UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SAMSUNG ELECTRONICS CO., LTD.
Petitioner

v.

RED ROCK ANALYTICS, LLC
Patent Owner

Patent No. 7,346,313

PETITION FOR *INTER PARTES* REVIEW OF U.S. PATENT NO. 7,346,313

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I. INTRODUCTION

Samsung Electronics Co., Ltd. ("Petitioner") requests *inter partes* review of claims 1-6 and 38-43 ("the challenged claims") of U.S. Patent No. 7,346,313 ("the '313 patent") (Ex. 1001), which, according to PTO records, is assigned to Red Rock Analytics, LLC ("Patent Owner"). For the reasons discussed below, the challenged claims should be found unpatentable and canceled.

II. MANDATORY NOTICES

Real Parties-in-Interest: Petitioner identifies the following as the real parties-in-interest: Samsung Electronics Co., Ltd.; Samsung Electronics America, Inc.; Samsung Semiconductor, Inc.; and Samsung Austin Semiconductor, LLC.

Related Matters: The '313 patent is at issue in *Red Rock Analytics, LLC v. Samsung Electronics Co. Ltd.*, Case No. 2-17-cv-00101 (E.D. Tex.) and in *Unified Patents Inc. v. Red Rock Analytics, LLC*, IPR2017-01490 (PTAB). Petitioner is concurrently filing two other petitions – one challenging claims 7, 11-21, 44, and 48-58 of the '313 patent and another petition challenging claims 22, 26-37, 59, and 63-74 of the '313 patent.

Counsel and Service Information: Lead counsel is Naveen Modi (Reg. No. 46,224), and Backup counsel are (1) Joseph E. Palys (Reg. No. 46,508), (2) Paul M. Anderson (Reg. No. 39,896), (3) Chetan R. Bansal (Limited Recognition No. L0667), and (4) Arvind Jairam (Reg. No. 62,759). Service information is Paul

Hastings LLP, 875 15th St. N.W., Washington, D.C., 20005, Tel.: 202.551.1700, Fax: 202.551.1705, email: PH-Samsung-Redrock-IPR@paulhastings.com. Petitioner consents to electronic service.

III. PAYMENT OF FEES

The PTO is authorized to charge any fees due during this proceeding to Deposit Account No. 50-2613.

IV. GROUNDS FOR STANDING

Petitioner certifies that the ’313 patent is available for review and Petitioner is not barred or estopped from requesting review on the grounds identified herein. Petitioner notes that the one-year deadline under § 315(b) started to run no earlier than February 3, 2017. Because February 3, 2018 was a Saturday, the one-year bar date under § 315(b) got extended to February 5, 2018. *See* 35 U.S.C. § 21(b); 37 C.F.R. § 1.7(a).

V. PRECISE RELIEF REQUESTED AND GROUND RAISED

The challenged claims should be canceled as unpatentable based on the following ground:

Ground 1: Claims 1-6 and 38-43 are unpatentable under pre-AIA 35 U.S.C. § 103(a) based on U.S. Patent No. 6,898,252 (“*Yellin*”) (Ex. 1005) and U.S. Patent No. 6,272,322 (“*Su*”) (Ex. 1006).

The ’313 patent issued from U.S. Application No. 10/379,352 filed on March 4, 2003. (Ex. 1001, Cover.) The ’313 patent claims the benefit of U.S. Provisional Application No. 60/361,630 (“the ’630 provisional”), filed March 4, 2002. (*See* Ex. 1001, 2nd Certificate of Correction.) *Yellin* issued May 24, 2005 and was filed July 21, 2000. *Su* issued on August 7, 2001 and was filed February 4, 2000. Even assuming that the claims of the ’313 patent are entitled to the filing date of the ’630 provisional, which Petitioner does not concede, *Yellin* and *Su* are prior art under pre-AIA 35 U.S.C. § 102(e). *Yellin* and *Su* were not considered by the Patent Office during prosecution of the ’313 patent. (*See, e.g.*, Ex. 1001, Cover (References Cited section); Ex. 1004.)

VI. LEVEL OF ORDINARY SKILL

A person of ordinary skill in the art at the time of the alleged invention of the ’313 patent (“POSITA”) would have had at least a Master’s degree in electrical engineering or a similar discipline, and at least one to two years of work experience in the design and analysis of radio frequency communication systems. (Ex. 1002, ¶¶19-20.)[1] More education can substitute for practical experience and vice versa.

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[1] Petitioner submits the declaration of R. Jacob Baker, Ph.D., P.E. (Ex. 1002), an expert in the field of the ’313 patent. (Ex. 1002, ¶¶1-18; Ex. 1003.)

VII. OVERVIEW OF THE ’313 PATENT AND THE PRIOR ART

A. Technology Overview

The ’313 patent is directed to balancing gain between in-phase and quadrature (I and Q) channels in a transceiver, e.g., a direct-conversion or heterodyne transceiver. (Ex. 1001, Abstract; Ex. 1002, ¶¶37-46.) Such transceivers were well known long before the alleged invention of the ’313 patent, and it was further known to balance the gain of the I and Q channels of such transceivers, as explained below. (Ex. 1002, ¶¶22-47.)

1. Transmitters and Receivers in Wireless Communication Systems

Transmitters and receivers in wireless communication systems were known as early as the early part of the twentieth century for radio and radar systems. (Ex. 1002, ¶22.) Wireless communication systems use radio waves (electromagnetic waves in approximately the 20 kHz to 300 GHz frequency range) to convey information from a source to a destination. (*Id.*) At the source, a transmitter processes a signal to prepare it to be propagated along a carrier wave at radio frequency (RF) to the destination, where the received RF signal is processed by a receiver to extract relevant information. (*Id.*)

The ’313 patent does not purport to have invented such transceivers (systems including both a transmitter and a receiver), and indeed acknowledges that various aspects of transceivers were known in the prior art. (Ex. 1001, 4:48-53 (“prior art"), 6:23—7:33, FIGS. 1A-3B (labeled "PRIOR ART"); Ex. 1002, ¶23.) Figure 1 of the '313 patent "shows a typical direct-conversion transceiver block diagram." (Ex. 1001, 6:23-24; *see also id.*, 4:47-48.) Figures 1A and 1B depict the transmit and receive chains, respectively, both of which were "conventional designs." (*Id.*, 6:46-48; *see also id.*, 4:48-50, 6:24, 6:36, FIGS. 1A-1B.)

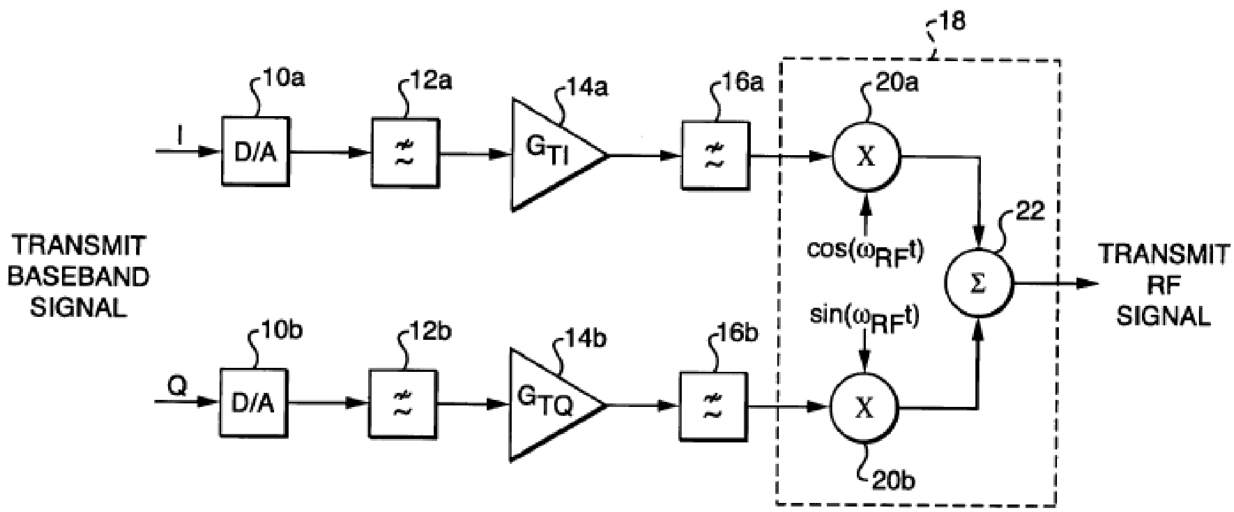

FIG. 1A
(PRIOR ART)

(*Id.*, FIG. 1A.)

