

PETITIONER'S TRIAL HEARING DEMONSTRATIVES

KANGXI COMMUNICATION TECHNOLOGIES
(SHANGHAI) Co., LTD.

v.

SKYWORKS SOLUTIONS, INC.

IPR2024-01456 AND IPR2024-01457
U.S. PATENT NOS. 9,450,579 AND 9,148,194

BEFORE AMBER L. HAGY, JON M. JURGOVAN AND STEPHEN E. BELISLE,
ADMINISTRATIVE PATENT JUDGES

TRIAL HEARING
MARCH 6, 2026

Overview of Grounds

Ground	Basis	Cited Art	'194 Claims	'579 Claims
1	103	Huang	1-11	1-3, 7-9, 13-15
2	103	Seshimo	1-11	1-3, 7-9, 13-15

Overview of Disputes

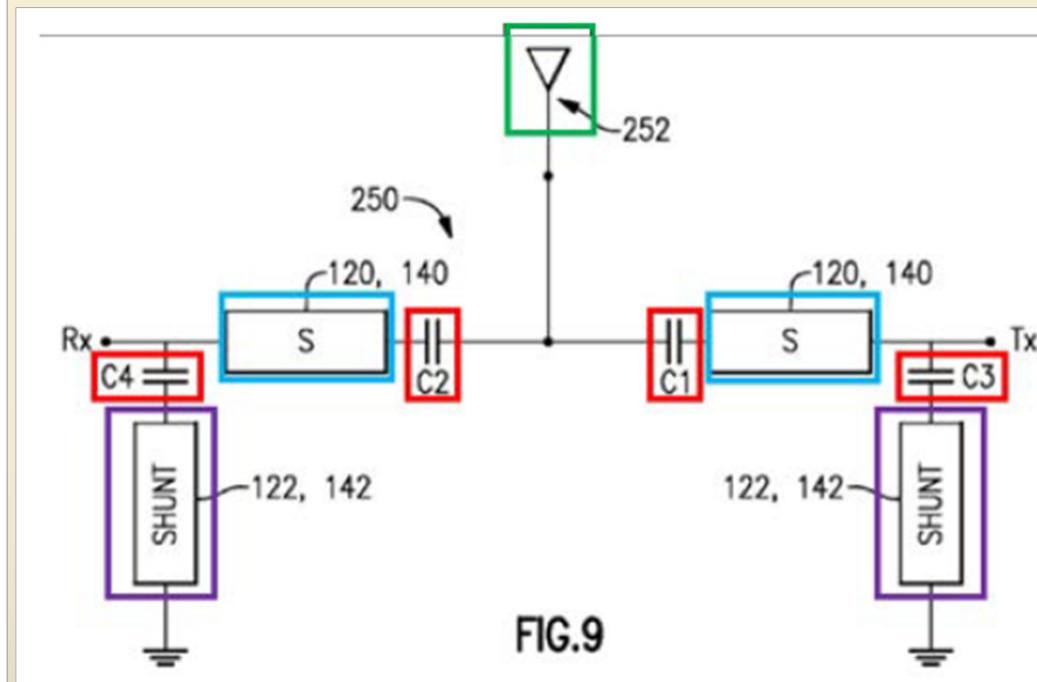
Dispute	Basis	'194 Claims	'579 Claims
1	<i>At least one of the 1st and 2nd capacitors is configured to inhibit a low-frequency blocker signal from mixing with a fundamental frequency signal</i>	2, 8	
	<i>Inhibiting a low-frequency blocker signal from mixing with a fundamental frequency signal using the 1st capacitor</i>		7
2	<i>1st and 2nd Capacitors formed on (or part of) the same substrate as the 1st and 2nd switch circuits</i>	5, 9	1, 15

Overview of the '579 and '149 Patents (the “Patents”)

Patents' Specific Description of Positioning of Capacitors to “*inhibit a low frequency-blocker signal...*”

The switching configuration of FIG. 9 is shown to include capacitors to inhibit a low-frequency blocker from mixing with a fundamental frequency. For example, a capacitor C1 is provided between the antenna node and the switch arm S of the Tx throw. Similarly, a capacitor C2 is provided between the antenna node and the switch arm S of the Rx throw. For the shunt arms, a capacitor C3 is provided between the Tx node and its shunt switch arm. Similarly, a capacitor C4 is provided between the Rx node and its shunt switch arm. In some embodiments, a shunt arm may or may not be provided for the Rx node. With the foregoing capacitors, a low-frequency jammer signal can be blocked or reduced from mixing with any ON or OFF paths. This can lead to improvement in IMD performance, especially for low-frequency blocker signals.

'579 Pat., 9:39-53, FIG. 9
Pet. 12-13

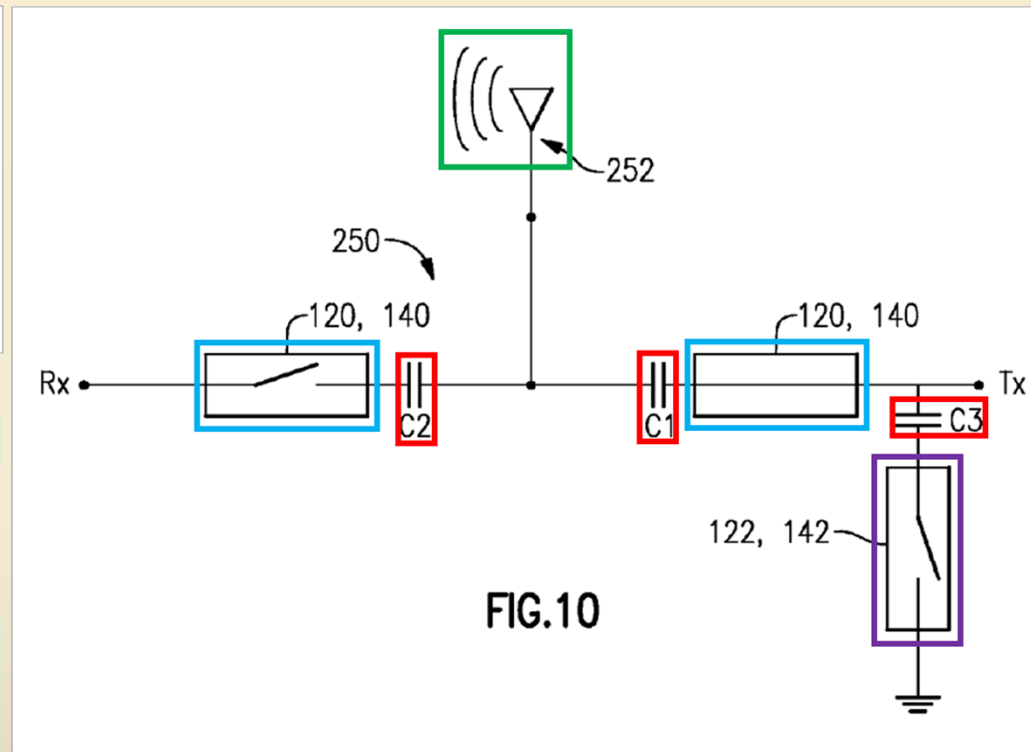


POR 6-7

Patents' Specific Description of Positioning of Capacitors to “*inhibit a low frequency-blocker signal...*”

FIG. 10 shows an example operating configuration where some of the foregoing capacitors can provide desirable switching functionalities. In the example, the switching configuration is in a transmit mode. Accordingly, the transmit switch arm is ON (closed), and the receive switch arm is OFF (open). The shunt arm for the Tx node is OFF (open).

In some implementations, and as described herein, the foregoing example configurations described in reference to FIGS. 9 and 10 can be relatively simpler and easier to implement, and can yield a number of improvements. For example, this technique can provide improved IMD performance by preventing a low-frequency blocker signal from mixing with a fundamental frequency signal.



'579 Pat., 9:54-59, 9:64-10:3

'194 Dependent Claim 2

'579 Claim 7 (Dispute 1)

'194 Patent Claims

1. A radio-frequency (RF) switch system comprising:
 - a first switch circuit connected between an antenna node and a transmit node;
 - a second switch circuit connected between the antenna node and a receive node;
 - a first capacitor connected in series with the first switch circuit between the first switch circuit and the antenna node;
 - a second capacitor connected in series with the second switch circuit between the second switch circuit and the antenna node;
 - a first shunt arm connected to the first switch circuit and the transmit node, the first shunt arm including a third switch circuit connected to ground; and
 - a second shunt arm connected to the second switch circuit and the receive node, the second shunt arm including a fourth switch circuit connected to ground.

