

**IN THE UNITED STATES DISTRICT COURT
FOR THE WESTERN DISTRICT OF TEXAS
WACO DIVISION**

LIONRA TECHNOLOGIES LIMITED,

Plaintiff,

v.

APPLE INC.,

Defendant.

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Civil Action No. 6:22-cv-00351-ADA

DEMAND FOR JURY TRIAL

APPLE INC.'S INVALIDITY CONTENTIONS

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I. INTRODUCTION

Apple Inc. (“Apple”) hereby makes the following disclosure of Invalidity Contentions (“Invalidity Contentions”) to Plaintiff Lionra Technologies Ltd. (“Lionra” or “Plaintiff”).

These contentions address only the claims of U.S. Patent No. 7,260,141 (the “’141 patent”) asserted in Plaintiff’s Amended Preliminary Disclosure of Asserted Claims and Infringement Contentions to Defendant Apple Inc. served on October 18, 2022 (“Amended Preliminary Infringement Contentions”).

Lionra has asserted the following claims (collectively, the “Asserted Claims”) against Apple: claims 1, 2, 3, 4, 7, 8, 9, 10, 18, 19, 21, and 22 of the ’141 patent. *See* Amended Preliminary Infringement Contentions, at 1.

With respect to each asserted claim and based on its investigation to date, Apple hereby:

- (a) identifies each item of prior art that anticipates and/or renders obvious each asserted claim;
- (b) specifies whether each such item of prior art anticipates each asserted claim and/or renders it obvious, and, if it renders it obvious, explains why the prior art renders the asserted claim obvious and identifies any combinations of prior art showing obviousness; (c) submits a chart identifying where specifically in each item of prior art each limitation of each asserted claim is found; and (d) identifies the grounds of invalidity based on 35 U.S.C. § 112.

As explained in more detail below, Apple’s investigation into the invalidity of the Asserted Claims is ongoing.

Lionra’s Amended Preliminary Infringement Contentions contain several deficiencies and fail provide adequate notice of Lionra’s infringement theories under the Court’s Standing Order Governing Patent Cases. *See* Standing Order Governing Proceedings (OGP) 4.3—Patent Cases (Apr. 4, 2023) at 2, 12. Apple reserves the right to amend its invalidity contentions after

Lionra serves infringement contentions that comply with the Court's Standing Order Governing Patent Cases.

Apple has served or will serve several third-party subpoenas to entities believed to have developed and/or distributed relevant prior art systems and products. Apple reserves the right to promptly amend these contentions to the extent relevant documents and information is produced in response to any subpoena.

II. RESERVATIONS

Apple reserves the right to amend these Invalidity Contentions. The information and documents that Apple produces are based on information available to date and are subject to further revision. Apple expressly reserves the right to amend these disclosures and the accompanying document production should Lionra provide any additional information that it failed to provide in its Amended Preliminary Infringement Contentions. As noted above, Lionra's Amended Preliminary Infringement Contentions fail to provide adequate notice of Lionra's infringement theories under the Court's Standing Order Governing Patent Cases. Apple reserves the right to amend its contentions based additional disclosure by Lionra including in its Final Infringement Contentions.

Further, because discovery (including discovery from third parties) is ongoing, Apple reserves the right to revise, amend, and/or supplement the information provided herein, including identifying and relying on additional references, should Apple's further search and analysis yield additional information or references, consistent with the Standing Order Governing Patent Cases and the Federal Rules of Civil Procedure. Apple reserves the right to rely on additional prior art; further analysis of prior art; application of prior art to new or different claims; depositions and discovery from prior art sources and authors; analysis of prior art products; combinations of references; expert opinion and/or testimony; evidence supporting

invalidity of any asserted claim; and any additional relevant information that may result from its further investigation and discovery. Additionally, Apple reserves the right to rely on additional information, testimony, and/or analysis concerning operation of prior art systems. Moreover, Apple reserves the right to revise its ultimate contentions concerning the invalidity of the Asserted Claims, which may change depending upon any findings as to the priority or invention date of the Asserted Claims, and/or positions that Lionra or its expert witness(es) may take concerning infringement and/or invalidity issues.

Prior art not included in this disclosure, whether known or unknown to Apple, may become relevant. Apple is currently unaware of the extent, if any, to which Lionra will contend that limitations of the Asserted Claims are not disclosed in the prior art identified by Apple, or will contend that any of the identified references do not qualify as prior art. The identification of any patent or patent publication shall be deemed to include any counterpart patent or application filed, published, or issued anywhere in the world.

The information and documents that Apple produces are based on Apple's present understanding of Lionra's infringement theories as advanced by Lionra in its Amended Preliminary Infringement Contentions. As noted above, Lionra's Amended Preliminary Infringement Contentions are deficient in numerous respects. For example, Lionra has failed to identify where each element of each Asserted Claim is found within each accused instrumentality, and does not identify a specific mapping from components of the accused instrumentalities to the elements of the Asserted Claims. Lionra has also failed to present any contentions for infringement under the doctrine of equivalents. Lionra has not provided detailed infringement contentions that identify each specific claim limitation allegedly infringed under the doctrine of equivalents and its alleged equivalent element in the accused

instrumentalities, or the basis for purported insubstantial differences between each such limitation and its alleged equivalent. If Lionra attempts or is permitted to cure such deficiencies, doing so may lead to further grounds for invalidity, and thus Apple specifically reserves the right to modify, amend, or supplement its contentions. Apple has provided notice to Lionra regarding the deficiencies in its Amended Preliminary Infringement Contentions. Lionra has failed to cure the deficiencies and has not undertaken reasonable efforts to prepare preliminary contentions to put Apple on notice of its theories of infringement. To the extent Lionra is granted leave to amend its contentions, or other additional information regarding Lionra's infringement theories becomes available, Apple anticipates that it will provide corresponding invalidity contentions which establish that, under Lionra's interpretation of the claims as set forth in its Amended Preliminary Infringement Contentions or Final Infringement Contentions, the asserted patents are not patentable over the prior art.

Further, Lionra has not produced prior art known to it, including any known prior art products. As discovery in this action provides Apple with additional information, Apple may serve additional subpoenas on third parties believed to have knowledge, documentation, and/or corroborating evidence relating to invalidity and/or prior art. It is therefore likely that Apple will discover additional prior art pertinent to the invalidity of the Asserted Claims and Apple reserves the right to supplement these Invalidity Contentions after becoming aware of additional prior art or information. Apple further reserves the right to introduce and use such supplemental materials at trial.

Apple's claim charts in Exhibits A1 through A13 and AA cite particular teachings and disclosures of the prior art as applied to features of the Asserted Claims. However, persons having ordinary skill in the art may view an item of prior art generally in the context of other

publications, literature, products, and understanding. Accordingly, the cited portions are only exemplary, and Apple expressly reserves the right to rely on uncited portions of the prior art references and on other publications and expert testimony as aids in understanding and interpreting the cited portions, as providing context thereto, and as additional evidence that a claim limitation is known or disclosed. Citations to figures are inclusive of all discussion of those figures. Apple further reserves the right to rely on uncited portions of the prior art references, other publications, documents explicitly or implicitly incorporated by reference, and testimony, to establish bases for combinations of certain cited references that render the Asserted Claims obvious. Further, for any combination, Apple reserves the right to rely additionally on information generally known to those skilled in the art and/or common sense.

The references discussed herein and in the claim charts in Exhibits A1 through A13 and AA, or elsewhere identified, may disclose the elements of the Asserted Claims explicitly and/or inherently, and/or they may be relied upon to show the state of the art in the relevant timeframe. The exemplary obviousness combinations are provided in the alternative to Apple's anticipation contentions and are not to be construed to suggest that any reference included in the combinations is not itself anticipatory.

Apple further reserves the right to assert that the Asserted Claims are invalid under 35 U.S.C. § 102(f) in the event that discovery reveals that the named inventor of the asserted patents did not invent (either alone or in conjunction with others) the subject matter recited in the Asserted Claims. If Apple asserts invalidity under Section 102(f), Apple will provide the name of the person(s) from whom, and the circumstances under which, the invention or any part of it was derived.

Apple further intends to rely on inventor admissions concerning the scope of the Asserted Claims or of the prior art relevant to the Asserted Claims found in, *inter alia*: the patent prosecution history and/or reexamination history for the asserted patents and related patents and/or patent applications; any deposition testimony of a named inventor of the asserted patents; and the papers filed and any evidence submitted by Lionra in conjunction with this litigation. Apple reserves the right to contend that the Asserted Claims are invalid for failure to name the correct inventor(s), and/or to contend that Lionra lacks standing to bring this litigation with respect to such patents.

Furthermore, nothing stated herein shall be treated as an admission or suggestion that Apple agrees with Lionra regarding either the scope of any asserted claim or the claim interpretations Lionra advances in its Amended Preliminary Infringement Contentions or Final Infringement Contentions or anywhere else. To the extent that Apple's Invalidity Contentions reflect constructions of claim limitations consistent with or suggested by Lionra's Amended Preliminary Infringement Contentions, no inference is intended nor should any be drawn that Apple agrees with Lionra's claim interpretations. Nor shall anything in these Invalidity Contentions be treated as an admission that Apple's accused products meet any limitation of any asserted claim. Apple denies that it infringes any claim of the asserted patents. To the extent that any prior art reference identified by Apple contains a claim element that is the same as or similar to an element in an accused product, based on a claim interpretation inferred from Lionra's Amended Preliminary Infringement Contentions or Final Infringement Contentions, inclusion of that reference in Apple's Invalidity Contentions shall not be deemed a waiver by Apple of any claim construction or noninfringement position. Apple expressly reserves the right

to contest any claim construction asserted by Lionra and expressly reserves all noninfringement arguments.

To the extent the Court's further construes any term of the Asserted Claims of the asserted patent, and/or positions that Lionra or its expert witness(es) may take concerning claim interpretation, infringement, and/or invalidity issues, the charted prior art references in Exhibit A1 through A13 and AA, or otherwise identified herein, may be of greater or lesser relevance, and different combinations of these references may be implicated. Given this uncertainty, the charts may reflect alternative applications of the prior art against the Asserted Claims. Nothing stated herein shall be construed as an admission or a waiver of any particular construction of any claim term.

In addition to these Invalidity Contentions and the prior art identified herein, Apple hereby relies on and incorporates by reference in their entirety and expressly reserves the right to rely upon invalidity expert reports, including all invalidity positions, invalidity charts and all prior art cited therein, as well as invalidity contentions presented by any present or former defendant in any of Lionra's or its predecessors' lawsuits or by potential or actual licensees to the asserted patents, including any reexamination or other post-grant review, involving the asserted patent or any patents that claim priority to, claim priority from, or are the basis for a claim of priority in the asserted patent (collectively, "related patents"). In particular, Apple incorporates by reference any invalidity contentions, invalidity charts, and invalidity positions in:

Lionra Technologies Limited v. Samsung Electronics Co., Ltd., No. 2:22-cv-00100 (E.D. Tex.); *Lionra Technologies Limited v. Motorola Mobility LLC*, No. 1:22-cv-02231 (N.D. Ill.); *Lionra Technologies Limited v. Google LLC*, No. 6:22-cv-00467 (W.D. Tex.); *Lionra Technologies Limited v. Cisco Systems, Inc.*, No. 2:22-cv-00305 (E.D. Tex.); *Lionra Technologies Limited v. Fortinet, Inc.*, No. 2:22-00322 (E.D. Tex.); *Lionra Technologies Limited v. Hewlett Packard Enter. Co.*, No. 2:22-cv-00319 (E.D. Tex.); *Lionra Technologies Limited v. Palo Alto Networks, Inc.*, No. 2:22-cv-003344 (E.D. Tex.).

III. PATENT-IN-SUIT

A. U.S. Patent No. 7,260,141

The '141 patent, titled "Integrated Beamformer/Modem Architecture," issued on August 21, 2007, from U.S. Application No. 10/084,614, filed on February 28, 2002, and published on October 24, 2002, as U.S. Patent Publication No. 2002/0154687.

B. Priority Date

Lionra asserts that each Asserted Claim is entitled to at least a priority date of February 28, 2001. Apple reserves the right to challenge any alleged date of conception earlier than the filing date of the asserted patent and/or Lionra's alleged priority date of February 28, 2001. Apple further reserves the right to seek discovery regarding any alleged conception and reduction to practice dates, as appropriate, and to demonstrate earlier invention by other parties under 35 U.S.C. § 102(g), public use and/or the on-sale bar under 35 U.S.C. § 102(b), and/or applicants' failure to comply with 35 U.S.C. § 112 to the extent Lionra alleges a date of conception earlier than the filing date of the asserted patent and/or Lionra's alleged priority date of February 28, 2001.

C. Asserted Claims

According to Lionra's Amended Preliminary Infringement Contentions served on October 18, 2022, Lionra is asserting claims 1, 2, 3, 4, 7, 8, 9, 10, 18, 19, 21, and 22 of the '141 patent. *See* Amended Preliminary Infringement Contentions, at 1.

1. Claim 1

Claim 1 of the '141 patent claims:

An apparatus for modulating and demodulating signals transmitted and received via an electronically steerable phased array antenna comprising a plurality of antenna elements, the apparatus comprising:

a baseband modulator configured to modulate outbound digital baseband signals to be transmitted via the phased array antenna;

a baseband demodulator configured to demodulate incoming digital baseband signals generated from signals received via the phased array antenna;
and

a shared baseband processor configured to receive digital baseband signals including the modulated outbound digital baseband signals and the incoming digital baseband signals, said shared baseband processor applying a single phase adjustment to each of the digital baseband signals to jointly account for both beamforming phase rotation and carrier phase rotation of individual antenna elements.

2. Claim 2

Claim 2 of the '141 patent depends from independent claim 1 (*supra*), and claims:

The apparatus of claim 1, wherein said digital baseband signals received by said shared baseband processor are time multiplexed, and said shared baseband processor operates on said digital baseband signals on a time-slot-by-time-slot basis.

3. Claim 3

Claim 3 of the '141 patent depends from independent claim 1 (*supra*), and claims:

The apparatus of claim 1, wherein said baseband modulator receives data symbols from a plurality of user channels and supplies to said shared baseband processor a time-multiplexed stream of modulated digital data symbols from said plurality of user channels.

4. Claim 4

Claim 4 of the '141 patent depends from independent claim 3 (*supra*), and claims:

The apparatus of claim 3, wherein, for each input digital data symbol, said baseband modulator generates a plurality of modulated digital data symbols in the time-multiplexed stream respectively corresponding to the plurality of antenna elements.

5. Claim 7

Claim 7 of the '141 patent depends from independent claim 1 (*supra*), and claims:

The apparatus of claim 1, wherein said shared baseband processor comprises a multiplier which performs complex multiplication on digital baseband signals relating to a plurality of user channels in a time-multiplexed manner.

6. Claim 8

Claim 8 of the '141 patent depends from independent claim 1 (*supra*), and claims:

The apparatus of claim 1, wherein said shared baseband processor comprises a multiplier which performs complex multiplication on digital baseband signals associated with a plurality of individual antenna elements in a time-multiplexed manner.

7. Claim 9

Claim 9 of the '141 patent depends from independent claim 1 (*supra*), and claims:

The apparatus of claim 1, wherein said shared baseband processor comprises a beam scaling and power control processor configured to generate a time-multiplexed stream of gain control signals for digital baseband signals corresponding to individual antenna elements for each of a plurality of user channels, the gain control signals jointly accounting for power control and antenna element beam scaling; and

a multiplier configured to adjust amplitudes of a time-multiplexed stream of digital baseband signals corresponding to the plurality of user channels in accordance with the gain control signals.