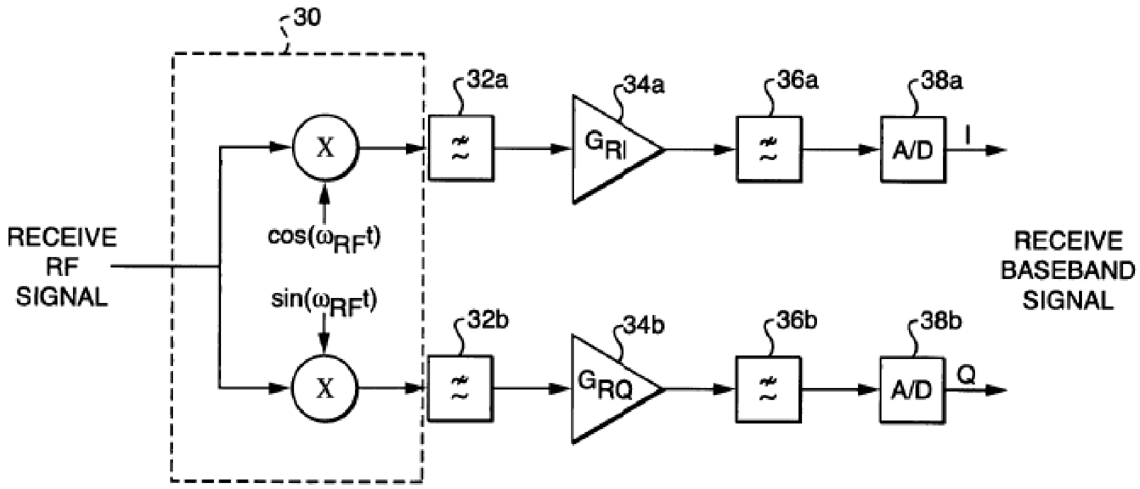

FIG. 1B
(PRIOR ART)

(*Id.*, FIG. 1B.)

The above configurations of Figures 1A and 1B are direct-conversion transmitter and receiver configurations, which were known before the alleged invention date to "convert directly between RF and baseband." (*Id.*, 1:22-23; Ex. 1002, ¶¶23-29.) Another type of configuration known before the alleged invention date was the heterodyne configuration, in which the transmit chain and receive chain used an intermediate frequency (IF) between baseband and RF. (Ex. 1001, 1:15-18 ("Traditional heterodyne transceivers, for example, employ most of the required gain at an Intermediate-Frequency (IF), between the Radio Frequency (RF) and baseband."), FIGS. 2A-2B (labeled "PRIOR ART"); Ex. 1002, ¶29.) Known heterodyne transmit and receive chains are shown in figures 2A and 2B:

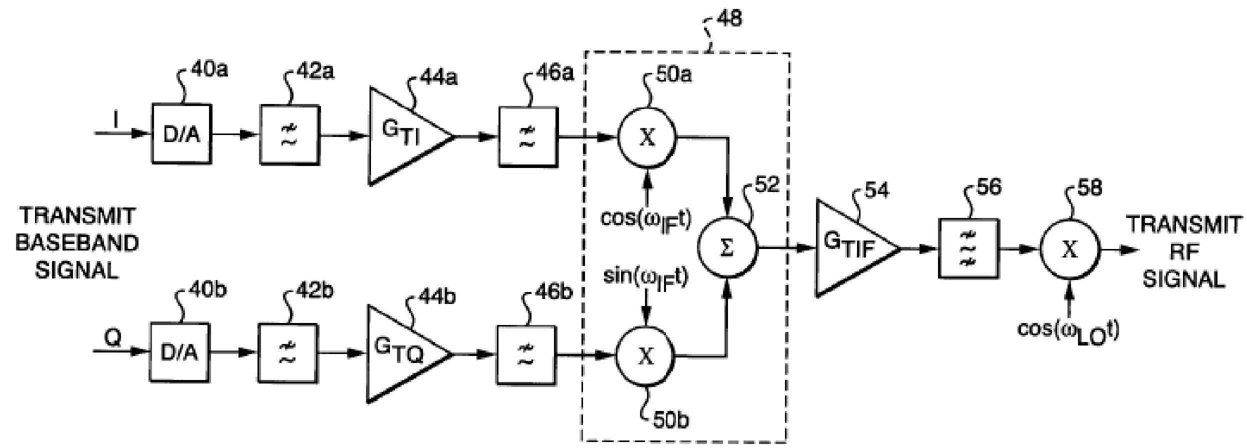

FIG. 2A
(PRIOR ART)

(Ex. 1001, FIG. 2A.)

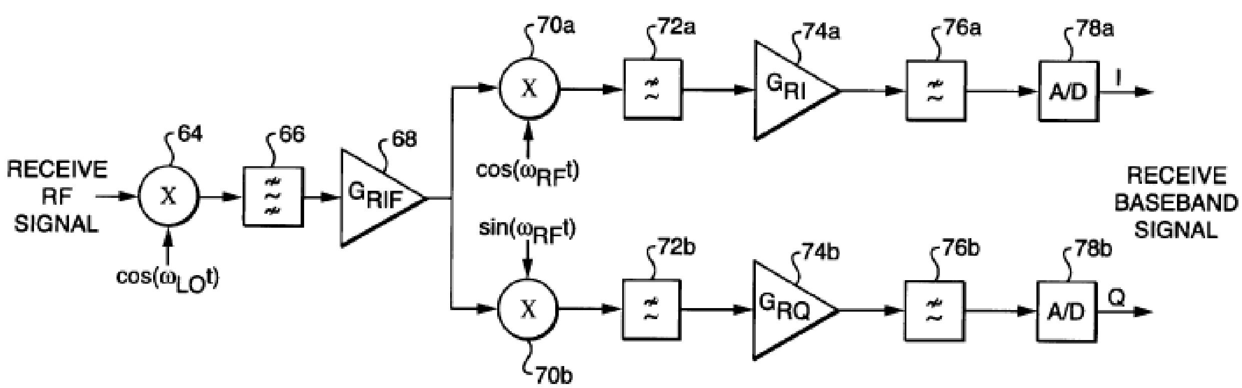

FIG. 2B
(PRIOR ART)

(*Id.*, FIG. 2B.)

As shown above, an additional mixer 58/64 is used in the heterodyne transceiver compared to the direct-conversion transceiver. (*Id.*, FIGS. 1-2; Ex. 1002, ¶30.)

