

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SHENZHEN HUIDING TECHNOLOGY CO., LTD.

Petitioner

v.

SYNAPTICS INCORPORATED

Patent Owner

PTAB Case No. IPR2016-00465

Patent No. 8,952,916 B2

**PETITION FOR *INTER PARTES* REVIEW
OF U.S. PATENT NO. 8,952,916 B2**

Paper No. 1

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EXHIBIT LIST

- Ex. 1001 Synaptics U.S. Patent No. 7,868,874 B2 to J. Kurth Reynolds, entitled “Methods and systems for detecting a position-based attribute of an object using digital codes” (“the 874 Patent”)
- Ex. 1002 Synaptics U.S. Patent No. 8,338,724 B2 to J. Kurth Reynolds, entitled “Methods and systems for detecting a position-based attribute of an object using digital codes” (“the 724 Patent”)
- Ex. 1003 Synaptics U.S. Patent No. 8,558,811 B2 to J. Kurth Reynolds, entitled “Methods and systems for detecting a position-based attribute of an object using digital codes” (“the 811 Patent”)
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- Ex. 1006 Declaration of Prof. Joshua Reynolds Smith on the 916 Patent
- Ex. 1007 U.S. Patent No. 7,084,645 B1 to Yuichi Umeda and Junichi Saito, entitled “Capacitance detecting circuit and method, and fingerprint sensor using the same” (“Umeda” or “Umeda 645”)
- Ex. 1008 U.S. Patent No. 5,831,600 to Kinya Inoue and Hiroshi Shigetaka, entitled “Coordinate input device” (“Inoue”)
- Ex. 1009 U.S. Patent Application Publication No. 2006/0166681 A1 to Andrew Lohbihler, entitled “Method and apparatus for position sensing” (“Lohbihler”)
- Ex. 1010 R. Prasad *et al.*, “An Overview of CDMA Evolution Toward Wide-band CDMA,” IEEE Communications Surveys 1:1, pp. 2-29 (1998).

- Ex. 1011 U.S. Patent No. 7,084,860 B1 to Denny Jaeger and Andrew Lohbihler, entitled “Method and Apparatus For A Touch Sensitive System Employing Direct Sequence Spread Spectrum (DSSS) Technology” (“Jaeger”)
- Ex. 1012 U.S. Patent Application Publication No. 2005/0073324 to Umeda *et al.* (“Umeda 324”)
- Ex. 1013 Prosecution file history of U.S. Patent No. 7,868,874
- Ex. 1014 ALPS Electric Co., ALPS Touch Input Devices, available at <http://www.alps.com/prod/info/E/HTML/InputDevice/> (last accessed Feb. 1, 2016)
- Ex. 1015 Declaration of Jennifer H. Payne regarding copies of documents as exhibits in the Petition

I. INTRODUCTION

Pursuant to 35 U.S.C. § 311 and 37 C.F.R. § 42.100, Shenzhen Huiding Technology Co., Ltd. (“Petitioner”) petitions for *inter partes* review (“IPR”) of claims 1-20 of U.S. Pat. No. 8,952,916 B2 (“the 916 Patent,” Ex. 1004), assigned to Synaptics Incorporated (“Patent Owner”). This Petition is a remedial measure to correct the issuance of invalid claims 1-20 in the original examination and is necessitated by Patent Owner’s improper enforcement of such invalid claims. This Petition shows a reasonable likelihood that Petitioner will prevail with respect to claims 1-20 challenged under 35 U.S.C. § 314(a) because claims 1-20 are unpatentable based on combined teachings of Umeda, Inoue and Jaeger.

II. MANDATORY NOTICES UNDER 37 C.F.R. § 42.8(B)

REAL PARTY IN INTEREST: Pursuant to 35 U.S.C. § 312(a)(2) and 37 C.F.R. § 42.8(b)(1), all real parties in interest for this IPR are Petitioner and Goodix Technology Inc.

RELATED MATTERS: Petitioner files this Petition as part of its defense against Patent Owner Synaptics’ accusation of patent infringement of the 916 Patent and three related 874 Patent (Ex. 1001), 724 Patent (Ex.1002) and 811 Patent (Ex. 1003) in *Synaptics Inc. v. Goodix Technology Inc. et al.*, No. 5:15-cv-01742 (N.D. Cal, filed Apr. 17, 2015), and *In the Matter of Certain Touchscreen Controllers and Products Containing the Same*, Inv. No. 337-TA-957 (U.S.I.T.C., filed

Apr. 21, 2015). Petitioner previously filed an IPR petition on the 916 Patent under Case No. IPR2015-01740 on Aug. 17, 2015. The Board's institution decision will occur by Feb. 23, 2016. Petitioner also filed IPR petitions on the 724 Patent (IPR2015-01741), the 811 Patent (IPR2015-01739) and the 874 Patent (IPR2015-01742 and IPR2015-01743). Furthermore, Petitioner is pursuing IPR petitions, IPR2016-00464 (the 811 Patent) and PR2016-00463 (the 724 Patent), based on the same combination of Umeda, Inoue and Jaeger.

NOTICE OF COUNSEL AND SERVICE INFORMATION: Pursuant to 37 C.F.R. §§ 42.8(b)(3), 42.8(b)(4) and 42.10(a), Petitioner appoints **Bing Ai** (Reg. No. 43,312) as its lead counsel, and **John Schnurer** (Reg. No. 52,196), **James Coughlan** (*pro hac vice*), and **Kevin Patariu** (Reg. No. 63,210) as its back-up counsel. Petitioner requests authorization to file a motion for Mr. Coughlan to appear *pro hac vice*. The above attorneys are all at Perkins Coie LLP, 11988 El Camino Real, Suite 350, San Diego, CA 92130, 858-720-5700 (phone) and 858-720-5799 (fax), and the following email for service and communications: goodix-synaptics-IPR-service@perkinscoie.com. Petitioner consents to electronic service under 37 C.F.R. § 42.6(e). Pursuant to 37 C.F.R. § 42.10(b), an executed Power of Attorney is concurrently filed.

III. REQUIREMENTS FOR *INTER PARTES* REVIEW

This Petition complies with all statutory requirements and requirements un-

der 37 C.F.R. §§ 42.104, 42.105 and 42.15 and thus should be accorded a filing date as the date of filing of this Petition pursuant to 37 C.F.R. § 42.106.

GROUND FOR STANDING: Pursuant to § 42.104(a), Petitioner hereby certifies that the 916 Patent is available for IPR and that the Petitioner is not barred or estopped from requesting IPR challenging claims of the 916 Patent on the grounds identified herein. Specifically, Petitioner has the standing, or meets all requirements, to file this Petition under 35 U.S.C. §§ 315(a)(1), 315(b), 315(e)(1) and 325(e)(1); and 37 C.F.R. §§42.73(d)(1), 42.101 and 42.102.

IDENTIFICATION OF CHALLENGE: Pursuant to 37 C.F.R. §§ 42.104(b) and 42.22, the precise relief requested is that the Board institute an IPR trial on claims 1-20 and cancel them on the ground and evidence presented in this Petition. The Prior Art relied upon is prior art discussed in the papers filed with this Petition. See the Exhibit List and Smith Declaration (Ex. 1006). Supporting Evidence Relied Upon For The Challenge includes the Smith Declaration (Ex. 1006) and other supporting evidence in the Exhibit List or referred in the papers filed with this Petition. The Statutory Ground(s) Of Challenge And Legal Principles for the review of patentability of claims 1-20 are pre-AIA 35 U.S.C. §§ 102 and 103 and AIA 35 U.S.C. §§ 311 to 319 and 325 govern this IPR proceeding. On Claim Construction, the 916 Patent has not expired and the Patent Office shall apply the broadest reasonable interpretation (BRI) standard to give a claim in the 916

Patent “its broadest reasonable construction in light of the specification of the patent in which it appears” to a person of ordinary skill in the art (“POSITA”). 37

C.F.R. § 42.100(b). Pursuant to 37 C.F.R. § 42.104 (b)(4), Section VI explains how claims 1-20 are unpatentable under pre-AIA 35 U.S.C. §§ 102 and 103, and identi-

5 fies where each claim element is found in the cited prior art.

IV. OVERVIEW OF THE 916 PATENT

The 916 Patent is one of a family of eight patents owned by Patent Owner Synaptics, all claiming priority to App. No. 11/274,999 filed on Nov. 15, 2005, which issued as the 874 Patent. *See* Synaptics 874 U.S. Patent Family Tree in Ex.

10 1005. The earliest priority date of the 916 Patent is no earlier than Nov. 15, 2005.

The 916 Patent describes capacitive position sensing of an object such as a finger or pointer which is located close to one or more sensing electrodes. In operation, the object capacitively couples to the one or more sensing electrodes to modify a capacitance at the one or more sensing electrodes. The sensed capacitance varies with the position of the object relative to the one or more sensing electrodes.

15 This touch sensing technology, however, was created, demonstrated and documented years before the filing of the 916 Patent, as shown by the evidence in this Petition and the Smith Declaration (Ex. 1006).

20 The 916 Patent describes and claims detecting a position-based attribute of a finger, stylus or other object with a touchpad or other sensor having a touch-

sensitive region that includes a plurality of electrodes, including generation of modulation signals for one or more electrodes as a function of any number of distinct digital codes and the associated demodulation for touch sensing in touch screens or touchpads. Ex. 1004, Abstract; 1:63-2:11. The modulation signals are applied to at least one of the plurality of electrodes to obtain a resultant signal that is electrically affected by the position of the object. The resultant signal is demodulated using the plurality of distinct digital codes to discriminate electrical effects produced by the object. The position-based attribute of the object is then determined with respect to the plurality of electrodes from the electrical effects. *Id.* Exemplary embodiments include capacitively-sensing touch screens, touchpads, and fingerprint sensors. *Id.* at 3:11-31. Ex. 1006, ¶¶ 56-60. The 916 Patent discloses a use in touch sensing of long-established and standardized techniques for radio communication signal modulation/demodulation based on spread spectrum techniques such as Code Division Multiplexing (CDM). Ex. 1004 at 2:50-3:10; 4:47-5:9. Claims 1-20 attempt to broadly cover this feature. Claim 1, *e.g.*, recites that first and second signals are distinct signals based on distinct digital codes.

This Petition discusses how those features were well known in the art, particularly as shown by this Petition's combination of Umeda, Inoue and Jaeger.

A. STATE OF PRIOR ART BEFORE THE 916 PATENT

The capacitive touch sensing described and claimed in the 916 Patent was

known and documented years before the 916 Patent. Ex. 1006, ¶¶ 39-42. Umeda, Inoue and Jaeger teach capacitive position sensing of one or more fingers, pointers, styli or other objects near sensing electrodes, where an object modifies a capacitance at the sensing electrodes and the modified capacitance varies with the position of the object relative to the sensing electrodes. Umeda and Inoue teach capacitive touch sensors like those described in the 916 Patent for detecting a position of the object in the same manner based on the modified capacitance measurements at the sensing electrodes caused by the touch of the object. In Umeda, Inoue and the 916 Patent, capacitive touch sensing is implemented in touch pads or touch screens by separating the object from the underlying one or more sensing electrodes by a dielectric material, which can be a cover or protective dielectric layer (*e.g.*, a glass, a crystalized material, a plastic, or a polymer material) or the air. *See, e.g.*, the top cover film 54 in FIGS. 2B and 3 of Umeda, the top protective film 8 in FIG. 2 of Inoue and top protective surface layer 704 in FIGS. 7 and 8 of the 916 Patent (Ex. 1004 at 13:19-22, “deposited or otherwise placed over the electrodes to provide consistent dielectric isolation and to protect against moisture, dust and other environmental effects”). Jaeger also discloses such touch sensing surfaces along with open conductive contact surfaces for touch sensing. Ex. 1011 at 1:32-2:15 and 5:26-60. The “touch” in such capacitive sensing devices that separate the object from the underlying sensing electrodes by a dielectric material in Umeda, Inoue

and Jaeger and in the 916 Patent means the object is in close proximity to the sensing electrodes without directly contacting a sensing electrode and the “touch” is between the object and the dielectric material that covers the underlying sensing electrodes. Such capacitive touch sensors mostly do not measure physical contact; rather, the capacitance induced by the proximity between the object and the electrodes behind the top dielectric material or cover is detected. Some devices are designed to sense the motion of the object at large distances from the sensing electrodes separated by air, a dielectric material, and may be referred to as “non-contact” capacitive sensing. Therefore, the term “touchpad”, “touch screen” or “touch capacitive sensing” is a misnomer in the context of the subject matter of capacitive touch sensing in the 916 Patent because there is no direct touch or direct contact between the object and a sensing electrode. Ex. 1006, ¶42.