8. Claim 10

Claim 10 of the '141 patent depends from independent claim 1 (*supra*), and claims:

The apparatus of claim 1, further comprising:

a baseband beamformer configured to receive time-multiplexed digital baseband signals from said shared baseband processor corresponding to individual antenna elements, said baseband beamformer forming a combined signal from said time-multiplex digital baseband signals.

9. Claim 18

Claim 18 of the '141 patent depends from independent claim 1 (*supra*), and claims:

The apparatus of claim 1, wherein said apparatus employs time division multiple access (TDMA) to transmit and receive signals.

10. Claim 19

Claim 19 of the '141 patent depends from independent claim 1 (*supra*), and claims:

The apparatus of claim 1, wherein said apparatus employs frequency division multiple access (FDMA) to transmit and receive signals.

11. Claim 21

Claim 21 of the '141 patent depends from independent claim 1 (supra), and claims:

The apparatus of claim 1, wherein the apparatus is implemented via a very large scale integration (VLSI) circuit or an application specific integrated circuit (ASIC).

12. Claim 22

Claim 22 of the '141 patent depends from independent claim 1 (supra), and claims:

The apparatus of claim 1, wherein said apparatus is a modem.

IV. PRIOR ART DISCLOSURES

In addition to the references cited on the face of the '141 patent and related patents, the admitted prior art references in the specifications of the '141 patent and related patents, the prosecution histories of the '141 patent and related patents, the references cited in any reexaminations, reissue proceedings, or other post-grant proceedings in the U.S. Patent Office concerning the '141 patent and related patents, and the references cited in any invalidity contentions or expert reports submitted in any action or proceedings involving the '141 patent or related patents, Apple below identifies the following prior art that anticipates each asserted claim and/or renders it obvious. Apple has set forth in detail in the accompanying claim charts the particular claims that are anticipated under 35 U.S.C. § 102 and/or rendered obvious under 35 U.S.C. § 103 by the particular reference.

A. Prior Art Patents

The following prior art patents and patent applications, including those references listed in Exhibits A1 through A13 and AA, anticipate and/or render obvious the Asserted Claims of the '141 patent.¹ Moreover, the following prior art patents and patent publications, at a

¹ To the extent Lionra contends that a reference is not prior art under § 102(e), Apple expressly reserves the right to perform a *Dynamic Drinkware* analysis. See *Dynamic Drinkware, LLC v. Nat'l Graphics, Inc.*, 800 F.3d 1375 (Fed. Cir. 2015).

minimum, demonstrate the state of the art and/or the knowledge of a person of ordinary skill in the art as it relates to the '141 patent in the relevant timeframe, and may be relied upon by Apple to demonstrate the state of the art and/or the knowledge of a person of ordinary skill in the art as it relates to the '141 patent in the relevant timeframe. Apple further incorporates by reference all patents and patent applications cited on the face of the '141 patent, during prosecution of the '141 patent, and in Apple's Petition for *Inter Partes* Review filed against the Asserted Claims of the '141 patent (*see Apple Inc. v. Lionra Technologies Ltd.*, IPR2023-00796, Petition for *Inter Partes* Review of U.S. Patent No. 7,260,141, Paper 1 (Apr. 25, 2023)).

Patent or Publication No.	Short Name	Filing Date	Issue or Publication Date	Bates No.
AU1507599A	Iinuma '599AU	12/15/1998	06/22/2000	APL-Lionra_00739285
EP0957532A2	Obayashi '532	5/14/1999	11/17/1999	APL-Lionra_00739319
EP1062746B1	Scherzer	09/15/1998	03/24/2004	APL-Lionra_00739363
EP1143559A1	Iinuma '559	1998/12/15	10/10/2001	APL-Lionra_00756198
JP2572141	JP '141	02/08/1990	01/16/1997	APL-Lionra_00739490; APL-Lionra_00739500 (machine translation)
JPH05-63427	JP '427	08/30/1991	03/12/1993	APL-Lionra_00739510; APL-Lionra_00739529 (machine translation)
U.S. Provisional Appl. 09/655610	Lin	09/06/2000		APL-Lionra_00739544
U.S. Provisional Appl. 60/239859	Williams '859	10/11/2000		APL-Lionra_00739583
U.S. Publication No. 2002/0042290	Williams	10/11/2001	04/11/2002	APL-Lionra_00739620
U.S. Publication No. 2002/0051434	Ozluturk	12/21/2000	05/02/2002	APL-Lionra_00752837
U.S. Publication No. 2002/0071053	Wittig	12/08/2000	06/13/2002	APL-Lionra_00739633

Patent or Publication No.	Short Name	Filing Date	Issue or Publication Date	Bates No.
U.S. Publication No. 2002/0072393	McGowan	12/11/2000	06/13/2002	APL-Lionra_00746870
U.S. Publication No. 2002/0141478	Ozluturk '478	12/21/2000	10/03/2002	APL-Lionra_00746880
U.S. Publication No. 2002/0155818	Boros	04/29/2002	10/24/2002	APL-Lionra_00739810
U.S. Publication No. 2007/0173195	Widrow	12/18/2006	07/26/2007	APL-Lionra_00739845
U.S. Publication No. 2008/0259826	Struhsaker	10/11/2007	10/23/2008	APL-Lionra_00741298
U.S. Publication No. 2016/0181693	Kapoor	01/09/2015	06/23/2016	APL-Lionra_00741331
U.S. Patent No. 4,985,707	Schmidt	01/09/1989	01/15/1991	APL-Lionra_00753005
U.S. Patent No. 5,086,302	Miller	04/10/1991	02/04/1992	APL-Lionra_00739885
U.S. Patent No. 5,353,307	Lester	07/20/1993	10/04/1994	APL-Lionra_00753031
U.S. Patent No. 5,541,607	Reinhardt	12/05/1994	07/30/1996	APL-Lionra_00739896
U.S. Patent No. 5,585,803	Miura	08/29/1995	12/17/1996	APL-Lionra_00741371
U.S. Patent No. 5,604,768	Fulton	12/21/1994	02/18/1997	APL-Lionra_00741443
U.S. Patent No. 5,675,554	Cole	07/15/1996	10/07/1997	APL-Lionra_00753075
U.S. Patent No. 5,715,516	Howard	10/18/1995	02/03/1998	APL-Lionra_00741462
U.S. Patent No. 5,764,187	Rudish	01/21/1997	06/09/1998	APL-Lionra_00753113
U.S. Patent No. 5,809,422	Raleigh	03/06/1996	09/15/1998	APL-Lionra_00739905
U.S. Patent No. 5,818,386	Belisle	11/22/1996	10/06/1998	APL-Lionra_00741534
U.S. Patent No. 5,838,732	Carney	10/31/1994	11/17/1998	APL-Lionra_00741548

Patent or Publication No.	Short Name	Filing Date	Issue or Publication Date	Bates No.
U.S. Patent No. 5,903,823	Moriyama	03/18/1996	05/11/1999	APL-Lionra_00753132
U.S. Patent No. 5,909,460	Dent	12/07/1995	06/01/1999	APL-Lionra_00753235
U.S. Patent No. 5,914,946	Avidor	11/08/1996	06/22/1999	APL-Lionra_00753261
U.S. Patent No. 5,937,348	Cina	01/23/1996	08/10/1999	APL-Lionra_00739929
U.S. Patent No. 6,016,124	Lo	04/06/1998	01/18/2000	APL-Lionra_00741567
U.S. Patent No. 6,029,116	Wright	08/20/1998	02/22/2000	APL-Lionra_00753292
U.S. Patent No. 6,052,085	Hanson	06/05/1998	04/18/2000	APL-Lionra_00739939
U.S. Patent No. 6,054,948	Dean	12/10/1997	04/25/2000	APL-Lionra_00747336
U.S. Patent No. 6,055,415	Suzuki	08/20/1997	04/25/2000	APL-Lionra_00741609
U.S. Patent No. 6,072,792	Mazur	07/03/1997	06/06/2000	APL-Lionra_00741643
U.S. Patent No. 6,088,386	Spruyt	07/15/1997	07/11/2000	APL-Lionra_00753326
U.S. Patent No. 6,108,565	Scherzer '565	09/15/1997	08/22/2000	APL-Lionra_00756162
U.S. Patent No. 6,157,340	Xu	10/26/1998	12/05/2000	APL-Lionra_00739948
U.S. Patent No. 6,157,681	Daniel	04/06/1998	12/05/2000	APL-Lionra_00739958
U.S. Patent No. 6,167,099	Rader	05/30/1996	12/26/2000	APL-Lionra_00739972
U.S. Patent No. 6,184,827	Dendy	02/26/1999	02/06/2001	APL-Lionra_00753361
U.S. Patent No. 6,215,983	Dogan	01/18/2000	04/10/2001	APL-Lionra_00753369
U.S. Patent No. 6,226,531	Holt	08/24/1998	05/01/2001	APL-Lionra_00741708

Patent or Publication No.	Short Name	Filing Date	Issue or Publication Date	Bates No.
U.S. Patent No. 6,232,921	Aiken '921	01/11/2000	05/15/2001	APL-Lionra_00741714
U.S. Patent No. 6,233,459 B1	Sullivan	03/18/1998	05/15/2001	APL-Lionra_00739997
U.S. Patent No. 6,249,249	Obayashi	05/12/1991	06/19/2001	APL-Lionra_00740006
U.S. Patent No. 6,292,135	Takatori	04/04/2000	09/18/2001	APL-Lionra_00740045
U.S. Patent No. 6,307,506	Despain	10/18/1999	10/23/2001	APL-Lionra_00740090
U.S. Patent No. 6,339,399	Andersson	06/26/2000	01/15/2002	APL-Lionra_00740103
U.S. Patent No. 6,370,182	Bierly	02/08/2001	04/09/2002	APL-Lionra_00740120
U.S. Patent No. 6,462,704	Rexberg	01/31/2001	10/08/2002	APL-Lionra_00740139
U.S. Patent No. 6,463,295	Yun	02/06/1998	10/08/2002	APL-Lionra_00740150
U.S. Patent No. 6,512,917	Hiramatsu	06/25/1999	01/28/2003	APL-Lionra_00741926
U.S. Patent No. 6,597,730	Bader	11/03/1999	07/22/2003	APL-Lionra_00740187
U.S. Patent No. 6,600,445	Li	02/11/2002	07/29/2003	APL-Lionra_00740199
U.S. Patent No. 6,600,935	Hiramatsu '935	11/28/2000	07/29/2003	APL-Lionra_00740211
U.S. Patent No. 6,636,726	Erhage	06/21/2000	10/21/2003	APL-Lionra_00741986
U.S. Patent No. 6,647,276	Kuwahara	08/30/2000	11/11/2003	APL-Lionra_00740227
U.S. Patent No. 6,693,588	Schlee	10/24/2000	02/17/2004	APL-Lionra_00740241
U.S. Patent No. 6,693,590	Toplicar	01/05/2000	02/17/2004	APL-Lionra_00742013
U.S. Patent No. 6,718,184	Aiken '184	09/28/2000	04/06/2004	APL-Lionra_00740248

Patent or Publication No.	Short Name	Filing Date	Issue or Publication Date	Bates No.
U.S. Patent No. 6,727,846	Brown	09/20/2000	04/27/2004	APL-Lionra_00740260
U.S. Patent No. 6,757,546	Hagen	08/21/2000	06/29/2004	APL-Lionra_00740274
U.S. Patent No. 6,771,985	Iinuma	11/17/2000	08/03/2004	APL-Lionra_00742065
U.S. Patent No. 6,778,130	Bevan	12/05/2001	08/17/2004	APL-Lionra_00740290
U.S. Patent No. 6,795,409	Youssefmir	09/29/2000	09/21/2004	APL-Lionra_00740314
U.S. Patent No. 6,823,170	Dent '170	07/26/2000	11/23/2004	APL-Lionra_00742129
U.S. Patent No. 6,831,943	Dabak	08/09/2000	12/14/2004	APL-Lionra_00740339
U.S. Patent No. 6,836,673	Trott	12/22/2000	12/28/2004	APL-Lionra_00748795
U.S. Patent No. 6,885,652	Ozukturk	09/21/1999	04/26/2005	APL-Lionra_00753494
U.S. Patent No. 6,895,230	Blount	08/16/2000	05/17/2005	APL-Lionra_00742198
U.S. Patent No. 6,980,527	Liu	04/25/2000	12/27/2005	APL-Lionra_00740382
U.S. Patent No. 6,996,418	Teo	04/26/2001	02/07/2006	APL-Lionra_00740410
U.S. Patent No. 7,043,271	Seto	09/12/2000	05/09/2006	APL-Lionra_00740440
U.S. Patent No. 7,076,168	Shattil	10/31/2000	07/11/2006	APL-Lionra_00742335
U.S. Patent No. 7,110,794	Iinuma '794	06/13/2001	09/19/2006	APL-Lionra_00756185
U.S. Patent No. 7,123,943	Ylitalo	03/13/2003	10/17/2006	APL-Lionra_00740506
U.S. Patent No. 7,587,174	Kuwahara '174	03/09/2007	09/08/2009	APL-Lionra_00742390
U.S. Patent No. 7,751,854	Leifer	09/19/2006	07/06/2010	APL-Lionra_00740516
WO1997044920A1	Mohebbi	04/17/1997	11/27/1997	APL-Lionra_00740541

Patent or Publication No.	Short Name	Filing Date	Issue or Publication Date	Bates No.
WO1999014870A2	Scherzer '870	09/15/1998	03/25/1999	APL-Lionra_00753574
WO1999055012A2	Evans	04/01/1999	10/28/1999	APL-Lionra_00753664
WO2000036701A1	Iinuma '701	12/15/1998	06/22/2000	APL-Lionra_00753686
WO2001008259 A1	Hardie	07/21/2000	02/01/2001	APL-Lionra_00740566
WO2002021716A2	Lin '716	08/28/2001	03/14/2002	APL-Lionra_00740599

B. Prior Art Publications

The following publications, including those references listed in Exhibits A1 through A-13 and AA, anticipate and/or render obvious the Asserted Claims of the '141 patent. Moreover, the following publications, at a minimum, demonstrate the state of the art and/or the knowledge of a person of ordinary skill in the art as it relates to the '141 patent in the relevant timeframe, and may be relied upon by Apple to demonstrate the state of the art and/or the knowledge of a person of ordinary skill in the art as it relates to the '141 patent in the relevant timeframe. Further, Apple incorporates by reference all publications cited on the face of the '141 patent, during prosecution of the '141 patent, and in Apple's Petitioner of *Inter Partes* Review filed against the Asserted Claims of the '141 patent (*see Apple Inc. v. Lionra Technologies Ltd.*, IPR2023-00796, Petition for *Inter Partes* Review of U.S. Patent No. 7,260,141, Paper 1 (Apr. 25, 2023)).

