level of skills. It is my
21 recollection that petitioner has proposed that a
22 master degree recipient without any practical
23 experience in LCDs would qualify as a POSITA. And so
24 we have in this regard some differences.

25 But as I said earlier when it comes to the

1 meaning of claim terms in the IPR I have used the
2 plain and ordinary meaning in the context of the
3 respective patent as understood by a person of
4 ordinary skill in the art at the time of the
5 invention. And I basically followed the same
6 principle in the District Court proceedings.

7 Q So in your declaration, Exhibit 2009,
8 paragraph 21, you provided your opinion on the level
9 of ordinary skill in the art. Did you apply that
10 level of ordinary skill in the art in this proceeding
11 and in the District Court?

12 A In this proceeding it is my understanding
13 that Dr. Murphy or petitioner has proposed a certain
14 level of skills for the POSITA and I have analyzed
15 Dr. Murphy's arguments based on among other factors
16 the POSITA that he has proposed.

17 Q So to be clear, in Exhibit 2009 you did
18 not apply your definition of a POSITA in paragraph 21
19 if you applied Dr. Murphy's?

20 A I had both POSITA definitions in mind and
21 I just thought that the level of skills that
22 Dr. Murphy proposed is relatively low. But I came to
23 the conclusion that the '157 patent is a valid
24 patent.

25 Q Would you turn to page 10? And I'm

1 specifically look at the section heading Roman
2 numeral 4, relevant legal principles, which spans
3 from paragraph 24 through paragraph 33 on page 12.
4 And under that heading Roman numeral 4 you have two
5 subheadings before paragraph 25. One is claim
6 construction and you have a second subheading
7 obviousness before paragraph 31, correct?

8 **A Yes.**

9 Q Does section 4 accurately summarize the
10 legal principles that you applied when coming to your
11 opinions in Exhibit 2009?

12 **A Yes.**

13 Q And just so the record is clear,
14 paragraphs 25 through 30, do those accurately
15 summarize the legal claim construction principles
16 that you applied when coming to your opinions in
17 Exhibit 2009?

18 **A Yes.**

19 Q Are there any claim construction
20 principles that you applied that are not stated in
21 paragraphs 25 to 30?

22 **A In the IPR or in the District Court?**

23 Q In this proceeding.

24 **A I don't think there are any additional**
25 **principles that I applied.**

1 Q And, again, paragraphs 31 to 33, do those
2 accurately summarize the legal principles of
3 obviousness that you applied when reaching your
4 opinions in 2009?

5 A **If I understand you correctly, you're**
6 **asking me to render a judgment on the legal**
7 **principles. I'm not a lawyer. And therefore I can**
8 **follow instructions that are provided from the legal**
9 **domain but to the extent that your question asks me**
10 **on the legal -- on legal aspects here I want to point**
11 **out that I'm not an attorney.**

12 Q Do paragraphs 31 to 33 relate the entirety
13 of the instructions you were provided for obviousness
14 for Exhibit 2009 when rendering your opinions?

15 A **(Reviewing document.) I think that**
16 **section obviousness is a fair characterization of**
17 **what I employed.**

18 Q Are there any principles of obviousness
19 that you applied when rendering your opinions in
20 Exhibit 2009 that are not stated in paragraphs 31 to
21 33?

22 A **None come to mind right now.**

23 Q When rendering your opinions in
24 Exhibit 2009 previously you said you applied the
25 plain and ordinary meaning. Were you ever asked to

1 assume or apply any other interpretation when forming
2 your opinions in Exhibit 2009?

3 **A I do not recall anyone asking me to use a**
4 **meaning different from the plain and ordinary**
5 **meaning.**

6 MR. RODKEY: All right. I think we're
7 pretty close. Why don't we take maybe a five-minute
8 break.

9 MR. LINDEN: Sure. You just need to
10 collect your notes or --

11 MR. RODKEY: Yeah.

12 MR. LINDEN: Okay.

13 (Recess from 12:45 p.m. to 12:57 p.m.)