2. The switch system of claim 1 wherein at least one of the first and second capacitors is configured to inhibit a low-frequency blocker signal from mixing with a fundamental-frequency signal in the switch.

3. The switch system of claim 1 wherein the first shunt arm includes a third capacitor connected between the third switch circuit and the transmit node, and the second shunt arm includes a fourth capacitor connected between the fourth switch circuit and the receive node.

'579 Patent Claims

7. A method for operating a radio-frequency (RF) device, the method comprising:

providing an RF device including a first switch circuit connected between an antenna node and a transmit node, a second switch circuit connected between the antenna node and a receiver node, a first capacitor connected in series with the first switch circuit between the first switch circuit and the antenna node, a second capacitor connected in series with the second switch circuit between the second switch circuit and the antenna node, and a first shunt arm connected to the first switch circuit and the transmit node, the first shunt arm including a third switch circuit connected to ground;

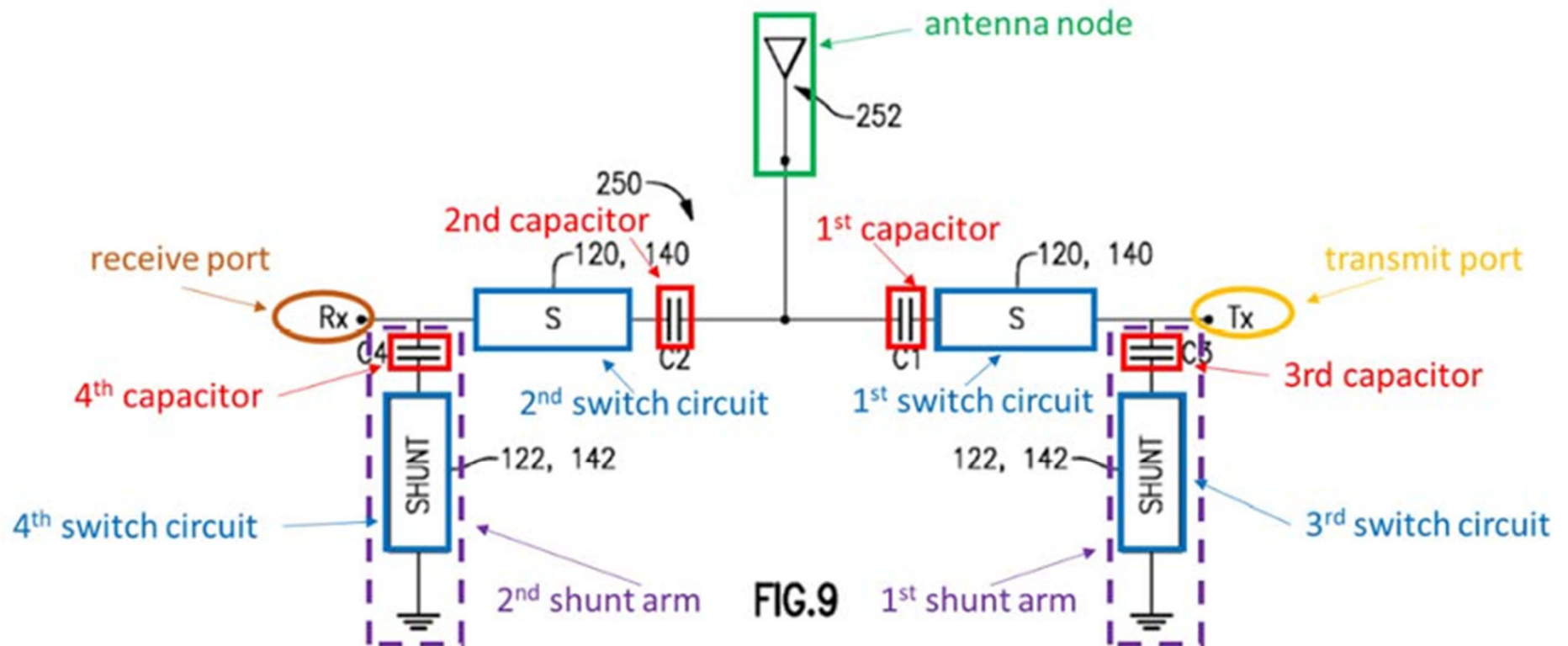
controlling an RF switch of the RF device by placing the first switch circuit in an ON state and placing the third switch circuit in an OFF state; and

inhibiting a low-frequency blocker signal from mixing with a fundamental-frequency signal in the RF switch using the first capacitor.

8. The method of claim 7 wherein the first switch circuit is formed on an insulator layer disposed between the first switch circuit and a semiconductor substrate.

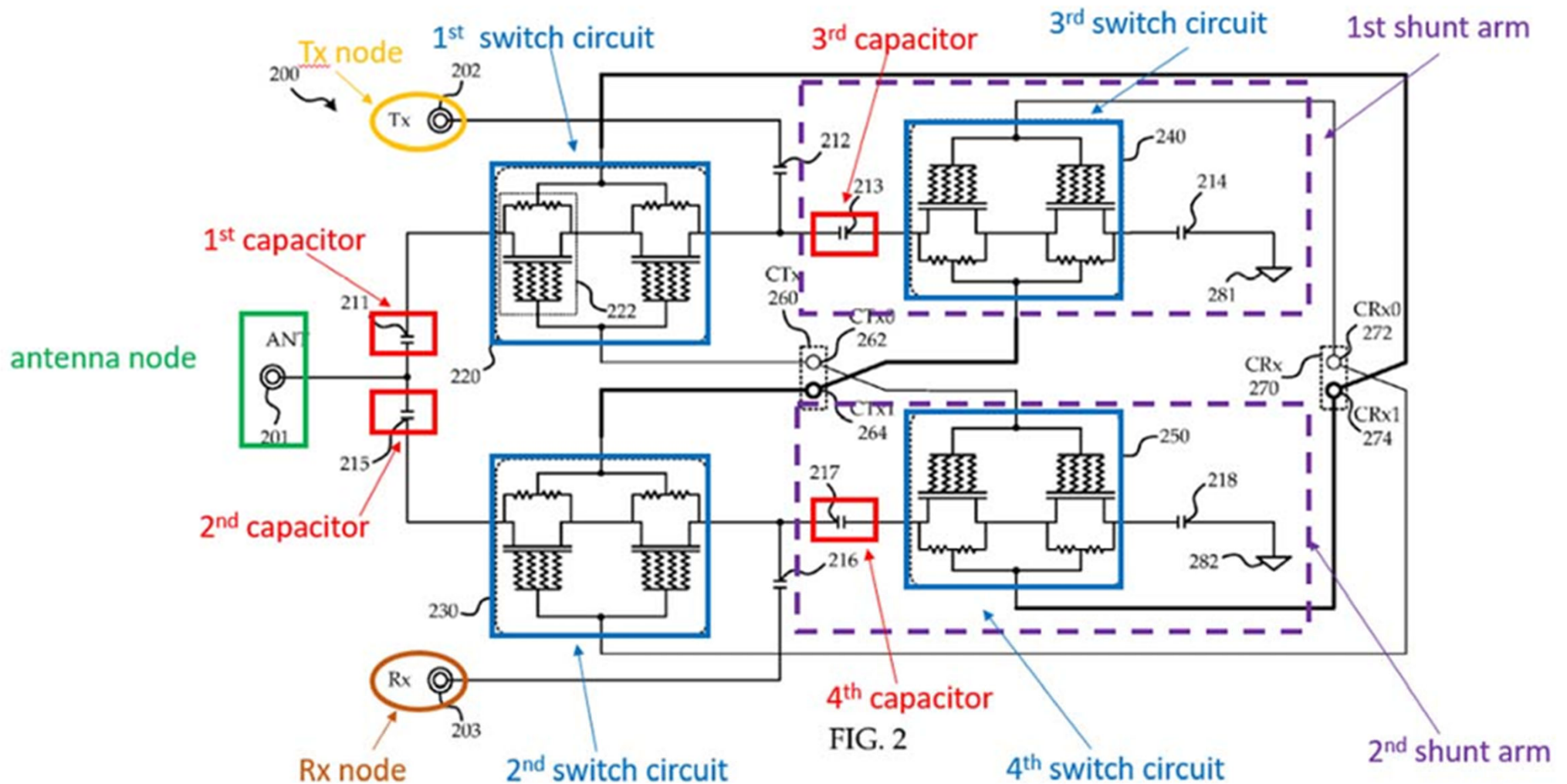
9. The method of claim 7 wherein the RF switch is a silicon-on-insulator (SOI) switch.