Title	Author/Publisher	Short Name	Date of Publication	Bates No.
A Mobile Base Station Phased Array Antenna	C. Alakija and S.P. Stapleton, Simon Fraser University School of Engineering Science, 1992 IEEE International Conference on Selected Topics in Wireless Communications	Alakija	June 1992	APL-Lionra_00754605
Proceedings of the 10th IEEE Signal Processing Workshop on Statistical Signal and Array Processing	Moeness G. Amin, The IEEE Signal Processing Society	Amin	August 2000	APL-Lionra_00753822
High Accuracy GPS Performance Using a Digital Adaptive Antenna Array	Alison Brown, NAVSYS Corporation, Proceedings of ION National Technical Meeting	Brown	January 2001	APL-Lionra_00739481
Intelligent Antennas for Wireless Communications—Uplink	R. Michael Buehrer, Achilles G. Kogiantis, Shang-shieh Liu, Jiann-an Tsai, and Dirck Uptegrove, Bell Labs Technical Journal, July-September 1999	Buehrer	July-September 1999	APL-Lionra_00754969
Graphical Investigation of Quantisation Effects of Phase Shifters on Array Patterns	Michel Clénet and Gilbert Morin, Defence Research Establishment Ottawa, DREO TR 2000-092	Clénet	November 2000	APL-Lionra_00754698

Title	Author/Publisher	Short Name	Date of Publication	Bates No.
A 8.75-MBaud Single-Chip Digital QAM Modulator with Frequency-Agility and Beamforming Diversity	Kyung-Ho Cho, CogNet Microsystems, and Henry Samueli, University of California Los Angeles Electrical Engineering Department, IEEE 2000 Custom Integrated Circuits Conference	Cho	May 2000	APL-Lionra_00753712
WTEC Final Report on Wireless Technologies and Information Networks	Anthony Ephremides, Tatsuo Itoh, Raymond Pickholtz, Magdy Iskander, Linda Katehi, Ramesh Rao, Wayne Stark, and Jack Winters, International Technology Research Institute World Technology Division	Ephremides	July 2000	APL-Lionra_00755991
Rapidly Deployable Radio Network	Joseph B. Evans, Gary J. Minden, K. S. Shanmugan, Glenn Prescott, Victor S. Frost, Ben Ewy, Ricardo Sanchez, Craig Sparks, K. Malinimohan, James Roberts, Richard Plumb, and Dave Petr, IEEE Journal on Selected Areas in Communications, vol. 17, No. 4	Evans	April 1999	APL-Lionra_00739409

Title	Author/Publisher	Short Name	Date of Publication	Bates No.
A Smart Antenna Receiver Array Using a Single RF Channel and Digital Beamforming	Jonathan D. Frederick, Yuanxun Wang, and Tatsuo Itoh, IEEE Transactions on Microwave Theory and Techniques, Vol. 50, No. 12	Frederick	December 2002	APL-Lionra_00753727
Computationally Efficient MIMO Demodulation	William A. Gardner et al., Statistical Signal Processing, Inc.	Gardner	June 2001	APL-Lionra_00740774
Application of Antenna Arrays to Mobile Communications, Part I: Performance Improvement, Feasibility, and System Considerations	Lal C. Godara, Proceedings of the IEEE, Vol. 85, No. 7	Godara I	July 1997	APL-Lionra_00754668
Application of Antenna Arrays to Mobile Communications, Part II: Beam-Forming and Direction-of-Arrival Considerations	Lal C. Godara, Proceedings of the IEEE, Vol. 85, No. 8	Godara II	August 1997	APL-Lionra_00754617
Digital Beamforming Receiver Design	Srikanth Gurrapu, Glenn Prescott and K. Sam Shanmugan, University of Kansas Information and Telecommunications Technology Center, ITTC-FY1997-TR-10920-25B	Gurrapu	May 1997	APL-Lionra_00739424

Title	Author/Publisher	Short Name	Date of Publication	Bates No.
Differential Unitary Space-Time Modulation	Bertrand M. Hochwald and Wim Sweldems, Bell Laboratories, Lucent Technologies	Hochwald	March 1999, revised February 2000	APL-Lionra_00754775
Electronically Steerable Array Antennas for Mobile Satellite Communications – A Review	Nemai C. Karmakar, Nanyang Technological University School of Electrical and Electronic Engineering, Marek E. Bialkowski, University of Queensland Department of Computer Science and Electrical Engineering, 2000 IEEE International Conference on Phased Array Systems and Technology	Karmakar	May 2000	APL-Lionra_00754830
Transmit/Receive Module Packaging: Electrical Design Issues	Bruce A. Kopp, Craig R. Moore, and Robert V. Coffman, Johns Hopkins APL Technical Digest, Vol. 20, No. 1	Kopp	1999	APL-Lionra_00755003
Polling-Based Media Access Protocols for Use with Smart Adaptive Array Antennas	Srikanth V. Krishnamurthy, Anthony S. Acampora, and Michele Sorzi, IEEE/ACM Transactions on Networking, Vol. 9, No. 2	Krishnamurthy	April 2001	APL-Lionra_00755052

Title	Author/Publisher	Short Name	Date of Publication	Bates No.
An Electronically Stabilized Phased Array System for Shipborne Atmospheric Wind Profiling	D.C. Law, et al., Journal of Atmospheric and Oceanic Technology, Vol. 19	Law	June 2002	APL-Lionra_00755014
Multibeam Phased-Array Antennas Developed and Characterized	Richard Q. Lee and Kevin M. Lambert, NASA Glenn Research Center	Lee	March 1, 2003	APL-Lionra_00755024
Benefits of Software GPS Receivers for Enhanced Signal Processing	Alison Brown, NAVSYS Corporation, Marvin May, Penn State University Applied Research Laboratory, and Barry Tanju, Space & Naval Warfare Systems Command, GPS Solutions 4(1) Summer, 2000	May	Summer 2000	APL-Lionra_00754580
An Amateur 900 MHz Spread-Spectrum Radio Design	Tom McDermott, Bob Stricklin, and Bill Reed, Tucson Amateur Packet Radio Corporation	McDermott	1997	APL-Lionra_00754912
A DBF Self-Beam Steering Array Antenna for Mobile Satellite Applications Using Beam-Space Maximal-Ratio Combination	Ryu Miura, Toyohisa Tanaka, Akio Horie, and Yoshio Karasawa, IEEE Transactions on Vehicular Technology, Vol. 48, No. 3	Miura	May 1999	APL-Lionra_00755028
Efficient Parallel Receive Beam Forming for Phased Array Imaging Using Phase Rotation	M. O'Donnell, General Electric Corporate Research & Development Center, IEEE 1990 Ultrasonics Symposium	O'Donnell	1990	APL-Lionra_00755039

Title	Author/Publisher	Short Name	Date of Publication	Bates No.
Electronically Steerable Passive Array Radiator Antennas for Low-Cost Analog Adaptive Beamforming	Takashi Ohira and Koichi Gyoda, ATR Adaptive Communications Research Laboratories, 2000 IEEE International Conference on Phased Array Systems and Technology	Ohira	May 2000	APL-Lionra_00755043
A MIMO Algorithm for Smart Antenna in CDMA Systems	J.D. Park, L.M. Tuan, and G.W. Yoon, Information & Communications University, and J.W. Kim, TeleCIS Technologies, Inc., IEEE 2001 International Conferences on Info-Tech and Info-Net	Park	November 2001	APL-Lionra_00755047
Programmable Digital Modem paper	John J. Poklemba, NASA, Lewis Research Center, Space Communications Technology Conference: Onboard Processing and Switching, 1991	Poklemba	11/01/1991	APL-Lionra_00740928
Architecture and Elements of Software Defined Radio Systems as Related to Standards, Technical Report 2.1	Software Defined Radio Forum	SDRF	November 1999	APL-Lionra_00755270

Title	Author/Publisher	Short Name	Date of Publication	Bates No.
SDMA/TDMA Dynamic Slot Assignment Using a Smart Antenna Basestation (Ph.D. Dissertation, McMaster University)	Faisal Shad, B.Eng. (Computer Systems Engineering), McMaster University Department of Electrical and Computer Engineering	Shad	2000	APL-Lionra_00755066
A GPS Digital Phased Array Antenna and Receiver	Alison Brown and Randy Silva, NAVSYS Corporation, Proceeding of IEEE Phased Array Symposium	Silva	May 2000	APL-Lionra_00754575
Digital Signal Processing Rapid Prototyping for Military Communication Systems	Srinivas Sivaprakasam, Christos Neophytou, Glenn Prescott, and Tim Johnson, CECASE Laboratory University of Kansas, Rome Laboratory, RL-TR-95-39	Sivapraksam	March 1995	APL-Lionra_00755631
The Performance Enhancement of Multibeam Adaptive Base-Station Antennas for Cellular Land Mobile Radio Systems	Simon C. Swales, Mark A. Beach, David J. Edwards, and Joseph P. McGeehan, IEEE transactions on Vehicular Technology, Vol. 39, No. 1	Swales	February 1990	APL-Lionra_00755719

Title	Author/Publisher	Short Name	Date of Publication	Bates No.
Analysis of a Decision Directed Beamformer	A. Lee Swindlehurst, Soumendra Daas, and Jiankan Yang, IEEE Transactions on Signal Processing, Vol. 43, No. 12	Swindlehurst	December 1995	APL-Lionra_00754609
Directional Virtual Carrier Sensing for Directional Antennas in Mobile Ad Hoc Networks	Mineo Takai and Jay Martin, UCLA Computer Science Department, and Aifeng Ren and Rajive Bagrodia, Scalable Network Technologies, Third ACM International Symposium on Mobile Ad Hoc Networking and Computing	Takai	June 2002	APL-Lionra_00754803
A Low Cost P-I-N Diode Phase Shifter for Airborne Phased-Array Antennas	Franklin G. Terrio, Ronald J. Stocktonm and Wayne D. Sato, IEEE Transactions on Microwave Theory and Techniques	Terrio	June 1974	APL-Lionra_00755738
Dynamic Slot Allocation (DSA) in Indoor SDMA/TDMA Using a Smart Antenna Basestation	Faisal Shad, Terence D. Todd, Vytas Kezys, and John Litva, IEEE/ACM Transactions on Networking, Col. 9, No. 1	Todd	February 2001	APL-Lionra_00754817

Title	Author/Publisher	Short Name	Date of Publication	Bates No.
The Use of Optical Techniques for Signal Distribution and Beam Formation in Phased Array Antennas (Ph.D. Dissertation, University of London)	Constantinos Zaglanikis, Department of Electronic and Electrical Engineering, University College London	Zaglanikis	August 1993	APL-Lionra_00755743

C. Prior Art Products, Systems, and/or Services

Apple also contends that the Asserted Claims of the '141 patent are invalid in view of public knowledge and uses and/or offers for sale or sales of products, systems, and/or services that are prior art under 35 U.S.C. §§ 102(a) or (b) that anticipate and/or render obvious the Asserted Claims. Apple also contends that the Asserted Claims of the '141 are invalid in view of public knowledge and uses and/or offers for sale or sales of products, systems, and/or services that are prior art under 35 U.S.C. § 102(g)(2) that anticipate and/or render obvious the Asserted Claims.

Apple's investigation into publicly-available prior art products, systems, and/or services that anticipate and/or render obvious each element of any Asserted Claims is ongoing. Fact discovery is in its preliminary stages, and Apple has served several third-party subpoenas seeking information regarding relevant prior art products, systems, and/or services. For example, as of the service date of Apple's Invalidity Contentions, Apple has served third-party subpoenas on the following entities:

- Qualcomm Inc.;
- ITT Inc.;
- Renesas Electronics America Inc.; and

- Ligado Networks LLC.

Apple is investigating additional publicly available prior art products, systems, and/or services, and may serve additional third-party subpoenas and/or obtain discovery from third parties. Apple reserves the right to amend its identification of prior art products, systems, or services as Apple becomes aware of the existence, functionality, and/or characteristics of prior art products, systems, and/or services as a result of its investigation and forthcoming discovery.

Based on Apple's investigation as of the service date of Apple's Invalidity Contentions, Apple contends that the Asserted Claims of the '141 patent are invalid in view of the following products, systems, and/or services that are prior art under 35 U.S.C. §§ 102(a), (b), and/or (g) that anticipate and/or render obvious the Asserted Claims.

Product, System, and/or Service Publicly Known or Used	Date the Offer or Use Took Place or the Information Became Known	Exemplary Evidence
Gurrapu System	At least by May 1997	Srikanth Gurrapu, Glenn Prescott and K. Sam Shanmugan, <i>Digital Beamforming Receiver Design</i> , University of Kansas Information and Telecommunications Technology Center, ITTC-FY1997-TR-10920-25B (APL-Lionra_00739424), evidence produced in discovery, and/or evidence in response to a third-party subpoena
Products, systems, or services offered by Qualcomm, Inc. (hereinafter, "Qualcomm Product(s)")	At least by February 28, 2001	Evidence in response to Apple's third-party subpoena
Products, systems, or services offered by ITT Inc. (hereinafter, "ITT Product(s)")	At least by February 28, 2001	Evidence in response to Apple's third-party subpoena

Product, System, and/or Service Publicly Known or Used	Date the Offer or Use Took Place or the Information Became Known	Exemplary Evidence
Products, systems, or services offered by Renesas Electronics America Inc., including Renesas Electronics America Inc.'s subsidiaries or predecessors (hereinafter, "Renesas Product(s)"), including for example and without limitation HSP45116, HSP43168, HSP43220, HSP50110, HSP50210, DEMODEVB, and/or HI5703 – EV	At least by February 28, 2001	Evidence in response to Apple's third-party subpoena
Products, systems, or services offered by L3Harris Technologies, Inc., including L3Harris Technologies, Inc.'s subsidiaries or predecessors (hereinafter, "L3Harris Product(s)"), including for example and without limitation HSP45116, HSP43168, HSP43220, HSP50110, HSP50210, DEMODEVB, and/or HI5703 – EV	At least by February 28, 2001	Evidence produced in discovery and/or in response to a third-party subpoena
Products, systems, or services offered by Ligado Networks LLC, including Ligado Networks LLC's subsidiaries or predecessors (hereinafter, "Ligado Product(s)"), including for example and without limitation satellite mobile communication systems and/or products developed by American Mobile Satellite Corporation	At least by February 28, 2001	Evidence produced in discovery and/or in response to a third-party subpoena

Product, System, and/or Service Publicly Known or Used	Date the Offer or Use Took Place or the Information Became Known	Exemplary Evidence
Products, systems, or services offered by MACOM Technology Solutions Inc., including MACOM Technology Solutions Inc.'s subsidiaries or predecessors (hereinafter, "MACOM Product(s)")	At least by February 28, 2001	Evidence produced in discovery and/or in response to a third-party subpoena
Products, systems, or services offered by Marvell Technology Inc., including Marvell Technology Inc.'s subsidiaries or predecessors (hereinafter, "Marvell Product(s)")	At least by February 28, 2001	Evidence produced in discovery and/or in response to a third-party subpoena
Products, systems, or services offered by Cirrus Logic, Inc., including Cirrus Logic, Inc.'s subsidiaries or predecessors (hereinafter, "Cirrus Product(s)")	At least by February 28, 2001	Evidence produced in discovery and/or in response to a third-party subpoena
Products, systems, or services offered by Silicon Laboratories Inc., including Silicon Laboratories Inc.'s subsidiaries or predecessors (hereinafter, "Silicon Product(s)")	At least by February 28, 2001	Evidence produced in discovery and/or in response to a third-party subpoena
Products, systems, or services offered by Viasat Inc., including Viasat Inc.'s subsidiaries or predecessors (hereinafter, "Viasat Product(s)"), including for example and without limitation ViaSat Satellite Ground Systems (e.g., 5.4-Meter Remote Sensing Ground Station)	At least by February 28, 2001	Evidence produced in discovery and/or in response to a third-party subpoena