2. I-Q Gain Imbalance

It was known prior to the alleged invention of the ’313 patent that imbalance between the I and Q gains in each of the transmit and receive chains was undesirable. (Ex. 1002, ¶31.) Indeed, several prior art references describe I-Q gain imbalance. (Ex. 1008, 1:22-24 (“gain imbalance in which the in-phase signal is amplified by a different amount than the quadrature signal”), 3:44-47 (“differences in the gain of the mixers 12 and 14 can result in a gain imbalance between the I and Q channels”); Ex. 1009, 1:19-21 (“For proper operation, the I and Q channels of the modulator must be calibrated to be equal in gain, i.e., balanced . . . .”); Ex. 1010, 1:30-36 (“Usually the I and Q channels of the modulator are calibrated to have equal gain (equal output amplitudes for equivalent inputs) . . . . This requires measurement and calibration of the vector modulator output signals to ensure equal gain in each channel . . . .”); Ex. 1011, 1:41-44 (“Another error, termed I/Q gain imbalance, occurs because the I modulation component and the Q modulation component from the IQ modulator do not have a desired ratio.”); Ex. 1012, 214 (“differential gain errors between the in-phase (I) and the quadrature (Q) channels”); Ex. 1013, 5:22-25 (describing “quadrature mismatch” as “an alteration in the gain of one of the quadrature paths relative to the other”); Ex. 1002, ¶31.)

Techniques for correcting I-Q gain imbalance were also known prior to the alleged invention date. (Ex. 1002, ¶¶32-36.) For example, *Whitmarsh* describes applying two calibration signals—a known point on the imaginary axis, and a known point on the real axis—and then measuring the resulting RF output level to determine values V_2 and V_1 for the real and imaginary calibration signals, respectively. (Ex. 1013, 6:16-23, FIG. 6.) A gain mismatch factor $A=V_2/V_1$ is then calculated, and gain mismatch is removed using the reciprocal of A. (*Id.*, 5:36-38, 6:23-26.) *Faulkner* describes a similar approach for correcting gain mismatch. (Ex. 1012, 215.)

B. The '313 Patent

The '313 patent "relates generally to transceivers for digital communications whose modulations require gain balance between I and Q channels, and more particularly for low-cost applications of such transceivers, such as wireless LANs." (*Id.*, 1:6-10.) The '313 patent acknowledges in its background section that it was known prior to the alleged invention of the '313 patent that the gains provided in the I and Q channels had to be balanced in transmitters and receivers of transceivers such as heterodyne and direct-conversion transceivers. (*Id.*, 1:19-60; Ex. 1002, ¶37.)

To address this issue, the '313 patent discloses "[a] system and method . . . for calibrating a transceiver system for transmitting and receiving data using both I and Q channels and including a transmit chain and a receive chain." (Ex. 1001, 2:14-17.) "A calibration RF signal, generated in response to and as a function of a signal generated through the transmit chain, is injected into the receive chain of the transceiver in order to independently calibrate the I-Q gain balance of the both transmit and receive chains in their entirety." (*Id.*, 2:17-22.) The '313 patent discloses a "preferred embodiment of a typical transceiver incorporating the present invention" with respect to figure 4. (*Id.*, 4:60-62.)

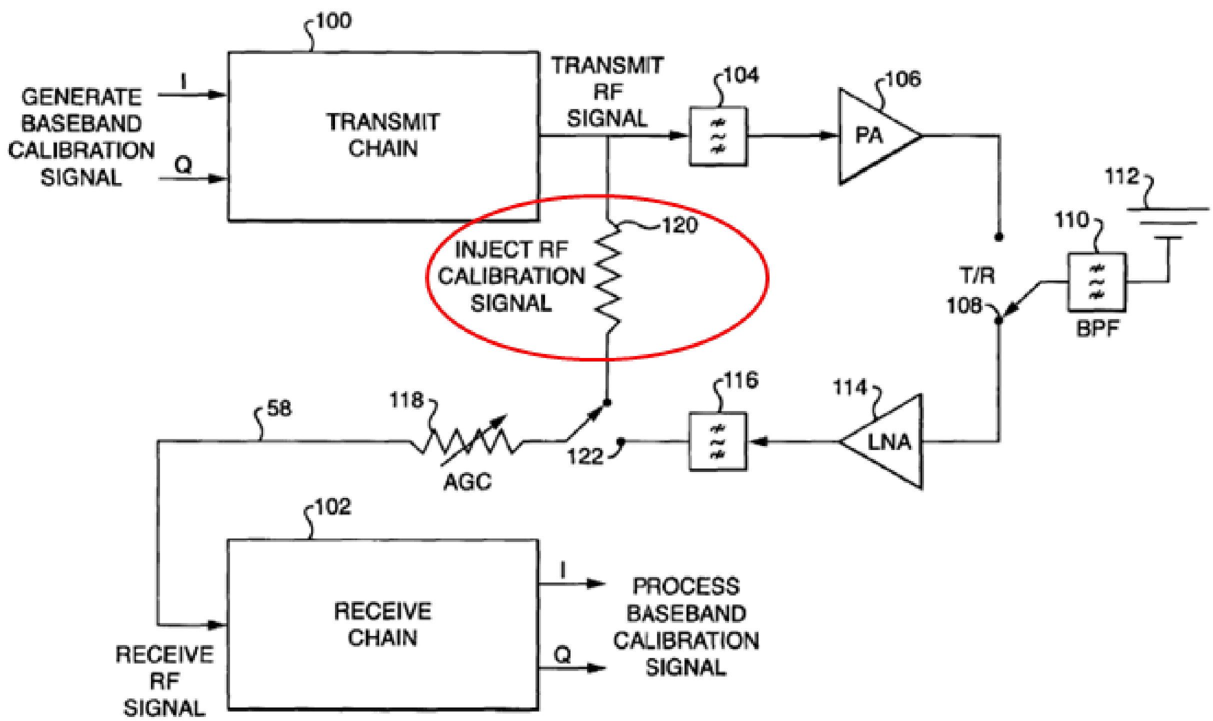

FIG. 4

(Ex. 1001, FIG. 4 (annotated); Ex. 1002, ¶38.)

Figure 4 of the '313 patent "shows a typical transceiver comprising the transmit and receive chains of FIG. 1 or FIG. 2" (Ex. 1001, 8:10-11), which are acknowledged as being prior art components (*id.*, 4:48-52, 6:23-24, 6:48 ("conventional designs as shown in FIG. 1"), 6:57-58). The '313 patent explains that "[t]he only additional circuitry required for calibration is that to provide injection of the calibration signal from RF transmit output to RF receive input." (*Id.*, 8:39-41; Ex. 1002, ¶39.)

"The calibration concept shown in FIG. 4 employs the normal baseband transmit input for introducing the calibration signal, and the normal baseband receive output for forming the observable indicative of I-Q gain imbalance." (Ex. 1001, 8:35-38.) Thus, during calibration mode, a calibration signal is applied at the baseband transmit input of the transmit chain, and the calibration signal is converted to RF either directly or after conversion to an intermediate frequency. (Ex. 1002, ¶40.) After conversion to RF, the calibration signal is provided to the receive chain. (*Id.*)

According to the '313 patent, calibration is performed by minimizing an observable indicator of gain imbalance. (Ex. 1001, 5:61-65; Ex. 1002, ¶¶41-46.) For example, "[t]he overall calibration process preferably proceeds by minimizing the imbalance observable with respect to gain adjustments in the transmit chain while holding the gains in the receive chain fixed, then minimizing the imbalance observable with respect to gain adjustments in the receive chain while holding the gains in the transmit chain fixed." (Ex. 1001, 6:1-6; *see also id.*, 10:24-42.) The

’313 patent discloses that “[t]he varying of differential I-Q gains in the transmit and receive chains can be effected in many ways.” (*Id.*, 10:43-44.) “It can be applied in a true differential manner, although this is not necessary and it is generally simpler to vary either the I or Q gain while holding the other fixed.” (*Id.*, 10:44-47.) The ’313 patent states that “the gains may be applied digitally to the digital representations of the transmit and/or receive baseband samples, or digital control of analog gain within the transmit and/or receive baseband gain chain.” (*Id.*, 10:47-51.)