Overview of Patents (FIG. 9)

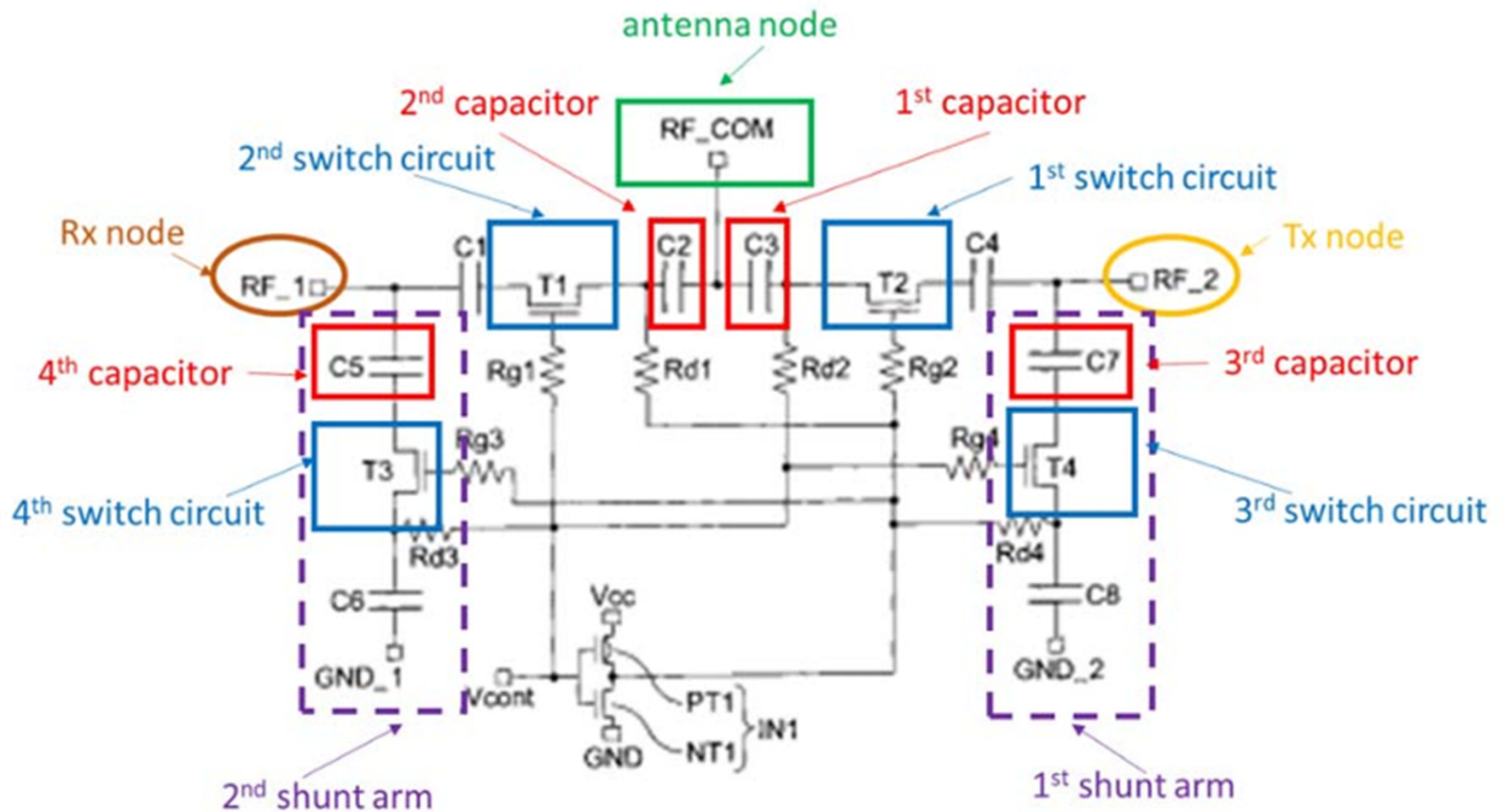


Pet. 3, 13

Ground 1 (Huang FIG. 2)



Ground 2 (Seshimo FIG. 3)



Dispute 1: *“configured to inhibit a low-frequency blocker signal from mixing with a fundamental frequency signal in the switch”*

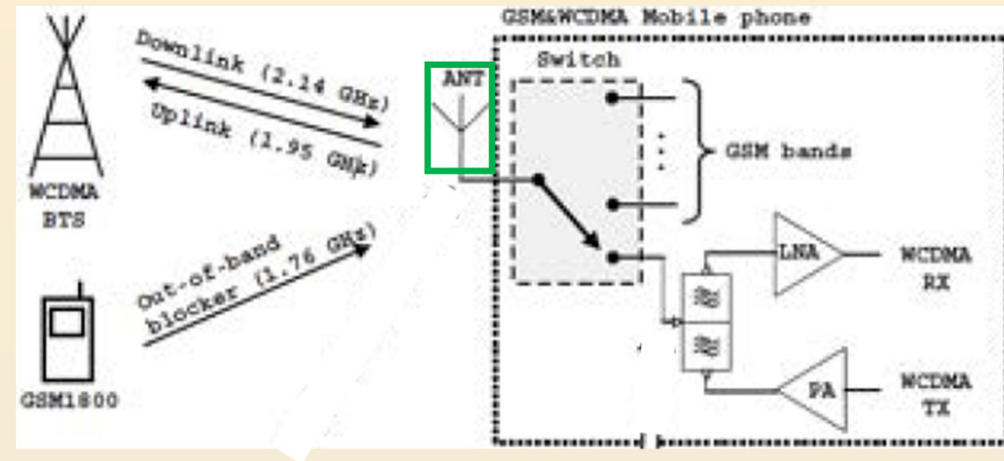
Patents Do Not Include Implementation Details

- **The Patents do not purport to invent:**
 - a new capacitor
 - a new use of a capacitor
 - a new technique for forming RF switch components (including capacitors) on a semiconductor substrate

Pet. Reply 2
- **The Patents do not include implementation details:**
 - **How C1 or C2** “inhibit[s] a low-frequency blocker signal from mixing with a fundamental frequency signal”?
 - Exemplary **origins of** “a low-frequency blocker signal” that **C1 or C2** “is configured to inhibit...”
 - Exemplary **frequency values** of “low-frequency blocker signals” relative to exemplary “fundamental frequency signals”
 - Exemplary **capacitance value (size)** of **C1 or C2** to “inhibit a low-frequency blocker signal from mixing with a fundamental frequency signal”? Pet. 5-6, 13-14
- **Patents:** FIGS. 9-10 capacitor “configur[ation] to inhibit...” is “relatively simpler and easier to implement” ’579 Pat., 9:64-10:3, FIGS. 9-10

Out-of-Band Interference Was a Well-Known Problem

- A well-known consideration in designing RF switches in wireless devices, especially those operating in multi-mode and multiband environments, was that a phone's **antenna ("ANT")** may pick-up "out-of-band blocker" signals transmitted in the area and, if allowed to mix with a wanted (fundamental) RF signal in an RF switch, the desired transmitted/received information may be degraded, further unwanted signals (IMD products (*e.g.*, $f_{TX} - f_{blocker}$ (IMD2), $2f_{TX} - f_{blocker}$ (IMD3))) may be created.



Band	TX f_{TX}	RX f_{RX}	IMD2 low	IMD3	IMD2 high
			Blocker 1 $f_{TX} + f_{RX} = f_{BO}$	Blocker 2 $2f_{TX} - f_{RX} = f_{BO}$	Blocker 3 $f_{RX} - f_{TX} = f_{BO}$
850	836.5	881.5	45	791.5	1718
1900	1880	1960	80	1800	3840
2100	1950	2140	190	1760	4090

Fig. 4. Dominating out-of-band blocking mechanisms and center frequencies for the 850, 1900 and 2100 WCDMA bands.

Pet. 25-27 and EX-1003 ¶¶68-70
(citing EX-1040, 3-6, FIGS. 3, 4)

PO's Expert Acknowledged the Well-Known Out-of-Band Interference Problem

Q. So nearby RF transmitted – transmitters were a well-known source of unwanted RF signals for RF switches and RF devices. Would you agree with that?

A. I would agree with that.

Q. And well-known examples of these RF devices could be a cellular phone or a wire[les]s LAN radio. Would you agree with that?

A. Yes. EX-1050 (PO's Expert's Depo) 132:3-11 (EX-2001, ¶20)

Q. The patents -- would you agree that the patents assume that non-linearities will exist in the switching devices at the RF switch?

A. Oh yes, very much so. Actually, I think they rely on that.

Q. Okay. A POSITA would understand that like in reality, there is no RF switch that operates perfectly linearly, is that right?