The 916 Patent describes and claims several features, including a capacitive position sensor for capacitive sensing, capacitive touch sensing circuitry that transmits and receives distinct signals based on distinct digital codes and adjustment of a frequency of a distinct signal based on observed noise in the resultant signal. However, as Prof. Smith explains (Ex. 1006), all of those features were well known and published long before the 916 Patent. Umeda, Inoue and Jaeger as specifically discussed in this Petition provide one particular perspective of rich prior art on capacitive touch sensing as to why all features in the 916 Patent were noth-

ing but known, routine or predictable features in the technical and patent literature in the public domain.

For example, capacitive position sensing was described in printed publications years before the filing of the 916 Patent. Ex. 1006, ¶¶39-42. The transmission and reception of distinct signals based on distinct digital codes were long used in radio communications even before their use in CDMA mobile communications in 1995 and were also used in capacitive touch sensing devices as early as the late 1990's. *Id.* at ¶¶40-42. For example, independent research by the MIT Media Lab and Mitsubishi Electric Research Lab (MERL) in Boston in the late 1990s developed and described systems that applied CDMA techniques like those already used in mobile communication systems to capacitive sensors by applying distinct digital codes to different sensor electrodes either directly or via a carrier signal, such as a sinusoidal wave or square wave, then demodulating the received signals using the same codes to distinguish signals from separate electrodes. *Id.* at ¶¶40-41. On the other side of the Pacific, Japanese engineers also developed capacitive touch sensing based on distinct digital codes as evidenced by the patent filings by Umeda and Saito at ALPS Electric Co. Ltd. in 2003. For example, U.S. Patent App. Pub. No. 2005/0073324 (Ex. 1012, "Umeda 324") cited during prosecution of the 874 Patent by the original Examiner McCommas in four consecutive rejections, teaches a capacitance detector that uses distinct digital spread spectrum codes to detect small

changes in capacitance in a 2-D array or matrix of “sensor elements” spatially distributed or located at different intersections of column lines and row lines. Such detected changes at the different sensor elements may be used, based on their locations at their respective intersections of the column lines and row lines, to construct a fingerprint pattern. Therefore, Umeda 324 teaches using distinct digital codes to measure changes in capacitances at different sensor elements to determine a position-based attribute of an object in a similar manner to that described in the 916 Patent. *See* Ex. 1012; *see also* U.S. Pat. No. 7,084,645 (“Umeda” or “Umeda 645”) (Ex. 1007), filed in 2003 by the same inventors as Umeda 324.

Frequency adjustment based on observed noise to improve signal-to-noise ratio or SNR, as claimed by the 916 Patent, was also known and published in the 1980’s and 1990’s. Ex. 1006, ¶¶52-54. As Prof. Smith explains, switching carrier frequencies to avoid noise was a well-known technique in numerous fields, ranging from something as simple as users of two-way radios changing frequencies to avoid static to more complex examples of frequency hopping schemes in CDMA. *Id.* Before June of 1996, the Japanese company ALPS Electric Co., the applicant of Umeda and Umeda 324, developed a capacitive sensing input device that could detect the contact position of an input object (such as an input pen or a finger) on a tablet. Ex. 1008 at Abstract, 1:5-2:67; 4:10-5:24; Figs. 1, 4. Inoue teaches adjusting a scan signal frequency based on observed noise in a capacitive sensing coordinate

input device that uses scan signals having different frequencies for detecting the contact on a tablet. *Id.* at 3:10-25, 5:25-7:25. The frequency of a scan signal can be selected and adjusted to minimize noise in scan operations, thus improving reliability of touch position detection. *Id.* at 3:10-25; 7:11-18.

5 The above and other prior art evidence in this Petition demonstrate that the 916 Patent is merely repetitive of well-known technical features in the long history of prior art publications that the Patent Owner attempts to claim as its own years later. *See, e.g.*, Ex. 1006, ¶¶ 69-189. Claims 1-20 are nothing more than the Patent Owner's belated effort to "re-patent" prior art subject matter that was already in the
10 public domain before its filing in November of 2005.

B. SUMMARY OF PROSECUTION HISTORY OF 916 PATENT

The 916 Patent is one of 7 issued U.S. patents claiming priority to the 874 Patent. Ex. 1005. In examining the 874 Patent, Examiner Stuart McCommas raised and maintained rejections to all claims under 35 U.S.C. § 103(a) over cited prior
15 art after 4 consecutive office actions and 2 examiner's interviews. Examiner Kevin Nguyen later took over the case, completely reversed the Office's prior art-based rejections without further explanation, and allowed the 874 Patent and 6 more patents (including the 916 Patent), all without any written discussion of any prior art. In the 916 Patent, Examiner Nguyen issued a single obviousness-type double pa-
20 tenting rejection over the 874 Patent and granted the 916 Patent after Patent Owner

filed a terminal disclaimer.

Upon review of the listed prior art references, a POSITA in the field of touch sensing technology would readily recognize highly relevant prior art references listed on the face of the 7 patents (including the 916 Patent) that reveal fatal defects in the issued claims.

For example, while Umeda 324 was cited in a rejection during prosecution of the parent 874 Patent, Patent Owner's primary argument to distinguish it- which was rejected by the original Examiner (Ex. 1013 at 429-430)- was that the bit-shifted code sequences of Umeda 324 were a "single code" rather than distinct codes. *Id.* at 372-374. This Patent Owner argument was contrary to the 874 Patent's specification (*e.g.*, Ex. 1001 at 8:12-14) Yet there was no discussion in the file history of either the 874 Patent or 916 Patent regarding Umeda 324's teaching that not just bit-shifted codes, but distinct orthogonal codes (*e.g.*, Walsh codes) could be read from memory and applied to separate transmission electrodes, nor do the file histories contain any discussion of the highly relevant Inoue and Jaeger.

In summary, the original examination of the 916 Patent failed to fully consider relevant prior art and was defective. This Petition is a remedial measure for correcting this unfortunate oversight by providing a fuller and more complete record of relevant prior art to the Office and to the public.

C. LEVEL OF ORDINARY SKILL IN THE ART

Prof. Smith explains a POSITA in the field of the 916 Patent in his declaration. Ex. 1006, ¶¶31-35.

D. PROPOSED CLAIM CONSTRUCTION

Petitioner proposes construction of certain claim terms below pursuant to the
5 broadest reasonable interpretation (BRI) standard for all IPRs. The proposed BRI
claim constructions are offered only to comply with 37 C.F.R. §§ 42.100(b) and
42.104(b)(3) and for the sole purpose of this Petition, and thus do not necessarily
reflect appropriate claim constructions to be used in litigation and other proceedings
where a different claim construction standard applies.

10 The 916 Patent specification broadly describes the “distinct digital codes”
for signal modulation and does not limit the type and generation method of the
“distinct digital codes.” Ex. 1004 at 8:3-33 (“the distinct digital codes 106 used to
create modulation signals 110A-D may be produced in any manner . . .”). Thus,
the proposed BRI claim construction for this term is its plain and ordinary meaning:
15 digital codes that are different from one another or each other. Ex. 1006, ¶ 67.

Claims 9 and 13 require the distinct digital codes to be “mathematically independent” but the 916 Patent specification does not explicitly use this term. The
relevant part of the 916 Patent specification on this term seems to be the text on
“substantially orthogonal” (916 Patent at 5:66-6:5) which states: “[t]he term ‘sub-
20 stantially orthogonal’ in the context of the distinct digital codes is intended to con-

vey that the distinct codes need not be perfectly orthogonal from each other in the *mathematical* sense, so long as the distinct codes are able to produce meaningful *independent* results” (emphasis added). Thus, the proposed claim construction for this term is “substantially orthogonal.” Ex. 1006, ¶ 68.

5 All other claim terms in claims 1-20 are construed for their respective plain and ordinary meaning under BRI. Ex. 1006, ¶ 66.

**V. THERE IS A REASONABLE LIKELIHOOD THAT AT
LEAST ONE CLAIM OF THE 916 PATENT IS UNPATENTABLE**

10 Claims 1-20 are unpatentable for merely reciting known, predictable and/or obvious combinations of the cited prior art references.

A. IDENTIFICATION OF THE REFERENCES AS PRIOR ART

Prior art references Umeda, Inoue and Jaeger were not discussed during the original examination. **Umeda (Ex. 1007)** was filed at USPTO on Nov. 10, 2004
15 and issued as a patent on Aug. 1, 2006. Umeda is prior art under pre-AIA 35 U.S.C. §102(e). Umeda was listed in an Information Disclosure Statement for 916 Patent but was not specifically discussed on record in the original examination of the 916 Patent or any other member of the 874 patent family. **Inoue (Ex. 1008)** was issued as a U.S. patent on Nov. 3, 1998 based on a filing on June 2, 1997 and thus is prior
20 art under pre-AIA 35 U.S.C. §102(b). **Jaeger (Ex. 1011)** was issued as a U.S. patent on Aug. 1, 2006 based on a U.S. filing on Jul. 25, 2002 and thus is prior art

under pre-AIA 35 U.S.C. §102(e).

B. SUMMARY OF INVALIDITY OVER UMEDA, INOUE AND JAEGER

5 The cited prior art in this Petition is applied as a combination of Umeda, In-
oué and Jaeger to claims 1-20. Under pre-AIA 35 U.S.C. § 103(a), this Petition ap-
plies the BRI claim construction from the perspective of a POSITA, determines the
scope and content of the cited prior art in the proposed invalidity ground, and ana-
lyzes the differences between the claimed invention and the cited prior art by con-
sidering the claimed invention as a whole and the cited prior art as a whole under
10 the BRI claim construction. Based on the above, this Petition concludes that the
combination of Umeda, Inoue and Jaeger discloses all elements recited in each
claim and under pre-AIA 35 U.S.C. § 103(a), renders the claimed subject matter as
a whole obvious and unpatentable.

**C. THIS PETITION PRESENTS QUESTIONS OF PATENTABIL-
15 ITY THAT HAVE NOT BEEN BEFORE THE OFFICE**

This Petition is distinct from Petitioner's first IPR petition on the 916 Patent
(IPR2015-01740, "First Petition") on Aug. 17, 2015, in which the PTAB will issue
its decision on institution no later than Feb. 23, 2016. The First Petition has two
different groups of prior art combinations, a first group (Grounds 1 and 2) based on
20 a combination of Smith and Mulligan, and a second group (Grounds 3 and 4) based
on Dietz or a combination of Dietz and Gerpheide. This second Petition proposes a

single invalidity ground based on combined teachings of Umeda, Inoue and Jaeger, that are distinct from the Smith-Mulligan and Dietz-Gerpheide combinations in the First Petition. Neither the combination of Umeda, Inoue and Jaeger, nor the overall ground, was presented in the First Petition.

5 One of the notable differences from the prior art in the First Petition is Umeda's detailed description of generating the "distinct digital codes" in the claims of the 916 Patent by using a phase-shifted version of a 15-bit PN code or applying separate orthogonal codes. This teaching in Umeda matches the 916 Patent's disclosure that "[a] digital bit sequence may be simply shifted in phase, for
10 example, to create multiple distinct codes." Ex. 1004 at 8:24-26; 6:11-15; 7:3-6; 8:2-12 (emphasis added). Such "distinct digital codes" are a contested issue in the on-going ITC litigation and will also be disputed in the district court litigation. This Petition shows why "distinct digital codes" for capacitive sensing are an old and well-known feature and how signal modulation and noise reduction based on
15 such distinct digital codes in capacitive touch sensing were also known.

 In addition, Umeda and Inoue are patent filings by the same company that has had a long history in developing capacitive touch sensing products and thus, the use of Umeda and Inoue in this Petition affords the PTAB a unique opportunity to understand why the claimed subject matter in each claim of the 916 Patent as a
20 whole is obvious and unpatentable.