C. Prosecution History of the ’313 Patent

During prosecution of the ’352 application which issued as the ’313 patent, the Examiner rejected certain claims based on anticipation by U.S. Patent No. 6,717,981 (“*Mohindra*”) (Ex. 1007) and certain other claims based on obviousness in view of *Mohindra* and admitted prior art. (Ex. 1004, 157-64, 196-202.) In response to the rejections, the Applicant amended claim 1 to additionally recite “wherein the calibration RF signal includes a calibration cycle, and the calibration cycle determines transmitter I-Q gain settings which minimize an observable indicator while holding receive I-Q gain settings constant, and which in turn determines receiver I-Q gain settings which minimizes the observable indicator while holding the transmit I-Q gain settings constant” and similarly amended the other independent claims. (*Id.*, 136-53 (Amendment dated September 26, 2007).)

The Examiner then allowed the application, stating that “reasons for allowance of [the allowed claims] are set forth in [accordance with] the applicant’s remarks stated on [page] 18 [of the Response dated September 26, 2007].” (*Id.*, 127 (Notice of Allowance dated October 23, 2007).)

D. *Yellin*

Yellin relates to a communication device that transmits and receives data using both I and Q channels. (Ex. 1002, ¶49.) For example, *Yellin* discloses an apparatus 300 shown in figure 2 that includes both transmitting and receiving functions.

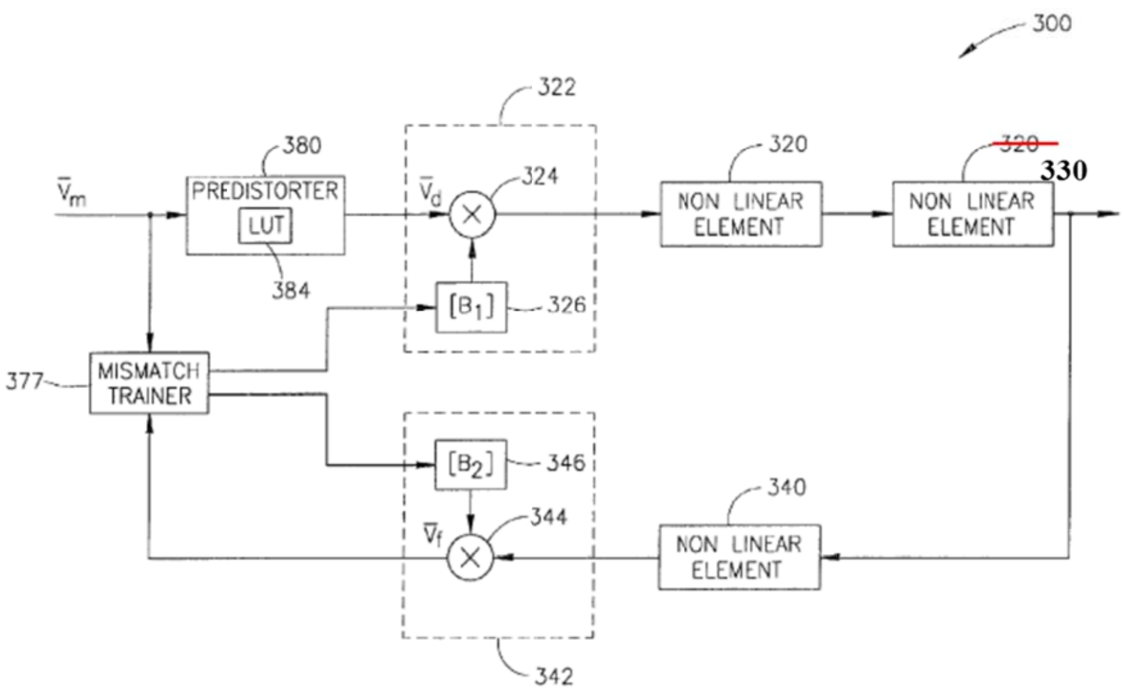

FIG.2

(Ex. 1005, FIG. 2 (annotated); Ex. 1002, ¶49[2].)

Each input vector V_m includes a real part (I_m) and an imaginary part (Q_m). (Ex. 1005, 3:11-15.) The vectors V_m are provided to a sequence of non-linear elements 320, 330, and 340 as shown in figure 2, where the non-linear elements can be RF elements such as, for example, a modulator and a demodulator. (*Id.*, 3:11-15, 4:10-15.) More specifically, *Yellin* discloses that non-linear element 320 is an IQ modulator and non-linear element 340 is an IQ demodulator. (*Id.*, 3:11-22.) The IQ modulator (non-linear element 320) modulates the received IQ vectors onto a high frequency carrier (e.g., RF). (Ex. 1002, ¶¶50-53.) The high frequency data output by non-linear element 340 is injected into IQ demodulator (non-linear element 340), which demodulates the received high frequency signal into baseband IQ vectors. (Ex. 1005, 3:65-66, 4:14-15, 10:5-10, FIG. 2; Ex. 1002, ¶54.)

Yellin discloses that the apparatus 300 shown in figure 2 suffers from IQ mismatch, which can include IQ gain imbalance and phase errors caused by distortions in non-linear elements 320 and 340. (Ex. 1005, 1:18-36, 3:8-11, 3:15-22; Ex. 1002, ¶¶55-58.) The parameters in matrices 326 and 346 of IQ correction

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[2] As explained by Dr. Baker, figure 2 of *Yellin* includes a typographical error because while two non-linear elements are labeled as "320," the last non-linear element should have been labeled as "330." (Ex. 1002, ¶49.)

units 322 and 342 are set by a mismatch trainer 377 in order to correct these gain and phase mismatch distortions caused by the non-linear elements 320 and 340. (Ex. 1005, 3:15-47; Ex. 1002, ¶¶59-67.)

E. *Su*

Su relates to wireless systems and calibration in transceivers used in wireless systems. (Ex. 1006, 1:1-10; Ex. 1002, ¶¶68-71.) For example, *Su* discloses that "[i]n a typical wireless communication system, the mobile units used for communication typically include transceiver[s] capable of transmitting and receiving messages." (Ex. 1006, 1:20-22.) *Su* discloses techniques for determining path loss between transceivers, and for determining transmit and receive gains for each transceiver. (*Id.*, 2:35-48, 4:9-19, 7:66—8:7.) *Su* discloses exemplary transmit and receive paths with respect to figures 2A and 2B, where such paths are included in a transceiver. (*Id.*, 2:60-64.)