A. Absolutely. EX-1050 (PO's Expert's Depo) 132:22-133:8 (EX-2001, ¶23)

Q. ...[A] POSITA would understand that because the[re] are non-linearities in the switching devices in an RF switch, that non-linearities would result in intermodulation distortion being generated, is that right?

A. Yes, through -- from blockers and fundamental frequencies or, yes, any combination thereof, really. EX-1050 (PO's Expert's Depo) 134:13-22

Low-Frequency Blocker Signals Were a Well-Known Part of the Out-of-Band Interference Problem

- A POSITA understood the many examples of low-frequency, out-of-band blocking signals, such as a low-frequency television blocking signal (190MHz) relative to fundamental cellular signals (1950-2140MHz), and, because of RF switch nonlinearities, the IMD caused by the mixing of such signals.

Band	TX f_{TX}	RX f_{RX}	IMD2 low	IMD3	IMD2 high
			Blocker 1 $f_{TX} + f_{TX} = f_{RX}$	Blocker 2 $2f_{TX} - f_{RX} = f_{RX}$	Blocker 3 $f_{RX} - f_{TX} = f_{RX}$
850	836.5	881.5	45	791.5	1718
1900	1880	1960	80	1800	3840
2100	1950	2140	190	1760	4090

Fig. 4. Dominating out-of-band blocking mechanisms and center frequencies for the 850, 1900 and 2100 WCDMA bands.

Pet. 26-27 and EX-1003 ¶¶69-70
(citing EX-1040, 3-6, FIG. 4; EX-1046, 23-24; EX-1045, 1)

- Pet. 25 and EX-1003 ¶65 citing EX-1049, p.3 (disclosing examples of low, out-of-band blocking frequencies of (i) $f_{\text{blocking}} = 45.1718\text{MHz}$ for fundamental frequencies of $f_{TX} = 836.5\text{MHz}$ and $f_{RX} = 881.5\text{MHz}$, (ii) $f_{\text{blocking}} = 45\text{MHz}$ for fundamental frequencies of $f_{TX} = 897.5\text{MHz}$ and $f_{RX} = 942.5\text{MHz}$, (iii) $f_{\text{blocking}} = 30\text{MHz}$ for fundamental frequencies of $f_{TX} = 710\text{MHz}$ and $f_{RX} = 740\text{MHz}$).

Pet. 25 and EX-1003 ¶68 (citing EX-1049
(PO April 2012 RF Switch Datasheet, 3)

Capacitor Characteristics Were Well-Known

- Capacitors are passive devices
- A fundamental characteristic of all capacitors is that their opposition to the flow of an AC waveform (*e.g.*, RF), called impedance is *inversely* determined by the product of the frequency and the capacitance; accordingly:
 - All capacitors are configured to block (fully inhibit) DC signals (0 Hz)
 - All capacitors are configured to inhibit (reduce the amplitude of) low-frequency AC signals relative to high-frequency AC signals

Pet. 16-17, 19-21 and EX-1003 ¶¶45 (fn. 7), ¶¶57-60

PO's Expert Acknowledged the Well-Known Low-Frequency-Inhibiting and High-Frequency-Passing Characteristics of All Capacitors

Q. So every capacitor blocks a DC signal?

A. Every capacitor with a finite capacitance, meaning not zero or non-infinity, would block a DC signal.

EX-1050 (PO's Expert's Depo) 61:15-18

Q. Every capacitor blocks the flow of direct current, right?

A. Direct current also known as DC. Yes, every capacitor blocks DC.

Q. And it will do that regardless of its -- the value of the capacitor, right?

A. Yes.

Q. Do you agree that it would -- with this dictionary definition, [EX-1051, 72], that every capacitor will permit the flow of alternating current to a degree dependent on the capacitor's capacitance [and] the current frequency?

A. Yes, I don't disagree with that.

EX-1050 (PO's Expert's Depo) 146:12-147:2

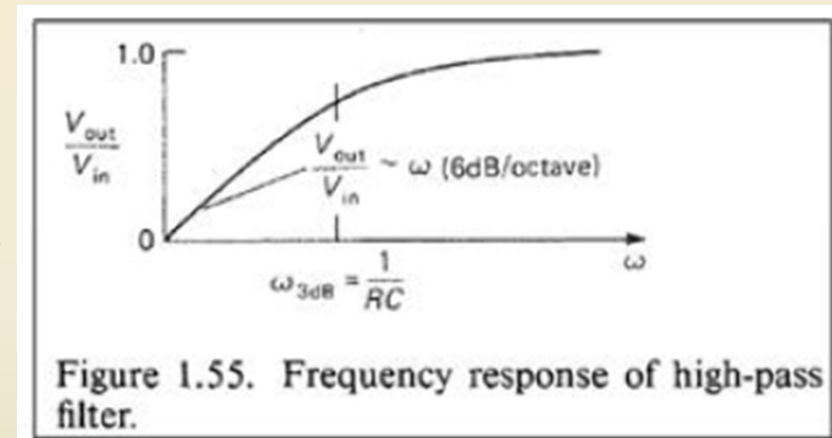
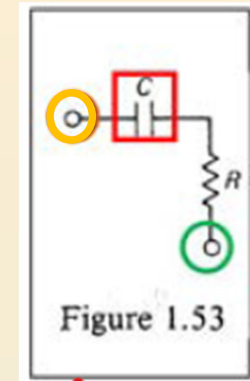
Q. If we assume that the -- if we assume that the same voltage is applied across a capacitor then would you agree that a POSITA would understand that it would permit less current at low frequency AC signals than at high frequency AC signals?

A. Yes. For the same voltage applied across it.

EX-1050 (PO's Expert's Depo) 148:2-9

Capacitors Were a Well-Known Solution to Interference From Unwanted Low-Frequency Signals

- Due to this fundamental low-frequency-blocking, and high-frequency-passing characteristic of capacitors, a basic high-pass filter was simply a **capacitor** connected in series between **the RF waveform source node** and **output node**, and in series with a resistor (with 50-ohm standard impedance commonly used as this resistor value) with the fundamental -3dB breakpoint of this filter shown in the graph of signal amplitude reduction (as a fractional ratio) versus AC signal frequency -3dB breakpoint is the low-frequency value at which the input AC signal amplitude is reduced to 0.707 of its maximum.



Pet. 21-22 and EX-1003 ¶¶61-62
(citing EX-1014, 35-37, Figures
1.53 and 1.55; EX-1044, 1-2).

Capacitors Were a Well-Known Solution to Interference From Low-Frequency Blocker Signals

- “The nonlinearity mechanisms of the switch may be...current (e.g. nonlinear series resistance) dependent... As the phase angle of the mismatch affects the relationship between current... swings, the IMD changes as a function of the phase angle... [T]he distortion products for current dependent nonlinearity in RF switches may be minimized by adjusting the phase so that the switch sees an open circuit at the blocker frequency.”
 - In other words, as explained by Petitioner’s expert: “[T]he known solution... to the well-known low-frequency, ‘out-of-band blocker’ signal problem in non-linear RF switches” was “having ‘the switch see[] an open circuit at the blocker frequencies.’”

Pet. 27 and EX-1003 ¶71 (*citing* EX-1040, 5; EX-1046, 23-24); Pet. 50, 70 and EX-1003 ¶¶ 114, 173 (*citing* EX-1040, 5; EX-1046, 23-24).