14 MR. RODKEY: I have no further questions.

15 MR. LINDEN: Just a few questions if my
16 computer would boot up.

17 EXAMINATION BY COUNSEL FOR THE PATENT OWNER
18 BY MR. LINDEN:

19 Q Dr. Schubert, you were asked a few
20 questions earlier today about the meaning you applied
21 claim terms in the District Court and the present IPR
22 proceedings. Do you recall that?

23 A **Yes.**

24 Q And you understand that one should apply
25 the same meaning to a claim term for both

1 infringement and validity, correct?

2 **A In the District Court?**

3 Q Just generally speaking one is to apply
4 the same meaning to a claim term when conducting an
5 infringement and a validity analysis, correct?

6 **A Yes.**

7 Q Can you think of any claim term for the
8 '157 patent in which you applied a different
9 understanding between this IPR proceeding and the
10 District Court proceeding?

11 **A To answer the question I would like to see**
12 **the claim construction order. I don't have that in**
13 **front of me so, you know, I'm not aware of what terms**
14 **have been construed in the District Court and I'm**
15 **happy to look at those terms but I feel like I'm**
16 **talking about something that I do not have that order**
17 **in hand. So if there is the theoretical possibility**
18 **that there was a claim construction order in the**
19 **District Court, I would follow that claim**
20 **construction order.**

21 Q Okay. And counsel for petitioner has not
22 provided you that claim construction order, correct?

23 **A Correct.**

24 Q And then you were asked some questions
25 about the different definitions of a POSITA proposed

1 by yourself, Dr. Murphy and Dr. Sourì in the various
2 proceedings, correct?

3 MR. RODKEY: Objection, mischaracterizes.

4 BY MR. LINDEN:

5 Q Let me rephrase that. Dr. Schubert, you
6 were asked him about the different definitions
7 proposed by yourself and Dr. Murphy in these
8 proceedings for a POSITA, correct?

9 A Correct.

10 Q Would your ultimate conclusions in this
11 proceeding have changed based on the application of
12 either Dr. Murphy's definition of a POSITA or your
13 definition of a POSITA?

14 A No. As I said earlier, I had both POSITA
15 definitions in mind and came to the conclusions that
16 are summarized in my report.

17 MR. LINDEN: No further questions.

18 MR. RODKEY: No questions. Thank you for
19 your time, Dr. Schubert.

20 THE WITNESS: Thank you.

21 MR. LINDEN: Thank you, Dr. Schubert.

22 (Whereupon, at 1:02 p.m. the deposition
23 concluded.)

24 * * * * *

25

1 REPORTER'S CERTIFICATE

2 STATE OF MINNESOTA)

3 COUNTY OF HENNEPIN)

4 SS.

5 I hereby certify that I reported the
6 deposition of DR. E. FRED SCHUBERT on May 28, 2025,
7 in Minneapolis, Minnesota, and that the witness was
8 by me first duly sworn to tell the whole truth;

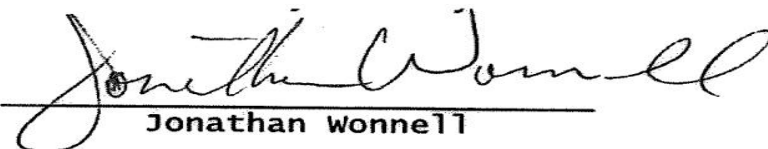
9 That the testimony was transcribed by me
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16 That I am not a relative or employee or
17 attorney or counsel of any of the parties, or a
18 relative or employee of such attorney or counsel;

19 That I am not financially interested in
20 the action and have no contract with the parties,
21 attorneys, or persons with an interest in the action
22 that affects or has a substantial tendency to affect
23 my impartiality.

24 WITNESS MY HAND AND SEAL THIS 29th day of
25 May, 2025.

20 
21 Jonathan Wonne11

22 Notary Public, Hennepin County, Minnesota
23 My Commission expires January 31, 2027

24

25

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