D. Applicant Admitted Prior Art (AAPA)

The '141 patent includes applicant admitted prior art (AAPA), which are statements acknowledging that many of the limitations of the '141 patent's claims were already known in the prior art. The statements include, but are not limited to, the following:

- “Directional antennas are widely used in a variety of communications systems to more efficiently transmit and receive radiated signals.” '141 patent at 1:22-24.
- “More specifically, beamforming is a type of spatial filtering in which an array of sensor elements is controlled with appropriate signal processing to implement a phased array antenna for the purpose of shaping the antenna response over time in a space-varying manner (i.e., steering gain in some directions, while producing attenuation or nulls in other directions).” '141 patent at 1:49-55.
- “A phased-array receive antenna achieves gain in a particular direction by phase shifting, or time shifting, the signal from each element, and then summing the phase-shifted element signals in a signal combiner. By choosing the relative phasing of each element appropriately, coherence can be achieved for a particular direction of arrival (DOA), across a particular signal bandwidth.” '141 patent at 1:60-67.
- “Digital beamforming is analogous to analog beamforming, except that the received signal on each antenna element is independently digitized, and the phasing/combining operation is performed mathematically on the digital samples.” '141 patent at 2:1-5.
- “Conventionally, digital beamforming is done on a wideband signal, prior to despread a CDMA waveform. This forces the computationally intense beamforming to take place at a much higher sampling rate, resulting in more mathematical operations per second, and corresponding increased hardware cost. To address this shortcoming, beamforming can be performed at baseband, as disclosed by Hanson et al. in U.S. Pat. No. 6,052,085, the disclosure of which is incorporated herein by reference in its entirety.” '141 patent at 2:16-19.
- “Furthermore, digital beamforming is conventionally performed as a separate process, independent of symbol modulation/demodulation, perhaps even as a separate product from the modem.” '141 patent at 2:20-23.
- “The largest cost-component of beamforming is the complex multiplication of each sample for each element with the beamforming weights.” '141 patent at 2:27-29.
- “When combined with the modem, there is potential to absorb the complex multiply required for beamforming into computation already taking place for

extremely low incremental cost. In U.S. Pat. No. 5,764,187, the disclosure of which is incorporated herein by reference, Rudish et al. disclose an implementation of beamforming using digital direct synthesis (DDS) functions.” ’141 patent at 2:36-42.

- “Beamforming in a multi-user modem or base station applications in the prior art has principally taken a non-integrated or detached approach. In some cases, beamforming rotation and combining is done in analog in the front-end UC/DC circuitry of the modem. In other cases, beamforming is performed using either analog or digital approaches as a distinct external apparatus from the modem.” ’141 patent at 6:59-65.
- “To support signal modulation and demodulation, baseband processors typically perform the functions of carrier phase tracking (involving carrier phase rotation) and automatic gain control (AGC) (i.e., adjusting the amplitude of the baseband signal to be within the operational range of downstream devices), although baseband processors do not generally process carrier phase and amplitude on an antenna-element-by-antenna-element basis.” ’141 patent at 7:4-11.
- “[T]he process of carrier tracking already rotates each complex baseband sample by some amount on the unit circle between 0 and 2π radians.” ’141 patent at 8:40-43.

V. CLAIM CHARTS

Apple’s prior art reference charts (attached hereto as Exhibits A1-A13 and AA) identify where specifically in each item of prior art, each element of each asserted claim is found, citing particular teachings/disclosure of the referenced art as applied to features of the asserted patents. However, persons of skill in the art generally would appreciate an item of prior art in the context of other publications, literature, products, and understandings. The citations are exemplary and not exclusive, and Apple reserves the right to rely on uncited portions of the prior art references and on other publications and expert testimony as aids in understanding and interpreting the cited portions, as providing context to them, and as additional evidence that the prior art discloses a claimed feature. Apple reserves the right to establish what was known to a person having ordinary skill in the art through other publications, products, and/or testimony. Apple also reserves the right to rely on uncited portions of the prior art references, other publications, and

testimony to establish that a person of skill in the art would have been motivated to combine certain of the cited references so as to render the claims obvious. Where Apple cites a figure or feature reference in an item of prior art, it incorporates by reference the discussion and/or explication of such referenced figure or feature. Moreover, Apple further reserves the right to supplement its disclosure after it has had the opportunity to investigate Lionra's theories of infringement during discovery. Indeed, Lionra's Amended Preliminary Infringement Contentions contain several deficiencies and fail provide adequate notice of Lionra's infringement theories under the Court's Standing Order Governing Patent Cases. *See Standing Order Governing Proceedings (OGP) 4.3—Patent Cases (Apr. 4, 2023)* at 2, 12. Apple therefore reserves the right to amend these contentions after Lionra serves infringement contentions that comply with the Court's Standing Order Governing Patent Cases.

VI. IDENTIFICATION OF INVALIDITY GROUNDS

A. Motivations to Combine

Subject to the reservation of rights above, and based on Apple's present understanding of the Asserted Claims and the apparent interpretations Lionra is applying in its Amended Preliminary Infringement Contentions, each of the prior art references identified above in Section IV and charted in Exhibits A1-A13 and AA renders the Asserted Claims anticipated and/or obvious.

To the extent a finder of fact finds that a limitation of a given claim was not disclosed by one of the references identified in Section IV, those claims are nevertheless obvious because the Asserted Claims contain nothing beyond ordinary improvements. To the extent not anticipated, no asserted claim does more than combine known elements to achieve predictable results or does more than choose between clear alternatives known to those of skill in the art, particularly in view of the state of the art as reflected in the relevant references listed above in Section IV.

Moreover, to the extent the foregoing references are found not to anticipate the Asserted Claims, the foregoing references render the Asserted Claims obvious either alone or in combination with one or more of the other references identified above in Section IV. As explained herein and/or in the accompanying charts, it would have been obvious to a person of skill in the art at the time of the alleged invention of the Asserted Claims to combine the various references cited herein so as to practice the Asserted Claims. In addition to the specific combinations of prior art and the specific combinations of groups of prior art disclosed, Apple reserves the right to rely on any other combination of any prior art references disclosed herein. Apple further reserves the right to rely upon combinations disclosed within the prosecution history of the references cited herein. These obviousness combinations reflect Apple's present understanding of the potential scope of the claims that Lionra appears to be advancing and should not be construed as Apple's acquiescence to Lionra's interpretation of the patent claims.

The multiple prior art references listed in Section IV disclose all the core concepts claimed in the asserted patent. To the extent that Lionra argues that any concept claimed in the asserted patent is not disclosed in any one prior art reference, it would, at a minimum, have been obvious to adapt each reference to include the concept or combine it with other references that disclose the concept. Each concept described and claimed in the asserted patent was known to those of skill in the art as available design choices for beamforming networks. The reasons for modifying or combining references include any reasons set forth in any invalidity contentions, invalidity charts, and invalidity positions produced in the following cases, which are incorporated here by reference:

Lionra Technologies Limited v. Samsung Electronics Co., Ltd., No. 2:22-cv-00100 (E.D. Tex.); *Lionra Technologies Limited v. Motorola Mobility LLC*, No. 1:22-cv-02231 (N.D. Ill.); *Lionra Technologies Limited v. Google LLC*, No. 6:22-cv-00467 (W.D. Tex.); *Lionra Technologies Limited v. Cisco Systems, Inc.*, No. 2:22-cv-

00305 (E.D. Tex.); *Lionra Technologies Limited v. Fortinet, Inc.*, No. 2:22-00322 (E.D. Tex.); *Lionra Technologies Limited v. Hewlett Packard Enter. Co.*, No. 2:22-cv-00319 (E.D. Tex.); *Lionra Technologies Limited v. Palo Alto Networks, Inc.*, No. 2:22-cv-003344 (E.D. Tex.).

The Supreme Court has held that “[t]he combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results.” *KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 416 (2007). “When a work is available in one field of endeavor, design incentives and other market forces can prompt variations of it, either in the same field or a different one.” *Id.* at 417. As the Supreme Court made clear, “[f]or the same reason, if a technique has been used to improve one device, and a person of ordinary skill in the art would recognize that it would improve similar devices in the same way, using the technique is obvious unless its actual application is beyond his or her skill.” *Id.*

To determine whether there is an apparent reason to combine the known elements in the fashion claimed by the patent at issue, a court can “look to interrelated teachings of multiple patents; the effects of demands known to the design community or present in the marketplace; and the background knowledge possessed by a person having ordinary skill in the art.” *Id.* at 418. For example, obviousness can be demonstrated by showing “there existed at the time of invention a known problem for which there was an obvious solution encompassed by the patent’s claims.” *Id.* at 420. “[A]ny need or problem known in the field of endeavor at the time of invention and addressed by the patent can provide a reason for combining the elements in the manner claimed.” *Id.* Common sense also teaches that “familiar items may have obvious uses beyond their primary purposes, and in many cases a person of ordinary skill will be able to fit the teachings of multiple patents together like pieces of a puzzle.” *Id.*

However, the Supreme Court in *KSR* held that a claimed invention can be obvious even if there is no explicit teaching, suggestion, or motivation for combining the prior art to produce that

invention. In summary, *KSR* holds that patents that are based on new combinations of elements or components already known in a technical field may be found to be obvious. *See generally KSR*, 550 U.S. 398. Specifically, the Court in *KSR* rejected a rigid application of the “teaching, suggestion, or motivation [to combine]” test. *Id.* at 399. “In determining whether the subject matter of a patent claim is obvious, neither the particular motivation nor the avowed purpose of the patentee controls. What matters is the objective reach of the claim.” *Id.* at 419. “Under the correct analysis, any need or problem known in the field of endeavor at the time of invention and addressed by the patent can provide a reason for combining the elements in the manner claimed.” *Id.* at 420. A key inquiry is whether the “improvement is more than the predictable use of prior art elements according to their established functions.” *Id.* at 401.

The rationale to combine or modify prior art references is significantly stronger when the references seek to solve the same problem, come from the same field, and correspond well to each other. *In re Inland Steel Co.*, 265 F.3d 1354, 1362 (Fed. Cir. 2001). The Federal Circuit has held that two references may be combined as invalidating art under similar circumstances, namely “[the prior art] focus[es] on the same problem that the . . . patent addresses: enhancing the magnetic properties of . . . steel. Moreover, both [prior art references] come from the same field Finally, the solutions to the identified problems found in the two references correspond well.” *Id.* at 1364 (concerning patents and prior art relating to improving the magnetic and electrical properties of steel).

In view of the Supreme Court’s *KSR* decision, the PTO issued a set of Examination Guidelines. *See Examination Guidelines for Determining Obviousness Under 35 U.S.C. §103* in view of the Supreme Court Decision in *KSR International Co. v. Teleflex, Inc.*, 72 Fed. Reg. 57526 (October 10, 2007). Those Guidelines summarized the *KSR* decision, and identified

various rationales for finding a claim obvious, including those based on other precedents. Those rationales include:

(A) Combining prior art elements according to known methods to yield predictable results;

(B) Simple substitution of one known element for another to obtain predictable results;

(C) Use of known technique to improve similar devices (methods, or products) in the same way;

(D) Applying a known technique to a known device (method, or product) ready for improvement to yield predictable results;

(E) “Obvious to try” – choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success;

(F) Known work in one field of endeavor may prompt variations of it for use in either the same field or a different one based on design incentives or other market forces if the variations would have been predictable to one of ordinary skill in the art;

(G) Some teaching, suggestion, or motivation in the prior art that would have led one of ordinary skill to modify the prior art reference or to combine prior art reference teachings to arrive at the claimed invention.

Id. at 57529. The above rationales likewise apply in rendering obvious the Asserted Claims of the asserted patent.

Apple specifically states the reason, suggestion, or motivation to modify or combine the references identified in Section IV above in the manner claimed can be found in the explicit

and/or implicit teachings of those references and the prior art as a whole, the general knowledge of those skilled in the art, including knowledge of trends in the field, and knowledge that the art is of special interest or importance in the field, and from the fact that all of the references concern the same or similar technologies. Much of the art identified above and in the attached Exhibits reflects common knowledge and the state of the art prior to the priority date of the asserted patents. In many instances where a particular contention calls for, or requires, combining references, any one of a number of references can be combined. The inclusion of exemplary combinations herein does not exclude other combinations based on the claim charts attached hereto.

The references disclosed herein, alone or in combination, contain an explicit and/or implicit teaching, suggestion, motivation, or inference to combine them due to the following: (1) the knowledge generally available to a person of ordinary skill in the art; (2) the prior art references as understood by a person of ordinary skill in the art; (3) the nature of the problem to be solved; (4) the fact that each prior art reference addresses similar problems; and (5) the knowledge of those skilled in the art that the disclosed components had been or could be used to implement various features. Apple may also rely on expert testimony to establish that the Asserted Claims are invalid for obviousness.

One of ordinary skill in the art would have understood how to combine the teachings of any of the above references with a reference missing such limitations and would have been motivated to pursue such combinations for numerous reasons. A strong motivation to combine references includes the common objectives and subject matter of the identified references.

As an example of those reasons and motivations, Daniel, Gurrapu, Kuwahara, Teo, Yun, Fulton, Hiramatsu, Iinuma, Williams, Trott, Iinuma '701, Hardie, the Gurrapu System, and other

references identified in Section IV generally relate to cellular technology and, in particular, beamforming networks. *See* Ex. A1 to A13 and AA. The attached charts in Exhibit A1 to A13 and AA provide additional reasons and motivations to combine the charted references.

Below are additional exemplary motivations to combine prior art for particular claim limitations. The following discussion of specific claim limitations are merely examples and are not limiting.

As a preliminary matter, the Asserted Claims of the '141 patent are purportedly directed to an apparatus for modulating and demodulating signals received via an electronically steerable phased antenna array. Each of the concepts claimed in the '141 patent were well known before the patent's alleged priority date. Specifically, at least the following concepts were well-known: (1) an electronically steerable phased array antenna, (2) a baseband modulator configured to modulate outbound digital baseband signals; (3) a baseband demodulator configured to demodulate incoming baseband digital baseband signals; and (4) a processor configured to receive digital baseband signals and apply a phase adjustment to the digital baseband signals to account for beamforming and/or carrier phase rotation of individual antenna elements.

As noted, prior to the '141 patent, electronically steerable phased array antennas were well-known to a person of ordinary skill in the art. For example:

- '141 patent at 1:60-67 ("A phased-array receive antenna achieves gain in a particular direction by phase shifting, or time shifting, the signal from each element, and then summing the phase-shifted element signals in a signal combiner. By choosing the relative phasing of each element appropriately, coherence can be achieved for a particular direction of arrival (DOA), across a particular signal bandwidth."), 2:1-5 ("Digital beamforming is analogous to analog beamforming, except that the received signal on each antenna element is independently digitized, and the phasing/combining operation is performed mathematically on the digital samples.")
- Williams, at [0008] ("An adaptive antenna array can also increase user capacity over traditional antenna technology by amplifying the signal coming from and going to the mobile user while dampening other signals coming from sources disposed in other

directions. This ability is commonly referred to as “digital beamforming.” By steering a beam and positioning multiple nulls, an adaptive array is able to reduce co-channel and adjacent channel interference.”)