Capacitors Had Long Been Used to Inhibit Low-Frequency Blocker Signals in RF Switches

- Capacitors had long been positioned and configured (value selected) to have very low impedance at fundamental frequencies and high impedance at low-frequency blocker signal frequencies, *e.g.*,
 - EX-1011: for WLAN ($f_{\text{fund}}=2.4\text{GHz}$) FEM, $2\times 10\text{pF}$ “on-chip DC blocking... capacitors” positioned in each series throw of SP3T switch ($f_{3\text{dB}}=636.9\text{MHz}$), respective 10pF capacitor between **antenna** and **Tx** series **switch** (and **Rx** series **switch**) EX-1011 (2616-2618, FIGS. 4, 6, 8)
 - EX-1010: $2\times 8.4\text{pF}$ capacitors positioned in each series throw of 2.45GHz SP3T, “monolithic” switch ($f_{3\text{dB}}=757.9\text{MHz}$), respective 8.4pF capacitor between **antenna** and **Tx** series **switch** (and **Rx** series **switch**) EX-1010 (FIG. 3A, [0009]-[0010], [0034]-[0036], [0040])
 - EX-1009: $2\times 5\text{pF}$ caps ($f_{3\text{dB}}=1.27\text{GHz}$) if $f_{\text{fund}}=1.8\text{GHz}$, and $2\times 13\text{pF}$ caps ($f_{3\text{dB}}=489.7\text{MHz}$) if $f_{\text{fund}}=900\text{MHz}$, positioned in each series throw of SPDT switch of “integrated on one chip SOICMOS [IC]”, which “prevents the [different] DC-component on transmission-side from being generated on the reception-side, or vice versa”, with respective capacitor between **antenna** and **Tx** series **switch** (and **Rx** series **switch**) EX-1009 (FIG. 2, [0060]-[0065], [0074]-[0076], [0083]-[0084], [0088])
 - EX-1024 (PO 2009 paper): for “SPnT switches... in wireless devices”, use capacitors to “DC block” with an “adequately low capacitive reactance at desired frequency of operation”, *e.g.*, $2\times$ “5 to 15pF ” capacitors in each throw ($f_{3\text{dB}}=1.27\text{GHz}$ to 424.4MHz), with a capacitor positioned between **antenna** and both **Tx** series **switch** and **Rx** series **switch** EX-1024 (1, 3-5, FIG. 15)

Low Capacitance Value (Picofarad) Capacitors are Small in Size and Typically Used in RF Switches

- EX-1011: 2x10pF “on-chip DC blocking... capacitors” in Tx throw of SP3T switch ($f_{3dB}=636.9\text{MHz}$) of WLAN ($f_{fund}=2.4\text{GHz}$) FEM
- EX-1010: 2x8.4pF capacitors per throw of 2.45GHz SP3T switch ($f_{3dB}=757.9\text{MHz}$) of “monolithic microwave integrated circuit”
- EX-1024 (PO 2009 paper): for “SPnT switches... in wireless devices”, use capacitors to “DC block” with an “adequately low capacitive reactance at desired frequency of operation”, e.g., 2x “5 to 15pF” capacitors in each throw ($f_{3dB}=1.27\text{GHz}$ to 424.4MHz)
- EX-1042 (exemplary PO SPDT / SP3T multiband switch datasheets at pp. 172, 180, 223, 286, 308, 312): each use 47pF “DC blocking” capacitors for $f_{fund}>500\text{MHz}$ ($f_{3dB}=135.45\text{MHz}$)
- EX-1009: 2x5pF caps ($f_{3dB}=1.27\text{GHz}$) if $f_{fund}=1.8\text{GHz}$, and 2x13pF caps ($f_{3dB}=489.7\text{MHz}$) if $f_{fund}=900\text{MHz}$, in Tx throw of SPDT switch of “integrated on one chip SOICMOS [IC]”
- EX-1029: 1x20pF on-chip capacitor per throw of 900MHz SPDT switch ($f_{3dB}=159.2\text{MHz}$)

Pet. 21-23, 30-33; EX-1003, ¶¶60-61, 63-64, 76

Huang and Seshimo Each Disclose the Recited Dispute 1 Limitations

- A “patent need not teach, and preferably omits, what is well known in the art.” *Hybritech, Inc. v. Monoclonal Antibodies, Inc.*, 802 F.2d 1367, 1384 (Fed. Cir. 1986).
- “What a reference teaches or suggests must be examined in the context of the knowledge, skill, and reasoning ability of a [POSITA]. What a reference teaches a [POSITA] is not... limited to what a reference specifically ‘talks about’ or what is specifically ‘mentioned’ or ‘written’ in the reference.” *Syntex (U.S.A.) LLC v. Apotex, Inc.*, 407 F.3d 1371, 1380 (Fed. Cir. 2005).
- The Board properly relied on expert testimony, factually supported by additional prior art, to demonstrate how a POSITA would have understood the disclosure of a single prior art reference, and in finding that the single reference, as understood by a POSITA, rendered challenged claims obvious by teaching every claim limitation. *Unification Techs. LLC v. Micron Technology Inc.*, 2024 WL 3738401, *5-6 (Fed. Cir. Aug. 9, 2024).
- “Regardless of the tribunal, the inquiry into whether any ‘differences’ between the invention and the prior art would have rendered the invention obvious to a skilled artisan necessarily depends on such artisan’s knowledge.” *Koninklijke Philips N.V. v. Google LLC*, 948 F.3d 1330, 1337-1338 (Fed. Cir 2020).

Selection of Capacitor Values Was a Well-Known Design Choice

- No capacitor values disclosed in Patents, *Huang* nor *Seshimo*
- Unrebutted expert testimony: “Selecting a capacitance value of capacitors in RF switches based on, for example, desired (fundamental) frequency values (for which designers want capacitors to essentially act as a short circuit, *i.e.*, pass through as a very low impedance resistor), practical size constraints, and low frequencies of undesired, potentially interfering signals (for which designers wanted capacitors to essentially act as an open circuit, *i.e.*, block as a very high impedance resistor), was widely known to, and well-within the skill and creativity of, POSITAs.”

EX-1003 ¶63 (Pet. 22-23)

PO's Expert Acknowledged Selection of Capacitor Values was a Well-Known Design Choice

Q. Where in the patent does it disclose values of capacitor in a way the person skilled in the art would specifically choose the capacitor?

A. I did not see any values given for any capacitors in the patent description.

EX-1050 (PO's Expert's Depo) 120:3-7

Q. Give me a specific example of the patent teaching choosing a value to inhibit the low frequency blocker signal to prevent IMD.

A. The patent doesn't give any values of capacitor. I don't -- I don't think it uses the word value in the patent description. But it would be understood to a POSITA that that is for the [F]igure 9 schematic when we are referring to that first capacitor, that would be one of the design choices for that POSITA would be how to pick the value of that capacitor.

EX-1050 (PO's Expert's Depo) 121:21-122:9

Q. I believe you said that a POSITA would understand that the construction of inhibit in the context of the claims would require a determination of the desired performance levels for a particular application, is that right?

A. Yes, to determine the amount of inhibiting, for example. That would be dependent on the application and the desired performance levels. Yes.

Q. Where in the patent -- the patents does it disclose a varying amount of attenuation based on desired performance levels of the application?

A. I don't believe the patent gives any numbers specifically for those amounts. I think for a POSITA who understands switch systems blockers and their impact on IMD would understand the impact that IMD has on the performance of the main radio.

EX-1050 (PO's Expert's Depo) 98:11-99:5

PO Argues that Huang's RF Switch is Linear (so No Need to Prevent IMD)

- Huang paragraphs [0042]-[0043] “explain the core of Huang’s teaching. Huang teaches that **linearity** in a switch device **can still be achieved** by choosing 1.0-1.5V for the off-state V_{gsd} and 2.0-2.5V for the on-state V_{gsd} instead of fully biasing transistors on/off.”

EX-2001 (PO’s Expert’s Decl), ¶¶35-36 (*citing* EX-1005 [0042]-[0043]); POR 11-12
- “Huang...**prevents** intermodulation distortion by improving linearity of its switches by precisely DC-biasing transistors and better isolating signal path, thereby minimizing any mixing in the switch and **obviating any need** to inhibit any signal from mixing in the switch.”

PO Sur-Reply 10-11 (*citing* EX-1005 [0043], [0056]; EX-1050 (PO’s Expert’s Depo) 195:8-196:9)

Huang Explicitly Discloses Non-Linearities in RF Switch and Resultant IMD

“In modern RF communication systems, a semiconductor-based transmit-receive switch is often the last/first component encountered by a transmitted/received signal before/after encountering an antenna. Figures of merit for signal quality of such a transmit-receive switch are switch linearity and spurious harmonic emissions.”

EX-1005 [0002]-[0003]; Pet. 39, 42-43, 48-49; Pet. Reply, 6-7

“[A] quality of the signals passing through the transmit-receive switch depends upon, **amongst other things**, the particular voltages chosen for off-state V_{gsd} and on-state V_{gsd} of the FETs within the switch... The inventors have found in the implementation of a high power transmit-receive switch using... SOI... **improved signal quality is obtained** from biasing the FETs at a level other than at the largest possible bias... [A]t relatively high signal strengths, spurious harmonic emissions were emanating from the [maximized] off-state FET group switches **and nonlinear effects in the switching circuit resulted**... In general, the off-state V_{gsd} level should be determined **after an acceptable upper limit to the spurious harmonic emissions and an acceptable lower limit of linearity** have been identified. Such identification will of course depend upon the application in which the switch is to be used. The identification of these limits allows reduction of the magnitude of the off-state V_{gsd} by only the amount required to meet the spurious harmonic and linearity requirements, and hence keeping as much of the benefits of higher isolation that large off-state V_{gsd} provides...”