Another notable difference between the combination of Umeda, Inoue and Jaeger from the prior art in the First Petition is the separate but common teaching of using distinct digital codes such as PN codes and orthogonal Walsh codes by Umeda and Jaeger to meet common goals such as improving SNR in the face of external noise and distinguishing between multiple touch locations on a touch sensing surface. The analyses of the combination of Umeda, Inoue and Jaeger provide an important perspective on how the use of distinct digital codes and spread spectrum principles for improving touch sensing were fully developed and matured in the commercial sector for touch sensing before the filing of the 916 Patent.

Overall, the combined teachings of Umeda, Inoue and Jaeger in this Petition provide the PTAB and the public with a fuller view of the prior art landscape prior to the filing of the 916 Patent that was not present in the original examination or in the First Petition. Furthermore, given the 60-page limit in the First Petition, the invalidity ground based on Umeda, Inoue and Jaeger must be filed in a separate petition as a matter of necessity in order to comply with the required burden of proof under the PTAB rules. In consideration of the need for the just resolution of the unpatentability issues under Rule 37 C.F.R. § 42.1(b), Petitioner respectfully requests the PTAB to institute this Petition.

VI. DETAILED EXPLANATION OF UNPATENTABILITY OF CLAIMS 1-20 OF THE 916 PATENT

A. A POSITA WOULD HAVE HAD REASONS OR WOULD

HAVE BEEN MOTIVATED TO COMBINE UMEDA, INOUE AND JAEGER

As an initial matter, Umeda, Inoue and Jaeger, individually, provide both highly relevant or pertinent and specifically related teachings in the same technical field and on the same specific capacitive touching sensing technical issues as the 916 Patent. In addition, the teachings in Umeda, Inoue and Jaeger provide specific and ample reasons and motivations from different perspectives that would have caused a POSITA to combine them as claimed in claims 1-20 under pre-AIA 35 U.S.C. § 103(a). Sections IV(B) and V(B) above explain at a high level the teachings of Umeda, Inoue and Jaeger related to the technology of the 916 Patent, while Section VI(A) and the individual claim and element analyses in Section VI(B) provide further detailed reasons or motivations to combine Umeda, Inoue and Jaeger as proposed in this Petition.

Umeda and Inoue were filed by the same company, ALPS Electric Co. Ltd. in the course of continuous and long-term R&D efforts regarding touch input devices such as capacitive touch panels, in the same field as the 916 Patent. *See* Ex. 1014. Those and other connections between Umeda and Inoue provide natural linkages between them that would have caused a POSITA to consider them together when designing a capacitive touch sensing device. Ex. 1006, ¶¶83-89.

The 916 Patent discloses capacitive touch sensing to provide position-based attributes from 1-D sensing arrays (e.g., by using electrodes 112A-D and 114 in its

FIG. 1A) and 2-D sensing arrays (e.g., by using electrodes 112A-C along a first direction and electrodes 112D-G along a second orthogonal direction in its FIG. 1B).

Ex. 1004 at 3:32-4:28. Such 1-D or 2-D sensing arrays are 1-D or 2-D arrays of position sensing elements or “virtual capacitors” formed at intersections between

5 different electrodes. *Id.* at 3:32-53 and 3:54-4:5. Ex. 1006, ¶60.

Like the 916 Patent, both Umeda and Inoue teach the use of a plurality of X and Y electrodes arranged in a 2-D matrix and use capacitance sensors formed at intersections of these X and Y electrodes to measure their respective capacitances associated with their X and Y position coordinates as “position-based attributes.”

10 Umeda teaches (1) a capacitance detecting circuit capable of detecting small capacitance changes in a 2-D matrix of intersections between different electrodes arranged as row and column lines of a sensor unit, and (2) the use of this circuit as a fingerprint sensor to construct a fingerprint pattern based on detected changes and their locations at their respective intersections of the column and row lines. Ex.

15 1007 at Title, 1:8-25; 2:65-3:7; 5:34-40; 7:21-50 and Figs. 1, 2A, 2B, 3 and 4. Ex. 1006, ¶¶72-77. Like the disclosure on the position sensor in the 916 Patent, Umeda explicitly teaches using intersections between column lines and row lines as a 2-D array or matrix of “sensor devices 55” that are spatially distributed at different electrode intersection locations. Ex. 1007, e.g., 3:32-4:3; FIG. 4 and 7:21-67;

20 12:29-34 and FIG. 10; 13:28-33 and FIG. 9. When a finger touches a screen in

Umeda, the ridges of the fingerprint change the intervals between the row lines (in the X direction) and the column lines (in the Y direction) due to the pressing by the ridges, which in turn changes capacitances at column-row intersections represented by respective X and Y coordinates as positions within the array or matrix formed

5 by the intersecting row lines and column lines. *Id.* at 1:19-25; 7:21-67; FIGS. 3 and 4; also see FIGS. 2A and 2B. The positions of the ridges of a finger in touch with the sensing surface are captured by capacitance changes at the column-row intersections and the position coordinates of the intersections. Umeda's capacitive detecting circuit uses measured capacitance changes and their associated positions of

10 respective intersections to construct the shape/image of the fingerprint. *Id.* at 1:8-25; 2:65-3:7; 3:62-4:3; 5:35-40; 27:53-59. In other words, Umeda's capacitive detecting circuit can detect the locations, or position-based attributes, of the fingerprint's ridges and valleys with respect to the column-row intersections. *Id.* It is this function of sensing a position-based attribute using the 2-D array or matrix of sensor devices 55 illustrated in FIG. 4 and the capability of providing sufficient spatial

15 resolution in sensing such a position-based attributes that enable Umeda's capacitive detecting circuit to perform fingerprint sensing. Notably, considering the fine spatial features or patterns of a fingerprint, Umeda's device must provide a sufficiently high spatial sensing resolution via its 2-D array or matrix of sensor devices

20 55 in FIG. 4 to perform fingerprint detection. In general, fingerprint detection is

technically more difficult than detecting a touch of an object because fingerprint detection requires detection of locations and shapes of finger ridges and demands a higher location or spatial sensing resolution to sense finger ridges. Ex. 1006, ¶111. Umeda's device is a high resolution position sensor capable of sensing locations
5 and fine features of finger ridges to construct an image of the finger ridges and valleys of a fingerprint. The 916 Patent likewise includes fingerprint sensors within a list of exemplary "position sensors." Ex. 1004 at 3:11-18.

Therefore, Umeda teaches a capacitance detecting circuit having a 2-D matrix of capacitor sensors at intersections between different electrodes arranged as
10 row and column lines of a sensor unit to provide position-based attributes by touch of a finger. Based on the specific teachings in Umeda, a POSITA would understand that Umeda's capacitance detecting circuit is a touch location sensor and can be used as a fingerprint sensor. Ex. 1007 at 2:65-3:7; 3:66-4:2; Ex. 1006, ¶111.

Other prior art references, such as Inoue, teach using a capacitance detecting circuit
15 similar to Umeda's to determine X-Y coordinates of a touch. Ex. 1006, ¶¶78-80.

Umeda recognizes the practical need to detect a very small capacitance in capacitive touch sensing such as in a fingerprint sensor, and based on such recognition, identifies the requirements for capacitive touch sensing: "[i]t is demanded that a capacitance detecting circuit used in, for example, a fingerprint sensor, have high
20 sensitivity since capacitance changes are very small. At the same time, however,

the detecting circuit must have resistance to noise (including high-frequency noise) transmitted from a human body or noise from other circuitry” and “[i]t is also demanded that the capacitance detecting circuit is not vulnerable to crosstalk noise between adjacent row lines or column lines.” Ex. 1007 at 1:56-64. In addition,

5 Umeda describes a prior art fingerprint sensor in which only a single column line is driven at a time to detect capacitance changes at the intersections between that single column line and a plurality of row lines. *Id.* at 2:17-24. The SNR of this prior art sensor is reduced due to external disturbance noise that cannot be removed. *Id.* at 2:17-61. Ex. 1006, ¶74.

10 To improve SNR, Umeda teaches using a column-line driver that drives *multiple* column lines simultaneously based on pseudorandom or orthogonal codes produced by a code generator. Ex. 1007 at 2:65-3:31. Driving multiple column lines simultaneously improves SNR because it allows each individual capacitance measurement to average over a longer time period and reduces the external noise.

15 *Id.* at 2:65-3:7; 3:32-52. Years later, the 916 Patent re-stated the same feature of using drive circuitry to simultaneously transmit distinct signals based on distinct digital codes onto different transmitter electrodes, respectively. Ex. 1004 at 11:24-56 and FIG. 4; Claims 1-20. Ex. 1006, ¶¶59, 74.

Inoue, a patent assigned to and filed by the same company, Alps Electric Co.,

20 as Umeda, discloses a capacitive sensing coordinate input device that can detect

the contact position of an input object (such as an input pen or a finger) on a tablet. Ex. 1008 at Abstract, 1:5-2:67; 4:10-5:24; Figs. 1, 4. The basic structure of Inoue's coordinate input device is very similar to those that are already known in the prior art (shown in Fig. 4 and described in 1:13 -2:67), including the structure disclosed in Umeda: a plurality of X and Y electrodes are arranged in a 2-D matrix, and capacitance is formed at each intersection of these X and Y electrodes. *Id.* at 1:29-2:15. The intersection's capacitance can be measured by sending scan signals to the X electrodes and then measuring the signal voltages output at the Y electrodes. *Id.* at 1:61-2:33. Because touching by the finger will decrease the capacitance at the touch point and thus reduce the signal voltage output, the touch position can be determined by calculating the Y and X electrodes having the smallest signal voltage value. *Id.* at 2:16-43. Therefore, Inoue, like Umeda, discloses the 916 Patent's capacitive touch sensing arrays of position sensing elements or "virtual capacitors" formed at intersections between different electrodes. Ex. 1006, ¶¶78-80.

The prior art device described in Inoue's background section has one drawback: if external noise has a frequency close to the frequency of the scan signal, such noise cannot be easily removed by a frequency filter, and thus will degrade the reliability of the touch position detection. Ex. 1008 at 2:54-67. To solve this problem, Inoue's touch position detect circuit uses a plurality of scan signals having different frequencies, and the operation area is scanned by these scan signals

sequentially. *Id.* at 3:10-19. The external noise superposed on data output from the operation area is measured each time the scan signal is changed, and the scan signal that produces the minimal external noise is selected. *Id.* Selecting the scan signal frequency based on measured noise level minimizes the noise's influence and enhances reliability in touch position sensing. *Id.* at 3:20-25. Ex. 1006, ¶80.

Inoue's teaching of adaptive frequency selection to improve SNR in capacitive touch sensing flows from the same recognition of a common problem in Umeda to improve SNR performance in capacitive touch sensing, as part of continuous R&D efforts by the common assignee. Only years later was this feature in Inoue included in the description and claims of the 916 Patent, e.g., Ex. 1004 at 10:56-11:23 and Claims 1-20 ("adjusting a frequency of the first and second signals based on observed noise in the resultant signals."). Ex. 1006, ¶¶58, 80.

In light of Inoue and Umeda, a POSITA would have readily recognized commonalities in the technologies and specific teachings of Umeda and Inoue because they both relate to the same technical area of capacitive touch sensing and they use similar approaches to sensing the touch location and reflect the company's continued efforts in reducing the influence of external noise to improve the reliability of detection in the company's capacitive touch sensing technology. This additional linkage between Umeda and Inoue within the capacitive touch sensing provides a further reason to a POSITA to combine them. Ex. 1006, ¶86.

In both Umeda and Inoue, driving signals are sent to one set of electrodes, and the resultant signals are sensed at the other set of electrodes. Touching positions are determined by measuring the changes of the resultant signals, which in turn reveals the capacitance changes at particular intersections. Those common
5 teachings of Umeda and Inoue would guide or motivate a POSITA to combine Umeda and Inoue when facing the same or similar technical issues in capacitive touch sensing. *Id.*

A POSITA would be further guided by the recognition in Umeda and Inoue of the noise problem in capacitance sensing circuitry. For example, Umeda recog-
10 nized the problems caused by an external disturbance noise source (*see, e.g.*, Ex. 1007 at 2:25-61) in meeting the requirements in capacitive touch sensing (*e.g.*, 1:56-64) to look for a solution that specifically addresses such problems and meets the desired sensing requirements. Umeda specifically teaches an example where the noise frequency is close to the sampling frequency of the capacitance detecting
15 circuit such as the noise from the fluorescent lamp (*Id.* at 2:35-61). Ex. 1006, ¶86.