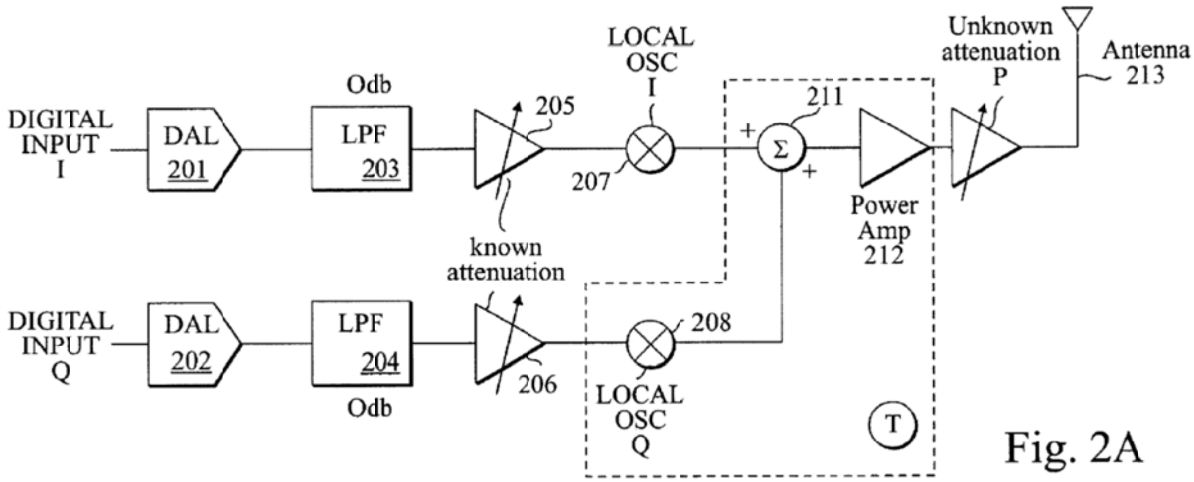

Fig. 2A

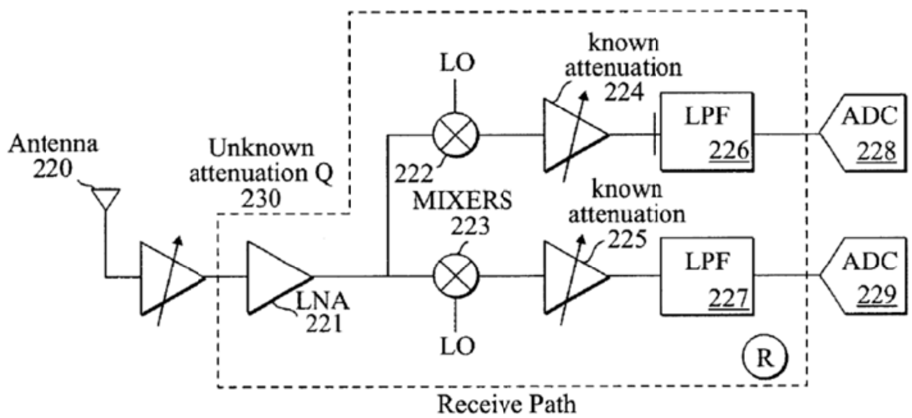

Fig. 2B

(*Id.*, FIGS. 2A, 2B.)

VIII. CLAIM CONSTRUCTION

A claim in an unexpired patent that will not expire before a final written decision is issued in an IPR receives the "broadest reasonable construction in light of the specification of the patent in which it appears." 37 C.F.R. § 42.100(b). The '313 patent has not expired and will not expire before a final written decision will be issued. Thus, for purposes of this proceeding, the claims of the '313 patent should be given their broadest reasonable construction.

The Board, however, only construes the claims when necessary to resolve the underlying controversy. *Toyota Motor Corp. v. Cellport Sys., Inc.*, IPR2015-00633, Paper No. 11 at 16 (Aug. 14, 2015) (citing *Vivid Techs., Inc. v. Am. Sci. & Eng'g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999)). Petitioner submits that for purposes of this proceeding, the terms of the challenged claims should be given their plain and ordinary meaning under the broadest reasonable interpretation (BRI) standard.[3] (Ex. 1002, ¶48.)

IX. DETAILED EXPLANATION OF GROUNDS

As discussed below, the challenged claims are unpatentable in view of the prior art.

A. Ground 1: *Yellin* in View of *Su* Renders Obvious Claims 1-6 and 38-43

1. Claim 1

a) [1.pre] "A transceiver system for transmitting and receiving data using both I and Q channels, comprising:"

To the extent the preamble is limiting, *Yellin* discloses this feature. (Ex. 1002, ¶¶73-90.) For example, *Yellin* discloses an apparatus 300 in figure 2. (Ex. 1005, FIG. 2, 3:5-11.) A POSITA would have understood that apparatus 300 is a

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[3] Because of the different claim interpretation standards used in this proceeding and in district courts, any claim interpretations submitted or implied herein for the purpose of this proceeding are not binding upon Petitioner in any litigation related to the '313 patent. Moreover, Petitioner does not concede that the challenged claims are not invalid under one or more sections of 35 U.S.C. § 112, which is something that cannot be pursued in this proceeding under the Rules.

"transceiver system" because apparatus 300 transmits and receives data using both I and Q channels. (Ex. 1002, ¶73.)

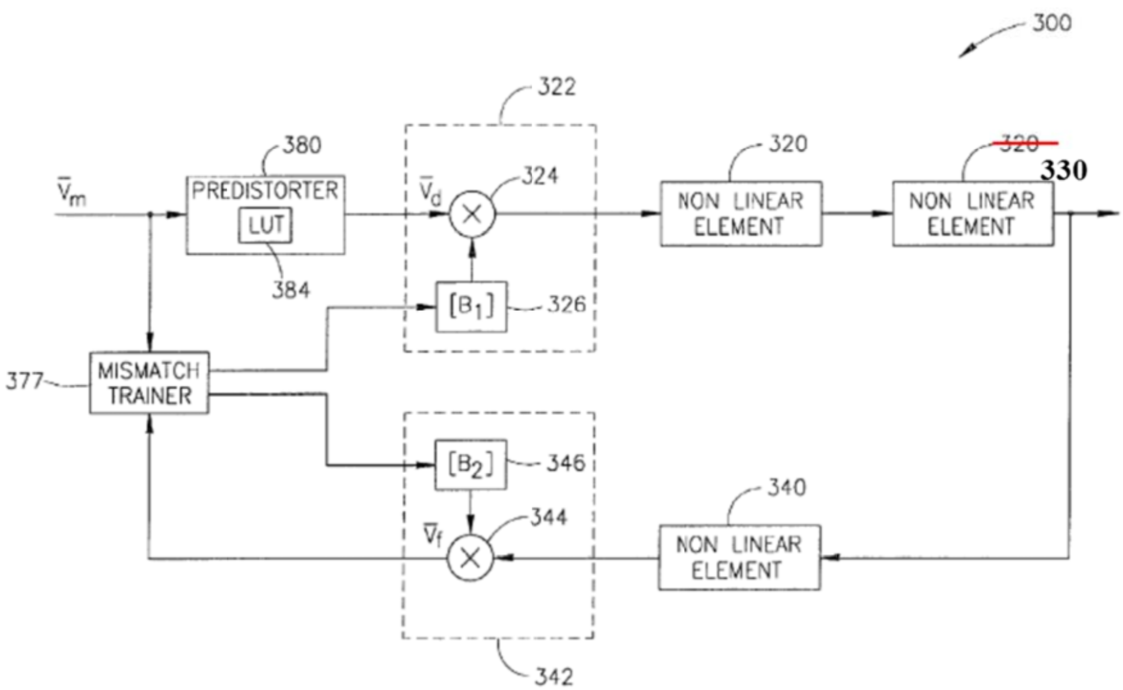

FIG.2

(Ex. 1005, FIG. 2 (annotated); Ex. 1002, ¶73.)