EX-1005 [0039]-[0040], [0042]-[0043]; Pet. 39, 42-43, 48-49; Pet. Reply 6-7

PO's Expert Acknowledged *Huang* Discloses a Non-Linear RF Switch and Resultant IMD

Q. A POSITA would understand that like in reality, there is no RF switch that operates perfectly linearly, is that right?

A. Absolutely.

EX-1050 (PO's Expert's Depo) 133:5-8

Q. The patent refers to $2f_1$ and $2f_2$ as being second order [inter]modulation distortion products, right?

A. That's correct.

Q. And $2f_1$ and $2f_2$, those are spurious harmonic signals that would be generated due to a nonlinear switch?

A. Correct.

EX-1050 (PO's Expert's Depo) 139:13-19

Q. When Huang is stating identifying acceptable lower limit of linearity in paragraph 42, the POSITA would understand this to mean identifying how little linearity is acceptable in the RF switch for a particular application. Do you agree with that?

A. Yes.

Q. In other words, a POSITA would understand identifying an acceptable lower limit of linearity in Huang to refer to identify[ing] how much non-linearity in the RF switch is acceptable for a particular application, is that right?

A. That's right.

Q. So POSITA reading Huang would understand in every implementation of its solution the [RF] switch operates non-linearly, is that right?

A. I don't know that Huang teaches that explicitly. But I would say a POSITA would understand that an RF switch would have some finite amount of non-linearity.

Q. And here Huang is saying that [of course] depends upon the application how much non-linearity is acceptable, is that right?

A. That's right. And that's consistent with what I've said about non-linearity and IMDs and how that's a function of the application and the performance that's required.

EX-1050 (PO's Expert's Depo) 189:15-190:19

PO Mischaracterizes Its Expert's Testimony

- PO Argument:

- “In Huang, the capacitors are DC blocking capacitors **that are used to isolate and precisely control the DC bias voltages** applied to the transistors to improve device linearity.”

PO Sur-Reply 9, 12 (*citing* POR 29; EX-1050
(PO's Expert's Depo) 195:3-196:16)

- Relied-on PO's Expert's Testimony:

- “Huang teaches improving the linearity of the switch as well as improving insertion loss and includes DC blocking capacitors **in order to apply different DC voltages to the switches** to improve their linearity. So a POSITA implementing Huang based on those teachings would be motivated to use the largest possible value for that DC blocking capacitor with ideally the highest quality factor as well.”

EX-1050 (PO's Expert's Depo) 195:22-196:9

- Other PO Expert Testimony:

- Q. Every capacitor blocks the flow of direct current, right?
- **A. Direct current also known as DC. Yes, every capacitor blocks DC.**
- Q. And it will do that regardless of its -- the value of the capacitor, right?
- **A. Yes.**

EX-1050 (PO's Expert's Depo) 146:12-18

PO's Cited Evidence Does Not Support Its Expert's Testimony That a "Blocking Capacitor" Only Blocks DC (and Passes All AC Frequency Signals Uninhibited)

- PO's cited evidence: dictionary definitions of "blocking capacitor" and "coupling capacitor" in The McGraw-Hill Dictionary of Electrical and Computer Engineering (6th Ed. 2003) (EX-2005, 57, 124)) EX-2001 (PO's Expert's Decl) ¶57 (*citing* EX-2005, 124)

– PO Did Not Cite: p. 72 of the same dictionary (EX-1051, 72)

– PO's Expert's Cross-Examination Testimony:

Q. Every capacitor blocks the flow of direct current, right?

A. Direct current also known as DC. Yes, every capacitor blocks DC.

Q. And it will do that regardless of its -- the value of the capacitor, right?

A. Yes.

Q. Do you agree that it would -- with this dictionary definition, [EX-1051, 72], that every capacitor will permit the flow of alternating current to a degree dependent on the capacitor's capacitance [and] the current frequency?

A. Yes, I don't disagree with that.

blocking capacitor See coupling capacitor.
{ 'bläk·iŋ kə'pas·əd·ər }

coupling capacitor [ELECTR] A capacitor used to block the flow of direct current while allowing alternating or signal current to pass; widely used for joining two circuits or stages. Also known as blocking capacitor; stopping capacitor.
{ 'kəp·liŋ kə'pas·əd·ər }

capacitor [ELEC] A device which consists essentially of two conductors (such as parallel metal plates) insulated from each other by a dielectric and which introduces capacitance into a circuit, stores electrical energy, blocks the flow of direct current, and permits the flow of alternating current to a degree dependent on the capacitor's capacitance and the current frequency. Symbolized C. Also known as condenser; electric condenser. { kə'pas·əd·ər }

PO's Relied-on Evidence Discredits Its Expert's Testimony That a "Blocking Capacitor" Only Blocks DC (And Passes All AC Frequency Signals Uninhibited)

- EX-1011: for WLAN ($f_{\text{fund}}=2.4\text{GHz}$) FEM, **2x10pF** “**on-chip** DC blocking... capacitors” positioned in each series throw of SP3T switch ($f_{3\text{dB}}=636.9\text{MHz}$) Pet. 21-23, 31 (EX-1003, ¶¶61-64, 75); EX-1050 168:7-173:7
- EX-1009: **2x5pF** caps ($f_{3\text{dB}}=1.27\text{GHz}$) if $f_{\text{fund}}=1.8\text{GHz}$, and **2x13pF** caps ($f_{3\text{dB}}=489.7\text{MHz}$) if $f_{\text{fund}}=900\text{MHz}$, positioned in each series throw of SPDT switch of “**integrated on one chip** SOICMOS [IC]”, which “prevents the [different] DC-component on transmission-side from being generated on the reception-side, or vice versa” Pet. 21-23, 32 (EX-1003, ¶¶60, 74, 76)
- EX-1029: for 900MHz SPDT switch, **on-chip**, “**20-pF** capacitors, CB1 and CB2... allow dc biasing” (1x20pF capacitor per throw of SPDT switch ($f_{3\text{dB}}=159.2\text{MHz}$)) Pet. 21-23, 30 (EX-1003, ¶¶60, 64, 73, 75)
- EX-1024 (PO 2009 paper): for “SPnT switches... in wireless devices”, use capacitors to “DC block” with an “adequately low capacitive reactance at desired frequency of operation”, e.g., 2x “**5 to 15pF**” capacitors in each throw ($f_{3\text{dB}}=1.27\text{GHz}$ to 424.4MHz) Pet. 20-25 (EX-1003, ¶¶61-66)
- EX-1035: for “antenna switch circuits”, e.g., “a high-frequency switch used in... a mobile phone”, where “GHz-band microwaves are often used”, “[i]t is desirable to use an **On-chip**... capacitor instead of bonding an external capacitor for the DC blocking capacitor [BC1, BC2, BC3, BC4, BC5, BC6].” Pet. 22-23, 28 (EX-1003, ¶¶63, 73)
- *All PO-cited evidence (in RF field) is instead consistent with “blocking capacitor” definition in Petitioner’s Responsive EX-1052*

Dispute 2: first and second capacitor *“formed on the semiconductor substrate”*

'194 Claim 5 and '194 Dependent Claim 9

5. A method for fabricating a semiconductor die, the method comprising:

- providing a semiconductor substrate;

- forming a first switch circuit on the semiconductor substrate so as to be connected between an antenna node and a transmit node;

- forming a second switch circuit on the semiconductor substrate so as to be connected between the antenna node and a receive node;

- forming a first capacitor on the semiconductor substrate so as to be connected in series with the first switch circuit between the first switch circuit and the antenna node;

- forming a second capacitor on the semiconductor substrate so as to be connected in series with the second switch circuit between the second switch circuit and the antenna node;

- forming a first shunt arm connected to the first switch circuit and the transmit node, the first shunt arm including a third switch circuit connected to ground; and

- forming a second shunt arm connected to the second switch circuit and the receive node, the second shunt arm including a fourth switch circuit connected to ground.

6. The method of claim 5 further comprising forming an insulator layer between the first switch circuit and the semiconductor substrate.

7. A radio-frequency (RF) switch module comprising:
a packaging substrate configured to receive a plurality of components;

- a semiconductor die mounted on the packaging substrate, the die including a first switch circuit connected between an antenna node and a transmit node and a second switch circuit connected between the antenna node and a receive node;

- a first capacitor connected in series with the first switch circuit between the first switch circuit and the antenna node;

- a second capacitor connected in series with the second switch circuit between the second switch circuit and the antenna node;

- a first shunt arm connected to the first switch circuit and the transmit node, the first shunt arm including a third switch circuit connected to ground; and

- a second shunt arm connected to the second switch circuit and the receive node, the second shunt arm including a fourth switch circuit connected to ground.