- Gurrapu, at 6 (“Beamforming also removes the requirement of having a mechanically steerable antenna since all beam steering is now performed through signal processing techniques applied on signals before reaching the antenna elements at the transmitter and after reaching the antenna elements at the receiver.”)
- Daniel, at 1:13-22 (“Phased-array and similar antennas generate antenna beams determined by the relative phase and amplitude relationships of signals that excite numerous antenna elements arranged in an array. Adjustable phase shifters and amplitude adjusters are often used in combination with a beamforming network, such as a Butler matrix or the like, and a corporate feed network to control the collective antenna beam formed from numerous beamlets associated with the numerous antenna elements. The adjustable phase shifters permit electronic steering of the antenna beam.”)
- Trott, at 3:8-20 (“Adaptive arrays (also known as ‘smart antennas’), which employ antenna arrays along with signal processing hardware and/or software, also have been utilized to decrease interference and improve performance in wireless communications. Antenna arrays typically include a number of antennas that are spatially separated and coupled to one or more digital signal processors and/or general purpose processors. Adaptive antenna arrays, or simply, adaptive arrays, periodically analyze the signals received from each of the antennas in an array to distinguish between desired signals (e.g., from a desired remote user terminal, such as cellular telephone or other communication device) and undesired signals (e.g., uplink signals of undesired remote user terminals in the same or different cell area), multipath, etc.”)
- Iinuma ’701 (Iinuma ’559)², at [0001] (“The present invention relates to an adaptive array apparatus that adaptively generates a directivity pattern for a plurality of antennas and to a compensation method for compensating a phase amount used when generating a directivity pattern.”)Hardie, at Abstract (“A reconfigurable active phased array distributes RF signals to an array of active antenna elements, each of which incorporates medium-power amplifiers and phase shifters. A switching network is configurable to distribute any of the RF signals to any of the active antenna elements. Phase shifters are provided for each active antenna element and are configurable to adjust the radiation pattern for the antenna array. Sensors detect signal power levels throughout the system to automatically reconfigure the signal distribution and phase shifts in response to component failures, changes in inbound traffic and other criteria.”)
- Kuwahara, at 3:3-47 (“As shown in FIG. 1, a radio base station apparatus according to one embodiment of the present invention comprises: an antenna apparatus 1 consisting of

² For the purpose of translation, this claim chart cites disclosures from European Patent Application No. 1,143,559 A1 (“Iinuma ’559”), the European national entry of Iinuma ’701. To the extent Lionra challenges that Iinuma ’559 is not an accurate translation of Iinuma ’701, Apple reserves the right to submit an additional translation.

a plurality of antenna elements 1; couplers 2 respectively provided in the neighborhoods of terminals of the antenna elements on the side of the base station apparatus; ...”)

- Yun, at 14:15-39 (“A multi-element antenna array is used in the base station in order to provide spatial processing. The number of antennas in the array is variable.”)
- Hiramatsu, at 2:55-62 (“FIG. 2 is a block diagram showing the entire configuration of a radio communication apparatus according to the first embodiment of the present invention. As shown in FIG. 2, the radio communication apparatus of this embodiment comprises adaptive antennas (hereinafter referred to as ‘AAA’) 101 in which N antenna elements are arranged close to each other (normally, the distance between antenna elements is about a $\frac{1}{2}$ wavelength).”)

Prior to the ’141 patent, baseband modulators configured to modulate outbound digital baseband signals to be transmitted were also well-known to a person of ordinary skill in the art.

For example:

- Williams, at [0039] (“Each antenna element has a dedicated transmit apparatus chain comprising filter/ duplexer 120, multi-carrier power amplifier (MCPA) 130-133 (hereafter 130), broadband digital transceiver 140-143, XMUX 150 (using the combiner) and associated connectors inclusive of respective digital signal processors 170. DSPs 170 are associated with specific antenna elements 110 and a specific frequency channel for processing respective ones of a plurality of incoming (voice/data) communication signals to be transmitted over respective frequency channels. Their processed (modulated and encoded) outputs are supplied to the digital array processor 160, which can apply appropriate net weighting factors to each active channel and for each transmit apparatus chain associated with each antenna element 110. For the transmit path, the phase and amplitude net weighting factors are preferably applied after the DSP 170 (modulation) and before the XMUX 150 (digital combiner). At these points in the signal path, each signal (RF frequency and time slot) is a baseband signal having an I and Q representation.”)
- Fulton, at 5:46-58 (“The base station 44 has a carrier frequency synthesizer 112 which produces a sinusoidal carrier signal 113 of, for example, 952 MHz from a highly accurate reference frequency source. Present technology allows the generation of a carrier signal 113 with a frequency stability of one part in 10^9 per day and an accuracy of about five parts in 10^9 . Filtered signals 114 and 115 are sent from the digital filters 108 to a quadrature modulator 118 where the 1200 bps signal 114 is modulated onto the sine component of the carrier signal 113, and the 1200 bps signal 115 is modulated onto the cosine component of the carrier signal 113 to produce a 9QPR modulated signal 120 with a bandwidth efficiency of 2 bps per Hertz.”)
- Gurrapu, at 9 (“In this work, DQPSK (Differential Quadrature Phase shift keying) modulation is implemented in conjunction with digital beamforming. A typical

DQPSK system as shown in Figure 2.5 [17] and is briefly discussed in this section to help in understanding the beamforming concept at the baseband.”)

- Daniel, at 3:27-34 (“Digital data stream 28 is routed to each of any number of direct modulators 30. In the preferred embodiment, each direct modulator 30 drives a single radiating element 12 so that the number of direct modulators 30 equals the number of antenna elements 12 in antenna 10. However, those skilled in the art can alternatively devise applications where each direct modulator 30 drives a plurality of elements 12.”)
- Trott, at 6:15-31 (“As shown in FIG. 2, each antenna element of the antenna array 22 is coupled to a power amplifier (PA) and low-noise amplifier (LNA) 24. The PA/LNA 24 of each antenna element amplifies the received (uplink) and/or transmitted (downlink) signal. As shown, each PA/LNA 24 is coupled to a down-converter 26 and an up-converter 28. The down-converter 26 converts the “raw” signal received by the antenna array 22 on a carrier frequency into a receive (Rx) baseband signal, which is provided to a baseband processor (also referred to as a modem board) 30. The up-converter 28, conversely, converts a transmit (Tx) baseband signal provided by the baseband processor 30 into a carrier frequency transmit signal, which is provided to the PA/LNA 24 to be transmitted (e.g., to a remote user terminal). Although not shown, analog-to-digital conversion (ADC) and digital-to-analog (DAC) circuitry may be coupled between the down-converter 26 and the baseband processor 30 and between the up-converter 28 and the baseband processor 30, respectively.”)
- Iinuma ’701 (Iinuma ’559), at [0020] (“In the radio unit 10, the modulator 11 modulates a baseband signal (symbol data) that is inputted from the control unit 50 to convert it into an intermediate frequency signal (hereinafter abbreviated to “IF signal”).”)
- Hardie, 10 (“At block 222, an RF up-converter 94 frequency shifts the baseband analog signals using, as a reference, the local oscillator signal that was used in the down-conversion process. The signals are thus restored to their original carrier frequency. At block 224, the up-converted signal is routed to an amplifier and filter 95. After the signals are amplified and undesired signals removed by filtering, the RF signals passes to a 3-dB hybrid 105, which is coupled to a termination 96 and a directional coupler 98. At block 226, the up-converted signal is sent to a radiating element 32 (FIGURE 4) via RF OUT.”)
- Kuwahara, at 3:3-28 (“As shown in FIG. 1, ... an antenna apparatus 1 consisting of a plurality of antenna elements 1; couplers 2 respectively provided in the neighborhoods of terminals of the antenna elements on the side of the base station apparatus; an RF unit 3 that converts a received signal to a baseband signal, converts a transmission signal to a radio frequency, and performs power control; an A/D converter 4 that converts the received baseband signal to a digital signal; an Rx beam form unit 6 that multiplies the digitized received signal by pre-set weight; a despreaders 7 that despreads this signal; a time-space demodulator 8 that demodulates

the despread signal to obtain user data; a despreader 9 for probe signal, that despreads the output signal of the A/D converter 4; a time-space modulator 14 that modulates user data; a spreader 13 that spreads this user data; a channel combiner 12 that performs channel combining with respect to signals from the spreader 13; a Tx calibrator 11 that controls signal calibration according to the present invention; a D/A converter 10 that converts a digital signal from the calibrator 11 to an analog signal to send it to the RF unit 3; a unit 16 for calculation of correlation matrix, that produces a probe signal for controlling the Rx calibration system and the Tx calibration system, and calculates calibration required for phase and amplitude calibration of a received signal;”)

- Yun, at 16:56-65 (“Transmit block 217 operates as follows. TX processor/modulator 221 accepts voice data from voice bus 231, SACCH and FACCH data from GPP 203 and transmit weights for spatial processing from TX_Wt bus 233. The functions of TX processor/modulator 221 include burst building, encryption, scrambling, CRC for each of the users being spatially multiplexed in each of the four timeslots, modulating, and applying complete transmit weights (including the amplitude as power control) for each burst just as the burst starts.”)Hiramatsu, at 4:31-36 (“A modulating circuit 111 modulates the transmitted Signal, a complex multiplying circuit 112 multiplies an output signal of the modulating circuit 111 by the transmission weight, and a D/A converter 113 converts an output Signal of the complex multiplying circuit 112 to an analog Signal.”)

Baseband demodulator configured to demodulate incoming baseband digital baseband signals received were also well-known to a person of ordinary skill in the art before the ’141 patent. For example:

- Williams, at [0038] (“For the receive path, the respective phase and amplitude net weighting factors are preferably applied after the XMUX 150 (digital channelizer) and before the DSP 170. DSP 170 receives the signal components adjusted with respective net weighting factors from each receive apparatus chain output by the digital array processor 160 and demodulates these signals to recover the combined beamformed communication signal.”)
- Fulton, at 6:10-29 (“The 24 MHz signal 136 undergoes selective gain filtering at an intermediate frequency (IF) amplifier 138, and the sine and cosine components 140 and 141 of the IF amplifier output 139 are separated by the separator 146 and heterodyned by heterodynes 142 and 143 with in-phase and quadrature 24 MHz signals 144 and 145 generated by the synthesized oscillator 148. The 24 MHz signals 144 and 145 are generated from the clock signal 111 by the synthesized oscillator 148 which increases the clock frequency by a factor of 2×10^4 . Heterodynes 142 and 143 output baseband signals 150 and 151. Analog baseband signals 150 and 151 are then converted to digital form and digitally filtered by digital filters 154 and sent to a burst demodulator 156.”)

- Gurrapu, at 11 (“Thus, each antenna element's output can be down converted to baseband. The down converted baseband signal will have both I and Q components and can be treated as a complex signal ($I+jQ$). The phase of such signal can be altered using complex multiplication with complex weights corresponding to the beam direction in the beamforming processor. The second stage of the QPSK demodulation, correlators and decision devices, have to remain after the beamforming process.”)
- Trott, at 6:15-31 (“As shown in FIG. 2, each antenna element of the antenna array 22 is coupled to a power amplifier (PA) and low-noise amplifier (LNA) 24. The PA/LNA 24 of each antenna element amplifies the received (uplink) and/or transmitted (downlink) signal. As shown, each PA/LNA 24 is coupled to a down-converter 26 and an up-converter 28. The down-converter 26 converts the “raw” signal received by the antenna array 22 on a carrier frequency into a receive (Rx) baseband signal, which is provided to a baseband processor (also referred to as a modem board) 30. The up-converter 28, conversely, converts a transmit (Tx) baseband signal provided by the baseband processor 30 into a carrier frequency transmit signal, which is provided to the PA/LNA 24 to be transmitted (e.g., to a remote user terminal). Although not shown, analog-to-digital conversion (ADC) and digital-to-analog (DAC) circuitry may be coupled between the down-converter 26 and the baseband processor 30 and between the up-converter 28 and the baseband processor 30, respectively.”)
- Iinuma '701 (Iinuma '559), at [0026] (“The demodulator 16 demodulates the IF signal received from the reception circuit 15 into a baseband signal.”)
- Hardie, at 9 (“Beginning at block 210, the system S processes each of the active RF signals that are received via RF input lines 73. Initially, the RF signals are converted to digital signals. For example, down-converters 72 (e.g., channel mixers) may frequency shift each of the RF signals to baseband signals to remove the RF carrier component of the signal (block 212). As described below in conjunction with FIGURE 7, the down-converters 72 may instead frequency shift the RF signals to an intermediate frequency range that is desired for the analog-to-digital conversion process (block 212).”)
- Kuwahara, at 3:3-28 (“As shown in FIG. 1, ... an antenna apparatus 1 consisting of a plurality of antenna elements 1; couplers 2 respectively provided in the neighborhoods of terminals of the antenna elements on the side of the base station apparatus; an RF unit 3 that converts a received signal to a baseband signal, converts a transmission signal to a radio frequency, and performs power control; an A/D converter 4 that converts the received baseband signal to a digital signal; an Rx beam form unit 6 that multiplies the digitized received signal by pre-set weight; a despreader 7 that despreads this signal; a time-space demodulator 8 that demodulates the despread signal to obtain user data; a despreader 9 for probe signal, that despreads the output signal of the A/D converter 4; a time-space modulator 14 that modulates user data; a spreader 13 that spreads this user data; a channel combiner 12 that performs channel combining with respect to signals from the

spreader 13; a Tx calibrator 11 that controls signal calibration according to the present invention: a D/A converter 10 that converts a digital signal from the calibrator 11 to an analog signal to send it to the RF unit 3; a unit 16 for calculation of correlation matrix, that produces a probe signal for controlling the Rx calibration system and the Tx calibration system, and calculates calibration required for phase and amplitude calibration of a received signal;”)

- Yun, at 16:23-33 (“The RX DSPs 209.1-209.4 are each a Motorola M56303 digital signal processor. Each RX DSP performs several functions, including: spatial processing, including determining weights; frequency offset correction; equalization; demodulation; and in one embodiment of the present invention, signal quality estimation.”)
- Hiramatsu, at 3:26-29 (“A demodulating circuit 107 provides demodulation processing to an output Signal of the AAA receiving circuit 105, and separates TPC from received data. The separated TPC is output to a gain controlling circuit 109.”)

Processors configured to receive digital baseband signals and apply a phase adjustment to each of the digital baseband signals to account for beamforming and/or carrier phase rotation of individual antenna elements were similarly well-known to a person of ordinary skill in the art prior to the ’141 patent. For example:

- ’141 patent at 2:1-5 (“Digital beamforming is analogous to analog beamforming, except that the received signal on each antenna element is independently digitized, and the phasing/combining operation is performed mathematically on the digital samples.”), 2:27-29 (“The largest cost-component of beamforming is the complex multiplication of each sample for each element with the beamforming weights.”), 2:36-42 (“When combined with the modem, there is potential to absorb the complex multiply required for beamforming into computation already taking place for extremely low incremental cost. In U.S. Pat. No. 5,764,187, the disclosure of which is incorporated herein by reference, Rudish et al. disclose an implementation of beamforming using digital direct synthesis (DDS) functions.”), 7:4-11 (“To support signal modulation and demodulation, baseband processors typically perform the functions of carrier phase tracking (involving carrier phase rotation) and automatic gain control (AGC) (i.e., adjusting the amplitude of the baseband signal to be within the operational range of downstream devices), although baseband processors do not generally process carrier phase and amplitude on an antenna-element-by-antenna-element basis.”), 8:40-43 (“[T]he process of carrier tracking already rotates each complex baseband sample by some amount on the unit circle between 0 and 2π radians.”)
- Williams, at [0036] (“Digital array processor 160 can be used to store the various adaptive array calibration factors and angular weighting factors. Calibration factors and angular weighting factors are preferably stored separately. Calibration factors are

used to compensate for relative path delay and amplitude variations that occur when signals traverse the various transmit and receive apparatus chains, with reference to a fixed reference angle (for example, north). The angular weighting factors are used to point the antenna beam and nulls into the desired directions (for both transmit and receive) relative to the reference angle (for example, +23 degrees north). The phases and amplitudes of the calibration factors and angular weighting factors are effectively added together to result in a net weighting factor that is applied to signals traveling in each antenna apparatus chain for each signal frequency (and time slot in TDM systems).”)