For instance, *Yellin* discloses that a "vector of signals $V_m = (I_m, Q_m)$, formed of a real part I_m and an imaginary part Q_m is provided to a sequence of non-linear elements 320, 330, and 340 . . . ." (Ex. 1005, 3:11-15.) The IQ vectors V_m (and more specifically, IQ vectors V_d, which are predistorted versions of IQ vector V_m)

are received by non-linear element 320, which *Yellin* explains is an IQ modulator.[4] (*Id.,* 3:11-22, 3:48-51, FIG. 2.) The IQ modulator modulates the received IQ vectors onto a high frequency carrier (e.g., RF frequency). (*Id.,* 4:14-15 ("the non-linear elements comprise RF elements"); *see also id.,* 1:5-29 (describing the role of an IQ modulator as modulating baseband I and Q components onto a high frequency carrier).) Therefore, *Yellin* discloses "transmitting . . . data using both I and Q channels" because data on I and Q channels in the form of IQ vectors V_d is transmitted by modulating the IQ channel data onto a high frequency carrier (e.g., an RF carrier). (Ex. 1002, ¶¶74, 50-53.)

The transmitted high frequency signal is injected into non-linear element 340, which is an "IQ demodulator." (Ex. 1005, FIG. 2, 3:21-22.) Non-linear element 340 outputs IQ vectors by demodulating the received high frequency signal. (*Id.,* 3:65-66, 4:14-15, 10:5-10; Ex. 1002, ¶¶75, 54.) IQ correction unit 342 acts upon the resulting IQ vectors to generate IQ vectors V_f, which are output to a mismatch trainer 377. (Ex. 1005, FIG. 2, 3:21-22, 4:31-41.) Therefore, *Yellin* discloses "receiving data using both I and Q channels" because the output vectors

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[4] The gain and the phase of the IQ vector V_d is altered or calibrated by IQ correction unit 322 prior to the vector being provided to non-linear element 320. (Ex. 1005 at 3:23-35; Ex. 1002 at ¶74.)

V_f, which are received by mismatch trainer 377, include data on both the I and Q channels. (Ex. 1002, ¶¶75, 54.)

To the extent Patent Owner contends that apparatus 300 is not a "transceiver," it would have been obvious to implement *Yellin*'s apparatus 300 as a "transceiver" in view of *Su*. (*Id.*, ¶¶76-90.) *Su* discloses that "[i]n a typical wireless communication system, the mobile units used for communication typically include *transceiver[s]* capable of transmitting and receiving messages." (Ex. 1006, 1:20-22 (emphasis added).) *Su* discloses techniques for determining path loss between transceivers, and for determining transmit and receive gains for each transceiver. (*Id.,* 2:35-48, 4:9-19, 7:66—8:7.) *Su* discloses an exemplary configuration of such a transceiver in figures 2A and 2B, which illustrate the configuration of a mobile device. (Ex. 1002, ¶76; Ex. 1006, 4:30-40.)

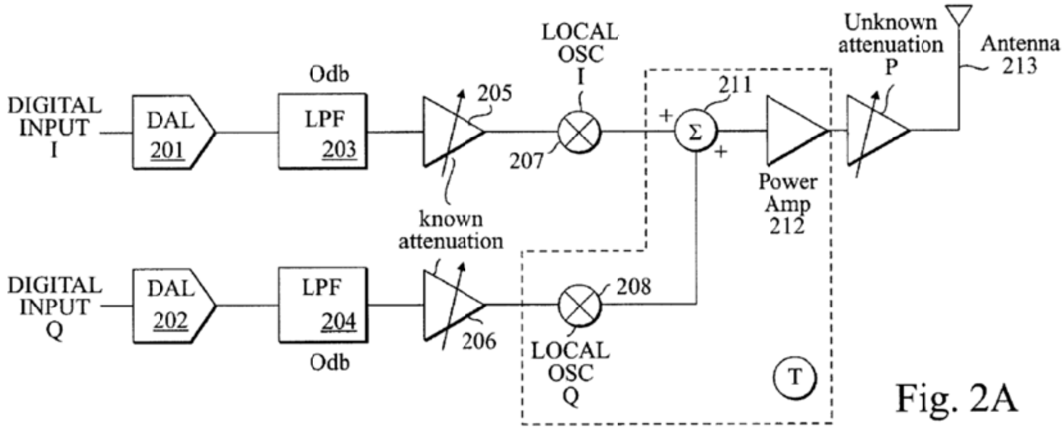

Fig. 2A

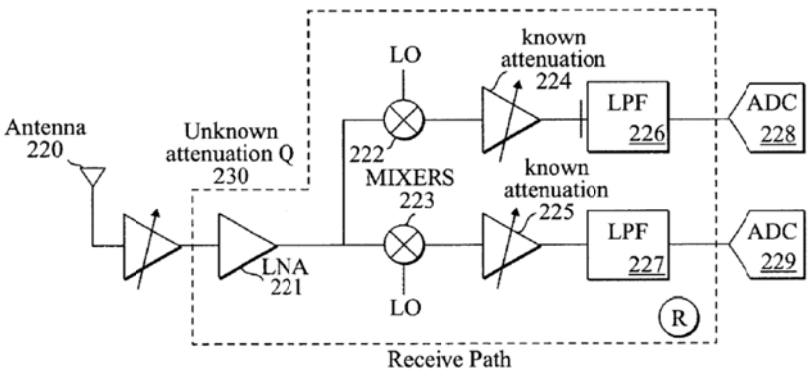

Fig. 2B

(Ex. 1006, FIGS. 2A, 2B.)

The transceiver disclosed in figures 2A and 2B of *Su* is a direct-conversion transceiver because the mobile device includes a transmit path (figure 2A) and a receive path (figure 2B) having direct conversion between baseband and RF. (*Id.*, 2:60-62, FIGS. 2A-2B, 4:35-40; Ex. 1002, ¶78.) Indeed, both the transmit and receive paths in *Su* include components that the ’313 patent admits were present in a “typical direct-conversion transceiver” at the time of the alleged invention of the ’313 patent. (Ex. 1002, ¶78; Ex. 1001, 6:23-24; *compare* Ex. 1006 (FIG. 2A), *with* Ex. 1001 (FIG. 1A); *compare* Ex. 1006 (FIG. 2B), *with* Ex. 1001 (FIG. 1B).)