9. The switch module of claim 7 wherein the first capacitor is part of the same semiconductor die as the first switch circuit.

10. The switch module of claim 7 wherein the first capacitor is part of a second die mounted on the packaging substrate.

11. The switch module of claim 7 wherein the first capacitor is disposed at a location outside of the semiconductor die.

'579 Claims 1-3 and '579 Dependent Claim 15

1. A semiconductor die comprising:

a semiconductor substrate;

a first switch circuit formed on the semiconductor substrate connected between an antenna node and a transmit node;

a second switch circuit formed on the semiconductor substrate and connected between the antenna node and a receive node;

a first capacitor formed on the semiconductor substrate and connected in series with the first switch circuit between the first switch circuit and the antenna node;

a second capacitor formed on the semiconductor substrate and connected in series with the second switch circuit between the second switch circuit and the antenna node; and

a first shunt arm formed on the semiconductor substrate and connected to the first switch circuit and the transmit node, the first shunt arm including a third switch circuit connected to ground.

2. The semiconductor die of claim 1 further comprising an insulator layer disposed between the first and second switch circuits and the semiconductor substrate.

3. The semiconductor die of claim 2 wherein the semiconductor die is a silicon-on-insulator (SOI) die.

13. A wireless device comprising:

a transceiver configured to process RF signals;

an antenna in communication with the transceiver; and

a switch module interconnected to the antenna and the transceiver and configured to selectively route RF signals to and from the antenna, the switch module including a first switch connected between the antenna and a transmit node, a second switch connected between the antenna and a receive node, a first capacitor connected in series with the first switch between the first switch and the antenna, a second capacitor connected in series with the second switch between the second switch and the antenna, and a first shunt arm connected to the first switch and the transmit node, the first shunt arm including a third switch connected to ground.

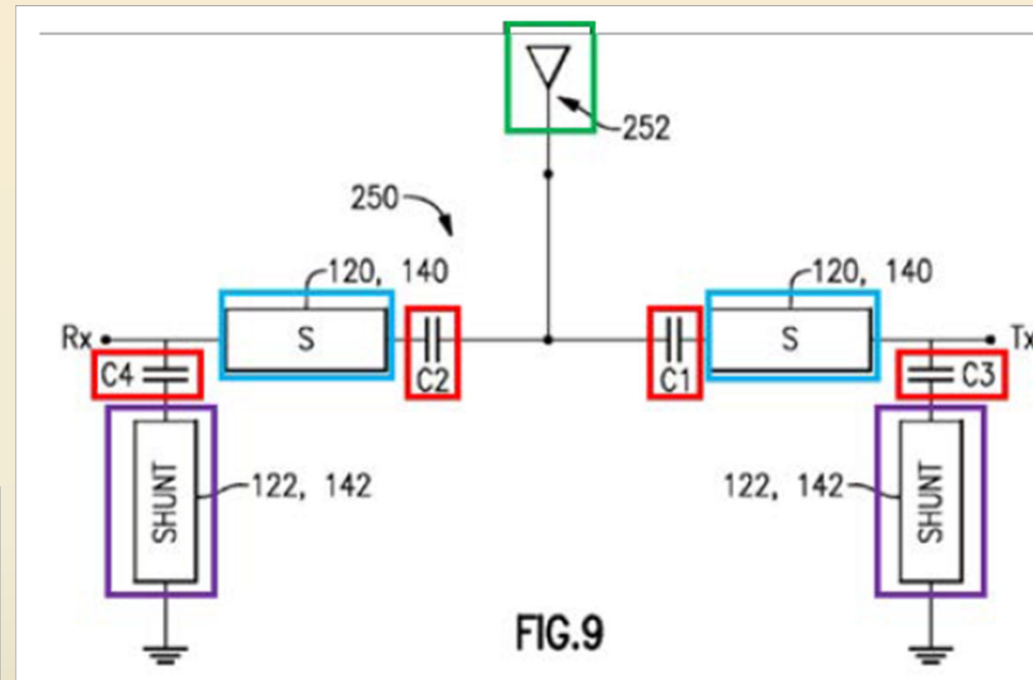
14. The wireless device of claim 13 wherein the first switch is formed on a silicon-on-insulator (SOI) die of the wireless device.

15. The wireless device of claim 13 wherein the first capacitor is part of the same semiconductor die as the first switch.

Patents' Sparse Description of Forming Capacitors on the Same Substrate as Switch Circuits

In some embodiments, the semiconductor die can be a silicon-on-insulator (SOI) die. In some embodiments, the capacitor can be part of the same semiconductor die as the FETs. In some embodiments, the capacitor can be part of a second die mounted on the packaging substrate. In some embodiments, the capacitor circuit can be disposed at a location outside of the semiconductor die. '579 Pat., 2:20-25

In some embodiments, capacitors C1-C4 described in reference to FIGS. 9 and 10 can be implemented on the same die as their respective switch circuits, off of the die, or any combination thereof. '579 Pat., 9:60-63



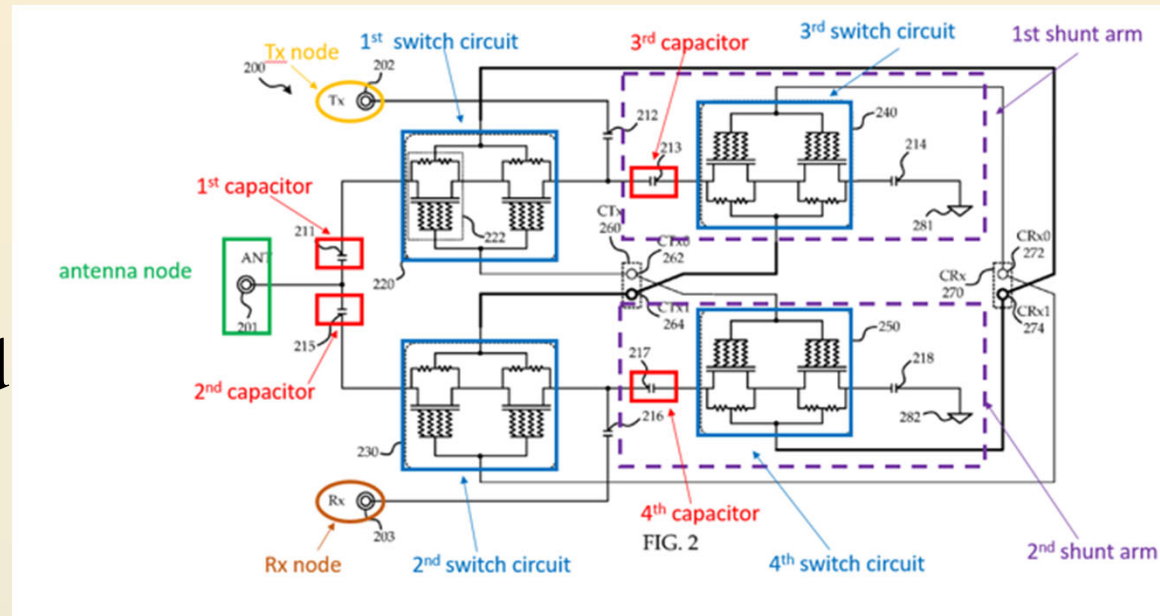
POR 6-7

- **The Patents do not purport to invent** a new technique for forming RF switch components (including capacitors) on a semiconductor substrate
- **The Patents do not identify** any benefits or tradeoffs associated with different well-known implementation options (e.g., on die, off die).