Inoue explicitly recognizes the same noise problem when the noise signal frequency is close to the frequency of the scan signal in capacitive sensing of the location of an input finger or device over a tablet. Referring to FIG. 4, Inoue states that, “[i]n the known coordinate input device, when signal voltages are read from
20 the tablet 51, external noise is superposed on the read signal voltages. In this case,

most of the external noise superposed on the signal voltages is removed by the first filter circuit 60 or a second filter circuit 66. However, when the external noise frequency is approximate to the frequency of the scan signal, the external noise cannot be removed by the first filter circuit 60 or the second filter circuit 66, and the signal voltages are input to the A/D 61 and the CPU 62 without removing the external noise from the signal voltages. For this reason, the external noise adversely affects detection of a coordinate position by the CPU 62, and the reliability of detection of the coordinate position is degraded.” Ex. 1008 at 2:54-67. Ex. 1006, ¶80.

Therefore, a POSITA would be guided by the same recognition of the same or similar noise problem in the capacitive sensing in Umeda and Inoue to combine Umeda and Inoue as suggested in this Petition. Ex. 1006, ¶¶83-89.

Furthermore, Inoue discloses a specific solution to the noise problem when the noise signal frequency is close to the frequency of the scan signal in capacitive sensing of the location of an input finger or device over a tablet: adjusting the frequency of the scan signal to avoid the noise frequency and thus improve the position sensor’s performance. Ex. 1008 at 3:10-25. This aspect of Umeda and Inoue would further motivate a POSITA to combine them. Ex. 1006, ¶¶87-89.

In the same technical field of capacitive touch sensing as Umeda and Inoue, Jaeger teaches touch sensing coordinate input devices that can detect the contact position of an input object (such as an input pen or a finger) on a tablet based on

various touch sensing techniques including capacitive touch sensing. Ex. 1011 at Abstract, 1:32-2:62, 5:10-6:27, and more detailed description in the “Description of the preferred embodiment” section (9:17-18:28). Thus the subject matter of Jaeger relates to the same touch sensing technology of the 916 Patent. Jaeger discloses
5 that X-Y locations on its touch screen are determined by X-Y locator and data signal processing unit based on the received signal strength (RSS) or amplitude of signals received by receiving sensors on the touch screen. *Id.* at 6:28-7:5, 7:39-57 and FIG. 4. While Jaeger does not rely on an X, Y sensor array like those taught by Umeda and Inoue, a POSITA would recognize that Jaeger’s teaching to generate
10 different signals based on distinct digital codes to distinguish different signal sources (e.g., touches by different touch devices) based on spread spectrum technology is readily applicable to an X,Y array since the underlying principle (identifying the signal source) is substantially similar. Ex. 1006, ¶¶92, 100.

In this regard, Umeda discloses use of distinct digital codes such as a pseudorandom noise (PN) code or orthogonal code for driving electrodes of the capacitor sensors based on recognition of the use of PN codes in CDMA-based on multiplexing and demultiplexing for improving cellular communications. Ex. 1007 at
15 3:32-52 and 10:12-24. Similarly, Jaeger discloses using spread spectrum and CDMA techniques such as direct sequence spread spectrum (DSSS) signal arrangements, to transmit signals from the touch stimulating devices for identifica-
20

tion and location determination. Ex. 1011 at Abstract, 3:13-5:9, 4:46-59 (CDMA discussion). Jaeger's touch sensing apparatus includes "a touch-sensing tablet (termed touch screen hereafter) [which] can be regarded as a touch screen, a digitizer, a writing panel, a modified mouse pad, or the like." *Id.* at 1:22-31. Therefore, 5 Jaeger and Umeda are based on the common recognition of the advantage of using distinct digital codes in capacitive touch sensing such as the codes used in CDMA, years before the 916 Patent. Ex. 1006, ¶91.

In addition, Jaeger teaches the benefits of (1) achieving improved SNR and (2) channelization with a plurality of different signal sources (e.g., different touch 10 devices) to distinguish different signals in detection by using distinct digital codes for encoding signals based on spread spectrum technology for capacitive touch sensing in its FIG. 1B and text at 4:30-5:9, 3:27-56, 6:22-27. Fig. 1B, which illustrates the benefits of, in touch sensing, spreading a signal across the spectrum to avoid sources of noise, is substantially similar to Figs. 3(A) and 3(B) of the 916 15 Patent. Ex. 1006, ¶44. This teaching in Jaeger of the benefits underlying the spread spectrum (SS) touch sensing technology is similar to the approach taught by Umeda to using distinctive digital codes such as PN or Walsh codes for capacitive touch sensing in both (1) improving the SNR and (2) detecting and distinguishing signals from different signal sources at intersections of column and row lines and. 20 Ex. 1007 at, e.g., 2:65-3:61. Such common recognitions using distinct digital codes

in touch sensing by both Jaeger and Umeda provide yet another reason, among many others, for a POSITA to combine Jaeger and Umeda in designing a touch sensing device by using distinct digital codes in signal modulation for preforming the touch sensing measurements. These teachings demonstrate the ready commercial applicability of the basic concept of applying CDMA codes to touch sensing, which was well-known in the art as shown by, for example, the MIT Media Lab and MERL research discussed in §IV(A), *supra*. Ex. 1006, ¶¶92-94.

Jaeger's disclosure of using code modulation based on DSSS/CDMA for touch sensing and the needs in Jaeger's touch sensing for improved SNR would lead a POSITA to the adaptive frequency adjustment for noise reduction disclosed in Inoue. This provides one of reasons as to why a POSITA would combine Umeda, Inoue and Jaeger when designing a capacitive touch sensing device based on distinct digital codes. Ex. 1006 at ¶¶90-102.

Umeda discloses M-series PN codes and orthogonal Walsh codes as specific examples of suitable distinct digital codes carried by column line voltage drive signals for capacitive touch sensing. Ex. 1007 at 3:32-4:3. Jaeger, as part of its disclosure of using PN codes and other suitable, well-known distinct digital codes for capacitive touch sensing along the same approach in Umeda, further discloses additional examples of suitable codes: M-sequences, Barker codes, Walsh codes, Gold codes and Kasami codes. Ex. 1011 at 4:60-5:9. This similarity between

Umeda and Jaeger would lead a POSITA to recognize the applicability of Jaeger's detailed teachings about modulation with specific codes to Umeda's code modulation process for capacitive touch sensing. In this regard, the combined teaching of Umeda and Jaeger discloses the capacitive touch sensing in the 916 Patent using long-established and standardized techniques for radio communication signal modulation/demodulation based on spread spectrum techniques such as Code Division Multiplexing (CDM) and the specific examples of the distinct digital codes listed in the 916 Patent (*See* Ex. 1004 at, e.g., 5:42-65). Ex. 1006, ¶¶95-101.

Umeda, Inoue and Jaeger each disclose related forms of signal modulation as part of the touch sensing process. Inoue discloses a signal modulation in generating scan signals by using oscillation signals from a oscillation circuit (similar to the signal generator 105 in Fig. 1(A) of the 916 patent) and adjusting the frequencies of the scan signals to minimize the noise during the sensing operation. Ex. 1011, Fig. 1, 4:30-41, 5:4-9, 5:13-15. In Umeda and Jaeger, modulated drive signals are generated based on distinct digital codes (e.g., PN codes, Walsh codes, or other suitable codes). As Prof. Smith explains, Direct Sequence Spread Spectrum Techniques (multiplying the data being transmitted by a code signal) can be accomplished either by modulating a carrier signal (e.g., a sinusoidal or square wave) or by directly modulating the coded signals onto a voltage and current to produce modulated carrier signals. Ex. 1006, ¶¶96, 99. Both alternatives resemble the dis-

closures of the 916 Patent, which teaches that digital codes may be modulated onto a carrier signal 111 generated by an oscillator or other signal generator 105 in some embodiments (e.g. Fig. 1(A)), while “the carrier signal 111 may be eliminated and/or conceptualized as a direct current (DC) signal in various alternate em-
5 bodiments,” such as the embodiment of Fig. 1(B) which omits the signal generator. Ex. 1004, 6:23-24, 6:31-36. Ex. 1006, ¶99.

Umeda teaches amplitude and phase modulating a carrier signal according to the distinct digital code: that is, when the PN code or orthogonal code value is 1, the amplitude of the column-line drive signal is set to a first voltage during the first
10 capacitance detection period; conversely, when the PN code or orthogonal code value is 0, the amplitude of the column-line drive signal is set to a second voltage during the first capacitance detection period. Ex. 1007 at Abstract, 4:14-24, 7:21-28, 7:51-67, 8:53-9:3, 11:48-58, 12:4-21, 13:3-13, 13:21-27, 14:32-47, 15:1-19, 16:42-49, 16:62-17:5, 17:14-20, 21:9-23, Figs. 8 and 22. The column line drive
15 signals are amplitude modulated by the corresponding first and second voltages. In Umeda, the first and second voltages are out of phase with each other, the column line drive signals are phase modulated based on the bit values of the PN codes or Walsh codes.

Umeda discloses modulating a carrier signal based on the principles of mul-
20 tiplexing/demultiplexing used in CDMA. Ex. 1007 at 10:20-24; *see also* discus-

sions for claims 6-8 *infra*. DSSS is also referred to as “directly carrier-modulated, code sequence modulation.” Ex. 1006, ¶¶48, 99. Directly carrier-modulated, code sequence modulation requires modulating a carrier signal. Umeda modulates the carrier signals using distinct digital codes, such as PN codes. Ex. 1006, ¶¶97-98.

5 Like Umeda, Jaeger describes carrier modulation based on distinct digital codes for touch screen devices using different modulation methods, including narrowband carrier modulation systems and wideband carrier modulation systems. Ex. 1011 at 2:16-62, 3:13-57, 4:30-5:9, and 16:37-59. Jaeger discloses directly carrier-modulated, code sequence modulation by Direct Sequence Spread Spectrum
10 (DSSS) signals as one of the time-domain spreading methods. *Id.* at 4:30-35. Ex. 1006, ¶¶81-82, 91-92.

 This sharing of the same carrier modulation approach based on distinct digital codes for touch sensing in both Umeda and Jaeger provides yet another reason for a POSITA to combine Umeda and Jaeger when designing a touch sensing sys-
15 tem or device based on distinct digital codes. Ex. 1006, ¶¶100-101.

 The above teachings and relationships in Umeda, Inoue and Jaeger provide reasons or motivations for a POSITA to combine Umeda, Inoue and Jaeger as suggested in this Petition. Additional reasons or motivations for combining Umeda and Inoue are further described in the element-by-element analyses below.

20 **B. INVALIDITY GROUND: CLAIMS 1-20 ARE UNPATENTABLE OVER UMEDA, INOUE AND JAEGER**

Claim 1 is discussed by its individual elements, and the claim as a whole is unpatentable as obvious over Umeda, Inoue, and Jaeger. Ex. 1006, ¶104-146.

1. Claim 1.Preamble: A method of detecting a position of an input object with respect to a touch-sensitive region, comprising the steps of:

5 While the preamble is non-limiting, it is nevertheless taught by the combination of Umeda, Inoue and Jaeger. Umeda discloses the claimed “method of detecting a position of an input object with respect to a touch-sensitive region” because Umeda teaches a circuit capable of detecting small capacitance changes at intersections between row lines and column lines. Ex. 1007 at 1:8-9; 2:65-3:7. The sensor
10 unit (area sensor) has multiple column lines and row lines that intersect with each other in a matrix, and the column-row intersections form capacitive sensor devices. *Id.* at 7:25-28, Figs. 1, 2A, 2B, 4. When a user touches the sensor unit, the ridges of the user’s finger press against the sensing surface to change the distances between the row lines and the column lines, which in turn change the capacitances at the af-
15 fected column-row intersections. *Id.* at 1:19-25; 7:44-50; Fig. 3. Umeda’s device measures those capacitance changes at different intersections of column and row lines and associates those changes with the touch locations of the finger’s ridges to construct the shape/image of finger ridges and valleys of the fingerprint for fingerprint sensing. *Id.* at 1:8-25; 2:65-3:7; 3:62-4:3; 5:35-40; 27:53-59. Because
20 Umeda’s device can detect the touch locations of finger ridges to map out the spatial image representing locations and shapes of finger ridges and valleys as a fin-

gerprint, it is obvious for a POSITA to understand that the Umeda device detects the touch location of input objects, such as a finger or a stylus, with respect to a touch-sensitive region. *Id.* at 2:65-3:7; 3:66-4:2. Umeda's sensor unit is controlled by a controller which includes a column line driver 5, a code generator 1, and a capacitor detecting circuit 100, as discussed in detail for claim elements 1.A to 1.D. Ex. 1007 at Figs. 1, 4, 17, 27. Ex. 1006, ¶¶104-111.