A POSITA would have looked to *Su* to refine the teachings of *Yellin* because, for instance, both *Yellin* and *Su* disclose techniques for improving the performance of wireless communication devices. (Ex. 1002, ¶80.) Indeed, *Yellin* explicitly contemplates the applicability of its teachings to wireless devices such as handsets, which correspond to the mobile devices in *Su*. (*Id.*; Ex. 1005, 9:57-61; Ex. 1006, 4:30-34.) Having looked to *Su*, a POSITA would have recognized that apparatus 300 in figure 2 of *Yellin* could be implemented as a transceiver without deviating from *Yellin*'s IQ mismatch correction technique. (Ex. 1002, ¶80.) The skilled artisan would have recognized that while apparatus 300 in *Yellin* is not explicitly stated as being a "transceiver," it includes two separate paths (the transmit chain and the receive chain) like those found in a typical transceiver as evidenced by both *Su* and the '313 patent. (*Id.*)

Moreover, a POSITA would have been motivated to implement apparatus 300 of figure 2 as a transceiver and not just as a transmitter, because doing so would have increased the utility of the apparatus 300 with minimal modifications. (*Id.*, ¶¶81-83.) Indeed, *Yellin* discloses performing a calibration cycle that includes calibrating the I-Q mismatch in both the transmit and receive chains (*see infra* Section IX.A.1(e)), thereby providing a fully calibrated receive chain that includes a demodulator and is capable of receiving RF signals and providing output vectors V_f in the form of IQ data. (Ex. 1002, ¶¶82, 59-67.) Furthermore, a POSITA would have been motivated to combine the teachings of *Yellin* and *Su* for the additional reason that *Yellin* discloses techniques for correcting the mismatch between I and Q channels in the transmit and receive chains, and *Su* discloses transmit/receive chains having distinct I and Q channels. (*Id.*, ¶¶84, 59-67; *see supra* Section VII.D, *infra* Section IX.A.1(d); Ex. 1006, FIGS. 2A, 2B.) *Yellin* discloses that the apparatus of figure 2 can be used with transmitters, receivers, or "any other apparatus which suffers from IQ mismatch" (Ex. 1005, 3:8-11), and the '313 patent confirms that direct-conversion transceivers, which were well known in the art, suffer from IQ mismatch. (Ex. 1002, ¶84; *see also* Ex. 1001, 1:37-45.) Therefore, combining the teachings of *Yellin* and *Su* would have allowed for the cancellation of I-Q mismatch in a direct-conversion transceiver as disclosed in *Su*. (Ex. 1002, ¶84.)

A POSITA would have understood that implementing *Yellin*'s apparatus 300 as a "transceiver" would have involved minimal modifications to *Yellin*'s apparatus that would have been within the realm of knowledge of a POSITA. (*Id.*, ¶¶85-88.) For instance, in order to implement *Yellin*'s apparatus 300 as a "transceiver," a POSITA would have provided a connection path between non-linear element 330 and an antenna to allow for transmission of the RF signal to an external device, and a similar path between the same antenna (or a separate antenna like in *Su*) and non-linear element 340 for receiving an incoming RF signal from an external device. (*Id.*, ¶85.) Indeed, *Yellin* already suggests such a configuration. (*See* Ex. 1005, FIG. 1B.) Furthermore, to the extent a single antenna was provided in the transceiver, a POSITA would have also known to add a switching mechanism that could select between a transmit mode (in which data is transmitted from the transmit chain) and a receive mode (in which data is receive by the receive chain). (Ex. 1002, ¶86.) Again, such a feature was well-known as evidenced by *Su* (*see* Ex. 1006, FIG. 6) and the '313 patent (*see* Ex. 1001, 8:10-18, admitting that "a transmit/receive (T/R) switch" was a well-known element of transceiver RF design.") (Ex. 1002, ¶86.) Other modifications to implement apparatus 300 as a "transceiver" would have been apparent to a POSITA given the knowledge of such a skilled person. (*Id.*, ¶¶87-88.)

Accordingly, it would have been obvious to a POSITA to implement the apparatus in figure 2 of *Yellin* as a transceiver like in *Su*. *KSR Int'l Co. v. Teleflex, Inc.,* 550 U.S. at 416-421 (2007). Indeed, a modification of *Yellin* based on *Su* such that *Yellin*'s apparatus 300 is implemented as a "transceiver" would have simply constituted the application of a known technique (*Yellin*'s IQ mismatch correction) to a known device (a transceiver like in *Su*) according to known methods (*Yellin* discloses IQ mismatch correction for both transmitters and receivers) to yield predictable results (I-Q gain imbalance reduction in a transceiver) and hence, would have been obvious to a POSITA. (Ex. 1002, ¶89.) *See KSR,* 550 U.S. at 416-17.

(*See also infra* Sections IX.A.1(b)-(e) for the remaining limitations of this claim.)

b) [1.b] "a transmit chain;"

The combined *Yellin-Su* system discloses or suggests this feature. (Ex. 1002, ¶91.) For instance, IQ correction unit 322 and non-linear element 320 constitute a "transmit chain." (*Id.*) Specifically, multiplier 324 of IQ correction unit 322 multiplies the incoming IQ vectors V_d by a matrix B_1 326. (Ex. 1005, FIG. 2, 3:23-35.) The resulting IQ vectors are modulated onto a high frequency carrier by non-linear element 320 (which is an IQ modulator) and the resulting signal is transmitted to non-linear elements 330 and 340. (S*ee supra* Section IX.A.1(a)); Ex. 1002, ¶¶91, 50-53.)

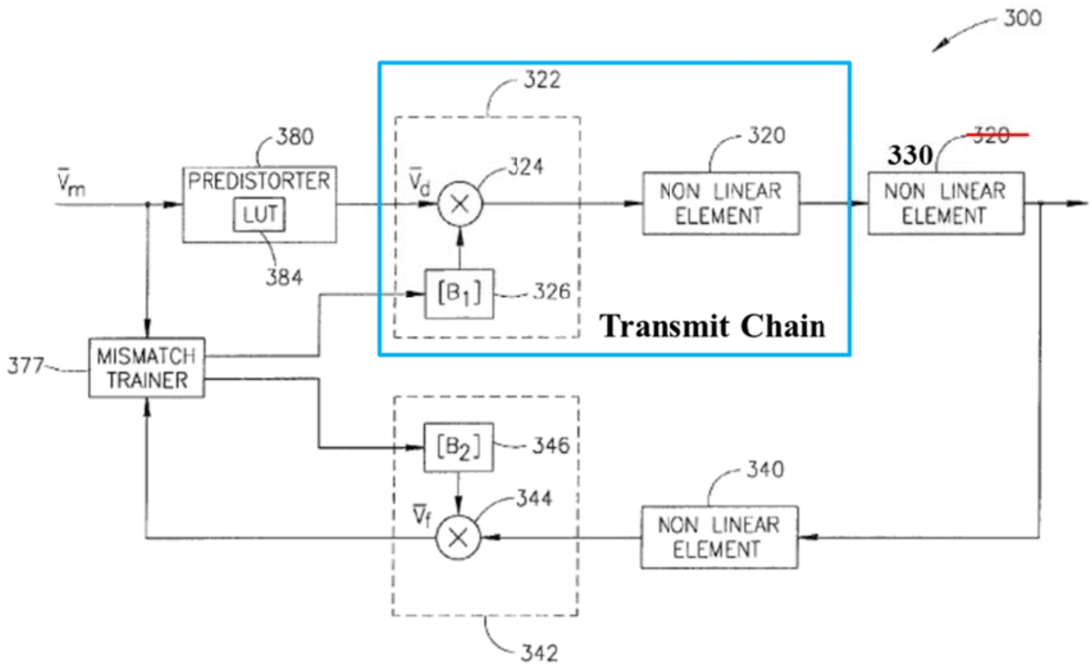

FIG.2

(Ex. 1005, FIG. 2 (annotated); Ex. 1002, ¶91.)

c) [1.c] "a receive chain; and"

The combined *Yellin-Su* system discloses or suggests this feature. (Ex. 1002, ¶92.) For instance, IQ correction unit 342 and non-linear element 340 constitute a "receive chain." (*Id.*) Specifically, the high frequency signal transmitted by the transmit chain is injected into non-linear element 340, which demodulates the high frequency signal and outputs a baseband signal. (*See supra* Section IX.A.1(a); Ex. 1002, ¶¶92, 54.) Multiplier 344 in IQ correction unit 342 multiplies the resulting baseband I-Q vectors by a matrix B_2 346. (Ex. 1005, FIG. 2, 3:22-35.)