- Fulton, at 9:55-62 (“A Costas phase detector 306 determines the amount of quadrature signal in signal 302 (or equivalently, the amount of in-phase signal in signal 303). Ramp estimator 310 generates a phase error signal 311 which controls the amount of rotation ϕ performed by the rotator 300 such that signals 302 and 303 become the in-phase and quadrature components, respectively, of the transmission.”)
- Gurrapu, at 6 (“Hence, to receive the beam in the direction θ , we need to calculate the phase shifts undergone by the signals from each antenna element and then, multiply by a complex weight to compensate for the path delays associated with them, and then simply add them.”), 11 (“Thus, each antenna element's output can be down converted to baseband. The down converted baseband signal will have both I and Q components and can be treated as a complex signal $(I+jQ)$. The phase of such signal can be altered using complex multiplication with complex weights corresponding to the beam direction in the beamforming processor. The second stage of the QPSK demodulation, correlators and decision devices, have to remain after the beamforming process.”)
- Daniel, at 6:50-63 (“In particular, modulator 74 includes a variable phase shifter 76 which receives RF carrier signal 34 and the element-specific stream of phase values generated by phase combining circuit 70. Phase shifter 76 shifts the phase of RF carrier signal 34 by an amount specified by the current phase value. The element-specific stream of phase values changes at the symbol rate, and these changes incorporate any beam reformation phase offsets which may be required from time-to-time. Accordingly, phase shifter 76 performs phase modulation of RF carrier signal 34. The output of phase shifter 76 is essentially a digital signal in that it conveys only frequency and phase information but no amplitude modulation. The output of phase shifter 76 couples to a signal input of a modulated digital amplifier 78.”)
- Trott, at 3:27-38 (“The process of combining the signals of a number of antenna elements to enhance the gain at the location of a desired remote user terminal, while diminishing gain at the location of one or more other remote user terminals, is generally referred to as beamforming. A downlink weight is computed by the antenna array system for describing a downlink beamforming strategy that provides a suitable radiation pattern for transmission of signals from the antenna array system to a desired remote user terminal. Conversely, an uplink weight is determined by the antenna array system for describing an uplink beamforming strategy that provides a suitable radiation pattern for reception of signals by the antenna array system.”)

- Iinuma '701 (Iinuma '559), at [0020] (“[T]he modulator 11 adds phase data and a compensation value that it receives from the control unit 50 and uses the result to generate the IF signal. This phase data is a phase amount that enables the generation of a same directivity pattern during transmission as during reception. The compensation value compensates for the phase shift in the transmission output due to the differences in characteristics between the transmission circuit 12 and the reception circuit 15.”)
- Hardie, at 11 (“In one embodiment, an adaptive calibration controller 107 provides phase calibration signals (cal. phase) and amplitude calibration signals (cal. amp) for the calibration/BIT switch operations described in conjunction with FIGURE 4. These calibration signals may, for example, be added to the phase and amplitude components of the signal by the phase shifter 87 and the polar-to-rectangular converter 88, respectively.”)Kuwahara, at 8:1-8 (“In FIG. 2, signals inputted to signal input lines 23 are signals from the respective antenna elements, signals from the despreaders 9 for probe signal, shown in FIG. 1, the probe signals applied to the terminals of the respective antenna elements, and the level and phase deviations applied in the RF unit and in the cables between the couplers 2 and the RF unit 3. In the shown case, the multiplexer 24 has a function of timesharing six input signals one by one.”), 10:8-11 (“The above-described embodiment of the present invention can also calibrate the amplitude and phase deviations owing to the cables, amplifiers, etc. in the transmission System.”)
- Yun, at 16:4-14 (“Each RX and TX block pair can handle the receive Spatial processing, demodulation, modulation, and transmit spatial processing for one carrier in a twelve antenna System, or for two carriers in a six antenna System, or three carriers in a four antenna System. Thus one modem board can handle the necessary processing for two carriers in a twelve-antenna System, or for four carriers in a six-antenna System, or six carriers with a four-antenna System.”)Hiramatsu, at 3:3-18 (“An AAA receiving circuit 105 calculates reception weight such that SINR of a combined signal of the signals, which have been output from the respective A/D converters 104, reaches a maximum value. The reception weight calculation method is described in the document ‘Wave Equalizing Technique for Digital Mobile Communication’ (Jun. 1, 1996).If the correlation among signals arriving to the respective antenna elements is large, the AAA receiving circuit 105 can direct directivity toward a direction of arrival by calculating the reception weight appropriately. Therefore, the transmission weight is calculated based on the reception weight and the signals are weighted by the calculated transmission weight so as to be transmitted, with the result that directivity can be directed toward the direction of the communication counterpart.”)

Moreover, each reference cited in Exhibits A1 through A13 and AA and reference in Section VI.B below is analogous art to the '141 patent because the references are in the same field of endeavor as the '141 patent and are pertinent to a purported problems solved by the '141

patent. *See, e.g.*, Williams, at [0013]-[0017], [0033], [0037]-[0039]; Fulton, at Abstract, 1:11–16, 1:52–65, 3:22–30, 11:44-54; Trott, at Abstract, 6:20–41, 7:3–13, 7:25–32; Iinuma ’701 (Iinuma ’559), at Abstract, [0001]; Hardie, at Abstract; Hiramatsu, at 1:7-9; Gurrapu, at 6. In other words, a person of ordinary skill in the art would have understood that each reference cited in Exhibits A1 through A13 and AA and reference in Section VI.B have similar functions and architectures.

Each reference also discloses similar components and techniques for the beamforming network of an adaptive antenna array that can be implemented using either analog technology or digital technology. *See, e.g.*, Ex. A1 to A13 and AA. A person of ordinary skill in the art would have known that analog techniques, including at Radio Frequency (RF), Intermediate Frequency (IF), or even baseband, were limited. *See, e.g.*, Gurrapu, at 8 (“[Analog beamforming] is a well proven technique, but only a limited number of beams (less than 10, in general) can be formed at the RF or IF stage with passive phased -array antennas and analog technology.”); Teo, at 1:60-63 (“One problem with this implementation is the limited power (or link gain) that a sector omnidirectional broadcast is capable of while reaching all of the mobile terminals within the coverage area simultaneously.”); Yun, at 1:29-38 (“With the increasing use of cellular wireless communication systems comprising a base station (BS) at each cell, and remote terminals (a remote terminal also is called a subscriber unit (SU) or a subscriber station) communicating with an assigned base station, the problem of interference between stations within a given cellular area, and between neighboring cells, requires intelligent interference management in order to more effectively use the allocated common RF bandwidth.”); Williams, at [0008] (“An adaptive antenna array can also increase user capacity over traditional antenna technology ... This ability is commonly referred to as “digital beamforming.”); Fulton, at 1:52-55 (“Accurate frequency

control is conventionally accomplished by using quartz crystal resonators. With careful manufacturing techniques and control of temperature effects, an accuracy of a few parts-per-million is obtainable. Another standard frequency control technique utilizes feedback circuitry.”); Iinuma ’701 (Iinuma ’559), at [0002]-[0004] (“To raise transfer efficiency, digital communication devices that transfer information by modulating a carrier wave using a digital information signal (baseband signal) have been developed in recent years. ... A representative technique is the adaptive array method.”); Hardie, at 2 (“An RF transmission system constructed according to one embodiment of the invention broadcasts modulated RF signals using a configurable array of active antenna elements. ... Provisions are made for dynamically reconfiguring the system to improve the efficiency of the transmitter, to compensate for system failures and to modify the RF radiation patterns.”).

A person of ordinary skill in the art would have also known that the digital approach at baseband, when compared to analog techniques, offers higher precision, flexibility, and capacity for future development. For example, Kuwahara, Daniel, Teo, Yun, Fulton, Gurrupu, Williams, Trott, Iinuma ’701, and Hardie, among others, describe techniques for implementing such digital technology at baseband. *See, e.g.*, Kuwahara, at 1:15-18 (“In this technique, a radiation pattern of an antenna is controlled to follow each of multi paths through which a user signal arrives so as to moderate interference by signals of other users.”); Daniel, at 1:32-34 (“However, this arrangement leads to undesirable effects which are related to the use of an analog baseband signal.”); Teo, at 1:17-19 (“In the present invention, a BTS utilizes a directional beam to transmit data traffic channels to target mobile terminal(s).”); Yun, at 3:59-63 (“The objective of ongoing power control problems for communications is to minimize the total power transmitted in the communication system while ensuring that a desired (“target”) signal to interference-plus-noise

ratio (SINR) for every connection within every cell is achieved.”); Fulton, at 2:45-52 (“More particularly, an object of this invention is to simplify the circuitry of a receiver with clock rate and carrier frequency recovery by providing a reception circuit which is coupled to the transmission circuit to produce transmission carrier stabilization, by providing independent clock rate and carrier frequency recovery from the received signal, and to provide a phase-lock loop at the baseband rather than the intermediate frequency level.”); Gurrapu, at 13 (“The Digital Beamforming Receiver (DBF) has to perform two functions: Beamforming and QPSK Demodulation. In terms of hardware, both of these functions are more efficiently performed using digital signal processing hardware than analog hardware. Particularly, digital hardware offers flexibility to the receiver in directing its antenna array in many directions.”); Williams, at [0008] (“This ability is commonly referred to as “digital beamforming.” By steering a beam and positioning multiple nulls, an adaptive array is able to reduce co-channel and adjacent channel interference.”); Trott, at 3:8-12 (“Adaptive arrays (also known as ‘smart antennas’), which employ antenna arrays along with signal processing hardware and/or software, also have been utilized to decrease interference and improve performance in wireless communications.”); Iinuma ’701 (Iinuma ’559), at [0003] (“In digital communication, frequencies can be more efficiently used by raising the transfer speed and converting single frequencies into multichannels for use by several users.”); Hardie, at 3 (“In one embodiment, the system may be configured to broadcast any of the input RF signals using any of the active antenna elements. Significantly, the configuration of the switching network may be modified as needed to change the distribution of the RF signals.”). As a result, a person of ordinary skill in the art would have understood that the references are in the same field, directed to solving similar problems, and describe similar solutions for resolving such problems.

As another example, the references relied on by Apple in the obviousness combinations listed in Section VI.B generally discuss or are directed to the goal of removing requirements for steerable antennae since all beamforming is performed through signal processing techniques. *See, e.g.*, Gurrapu, at 5-12 (describing digital beamforming); Kuwahara, at 2:35-40 (“With respect to a receiving system of the base station apparatus, it is not necessary to compensate the level and phase as mentioned above, as long as an adaptive array antenna is employed. This is because, in the process of realizing the optimum array weight control, phase deviation and level deviation are compensated automatically.”); Daniel, at 1:65-67 (“Accordingly, a need exists for an array antenna transmitting apparatus that is not driven by a conventional analog baseband input signal.”); Teo, at 2:33-37 (“The beam transmitting the data traffic information is a directional beam to ensure sufficient power is directed at the target mobile terminal(s) while the beam transmitting the service information can either be a sector omni-directional beam or a rotating directional beam.”); Williams, at [0020] (“A method for determining calibration factors for respective transmit and receive paths associated with an adaptive antenna array having a plurality of antenna elements is accomplished.”).

A person of ordinary skill in the art would have also understood that prior to the ’141 patent, beamforming was well-known and well-proven technique, but had limitations. For instance, Gurrapu explains that beamforming is a well proven and well-known technique but only a limited number of beams can be formed. Gurrapu, at 8; *see also* Daniel, at 1:56-59 (“The layout burden is exceptionally severe when imposed upon beamforming networks. As the frequencies at which RF communications take place increase, the array antenna geometry shrinks.”). Thus, beamforming, though well-known, had some disadvantages such as “difficult

control of the side lobe level, high loss, absence of individual beam shape control, complex construction, and corresponding heavy equipment.” Gurrapu, at 8.

A person of ordinary skill in the art would have understood that the prior art references in Exhibits A1 through A13 and AA and listed in Section VI.B target solutions to these disadvantages. *See, e.g.*, Gurrapu, at 8; Kuwahara, at 2:35-40 (“With respect to a receiving system of the base station apparatus, it is not necessary to compensate the level and phase as mentioned above, as long as an adaptive array antenna is employed. This is because, in the process of realizing the optimum array weight control, phase deviation and level deviation are compensated automatically.”); Daniel, at 3:2-4 (“One goal is the communication of digital data, and the other goal is the formation of beam 16.”); Teo, at 2:9-12 (“Preferably, this modified transmission technique would also reduce the interference introduced into adjacent cells or sectors.”); Yun, at 3:28-33 (“No practical methods of ongoing power control are known in the prior art that are applicable to systems using SDMA techniques, in that the power control methods can effectively adjust all of the SDMA system parameters required for minimizing the total radiated RF power while maintaining acceptable quality levels for all channels.”); Williams, at [0033] (“Referring to FIG. 1, a simplified block diagram of a digital beam forming base transceiver Station (BTS) is shown.”).

A person of ordinary skill in the art would have also understood that digital beamforming also provides many advantages, including, separate control of each beam, improved adaptive pattern nulling, and manipulation of physical input signals. *See, e.g.*, Gurrapu, at 9. Thus, a person of ordinary skill in the art would have been motivated to implement (and improve) digital beamforming. *See, e.g.*, Kuwahara, at 1:25-32 (“Thus, when there is deviation between signals arriving at respective antennas, it is impossible to transmit the signal with a desired radiation

pattern.”); Daniel, at 3:2-4 (“One goal is the communication of digital data, and the other goal is the formation of beam 16.”); Teo, at 2:7-9 (“Hence, modified transmission techniques are required that allow for sufficient signal power such that the BTS can reach any target mobile terminal within its coverage area.”); Yun, at 4:17-20 (“Thus there is a need in the art for locally optimal power control methods for systems with SDMA that are ‘distributed,’ in that no inter-base station communication of power control information is required for operation.”); Gurrapu, at 9; Williams, at [0008] (“An adaptive antenna array can also increase user capacity over traditional antenna technology by amplifying the signal coming from and going to the mobile user while dampening other signals coming from sources disposed in other directions. This ability is commonly referred to as ‘digital beamforming.’ By steering a beam and positioning multiple nulls, an adaptive array is able to reduce co-channel and adjacent channel interference.”), Fig. 1;

Because the references in Exhibits A1 through A13 and AA and identified in Section VI.B are directed the same field as the ’141 patent, pertinent to the same problems the ’141 patent purports to solve, and describe solutions for solving the purported problems, a person of ordinary skill in the art would have found it obvious to combine the prior art references as detailed in Section VI.B and would have a reasonable expectation of success in doing so. Indeed, a person of ordinary skill in the art would have known that combining the prior art as detailed in Section VI.B would have simply involved combining prior art elements according to known methods to yield predictable results. Further, a person of ordinary skill in the art would have understood that the combinations detailed in Section VI.B would have simply involved the simple substitution of one known element for another to obtain predictable results. A person of ordinary skill in the art would have also known that combining the prior art as detailed in Section

VI.B would have simply involved using a known technique to improve similar devices in the same way and applying a known technique to a known device ready for improvement to yield a predictable result. And at a minimum, a person of ordinary skill in the art would have found it obvious to try the combinations listed in Section VI.B because doing so would have simply involved choosing a predictable solution and a person of ordinary skill in the art would have had a reasonable expectation of success in trying such combinations.