Like Umeda, Inoue also discloses a capacitive position sensor that detects coordinates of an input object's contact position on an operation area formed by a matrix of X and Y electrodes. Ex. 1008 at Abstract; 1:6-20; 4:10-29; Figs. 1 and 4. Inoue discloses a controller for its capacitive position sensor to include the coordinate data generation section 3 which includes among others, X-axis side multiplexer 17, Y-axis side multiplexer 18, drive selection circuit 24 and 30, CPU 22 and scan signal switching section 28 that collectively control Inoue's position sensor. *Id.* at 1:21-2:67, Fig. 4, 4:10-7:4; Figs. 1 and 3. Ex. 1006, ¶112.

A POSITA would be motivated to combine the teachings of Umeda and Inoue regarding this element because both teach common features, including: (1) similar hardware structures, *e.g.* a sensor unit formed by a matrix of X and Y (column and row) electrodes, where capacitance is formed at the column-row intersections; (2) touching by an object such as a user's finger changes the capacitance at the column-row intersections in both references; and (3) the location and magni-

tude of such capacitance changes can be measured by sensors in both references.

Ex. 1006, ¶113. A POSITA would be also motivated to combine Umeda and Inoue

because their teachings relate to a common problem when the noise frequency is

close to the frequency of a signal or the device such as the aforementioned fre-

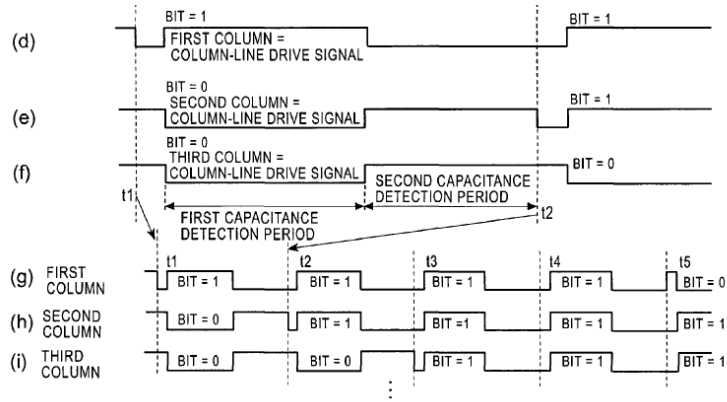
5 quency of the scan signal in Inoue or the sampling frequency of the capacitor de-

tecting circuit in Umeda. The method is practiced simply by using the device. Ex.

1006, ¶113.

**2. Claim Element 1.A: simultaneously applying a first one of a plurality of
distinct modulation signals to a first electrode and a second one of the plurali-
ty of distinct modulation signals to a second electrode to obtain resultant sig-
nals that are electrically affected by the position of the input object:**

Umeda's column line
driver can simultaneously
apply distinct modulation
signals to different column
lines, i.e., transmitter elec-



trodes, based on different PN or orthogonal codes generated by the code generator.

Ex. 1007 at 3:8-52; 9:25-67; 10:47-11:9; 11:20-26; Figs. 1, 6A, 6B, 8, 9. Fig. 8 of

Umeda, for example, shows that the column line driver simultaneously applies dif-

ferent signals to different column lines based on distinct digital codes: signal based

on bit sequence {1,1,1,1,0 . . .} , as shown in rows (d) and (g) of Fig. 8 (same

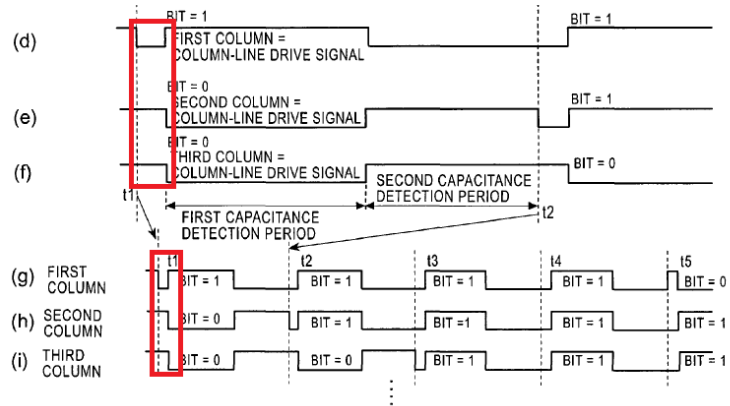
waveform, different scales), is applied to first column C1; signal based on bit se-

quence {0,1,1,1,1 . . .}, as shown in rows (e) and (h), is applied to second column C2, and signal based on bit sequence {0,0,1,1,1 . . .}, as shown in rows (f) and (i), is applied to third column C3. *Id.*, 12:15-21; 13:14-20; 14:33-47; 17:6-13; Fig. 8. Ex. 1006, ¶115.

5 The following paragraphs explain the signals shown in Fig. 8 in more detail, using a 15-bit PN code as an example. Ex. 1007 at 7:15-20:23 (first embodiment). Because a 15-bit code is used, one capacitance measurement cycle has 15 measurement periods, t1 to t15. *Id.* at 10:27-35; 10:46-54. Each period of t1 to t15 is further divided into a first capacitance detection period and a second capacitance
10 detection period. *Id.* at 4:14-24; 8:54-64. Ex. 1006, ¶116.

 At the beginning of the capacitance measurement cycle, the code generator generates a 15-bit PN code, e.g., {1,1,1,1,0,1,0,1,1,0,0,1,0,0,0} and outputs this PN code for storage in a shift register having 15 bits. Ex. 1007 at 9:25-67; 10:47-11:9; 11:20-26, Figs. 1, 6A, 6B, 9. At the start of time t1, the shift register shifts this PN
15 code by one bit to the left, resulting in the data string {1,1,1,0,1,0,1,1,0,0,1,0,0,0,1}. *Id.* at 11:27-31, Fig. 9. An inverting circuit inverts this data string into {0,0,0,1,0,1,0,0,1,1,0,1,1,1,0} and outputs the inverted data to the column line driver circuit. *Id.* at 41-47. The column line driver circuit then drives the corresponding column lines based on this bit string. *Id.* at 11: 48-50. Specifically, col-
20 umn lines C2, C3, C4, C6, C7, C10, and C12 corresponding to bit “1” in the bit

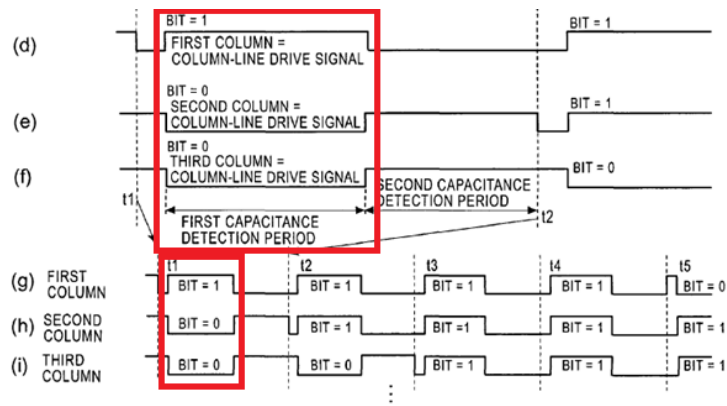
string (counting from right to left) are driven to high voltage level, and the column lines C1, C5, C8, C9, C11, C13, C14, and C15 corresponding to bit



“0” in the bit string are driven to low voltage level, as shown in the portion of signals in Fig. 8 highlighted by the red boxes. *Id.* at 11:51-58; Fig. 8. Ex. 1006, ¶117.

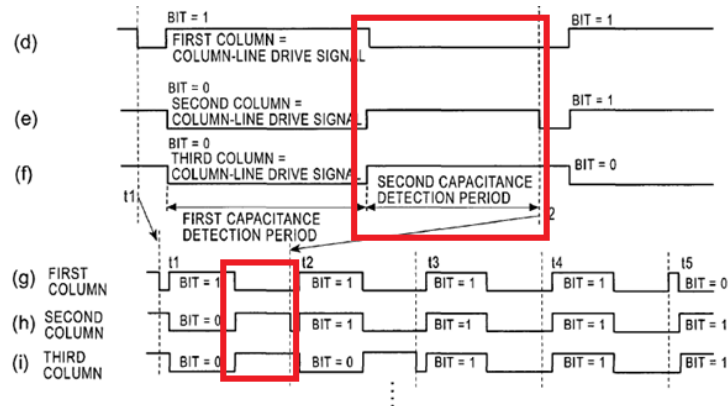
After a predetermined lapse of time subsequent to the input of the reset signal at time t1, that is, when the “first capacitance detection period” is reached, the inverting control circuit outputs a control signal for causing the inverting circuit to output the data from the storage shift register without inverting it. Ex. 1007 at 11:59-64. Accordingly, in the first capacitance detection period, the bit string {1,1,1,0,1,0,1,1,0,0,1,0,0,0,1} is sent to the column line driver, which drives the column line C1 to rise from low to high because the 15th bit data (counting from left) is changed from 0 to 1, drives the column line C2 to fall from the high to low because the 14th bit data is

changed from 1 to 0, and similarly drives other column lines in accordance with changes in the data at



the corresponding bit positions. *Id.* at 12:4-14. During this first capacitance detection period, column lines C1, C5, C8, C9, C11, C13, C14, and C15 are driven as the first column line group by a high voltage, while the column lines C2, C3, C4, C6, C7, C10, and C12 are driven as the second column line group by a low voltage, as highlighted in red below. *Id.* at 12:22-28; Fig. 8. Ex. 1006, ¶118.

A second capacitance detection period follows the first capacitance detection period. During the second capacitance detection period, the in-



verting circuit inverts the data output from the storage shift register, and thus the column line driver drives the column lines according to the bit string {0,0,0,1,0,1,0,0,1,1,0,1,1,1,0}, the inversion of the bit string used during the first capacitance detection period. Ex. 1007 at 12:57-13:13. That is, column line C1 is driven to fall from high to low, column line C2 is driven to rise from low to high, C3 is driven from low to high, etc., all in opposite direction as during the first capacitance detection period. *Id.* at 13:2-13, Fig. 8 (the red boxes show the signals sent to columns C1 - C3 during the second capacitance detection period). Ex. 1006, ¶119.

In the next measurement period t2, the PN-code generating circuit of the

code generator outputs one bit (bit value “1”) and the storage shift register shifts

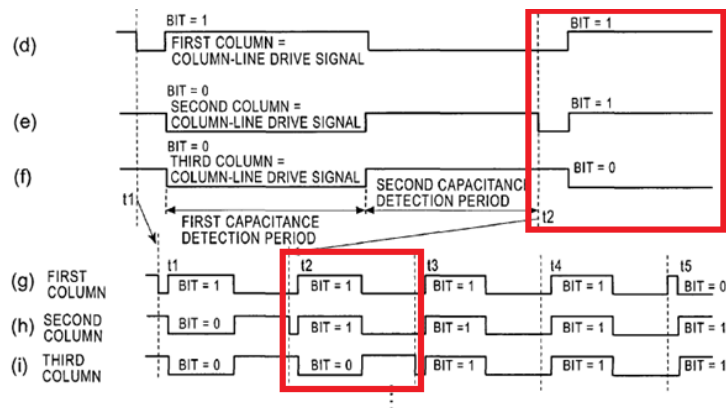
the bit data stored in the regis-

ters numbers 1 to 14 to regis-

ters numbers 2 to 15, and in-

5 puts the one-bit data into the

register number 1. Ex. 1007 at



16:14-22. Effectively, the data stored in the registers are circulated by one bit, from

{1,1,1,0,1,0,1,1,0,0,1,0,0,0,1} to {1,1,0,1,0,1,1,0,0,1,0,0,0,1,1}. *Id.* at 16:23-26.

The column lines are then driven according to this new, bit-shifted PN code as de-

10 scribed for measurement period t1 above. *Id.* at 16:27-18:4. Ex. 1006, ¶120.