Pet. 14; Pet. Reply 2-3

Huang Describes Using SOI Technology to Form the RF Switch Components

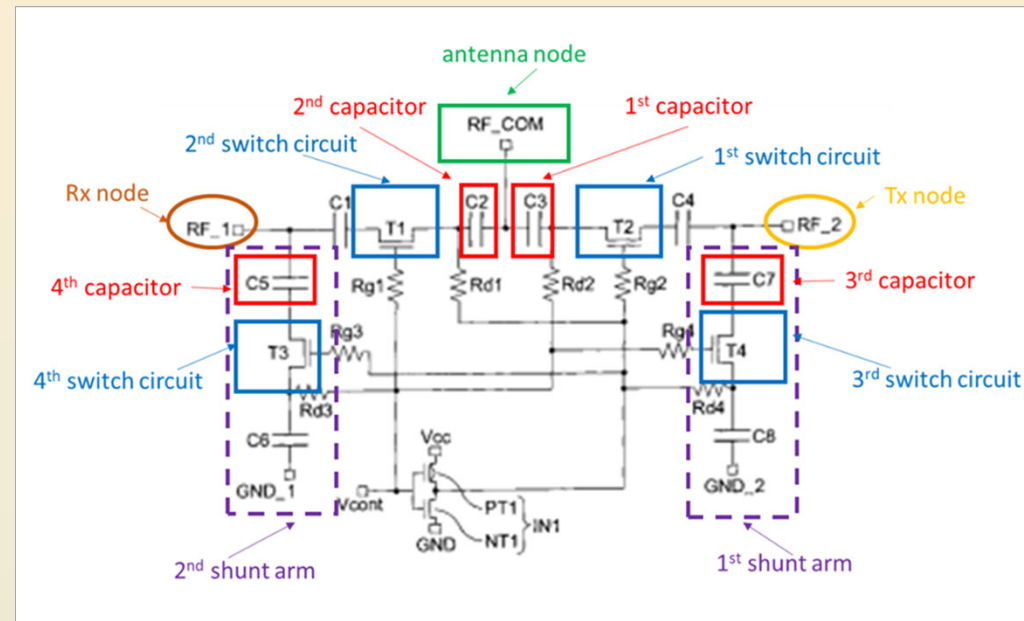
- Huang states “[t]he invention relates to high power semiconductor switches”, discloses the “transistor switches” in such high power, “semiconductor-based transmit-receive switches”, including SPDT switch 200, can be “silicon-on-insulator FET switches”, and that SPDT switch 200 “may be utilized in a traditional WLAN radio.”



Pet. 39, 42 and EX-1003 ¶¶83, 88 (EX-1005 [0001], [0040], [0042]-[0043], [0045], claims 5, 19; FIG. 2)

Seshimo Describes Using SOI Technology to Form the RF Switch Components and Identifies Well-Known Integration Benefits of Using SOI (and other CMOS Processes)

- Seshimo states “[t]he present invention... is particularly suitable for high-frequency semiconductor switching circuit including a MOSFET formed on a silicon substrate”, identifies well-known benefits of “develop[ing] high-frequency semiconductor switching circuits using CMOS processes”, namely “that a CMOS switch can be integrated into another CMOS RF IC”, and states “the use of SOI is also effective in the present invention”, that the SPDT components and control circuits all “may be configured as CMOS circuits and integrated on the same semiconductor substrate”, and that the SPDT switch is “usable by a PHS (Personal Handyphone System)” where it would be “used as a transmission/reception changeover switch.”



Pet. 57-58, 60-61 and EX-1003 ¶¶139, 146 (EX-1007 [0001], [0003], [0029] [0054], [0084], [0087]-[0088]; FIG. 3)

Well-Known that Using SOI Technology to Form RF Switch Components Provided Monolithic (Same Die/Chip) Integration Benefits

- Compared to using pHEMT FETs in SPnT switches, it was well-understood by POSITAs that choosing to fabricat[e] the SPnT switch components in SOI would realize well-understood benefits including lower cost, reduced dielectric losses associated with the silicon substrate, allowing monolithic (same die/chip) integration of SPnT switch and control components and other front-end module (FEM) components, etc.
 - EX-1009: discloses SPDT switch in which, “to achieve a reduction in cost,... silicon[] (CMOS)” instead of “pHEMT” is used to fabricate the FETs, and as part of an “**integrated on one chip** SOICMOS integrated circuit.”
 - EX-1018: “Formation of the [SPDT] switch on a thick oxide layer on a silicon substrate permits control circuitry for control electrodes **to be integrated on the same die as the switch**. The oxide also helps reduce dielectric losses associated with the silicon substrate.”

Pet. 28-30 and EX-1003 ¶74 (*citing* EX-1009, FIG. 2, [0004], [0058], [0083]-[0084], [0088]; EX-1018, 4:27-41, 3:50-54, FIGS. 3-4)

Well-Known that Using SOI Technology to Form RF Switch Components Provided Monolithic (Same Die/Chip) Integration Benefits

- It was well-known to POSITAs that monolithic (same die/chip) integration benefits result from forming RF SPnT switches using SOI technology.

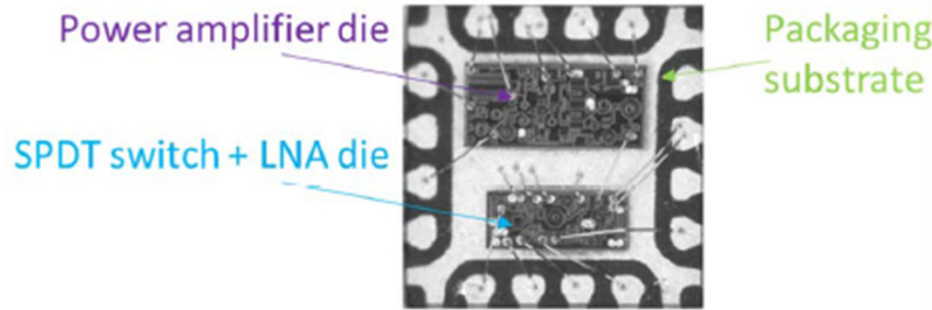


Fig.2. The high linearity 4.9-5.9 GHz FEM in a 3 x 3 mm QFN package.

[For] WLAN radios in portable electronic devices... [a]s shown in Fig. 2, the FEM design consists of two die: a power amplifier (based on SiGe BiCMOS) and a [dual-band SPDT] switched low noise amplifier (based on Silicon-on-Insulator, SOI).

EX-1028, FIGS. 2, 4, 5 (circuit schematics showing components integrated on dual-band-SPDT-LNA die based on SOI), pp. 2-3;

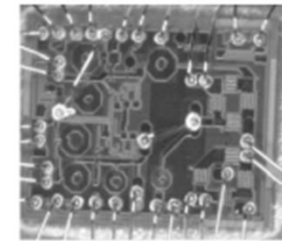


Fig. 1. Die photo for the SP4T T/R switch with dual-band LNA and bypass attenuators. The die size is 1.2x1.6 mm².

In this paper, a novel **dual-band, single-pole, 4-throw (SP4T) T/R switch with an integrated dual-band LNA and bypass attenuators** is presented as shown in Fig. 1. The design is based on SOI technology... Using SOI technology, analogue circuitry such as temperature/voltage compensated bias circuits, enable/disable controls, bypass attenuator controllers, and switch logic decoder can be easily integrated onto the same die.

EX-1021, FIGS. 1-2, 4-5, pp. 2-3;

EX-1003 ¶75 and Pet. 30-31

Well-Known Benefits and Tradeoffs to Forming RF Switch Components On-Chip

- It was well-known to POSITAs that:
 - “[o]n-chip... capacitor[s] can be easily manufactured through a semiconductor process” (pHEMT, CMOS, SOI)
 - unlike external capacitors, “[o]n-chip... capacitor[s]... do[] not require additional work such as capacitor bonding from an external user”
 - “especially if multiple capacitors are required, the cost of the external capacitor itself and the cost of connecting it to the switch increase significantly, and the pad area for capacitor bonding in the switch IC becomes very large, which can be a problem.”

EX-1003 ¶73 and Pet. 28
(*citing* EX-1035, 2-5)

PO's Expert Acknowledged Well-Known Benefits and Tradeoffs to Forming RF Switch Components On-Chip

Q. In the same common example, if the switched circuits were formed using SOI technology, why would a POSITA want to form the capacitors on the same substrate as the switch circuit?

A. There are multiple reasons why one might want to include the capacitor on the same substrate. Again, there is tradeoffs with on-chip versus off-chip capacitor. Perhaps one reason would be to reduce the number of external components to have a more integrated or smaller solution.

EX-1050 (PO's Expert's Depo) 83:14-84:1

Q. You had mentioned that one of the reasons you may want to include the capacitors on the same substrate as the switch circuits would be to reduce the number of external components to have a more integrated or smaller solution. Do you recall that?

A. Yes.

Q. Okay. And would having a smaller solution, a more integrated or smaller solution have a benefit if this switch is used in a cellular phone, for example?

A. It could, yes.

Q. And would that same benefit of having an integrated or smaller solution be beneficial in the case of a wireless LAN radio?

A. Wireless LAN meaning WiFi?

Q. WiFi.

EX-1050 (PO's Expert's Depo) 85:2-18

A. It could.

Q. Would a POSITA understand that for these WLAN radios that saving die size and cost was important consideration?

A. Yes.

Q. And would you agree that a POSITA understood that saving cost was important consideration when designing a front-end circuit for a wireless LAN radio?

EX-1050 (PO's Expert's Depo) 166:21-167:7 (discussing EX-1011)

A. Yes.