As one example, it would have been obvious to one of ordinary skill in the art to implement digital beamforming at baseband in a network to more easily manipulate and control input signals and each individual beam. *See, e.g.*, Gurrupu, at 8-9; Daniel, at 3:2-4 (“One goal is the communication of digital data, and the other goal is the formation of beam 16.”); Teo, at 2:7-12 (“Hence, modified transmission techniques are required that allow for sufficient signal power such that the BTS can reach any target mobile terminal within its coverage area. Preferably, this modified transmission technique would also reduce the interference introduced into adjacent cells or sectors.”). It also would have been obvious to a person of ordinary skill in the art to down convert antenna output to baseband to ease computational requirements on the digital beamforming processor. *E.g.*, Gurrupu, at 8; Daniel, at 1:24-29 (“In a typical arrangement used in the communication of digital signals, a digital input signal is converted into an analog baseband signal that is mixed with an intermediate frequency (IF) signal, amplified, mixed with a radio frequency (RF) signal, and then amplified again to produce a communication signal.”); Yun, at 5:36-38 (“Another aspect of the invention is an initial power control method and application using the signal quality estimation method and/or apparatus.”); *see also* ’141 patent at 2:27-29 (“[t]he largest cost-component of beamforming is the complex multiplication of each sample for each element with the beamforming weights”), 2:36-39 (“[w]hen combined with the

modem, there is potential to absorb the complex multiply required for beamforming into computation already taking place for extremely low incremental cost”).

As another example, a person of ordinary skill in the art would have recognized that beamforming is controlled by adjusting phases, among other things, of the signals that go through antenna elements. *See, e.g.*, Williams, at [0010] (“[T]he phases and amplitudes of the currents exciting the array elements as well as the number of array elements determine the gain of the array in a certain direction. The phases and amplitudes of the currents on the antenna array elements can be electronically adjusted such that received signals from a certain direction add in phase, and maximum gain is achieved in that direction.”); Iinuma ’701 (Iinuma ’559), at [0006] (“A directivity pattern is formed by adjusting the gain and phase for each antenna.”); Hardie, at 2-3 (“The phase shifters in each of the active antenna elements may be used to adjust the radiation pattern for the antenna array.”); Daniel, at 1:21-22 (“The adjustable phase shifters permit electronic steering of the antenna beam.”); Gurrupu, at 6 (“Hence, to receive the beam in the direction θ , we need to calculate the phase shifts undergone by the signals from each antenna element and then, multiply by a complex weight to compensate for the path delays associated with them, and then simply add them.”); Trott, at 3:27-38 (“The process of combining the signals of a number of antenna elements to enhance the gain at the location of a desired remote user terminal, while diminishing gain at the location of one or more other remote user terminals, is generally referred to as beamforming. A downlink weight is computed by the antenna array system for describing a downlink beamforming strategy that provides a suitable radiation pattern for transmission of signals from the antenna array system to a desired remote user terminal. Conversely, an uplink weight is determined by the antenna array system for describing an uplink beamforming strategy that provides a suitable radiation pattern for reception of signals by the

antenna array system.”); Hiramatsu, Figures 3, 4; *see also* ’141 patent at 1:60-67 (“[a] phased-array receive antenna achieves gain in a particular direction by phase shifting, or time shifting, the signal from each element, and then summing the phase-shifted element signals in a signal combiner. By choosing the relative phasing of each element appropriately, coherence can be achieved for a particular direction of arrival (DOA), across a particular signal bandwidth”), 2:2-5 (“the received signal on each antenna element is independently digitized, and the phasing/combining operation is performed mathematically on the digital samples”).

Also, a person of ordinary skill in the art would have recognized that circuitries including modulators and demodulators introduce signal phase shifts and thus implementing an adjustment that accounts for phase rotation would at least provide for greater accuracy in signal transmission and reception. *See, e.g.,* Fulton, at 2:6-7 (“An object of the present invention is to provide a high through-put bidirectional radio communications system between at least one base station and a large number of remote stations.”), 2:15-24 (“Another object of the present invention is to provide a low-cost method of generating a high accuracy transmission carrier at a remote station utilizing both information contained in the received carrier and information in the modulation of the carrier, particularly the clock rate of the signal.”), 2:45-52 (“More particularly, an object of this invention is to simplify the circuitry of a receiver with clock rate and carrier frequency recovery by providing a reception circuit which is coupled to the transmission circuit to produce transmission carrier stabilization, by providing independent clock rate and carrier frequency recovery from the received signal, and to provide a phase-lock loop at the baseband rather than the intermediate frequency level.”); *see also* ’141 patent at 7:4-7 (“[t]o support signal modulation and demodulation, baseband processors typically perform the functions of carrier phase tracking

(involving carrier phase rotation)'), 8:40-43 ("[t]he process of carrier tracking already rotates each complex baseband sample by some amount on the unit circle between 0 and 2π radians").

A person of ordinary skill in the art would have also found it obvious to combine phase adjustments for carrier phase rotation and beamforming at baseband into a single step. *See, e.g.*, Williams, at [0036] ("Calibration factors are used to compensate for relative path delay and amplitude variations that occur when signals traverse the various transmit and receive apparatus chains, with reference to a fixed reference angle (for example, north). The angular weighting factors are used to point the antenna beam and nulls into the desired directions (for both transmit and receive) relative to the reference angle (for example, +23 degrees north). The phases and amplitudes of the calibration factors and angular weighting factors are effectively added together to result in a net weighting factor that is applied to signals traveling in each antenna apparatus chain for each signal frequency"); Gurrapu, at 6 ("Hence, to receive the beam in the direction θ , we need to calculate the phase shifts undergone by the signals from each antenna element and then, multiply by a complex weight to compensate for the path delays associated with them, and then simply add them."); Iinuma '701, at [0020] ("[T]he modulator 11 adds phase data and a compensation value that it receives from the control unit 50 and uses the result to generate the IF signal. This phase data is a phase amount that enables the generation of a same directivity pattern during transmission as during reception. The compensation value compensates for the phase shift in the transmission output due to the differences in characteristics between the transmission circuit 12 and the reception circuit 15."); Hardie, at 11 ("In one embodiment, an adaptive calibration controller 107 provides phase calibration signals (cal. phase) and amplitude calibration signals (cal. amp) for the calibration/BIT switch operations described in conjunction with FIGURE 4. These calibration signals may, for example, be added to the phase and

amplitude components of the signal by the phase shifter 87 and the polar-to-rectangular converter 88, respectively.”), Figure 7; Kuwahara, at 8:1-8 (“In FIG. 2, signals inputted to signal input lines 23 are signals from the respective antenna elements, signals from the despreader 9 for probe signal, shown in FIG. 1, the probe signals applied to the terminals of the respective antenna elements, and the level and phase deviations applied in the RF unit and in the cables between the couplers 2 and the RF unit 3. In the shown case, the multiplexer 24 has a function of timesharing six input signals one by one.”), 10:8-11 (“The above-described embodiment of the present invention can also calibrate the amplitude and phase deviations owing to the cables, amplifiers, etc. in the transmission System.”); *see also* ’141 patent at 8:40-43 (“[t]he process of carrier tracking already rotates each complex baseband sample by some amount on the unit circle between 0 and 2π radians”). Indeed, as noted above, making such a combination would have been straightforward and yielded predictable results.

Finally, it would have been well within the ability of a person of ordinary skill in the art to design an apparatus for modulating and demodulating signals as arranged in the manner described by the ’141 patent to maximize signal processing. *See, e.g.*, Williams, at [0020] (“A method for determining calibration factors for respective transmit and receive paths associated with an adaptive antenna array having a plurality of antenna elements is accomplished.”); Kuwahara, at 2:35-40 (“With respect to a receiving system of the base station apparatus, it is not necessary to compensate the level and phase as mentioned above, as long as an adaptive array antenna is employed. This is because, in the process of realizing the optimum array weight control, phase deviation and level deviation are compensated automatically.”); Daniel, 2:53-3:44 (“In a manner known to those skilled in the art, the relative phase and amplitude relationships of the communication signal components determine the shape and direction of beam 16. Beam 16 is

electronically steered by varying these phase and amplitude relationships ... One goal is the communication of digital data, and the other goal is the formation of beam 16.”); Teo, 2:7-9 (“Hence, modified transmission techniques are required that allow for sufficient signal power such that the BTS can reach any target mobile terminal within its coverage area.”); Yun, 5:22-27 (“Thus there is a need in the art for power control methods that use a process for estimating the quality of received signal which (a) is fast; (b) is substantially insensitive to frequency offset variations; and (c) leads to a measure, for example the signal to interference-and-noise ratio (SINR), that differentiates signal from interference and noise.”); Iinuma ’701, at [0020] (“[T]he modulator 11 adds phase data and a compensation value that it receives from the control unit 50 and uses the result to generate the IF signal. This phase data is a phase amount that enables the generation of a same directivity pattern during transmission as during reception. The compensation value compensates for the phase shift in the transmission output due to the differences in characteristics between the transmission circuit 12 and the reception circuit 15.”); Hardie, at 11 (“In one embodiment, an adaptive calibration controller 107 provides phase calibration signals (cal. phase) and amplitude calibration signals (cal. amp) for the calibration/BIT switch operations[.] These calibration signals may, for example, be added to the phase and amplitude components of the signal by the phase shifter 87 and the polar-to-rectangular converter 88, respectively.”), Figure 7; *see also* ’141 patent at 7:4-7 (“[t]o support signal modulation and demodulation, baseband processors typically perform the functions of carrier phase tracking (involving carrier phase rotation)”), 8:40-43 (“[t]he process of carrier tracking already rotates each complex baseband sample by some amount on the unit circle between 0 and 2π radians”).

Accordingly, a person of ordinary skill in the art would have found it obvious to combine the prior art references as detailed in Section VI.B such that all Asserted Claims of the '141 patent are obvious.

B. Primary and Secondary References, and Obviousness Combinations

Subject to the above reservations and based on Apple's investigation to date, Apple identifies the following and Primary and Secondary References, and Obviousness Combinations for the '141 patent:

Primary Reference Exhibit No.	Primary References	Secondary References
A1	U.S. Patent No. 6,157,681 ("Daniel")	A2, A3, A4, 5, A-6, 7, A8, A9, A10, A11, A12, References identified in AA, AAPA, and/or the knowledge of a person of ordinary skill in the art
A2	ITTC-FY1997-TR-10920-25B ("Gurrapu")	A1, A3, A4, A5, A6, A7, A8, A9, A10, A11, A12, References identified in AA, AAPA, and/or the knowledge of a person of ordinary skill in the art
A3	U.S. Patent No. 6,647,276 ("Kuwahara")	A1, A2, A4, A5, A6, A7, A8, A9, A10, A11, A12, References identified in AA, AAPA, and/or the knowledge of a person of ordinary skill in the art
A4	U.S. Patent No. 6,996,418 ("Teo")	A1, A2, A3, A5, A6, A7, A8, A9, A10, A11, A12, References identified in AA, AAPA, and/or the knowledge of a person of ordinary skill in the art
A5	U.S. Patent No. 6,463,295 ("Yun")	A1, A2, A3, A4, A6, A7, A8, A9, A10, A11, A12, References identified in AA, AAPA, and/or the knowledge of a person of ordinary skill in the art
A6	U.S. Patent No. 5,604,768 ("Fulton")	A1, A2, A3, A4, A5, A7, A8, A9, A10, A11, A12, References identified in AA, AAPA, and/or the knowledge of a person of ordinary skill in the art
A7	U.S. Patent No. 6,512,917 ("Hiramatsu")	A1, A2, A3, A4, A5, A6, A8, A9, A10, A11, A12, References identified in AA, AAPA, and/or the knowledge of a person of ordinary skill in the art

Primary Reference Exhibit No.	Primary References	Secondary References
A8	U.S. Patent No. 6,771,985 (“Iinuma”)	A1, A2, A3, A4, A5, A6, A7, A9, A10, A11, A12, References identified in AA, AAPA, and/or the knowledge of a person of ordinary skill in the art
A9	U.S. Patent Publication No. 2002/0042290 (“Williams”)	A1, A2, A3, A4, A5, A6, A7, A8, A10, A11, A12, References identified in AA, AAPA, and/or the knowledge of a person of ordinary skill in the art
A10	U.S. Patent No. 6,836,673 (“Trott”)	A1, A2, A3, A4, A5, A6, A7, A8, A9, A11, A12, References identified in AA, AAPA, and/or the knowledge of a person of ordinary skill in the art
A11	PCT Publication WO 2000/036701 (“Iinuma ’701”)	A1, A2, A3, A4, A5, A6, A7, A8, A9, A10, A12, References identified in AA, AAPA, and/or the knowledge of a person of ordinary skill in the art
A12	PCT Publication WO 2001/008259 (“Hardie”)	A1, A2, A3, A4, A5, A6, A7, A8, A9, A10, A11, References identified in AA, AAPA, and/or the knowledge of a person of ordinary skill in the art
A13	Gurrapu System ³	A1, A2, A3, A4, A5, A6, A7, A8, A9, A10, A11, A12, B1-B10, ⁴ References identified in AA, AAPA, and/or the knowledge of a person of ordinary skill in the art
AA	35 U.S.C. § 103	A1, A2, A3, A4, A5, A6, A7, A8, A9, A10, A11, A12, AAPA, and/or knowledge of a person of ordinary skill in the art

Obviousness Combinations:

- Kuwahara alone or in combination with Daniel, Yun, Teo, Hiramatsu, Gurrapu, Iinuma, Williams, Trott, Iinuma ’701, Hardie, references in Section IV, AAPA, and/or the knowledge of a person of ordinary skill in the art.
- Daniel alone or in combination with Kuwahara, Yun, Teo, Hiramatsu, Gurrapu, Iinuma, Williams, Trott, Iinuma ’701, Hardie, references in Section IV, AAPA, and/or the knowledge of a person of ordinary skill in the art.

³ As detailed above, Apple’s investigation into prior art products, systems, and/or services is ongoing, including the Gurrapu System.

⁴ See *infra* pages 61-62.