For measurement time periods t3 to t15, the column line driving and capaci-

tance measuring operations are repeated as described for t1 and t2 above, with the

PN-code shifted one bit at a time. Ex. 1007 at 17:46-53; Fig. 8 (showing the wave-

form of column line driving signals for C1, C2 and C3 during time periods t1 to t5);

15 Fig. 14. Thus, throughout the entire measurement time period t1 to t15, a plurality

of column lines in Umeda are driven by different signals sent by the column line

driver. Ex. 1006, ¶121.

In addition to the PN-code, the column line driver in Umeda can also simul-

taneously transmit different signals to different column lines based on distinct digi-

20 tal codes such as orthogonal codes (e.g., Walsh codes) generated by the code gen-

erator. Ex. 1007 at 20:25-26:17 (second embodiment); Figs. 1, 19-24. As shown in

Fig. 22 below, each column

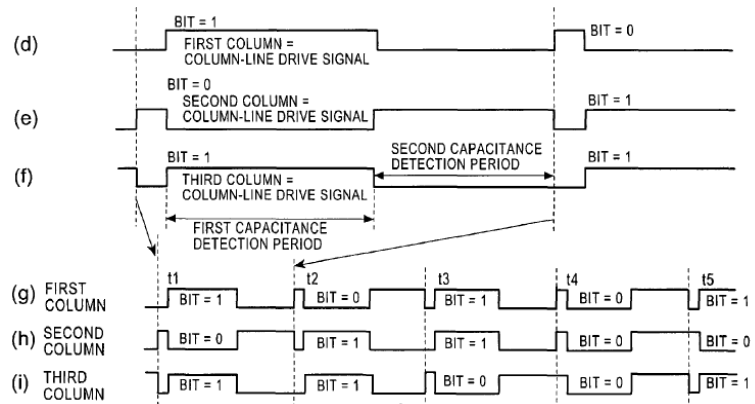
was driven by a distinct driv-

ing signal, which is based on

a distinct orthogonal code. *Id.*

at Fig. 22, rows (d) to (i). Ex.

1006, ¶122.



Therefore, the code generator 1 and column line driver 5 in Umeda form a driver circuit that practices the claimed “simultaneously applying” element. In ad-

dition, the timing control circuit 11 in the capacitor detecting circuit 100 may also be considered part of this driver circuit due to the generation of the clock by circuit 11. Each intersection of row and column lines 55 forms a capacitor, while the voltage of each row line, which is affected by the capacitances at each intersection and the presence of an input object, is measured by a capacitor detecting circuit 100.

Ex. 1007, 7:44-8:44, Fig. 4. Ex. 1006 ¶123.

Umeda also discloses the claim element “to obtain resultant signals that are electrically affected by the position of the input object.” Umeda’s capacitance detecting circuit includes a set of row lines 3 as receiver electrodes, that intersect with the column lines 2 to form a 2-D electrode matrix. Ex. 1007 at 7:21-67, Figs.

1 and 4. The column lines are driven by the column line driver 5 to transmit col-

umn drive signals (*id.* at 7:51-67) and thus are transmitter electrodes that correspond to the claimed first and second transmitter electrodes. The row lines are placed proximate to the column lines, separated by an insulating film and a gap. *Id.* at 7:29-39, Figs. 2A, 2B. The row lines are capacitively coupled to the column lines, forming capacitor devices having predetermined capacitances and known location coordinates at the intersections. *Id.* at 7:39-43, Fig. 4. As the receiver electrodes, the row lines receive displacement currents as resultant signals which are converted to voltages to measure capacitance changes at the intersections. *Id.* at 12:29-45. The capacitor detecting circuit 100 in FIGS. 1 and 4 includes circuit elements or modules that are downstream in the signal processing chain from the row lines 3. For example, the receiver circuitry may include the output terminals of the row lines 3 and the charger amplifier circuits 6 and the sample-and-hold circuits 7. The additional circuit elements, e.g., the selector circuit 8, the A/D converter 9 and the decoding computation circuit 10 may form part of the receiver circuitry. *Id.*, FIG. 1. Ex. 1006 ¶¶126-129.

Like Umeda, Inoue teaches driving the X electrodes of the position sensor using scan signals. Ex. 1008 at 1:61-2:15; 2:44-53; 4:60-5:3; 5:14-16; 5:35-40; 6:1-8; 6:64-7:4. For example, Inoue discloses a drive circuitry in the examples of circuit 3 in FIG. 1 or circuit 53 in FIG. 4. In the example in FIG. 1, Inoue's drive circuitry includes, e.g., X-axis side multiplexer 17, Y-axis side multiplexer 18, drive

selection circuit 24 and 30, CPU 22 and scan signal switching section 28 that collectively control Inoue's position sensor. Inoue also teaches obtaining "resultant signals", e.g., changes in capacitances at the intersections of the X and Y electrodes, that are electrically affected by the position of the input object. Ex. 1008 at 5 2:9-43, 2:16-33; 5:25-48. Ex. 1006, ¶¶124, 129-130.

In the context of the combination of Umeda, Inoue and Jaeger, a POSITA would be motivated by specific teachings in Umeda and Inoue to apply Umeda's multi-electrodes driving method in Inoue to provide the claimed drive circuitry of the claimed controller, because doing so can improve the SNR properties of the 10 capacitance sensor. Ex. 1006, ¶¶125, 131.

3. Claim Element 1.B: wherein each of the plurality of distinct modulation signals is based on a different one of a plurality of distinct digital codes;

As discussed for claim element 1.A, the column line driver in Umeda can drive the column lines based on distinct digital codes including orthogonal codes 15 (e.g., Walsh codes) or PN codes generated by the code generator. Figs. 19 and 20 in Umeda show an example of using orthogonal codes: a 15x15-bit matrix based on orthogonal Walsh codes are generated and applied to column lines C1 to C15. Ex. 1007 at 21:37-22:26, Figs. 19 and 20. Each column in Fig. 20 shows the bit sequence applied to a specific column line from t1 to t15, which is distinct from one 20 another. For example, a bit sequence of {1,0,1,0,1,0,1,0,1,0,1,0,1}

is applied to column line C1, a different bit sequence of

{0,1,1,0,0,1,1,0,0,1,1,0,0,1,1} is applied to C2, and another different bit sequence

of {1,1,0,1,0,0,1,1,0,0,1,0,1,1,0} is ap-

plied to C15, etc. This application of

5 different bit sequences is highlighted

below in an annotated version of Fig.

20 pointing out the above three exam-

ples of different bit sequences. Ex.

1006 ¶132-133.

	(LSB)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	(MSB)
t1	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0
t2	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0
t3	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	1
t4	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	1
t5	1	0	1	1	0	1	0	0	1	0	1	1	0	1	0	0
t6	0	1	1	1	1	0	0	0	0	1	1	1	1	0	0	0
t7	1	1	0	1	0	0	1	0	1	1	0	1	1	0	0	1
t8	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1
t9	1	0	1	0	1	0	1	1	0	1	0	1	0	1	0	0
t10	0	1	1	0	0	1	1	1	1	0	0	1	1	0	0	0
t11	1	1	0	0	1	1	0	1	0	0	1	1	0	0	0	1
t12	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0
t13	1	0	1	1	0	1	0	1	0	1	0	0	1	0	1	1
t14	0	1	1	1	1	0	0	1	1	0	0	0	0	1	1	1
t15	1	1	0	1	0	0	1	1	0	0	1	0	1	1	0	0

ORTHOGONAL CODE (15x15)

Fig. 20 in Umeda

Fig. 22 of Umeda, in its rows (d) to (i), further illustrates the driving signals

and the distinct orthogonal codes applied to the column lines, e.g., {1,0,1,0,1,...}

for C1, {0,1,1,0,0,...} for C2, and {1,1,0,0,1,...} for C3. Ex. 1007 at Fig. 22. These

codes are consistent with the codes shown in the columns of Fig. 20. Ex. 1006,

¶134.

Fig. 14 of Umeda shows using distinct PN-codes to drive the column lines.

Specifically, Fig. 14 shows the PN-code bit strings stored in the storage shift regis-

ter at time periods t1 to t15. Ex. 1007 at 17:46-53; Fig. 14. Therefore, each column

of Fig. 14 contains the PN-code bits used to drive the lines C1 to C15 from t1 to

t15. For example, the PN-code sequence driving C1 is shown in the first column of

Fig. 14 (i.e., the LSB column): {1,1,1,1,0,1,0,1,1,0,0,1,0,0,0}, the PN-code driving

C2 is contained in the second column:

{0,1,1,1,1,0,1,0,1,1,0,0,1,0,0}, and the

PN-code driving C15 is shown in the

last column (the MSB column) of Fig.

5 14: {1,1,1,0,1,0,1,1,0,0,1,0,0,1}. *Id.* at

Fig. 14 (highlighted in red). These dig-

	LSB		3	4	5	6	7	8	9	10	11	12	13	14	MSB	SHIFT AMOUNT
t1	1	2	0	0	0	1	0	0	1	1	0	1	0	1	1	0
t2	1	1	0	0	0	1	0	0	1	1	0	1	0	1	1	1
t3	1	1	1	0	0	0	1	0	0	1	1	0	1	0	1	2
t4	1	1	1	1	0	0	0	1	0	0	1	1	0	1	0	3
t5	0	1	1	1	1	0	0	0	1	0	0	1	1	0	1	4
t6	1	0	1	1	1	1	0	0	0	1	0	0	1	1	0	5
t7	0	1	0	1	1	1	1	0	0	0	1	0	0	1	1	6
t8	1	0	1	0	1	1	1	1	0	0	0	1	0	0	1	7
t9	1	1	0	1	0	1	1	1	1	0	0	0	1	0	0	8
t10	0	1	1	0	1	0	1	1	1	1	0	0	0	1	0	9
t11	0	0	1	1	0	1	0	1	1	1	1	0	0	0	1	10
t12	1	0	0	1	1	0	1	0	1	1	1	1	0	0	0	11
t13	0	1	0	0	1	1	0	1	0	1	1	1	1	0	0	12
t14	0	0	1	0	0	1	1	0	1	0	1	1	1	1	0	13
t15	0	0	0	1	0	0	1	1	0	1	0	1	1	1	1	14

Fig. 14 of Umeda

ital codes, which are phase-shifted version of a 15-bit PN code, constitute “distinct

digital codes”: “A digital bit sequence may be simply shifted in phase, for exam-

ple, to create multiple distinct codes.” Ex. 1004 at 8:24-26; 6:11-14; 7:3-6; 8:6-12

10 (emphasis added). Ex. 1006, ¶135.

In addition to Fig. 14, the waveform in Fig. 8 at lines (d) - (i) further illus-

trates the distinct driving signals sent to columns C1, C2 and C3 based on the dis-

tinct PN-code sequences described above. Ex. 1007 at Fig. 8. The bit sequences

shown in Fig. 8, e.g., {1,1,1,1,0,...} for C1, {0,1,1,1,1,...} for C2, and

15 {0,0,1,1,1,...} for C3, are consistent with the bit sequences shown in Fig. 14. Ex.

1006, ¶136.

Therefore, for both PN-code and orthogonal code scenarios, the driving sig-

nals on each column line are distinct from each other, and are based on distinct

digital codes. Ex. 1006, ¶137.

20 **4. Claim Element 1.C: demodulating the resultant signals using the plural-
ity of distinct digital codes to thereby discriminate electrical effects produced**

by the input object:

As previously discussed for Claim Element 1.Preamble, Umeda teaches that “electrical effects,” e.g., capacitance changes at the intersections formed by the column and row lines, are produced by touches of an input object. Umeda further
5 teaches the use of a decoding circuit which uses the distinct digital codes applied to the column lines to demodulate the signals received from the row lines to discriminate the electrical effects produced by the input object. Ex. 1006, ¶138. As shown in FIGS. 1, 13, 27 and 36 in Umeda, signals for each row line are transmitted to a decode processing circuit 10 which “decodes the multiplexed signal by performing
10 product sum computation by using the same PN code as the PN code used for coding so as to demultiplex the multiplexed signal into voltage data components indicating the changed capacitances of the sensor devices.” Ex. 1007, 8:34-44, 10:20-24, 20:64-8, 29:16-20, 30:23-29. The distinct digital codes used in Umeda for decoding/demodulation are the same as the codes used for modulation. *Id.* at col.
15 3:20-24; 3:53-61; 4:56-63; 5:6-13; 5:49-55; 6:34-36; 6:60-62; 7:5-7; 8:34-44; 18:32-20:23; 24:22-25:67; Figs. 16, 26 and 31. *See also* discussions for Claim Element 13.B *infra*. Ex. 1006, ¶¶139-140.

Jaeger similarly teaches that the signals generated using spread spectrum codes may be “de-spread” (*i.e.*, demodulated) using the same codes. Ex. 1011,

3:42-47, 4:60-63, 6:22-27, 7:59-68, 10:37-38; Figs. 4 (blocks 8, 10, 15), 5, 7B, 11A, 11B, 1. Ex. 1006, ¶140.

5. Claim Element 1.D: determining the position of the input object from the electrical effects.

5 As discussed in Claim Element 1.Preamble, Umeda teaches a capacitor sensor that can detect the capacitance change at each intersection of column lines and row lines. Ex. 1007 at 3:8-31; 4:4-14; 24:43-50, Fig. 4. See more detailed discussion on this aspect of Umeda in prior section VI(A) of this Petition at Page 18, line 8 to Page 21, line 20. Therefore, Umeda teaches a use of the capacitances at intersections of column and row lines as the claimed electrical effects to determine position-based attribute of an input object, such as a user's finger, when the finger touches the surface of the capacitive position sensor, as shown in Fig. 3. *Id.* at 10 5:34-40; 7:44-50, Fig. 3. Ex. 1006, ¶¶141-143.

Inoue's coordinate input device can also determine the position, i.e., the coordinates of an input object such as an input pen or a finger, when it is proximate a 15 surface of the capacitive position sensor. Ex. 1008 at Abstract. Specifically, X and Y coordinates show the contact position of the input object on the sensing area, and the Z coordinate indicates whether the input object is close to or in contact with the touch sensing area. *Id.* at 5:54-67. These coordinates are determined based on the 20 resultant signals, i.e., the signal voltages sensed by the Y electrodes. Ex. 1006, ¶144.

Because both Umeda and Inoue teach the features of this claim element, it would have been obvious to a person of ordinary skill in the art to combine the teachings of Umeda and Inoue in light of the common teachings shared by both including using a matrix of X and Y electrodes to perform capacitive position sensing. Ex. 1006, ¶145. Therefore, the combined teaching of Umeda and Inoue under the combination of Umeda, Inoue and Jaeger discloses this element. Ex. 1006, ¶146.

6. Claim 2: The method of claim 1, wherein a first one of the distinct digital codes comprises a shifted digital bit sequence of a second one of the distinct digital codes;

As discussed above regarding claim element 1.A, in the first embodiment of Umeda, the distinct digital codes applied to different column lines are bit-shifted versions of the same PN code. Ex. 1007, 9:25-67; 10:47-11:9; 11:20-31, 11:41-64, 12:4-14, 16:14-18:4, Figs. 1, 6A, 6B, 8, 9. Ex. 1006, ¶147.

7. Claim 3: The method of claim 1, further comprising adjusting a frequency of the first and second signals based on observed noise in the resultant signals.

Inoue teaches adjusting the scan signal frequency based on observed noise. The CPU 22 in the circuit 2 in FIG. 1 of Inoue performs this adjustment of the scan signal frequency. Ex. 1008 at 5:25-7:25 and FIG. 3. Unlike other designs using only one scan signal frequency discussed in Inoue, Inoue's invention for the coordinate input device has a plurality of scan signals having different frequencies to se-

quentially scan the operation area of a touch sensor. *Id.* at 3:10-25; 7:5-11. The external noise in the data output can be measured each time the scan signals are changed. *Id.* The scan signal producing the minimum level of noise can be selected for future scan operations, thus minimizing the influence of external noise and improving the reliability of the touch position detection. *Id.* at 3:10-25; 7:11-18. A noise level measurement section measures the current noise level of the sensed digital signal. *Id.* at 6:57-59. If the measured noise level is unsatisfactory (*i.e.*, at or close to the worst measurement index), the CPU 22 will drive the scan signal switching section to generate another scan signal at a different frequency to replace the current scan signal. *Id.* at 6:59-7:18, *see also* 5:34-6:59, Fig. 3. By adjusting the scan signal frequency based on the observed noise level, the influence of the external noise can be minimized and the reliability of the touch position detection is improved. *Id.* at 7:26-8:10. Therefore, this claimed element is taught by Inoue. Ex. 1006, ¶¶148-150.

Umeda recognizes various noise-related technical issues in capacitive touch sensing due to the small changes in the capacitances at the intersections to be measured and due to other noise contributions. Ex. 1007 at 2:9-61. In particular, Umeda recognizes that, if a noise source (e.g., a fluorescent light) has a frequency close to the sampling frequency of the capacitor detecting circuit, the external disturbance caused by the noise will reduce the SNR of the capacitor detecting circuit.

Id. at 2:51-61. Umeda's controller uses the capacitance detecting circuit 100, the code generator 1 and column line driver 5 to apply various driving modes to drive the column lines in the sensor unit 4 based on distinct digital codes to improve the noise performance in capacitive touch sensing. Applying different PN codes or

5 Walsh codes in the drive signals will cause differences in the wideband spectra of the resultant signals, as well known in the spread spectrum technology explained by Jaeger's description related to FIG. 1B. Ex. 1011 at 4:30-5:9, 3:27-56, 6:22-27. Therefore, the teachings in Umeda and Jaeger on using PN or Walsh codes for touch sensing is based on spreading the signal spectrum over a wideband to im-
10 prove the signal to noise ratio in the signal detection. Such teachings in Umeda and Jaeger are related to signal manipulation to cause a change in the signal spectral pattern in touch sensing.

In light of the various connections and relationships between Umeda/Jaeger and Inoue, faced with the noise interference problem described in Umeda and Jae-
15 ger, a POSITA would be motivated to look into closely related literature for a solution such as Inoue which teaches adjusting the operating frequency to reduce the noise interference and to enhance the SNR in the touch sensing device disclosed by Umeda and Jaeger. A POSITA would recognize from Inoue's teaching of adaptive frequency modification to adjust at least one of a carrier frequency if a carrier fre-
20 quency is being used, or the frequency at which the bits or the spreading codes are

modulated onto the carrier signal (for example, the time periods over which bits of the coded signals in Umeda are applied define its period, and the inverse is the frequency) in order to avoid particularly noisy frequencies. Ex. 1006, ¶153.

- 5 **8. Claim 4: The method of claim 1, wherein simultaneously applying comprises: applying the first modulation signal using a first signal path coupled to the first transmitter electrode, and applying the second modulation signal using a second signal path coupled to the second transmitter electrode.**

As discussed above regarding claim element 1.A, each column line (transmitter electrode) in Umeda has a separate signal pathway via code generator and column line driver to which the distinct digital codes discussed regarding claim element 1.A are applied. Ex. 1007, 3:8-31, 4:14-24, 7:51-67, Figs. 4, 9-12, 17, 21, 23-24, 27. Similarly, Inoue also teaches using separate signal paths for applying different signals. *See, e.g.*, Ex. 1008 at Fig. 1. Ex. 1006, ¶¶154-155.

- 15 **9. Claim 5: The method of claim 4, wherein the first and second signal paths each comprise at least one of an amplifier and a driver.**

Umeda teaches that the signal paths taken by the plurality of signals to column lines each includes a column line driver 5. Ex.1007, Abstract, 3:8-31, 4:14-24, 4:32-40, 5:29-34, 6:46-49, 7:51-67, 8:45-64, 9:4-9, 10:36-46, Figs. 1, 4, 9-12, 17, 21, 23-24. Additionally, the full signal path for each column and row intersection, includes an amplifier for each row line. *Id.*, 8:1-23, 8:29-33, 8:45-52, 9:10-24, 12:35-456, 13:41-47, 13:59-67, Figs. 1, 5, 13. Ex. 1006, ¶156.

Like Umeda, Inoue's touch sensing device also contains an amplifier and a driver, as represented by the triangle symbol in the oscillation circuit 23. *See, e.g.*, Ex. 1008 at Fig. 1. Inoue's device uses amplification circuits 19 and 25 to amplify signal voltages. *See, e.g., Id.* at 4:30-41; 5:4-49; Fig. 1. Ex. 1006, ¶157. Additionally, amplifiers and drivers are standard off-the-shelf circuit components, and a POSITA would find it obvious to use both amplifiers and drivers in signal paths that transmit modulation signals to electrodes. Ex. 1006, ¶158.

10. Claim 6: The method of claim 1, wherein simultaneously applying comprises frequency modulating a carrier signal according to the distinct digital codes

Frequency modulation is expressly taught in Jaeger, which discloses that “process of spectral spreading is accomplished by, e.g., coding the information bits or the carrier frequency with one or more wideband codes having continuous bandwidths.” Ex. 1011 at 3:42-46. Additionally, as discussed for claims 7 and 8 below, It is a well-known, basic principle in signal processing, including but not limited to spread spectrum applications, that a carrier signal can be modulated using one of several standard schemes such as frequency, amplitude, and phase modulation. Therefore, a POSITA would have had good reason to pursue one of these identified, predictable solutions. Ex. 1006, ¶159.

11. Claim 7: The method of claim 1, wherein simultaneously applying comprises phase modulating a carrier signal according to the distinct digital codes

Umeda teaches phase modulating the carrier signal during the second ca-

capacitance detection period when complementarily driving the column lines using the inverted data of the bit data of the PN code that drove the column lines in the first capacitance detection period. Ex. 1007 at Abstract, 3:32-52; 5:14-21; 10:41-54; 22:29-23:59; 24:32-25:35; 26:27-25; 27:46-67. Complementarily driving the column lines using the inverted data results in inverted modulated signals that are 180 degrees out of phase with the signal driven with the non-inverted data.

The timing charts in FIGS. 8 and 22 of Umeda show the claimed carrier signals as column-line drive pulse signals in rows (d), (e), and (f) (and zoomed out versions (h), (i), and (j)). The column-line drive pulse signals are carrier signals modulated by the distinct digital codes because they are periodic pulse signals having a pre-defined waveform, amplitude, and frequency. Ex. 1006, ¶¶160-163. As discussed above, it is a well-known, basic principle in signal processing, including but not limited to spread spectrum applications, that a carrier signal can be modulated using one of several standard schemes such as frequency, amplitude, and phase modulation. Therefore, a POSITA would have had good reason to pursue one of these identified, predictable solutions. Ex. 1006, ¶164.

12. Claim 8: The method of claim 1, wherein simultaneously applying comprises amplitude modulating a carrier signal according to the distinct digital codes

Umeda teaches amplitude modulating a carrier signal according to the distinct digital code: that is, when the PN code or orthogonal code value is 1, the am-

plitude of the column-line drive signal is set to a first voltage during the first capacitance detection period; conversely, when the PN code or orthogonal code value is 0, the amplitude of the column-line drive signal is set to a second voltage during the first capacitance detection period. Ex. 1007 at Abstract, 4:14-24, 7:21-28, 7:51-
5 67, 8:53-9:3, 11:48-58, 12:4-21, 13:3-13, 13:21-27, 14:32-47, 15:1-19, 16:42-49, 16:62-17:5, 17:14-20, 21:9-23, Figs. 8 and 22. The column line drive signals are amplitude modulated by the corresponding first and second voltages.

In addition, Umeda discloses modulating a carrier signal because Umeda discloses that the characteristics of the PN code is similar to the principles of multiplexing/demultiplexing in CDMA. *Id.* at 10:20-24. CDMA is one type of direct
10 sequence spread spectrum (DSSS) technique and it is well-known in the art that DSSS is more accurately known as “directly carrier-modulated, code sequence modulation.” Ex. 1006 at ¶32 citing to Dixon at p. 15. Directly carrier-modulated, code sequence modulation expressly requires modulating a carrier signal. Umeda
15 modulates the carrier signals using the distinct digital codes, such as PN codes, e.g., PN code examples in Fig. 8, (d), (e), (f), (g), (h), and (i)) or orthogonal codes, e.g., Walsh code in Figs. 22, (d), (e), (f), (g), (h), and (i)). *Id.*; Ex. 1006, ¶¶160-163.