- Yun alone or in combination with Kuwahara, Daniel, Teo, Hiramatsu, Gurrapu, Iinuma, Williams, Trott, Iinuma '701, Hardie, references in Section IV, AAPA, and/or the knowledge of a person of ordinary skill in the art.
- Teo alone or in combination with Kuwahara, Daniel, Yun, Hiramatsu, Gurrapu, Iinuma, Williams, Trott, Iinuma '701, Hardie, references in Section IV, AAPA, and/or the knowledge of a person of ordinary skill in the art .
- Hiramatsu alone or in combination with Kuwahara, Daniel, Yun, Teo, Gurrapu, Iinuma, Williams, Trott, Iinuma '701, Hardie, references in Section IV, AAPA, and/or the knowledge of a person of ordinary skill in the art.
- Gurrapu alone or in combination with Kuwahara, Daniel, Yun, Teo, Hiramatsu, Iinuma, Williams, Trott, Iinuma '701, Hardie, references in Section IV, AAPA, and/or the knowledge of a person of ordinary skill in the art.
- Iinuma alone or in combination with Kuwahara, Daniel, Yun, Teo, Hiramatsu, Gurrapu, Williams, Trott, Iinuma '701, Hardie, references in Section IV, AAPA, and/or the knowledge of a person of ordinary skill in the art.
- Williams alone or in combination with Kuwahara, Daniel, Yun, Teo, Hiramatsu, Gurrapu, Iinuma, Trott, references in Section IV, AAPA, and/or the knowledge of a person of ordinary skill in the art.
- Trott alone or in combination with Kuwahara, Daniel, Yun, Teo, Hiramatsu, Gurrapu, Iinuma, Williams, Iinuma '701, Hardie, references in Section IV, AAPA, and/or the knowledge of a person of ordinary skill in the art.
- Iinuma '701 alone or in combination with Kuwahara, Daniel, Yun, Teo, Hiramatsu, Gurrapu, Iinuma, Williams, Trott, Hardie, references in Section III.A, AAPA, and/or the knowledge of a person of ordinary skill in the art.
- Hardie alone or in combination with Kuwahara, Daniel, Yun, Teo, Hiramatsu, Gurrapu, Iinuma, Williams, Trott, Iinuma '701, references in Section IV, AAPA, and/or the knowledge of a person of ordinary skill in the art.
- Gurrapu System alone or in combination with Kuwahara, Daniel, Yun, Teo, Hiramatsu, Gurrapu, Iinuma, Williams, Trott, Iinuma '701, Hardie, references in Section IV, references in AAPA, and/or the knowledge of a person of ordinary skill in the art.

* * *

Moreover, as detailed above, Apple's investigation into publicly-available prior art products, systems, and/or services that include and/or render obvious each element of any Asserted Claims is ongoing. Based on Apple's investigation to date, Apple identifies the

following Primary References that are based on prior art products, systems, and or services and Secondary References, and Obviousness Combinations for the '141 patent:

Primary Reference No.	Primary References	Secondary References
B1	Qualcomm Product(s)	A1-A13, B2-B10, AAPA, and/or knowledge of a person of ordinary skill in the art
B2	ITT Product(s)	A1-A13, B1, B3-B10, AAPA, and/or knowledge of a person of ordinary skill in the art
B3	Renesas Product(s)	A1-A13, B1-B2, B4-B10, AAPA, and/or knowledge of a person of ordinary skill in the art
B4	L3Harris Product(s)	A1-A13, B1-B3, B4-B10, AAPA, and/or knowledge of a person of ordinary skill in the art
B5	Ligado Product(s)	A1-A13, B1-B4, B6-B10, AAPA, and/or knowledge of a person of ordinary skill in the art
B6	MACOM Product(s)	A1-A13, B1-B5, B7-B10, AAPA, and/or knowledge of a person of ordinary skill in the art
B7	Marvell Product(s)	A1-A13, B1-B6, B8-B10, AAPA, and/or knowledge of a person of ordinary skill in the art
B8	Cirrus Product(s)	A1-A13, B1-B7, B9-B10, AAPA, and/or knowledge of a person of ordinary skill in the art
B9	Silicon Product(s)	A1-A13, B1-B8, B10, AAPA, and/or knowledge of a person of ordinary skill in the art
B10	Viasat Product(s)	A1-A13, B1-B9, AAPA, and/or knowledge of a person of ordinary skill in the art

Obviousness Combinations:

- Qualcomm Product(s) alone or in combination with Daniel, Kuwahara, Yun, Teo, Hiramatsu, Gurrapu, Inuma, Williams, Trott, Inuma '701, Hardie, references in Section IV, AAPA, the knowledge of a person of ordinary skill in the art, ITT Product(s); Renesas Product(s); L3Harris Product(s); Ligado Product(s); MACOM Product(s); Marvell Product(s); Cirrus Product(s); Silicon Product(s); and/or Viasat Product(s);

- ITT Product(s) alone or in combination with Daniel, Kuwahara, Yun, Teo, Hiramatsu, Gurrapu, Inuma, Williams, Trott, Inuma '701, Hardie, references in Section IV, AAPA, the knowledge of a person of ordinary skill in the art, Qualcomm Product(s); Renesas Product(s); L3Harris Product(s); Ligado Product(s); MACOM Product(s); Marvell Product(s); Cirrus Product(s); Silicon Product(s); and/or Viasat Product(s);
- Renesas Product(s) alone or in combination with Daniel, Kuwahara, Yun, Teo, Hiramatsu, Gurrapu, Inuma, Williams, Trott, Inuma '701, Hardie, references in Section IV, AAPA, the knowledge of a person of ordinary skill in the art, Qualcomm Product(s); ITT Product(s); L3Harris Product(s); Ligado Product(s); MACOM Product(s); Marvell Product(s); Cirrus Product(s); Silicon Product(s); and/or Viasat Product(s);
- L3Harris Product(s) alone or in combination with Daniel, Kuwahara, Yun, Teo, Hiramatsu, Gurrapu, Inuma, Williams, Trott, Inuma '701, Hardie, references in Section IV, AAPA, the knowledge of a person of ordinary skill in the art, Qualcomm Product(s); ITT Product(s); Renesas Product(s); Ligado Product(s); MACOM Product(s); Marvell Product(s); Cirrus Product(s); Silicon Product(s); and/or Viasat Product(s);
- Ligado Product(s) alone or in combination with Daniel, Kuwahara, Yun, Teo, Hiramatsu, Gurrapu, Inuma, Williams, Trott, Inuma '701, Hardie, references in Section IV, AAPA, the knowledge of a person of ordinary skill in the art, Qualcomm Product(s); ITT Product(s); Renesas Product(s); L3Harris Product(s); MACOM Product(s); Marvell Product(s); Cirrus Product(s); Silicon Product(s); and/or Viasat Product(s);
- MACOM Product(s) alone or in combination with Daniel, Kuwahara, Yun, Teo, Hiramatsu, Gurrapu, Inuma, Williams, Trott, Inuma '701, Hardie, references in Section IV, AAPA, the knowledge of a person of ordinary skill in the art, Qualcomm Product(s); ITT Product(s); Renesas Product(s); L3Harris Product(s); Ligado Product(s); Marvell Product(s); Cirrus Product(s); Silicon Product(s); and/or Viasat Product(s);
- Marvell Product(s) alone or in combination with Daniel, Kuwahara, Yun, Teo, Hiramatsu, Gurrapu, Inuma, Williams, Trott, Inuma '701, Hardie, references in Section IV, AAPA, the knowledge of a person of ordinary skill in the art, Qualcomm Product(s); ITT Product(s); Renesas Product(s); L3Harris Product(s); Ligado Product(s); MACOM Product(s); Cirrus Product(s); Silicon Product(s); and/or Viasat Product(s);
- Cirrus Product(s) alone or in combination with Daniel, Kuwahara, Yun, Teo, Hiramatsu, Gurrapu, Inuma, Williams, Trott, Inuma '701, Hardie, references in Section IV, AAPA, the knowledge of a person of ordinary skill in the art, Qualcomm Product(s); ITT Product(s); Renesas Product(s); L3Harris Product(s); Ligado Product(s); MACOM Product(s); Marvell Product(s); Silicon Product(s); and/or Viasat Product(s);
- Silicon Product(s) alone or in combination with Daniel, Kuwahara, Yun, Teo, Hiramatsu, Gurrapu, Inuma, Williams, Trott, Inuma '701, Hardie, references in Section IV, AAPA, the knowledge of a person of ordinary skill in the art, Qualcomm Product(s); ITT Product(s); Renesas Product(s); L3Harris Product(s); Ligado Product(s); MACOM Product(s); Marvell Product(s); Cirrus Product(s); and/or Viasat Product(s);

- Viasat Product(s) alone or in combination with Daniel, Kuwahara, Yun, Teo, Hiramatsu, Gurrapu, Inuma, Williams, Trott, Inuma '701, Hardie, references in Section IV, AAPA, the knowledge of a person of ordinary skill in the art, Qualcomm Product(s); ITT Product(s); Renesas Product(s); L3Harris Product(s); Ligado Product(s); MACOM Product(s); Marvell Product(s); Cirrus Product(s); and/or Silicon Product(s).

C. Incorporation By Reference Of Grounds In IPR2023-00796

Apple filed a petition requesting *inter partes* review of the Asserted Claims of the '141 patent on April 5, 2023. *Apple Inc. v. Lionra Technologies Ltd.*, IPR2023-00796, Petition for *Inter Partes* Review of U.S. Patent No. 7,260,141, Paper 1 (Apr. 25, 2023). Apple hereby incorporates by reference all the positions set forth in the petition. *Id.*

VII. CONTENTIONS UNDER 35 U.S.C. § 112

To comply with the written description requirement of 35 U.S.C. § 112, a patent's written description must "reasonably convey[] to those skilled in the art that the inventor had possession of the claimed subject matter as of the filing date." *Ariad Pharm., Inc. v. Eli Lilly & Co.*, 598 F.3d 1336, 1351 (Fed. Cir. 2010) (en banc) (citations omitted). Under the enablement requirement of 35 U.S.C. § 112, a specification must "teach those skilled in the art how to make and use the full scope of the claimed invention without 'undue experimentation.'" *Streck, Inc. v. Res. & Diagnostic Sys., Inc.*, 665 F.3d 1269, 1288 (Fed. Cir. 2012) (citations omitted).

A patent claim is also invalid for indefiniteness under Section 112 if its language, when "read in light of the specification . . . and the prosecution history, fail[s] to inform, with reasonable certainty, those skilled in the art about the scope of the invention." *Nautilus, Inc. v. Biosig Instruments, Inc.*, 572 U.S. 898, 901 (2014); *see also id.* at 909 ("[A] patent must be precise enough to afford clear notice of what is claimed, thereby apprising the public of what is still open to them." (internal quotation omitted)). Claim terms may also be indefinite "if a term does not have proper antecedent basis where such basis is not otherwise present by implication

or the meaning is not reasonably ascertainable.” *Halliburton Energy Servs., Inc. v. M-I LLC*, 514 F.3d 1244, 1249 (Fed. Cir. 2008) (citations omitted).

As explained below, the Asserted Claims are invalid under 35 U.S.C. § 112. Apple reserves the right to present additional § 112 defense if Lionra proffers an interpretation for certain terms and phrases that is broader than, or inconsistent with, the Court’s claim constructions or any construction that would be supportable by the disclosure set forth in the specification. Accordingly, Apple reserves the right to supplement, amend, and/or modify these § 112 invalidity contentions as discovery progresses.

A. Lack of Written Description

1. Claim 1: “said shared baseband processor applying a single phase adjustment to each of the digital baseband signals to jointly account for both beamforming phase rotation and carrier phase rotation of individual antenna elements”

Claim 1 requires the “shared baseband processor” to “appl[y] a single phase adjustment to each of the digital baseband signals to jointly account for both beamforming phase rotation and carrier phase rotation of individual antenna elements.” However, the specification of the ’141 patent fails to describe how the shared baseband processor applies a *single phase adjustment* to each of the digital baseband signals to *jointly account for both* beamforming phase rotation and carrier phase rotation of individual antenna elements. Indeed, the specification never defines, nor even uses, the phrase “single phase adjustment.” As a result, “said shared baseband processor applying a single phase adjustment to each of the digital baseband signals to jointly account for both beamforming phase rotation and carrier phase rotation of individual antenna elements” as claimed lacks written description support because the ’141 patent’s specification does not “convey[] with reasonably clarity” that the ’141 patent’s

inventors were in possession of the alleged invention.” *See Quake v. Lo*, 928 F.3d 1365, 1373 (Fed. Cir. 2019).

Moreover, Lionra’s infringement allegations in its Amended Preliminary Infringement Contentions⁵ for “said shared baseband processor applying a single phase adjustment to each of the digital baseband signals to jointly account for both beamforming phase rotation and carrier phase rotation of individual antenna elements” are based on specific portions of the “3GPP technical specifications.” Lionra’s Amended Preliminary Infringement Contentions, Exhibit A at 48-72, Exhibit B at 20-36. For Lionra’s infringement allegations directed to “Mobile devices that support 5G cellular communications,” Lionra relies on specific portions of 3GPP TS 38.211 and 3GPP TS 38.214. *Id.*, Exhibit A at 1, 58-71. In particular, Lionra relies on the “uplink W matrix . . . defined in 3GPP TS 38.211” and “the downlink W matrix . . . defined in 3GPP TS 38.214” to allege infringement. *Id.*, Exhibit A at 58-71. For Lionra’s infringement allegations directed to “LTE cellular communications,” Lionra relies on specific portions of 3GPP TS 36.211. *Id.*, Exhibit B at 1, 24-36. Specifically, Lionra’s allegations for infringement for “LTE cellular communications” specifically rely on “the W matrix . . . defined for the downlink in 3GPP TS 36.211.” *Id.*

To the extent Lionra maintains that 3GPP TS 38.211, 3GPP TS 38.214, and/or 3GPP TS 36.211 are within the scope of this limitation, the specification fails to provide sufficient written description support to show that the inventor was in the possession of such subject matter for claim 1. For example, the patent fails to explain how the claimed shared baseband processor accomplishes the functions that Lionra accuses of infringement. As a result, the phrase “said

⁵ As noted above, Lionra’s Amended Preliminary Infringement fail provide adequate notice of Lionra’s infringement theories under the Court’s Standing Order Governing Patent Cases. *See* Standing Order Governing Proceedings (OGP) 4.3—Patent Cases (Apr. 4, 2023) at 2, 12.

shared baseband processor applying a single phase adjustment to each of the digital baseband signals to jointly account for both beamforming phase rotation and carrier phase rotation of individual antenna elements” lacks written description support under Lionra’s interpretation of this limitation because the ’141 patent’s specification does not “convey[] with reasonably clarity” that the ’141 patent’s inventors were in possession of the alleged invention.” *See Quake*, 928 F.3d at 1373.

B. Enablement

1. Claim 1: “said shared baseband processor applying a single phase adjustment to each of the digital baseband signals to jointly account for both beamforming phase rotation and carrier phase rotation of individual antenna elements”

As detailed above in Section VII.A, Lionra's infringement allegations are based on specific portions of the “3GPP technical specifications.” Lionra’s Amended Preliminary Infringement Contentions, Exhibit A at 48-72, Exhibit B at 20-36. As detailed above, Apple contends and maintains that the Asserted Claims are invalid as obvious. In the alternative, to the extent the claims are not obvious and to the extent Lionra contends that the full scope of the phrase “said shared baseband processor applying a single phase adjustment to each of the digital baseband signals to jointly account for both beamforming phase rotation and carrier phase rotation of individual antenna elements” covers 3GPP TS 38.211, 3GPP TS 38.214, and/or 3GPP TS 36.211 (and/or any other sections of the “3GPP technical specifications” relied on by Lionra in its infringement allegations), this limitation is not enabled.

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CERTIFICATE OF SERVICE

I hereby certify that all counsel of record are being served with a copy of the foregoing document via e-mail on June 28, 2023.

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