Moreover, Umeda recognizes that driving multiple column lines based on PN-code bit strings “is similar to the principle of multiplexing/demultiplexing in
20 code division multiple access (CDMA) used in cellular telephones” Ex. 1007

at 10:20-24. It is a well-known, basic principle in signal processing, including but not limited to spread spectrum applications, that a carrier signal can be modulated using one of several standard schemes such as frequency, amplitude, and phase modulation. Therefore, a POSITA would have had good reason to pursue one of these identified, predictable solutions. Ex. 1006, ¶164.

13. Claim 9: The method of claim 1, wherein the distinct digital codes are mathematically independent

Umeda discloses distinct digital codes such as PN-code (e.g., M-series code, a.k.a. maximum length sequence) or orthogonal code (e.g., Walsh code). Ex. 1007 at 3:48-52; 4:56-67; 6:42-44; 7:21-28; 9:43-55; 19:64-20:2; 20:33-41; 21:56-61; 22:10-13; 22:24-26. Both kinds of codes are mathematically independent because they are either orthogonal to each other (for Walsh codes), or substantially orthogonal to each other (for M-series codes). *Id.* at Abstract; 3:32-37; Figs. 7A, 7B. Jaeger further discloses the distinct digital codes are mathematically independent for touch sensing. Ex. 1011 at 4:46-5:9. Ex. 1006, ¶¶166-167.

14. Claim 10: The method of claim 1, wherein each of a plurality of the distinct digital codes comprises a shifted digital bit sequence of another one of the plurality of distinct digital codes

As discussed above regarding claim 2, in the PN code embodiment of Umeda, distinct digital codes are applied to the column line drivers by bit shifting a PN code sequence. Therefore, each code applied to each column line driver is a bit shifted version of another one of the PN codes. Ex. 1006, ¶168.

15. Claim 11: The method of claim 1, wherein the distinct digital codes comprise Pseudo-Random codes.

As discussed above in detail regarding claim element 1.B, Umeda teaches the generation of Pseudo-Random (PN) codes, such as M-series codes. Ex. 1007 at 3:32-52; 4:52-63; 5:48-55; 7:21-28; 7:51-67; 8:36-11:26; 12:29-34; 13:28-33; 13:48-58; 14:32-51; 15:1-19; 16:18-22; 17:21-26; 17:46-20:2; 26:35-40; 26:53-57; 26:59-27:24; 27:60-28:8; claim 9; Figs. 6A, 6B, 7B, 9-12, 14, 15, 16. Jaeger likewise teaches PN codes as examples of suitable distinct digital codes for touch sensing. Ex. 1011, 4:46-5:9. Ex. 1006, ¶ 169.

16. Claim 12: The method of claim 1, wherein the distinct digital codes are binary.

See discussion for claim element 1.B and claim 11: the PN and orthogonal codes used in Umeda have values of 0 and 1 and thus are binary. In addition, Jaeger discloses PN codes which can also be binary. Ex. 1011 at 4:46-5:9. Smith Dec., ¶¶170-171.

17. Claim 13.Preamble: A controller for a position sensor, comprising:

Both Umeda and Inoue describe a controller as discussed regarding Claim 1, Preamble and Element 1.A. Such controller includes drive circuitry coupled to the transmitter electrodes discussed regarding claim elements 1.A and 1.B, and receiver circuitry coupled to receiver electrodes discussed regarding claim elements 1.A, 1.C and 1.D. Also see discussions for claim elements 13.A and 13.B below. Ex. 1006, ¶172.

18. Claim Element 13.A: drive circuitry configured to simultaneously transmit a first signal based on a first one of a plurality of mathematically independent binary codes with a first transmitter electrode, and to transmit a second signal based on a second one of the plurality of mathematically independent binary codes with a second transmitter electrode:

See discussions for claim element 1.A (drive circuitry) and claims 9 (mathematically independent codes) and 12 (binary codes). Ex. 1006, ¶173.

19. Claim Element 13.B: receiver circuitry coupled to at least one receiver electrode and configured to receive electrical effects associated with the first and second signals:

See discussions for claim elements 1.A and 1.C. Ex. 1006, ¶ 174. In addition, Umeda teaches that its receiver circuitry receives electrical effects with at least one receiver electrode by the use of distinct digital codes (e.g., PN codes or orthogonal codes) to sense position-based attributes measured by a 2-D matrix or array of

“sensor devices 55” formed by different intersections of column lines and row lines. Ex. 1007, e.g., 3:32-4:3; FIG. 4 and 7:21-67. The sensor devices 55 measure electrical effects represented by the capacitances at the intersections of column lines and row lines with respect to their locations. *Id.*, and also 1:12-25. In Umeda, the electrical effects represented by the capacitances at the intersections are associated with column drive signals applied to column lines by the column line driver (corresponding to the claimed first and second signals) because the row lines are capacitively coupled to the column lines, forming capacitor devices having predetermined capacitances and known location coordinates at the intersections. *Id.* at

7:39-43, Fig. 4 and 7:51-67. Accordingly, Umeda teaches capacitance sensors that detect the capacitance changes as electrical effects at intersections of column lines and row lines. *Id.* at 3:8-31; 4:4-14; 24:43-50, Fig. 4. Umeda further teaches using measurements of such electrical effects to determine position-based attribute of an input object, such as a user's finger, when the finger touches the surface of the capacitive position sensor, as shown in Fig. 3. *Id.* at 5:34-40; 7:44-50, Fig. 3; Ex. 1006, ¶¶127-128, 174.

Like Umeda, Inoue discloses a matrix of X and Y electrodes forming the touch sensing area. Ex. 1008 at 1:29-34; 4:20-29; Figs. 1, 2, 4. The X and Y electrodes are proximate to each other - separated only by a film substrate (4:20-29, Fig. 2), and they are capacitively coupled to form capacitances at the intersections of the X and Y electrodes. *Id.* at 2:9-43. Signal voltages are applied to X and Y electrodes via X electrodes and are received through the Y electrodes. *Id.* 2:16-33, 5:25-48. Thus, X electrodes in Inoue correspond to the claimed first and second transmitter electrodes and Y electrodes in Inoue correspond to the claimed receiver electrodes. The received signal voltages from Y electrodes are then used by the CPU 22 in FIG. 1 or CPU 62 in FIG. 4 to calculate the contact position of the finger on the touch sensor. *Id.* at 2:34-67 and 5:25-7:18. Accordingly, the receiver circuitry in Inoue that corresponds to the claimed receiver circuitry may include Y-axis multiplexer 18 having a plurality of (M) switches S1 to SM arranged in par-

allel in FIG. 1 and may further include more or more downstream circuit elements such as the first amplification circuit 19, the first filter circuit 20, the analog/digital converter (A/D) 21 and the controller (CPU) 22. Ex. 1006, ¶¶129-130.

Therefore, both references disclose the claimed receiver circuitry. A POSI-
5 TA would be guided and motivated by teachings in both references to combine the teachings of Umeda and Inoue when designing a capacitive touch sensor because (1) both references use the similar hardware structure of a matrix of X and Y electrodes, where capacitance is formed at the intersections of those electrodes; and (2) they use similar methods for sensing the capacitance changes at the intersections,
10 *i.e.*, transmitting driving signals to one set of electrodes and detecting the changes of resultant signals at the other set of electrodes, from which the capacitance changes can be calculated. Ex. 1006, ¶131.

20. Claim Element 13.C: wherein the controller is configured to determine a position-based attribute of an input object based on the electrical effects:

15 See discussions for claim element 1.D. Ex. 1006, ¶175.

21. Claim 14: the controller of claim 13, wherein the first and second digital codes define the first signal to be in phase with the second signal during a first time, and the first signal to be out of phase with the second signal during a second time:

20 Umeda teaches that the distinct digital codes (PN or Walsh codes) modulate the signals so that the square waveforms applied to different column line drivers are in phase at certain times and out of phase at others. For example, Fig. 8 shows

the signals applied to the first and second columns in phase at t2 but out of phase at t1. See also Ex. 1007, 6:11-13, 10:1-35, 11:20-26; 13:56-58; 17:54-18:22; 19:52-63; claim 9, Fig. 7A. Ex. 1006, Section X.A.5.n.

5 **22. Claim 15: The controller of claim 13, wherein each of the plurality of mathematically independent binary codes comprises a shifted version of another one of the plurality of mathematically independent binary codes:**

See discussions for claim 2. Ex. 1006, ¶176.

10 **23. Claim 16: The controller of claim 13, wherein the drive circuitry is further configured to simultaneously transmit a third signal based on a third one of plurality of mathematically independent binary codes with a third transmitter electrode:**

As discussed regarding claim element 1.A (drive circuitry), Umeda teaches that bit-shifted versions of a PN code or distinct orthogonal codes are transmitted to several column lines (e.g. 15 column lines in the examples throughout Umeda).
15 Therefore, at least the claimed “third signal” based on a third...code” with a “third transmitter electrode” is taught by Umeda. See also discussions for claims 9 (mathematically independent codes) and 12 (binary codes). Ex. 1006, ¶177.

24. Claim 17: The controller of claim 13, further comprising a code generation module configured to generate each of the distinct digital codes:

20 See discussions and citations for claim element 1.A. Umeda teaches a code generator 1, 1B which includes either a PN code generating circuit or an orthogonal code reading circuit linked to a code memory. Ex. 1006, ¶178.

25 **25. Claim 18: The controller of claim 13, wherein the drive circuitry comprises a first signal path between the controller and the first transmitter electrode, and a second signal path between the controller and the second trans-**

mitter electrode:

See discussions and for claim 4. Ex. 1006, ¶179.

26. Claim 19: The controller of claim 18, wherein the first and second signal paths each comprise at least one of an amplifier and a driver:

5 See discussions and for claim 5. Ex. 1006, ¶180.

27. Claim Element 20.Preamble: An input device comprising:

See discussions for claim 1, preamble. Specifically, an “input device” is explicitly taught by Inoue, which discloses a “coordinate input device.” *See, e.g.*, Ex. 1008 at Abstract. Ex. 1006, ¶181.

10 **28. Claim Element 20.A: A first transmitter electrode, a second transmitter electrode, and a plurality of receiver electrodes proximate to and configured to be capacitively coupled with the first transmitter electrode and the second transmitter electrode:**

See discussions for claim elements 1.A, 1C and 13.B. Ex. 1006, ¶182.

15 **29. Claim Element 20.B: A controller configured to:**

See discussions for claim 13, preamble. Ex. 1006, ¶183.

20 **30. Claim Element 20.C: Simultaneously apply a first one of a plurality of distinct modulation signals to a first signal path connecting the controller to the first electrode, and a second one of the plurality of distinct modulation signals to a second signal path connecting the controller to the second electrode:**

See discussions for claim element 1.A and claim 4. Ex. 1006, ¶184.

31. Claim Element 20.D: Wherein each of the plurality of distinct modulation signals is based on a different one of a plurality of distinct digital codes:

25 See discussions for claim element 1.B. Ex. 1006, ¶185.

32. Claim Element 20.E: Receive resultant signals that are electrically af-

fect by the position of the input object from the; plurality of receiver electrodes:

See discussions for claim elements 1.A and 13.B. Ex. 1006, ¶186.

5 **33. Claim Element 20.F: demodulate the resultant signals using the plurality of distinct digital codes to thereby discriminate electrical effects produced by the input object:**

See discussions for claim element 1.C. Ex. 1006, ¶187.

34. Claim Element 20.G: determine the position of the input object from the electrical effects:

10 See discussions for claim element 1.D. Ex. 1006, ¶188.

VII. CONCLUSION

This Petition has demonstrated that there is a reasonable likelihood that Petitioner will prevail in its challenge of patentability for claims 1-20. It is respectfully requested that a trial for IPR review of the 916 Patent be instituted.

15 In addition, this Petition has shown that, by the evidence as presented, claims 1-20 are invalid and must be canceled. Cancellation of these claims will prevent Patent Owner from improperly claiming technologies that were already known in the prior art before its patent filing, and from asserting invalid patent claims to exclude Petitioner and others.

20

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Respectfully submitted,

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CERTIFICATE OF SERVICE

The undersigned hereby certifies that a true copy of the foregoing PETITION FOR *INTER PARTES* REVIEW OF U.S. PATENT NO. 8,952,916 B2 and supporting materials (Exhibits 1001-1015 and Power of Attorney) have been served in its entirety this Second Day of February, 2016 by FedEx® on Patent Owner at the correspondence address for the attorney of record for the 916 Patent shown in USPTO PAIR:

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