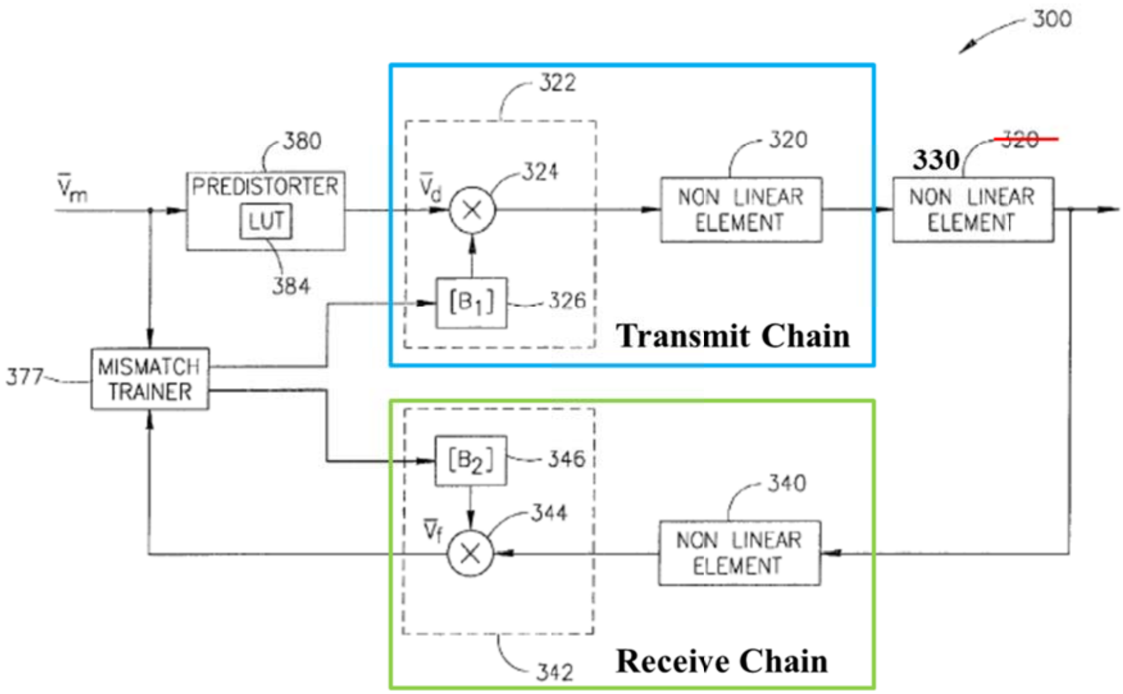

FIG.2

(Ex. 1005, FIG. 2 (annotated); Ex. 1002, ¶92.)

d) [1.d] "a calibration subsystem comprising a signal path for injecting a calibration RF signal, generated in response to and as a function of a signal generated through the transmit chain, into the receive chain of the transceiver in order to independently calibrate the I-Q gain balance of the both transmit and receive chains in their entirety;"

The combined *Yellin-Su* system discloses or suggests this feature. (Ex. 1002, ¶¶93-104.) Figure 2 of *Yellin* includes a mismatch trainer 377, which sets the parameters θ_1, β_1, θ_2, $\beta_{2,}$ of matrices B_1 and B_2 to correct IQ mismatch distortions in non-linear elements 320 and 340. (Ex. 1005, 3:15-38.) As explained below, *Yellin* also discloses a "calibration RF signal" transmitted by non-linear element 330 and injected into non-linear element 340. The combination of mismatch trainer 377 and the signal path carrying the calibration RF signal is a "calibration subsystem" because, as explained below, the combination calibrates the I-Q gain in both the transmit and receive chains. (Ex. 1002, ¶93; *see also supra* Section VII.D.)

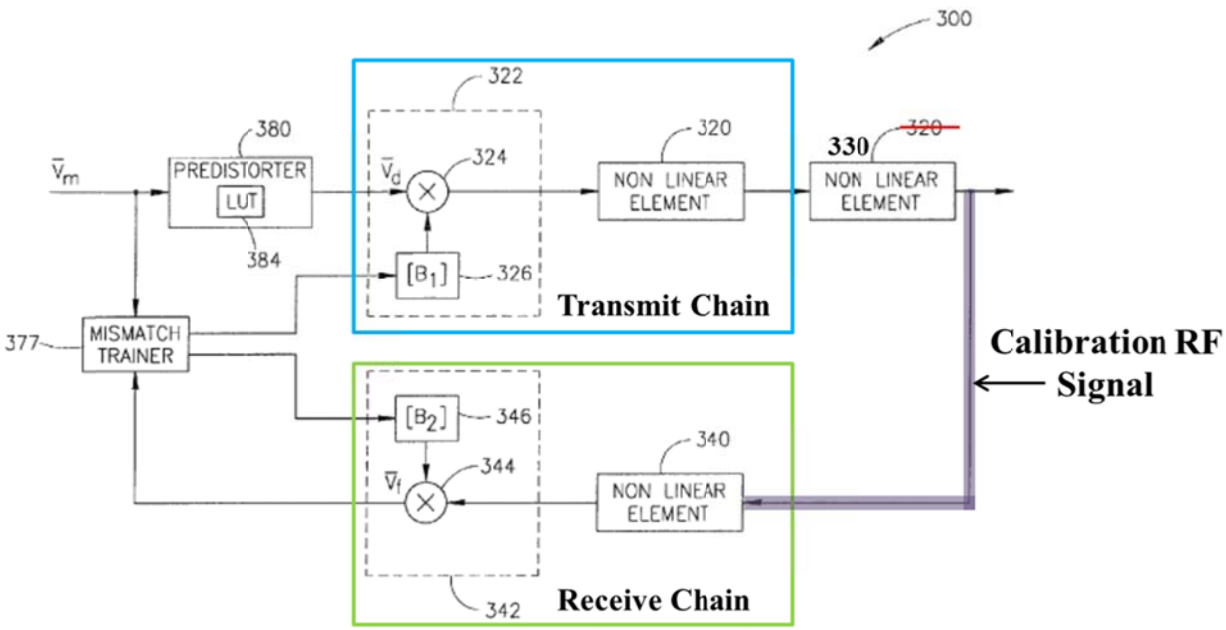

FIG.2

(Ex. 1005, FIG. 2 (annotated); Ex. 1002, ¶93.)

The signal path from non-linear element 330 to non-linear element 340 is "a signal path for injecting a calibration RF signal." (Ex. 1002, ¶94.) For instance, *Yellin* explains that "the non-linear elements comprise RF elements." (Ex. 1005, 4:14-15.) *Yellin* further explains that the V_f vectors in FIG. 2 "pass through additional or less RF elements," which further confirms that the signal injected into non-linear element 340 is an "RF" signal. (*Id.*, 10:5-9; Ex. 1002, ¶94.) The injected "RF" signal is a "calibration" RF signal because the combination of I-Q correction unit 342 and non-linear element 340 outputs IQ vectors V_f based on the injected RF signal and the output IQ vectors V_f are used by mismatch trainer 377 to calibrate (i.e., observe and correct) the matrices B_1 and B_2 by setting the values of θ_1, β_1, θ_2, β_2. (Ex. 1005, 3:64-65, 4:32-51; Ex. 1002, ¶94.)

Yellin also discloses that the "calibration RF signal [is] generated in response to and as a function of a signal generated through the transmit chain" as claimed. (Ex. 1002, ¶95.) For instance, multiplier 324 multiplies the incoming IQ vectors V_d by a matrix B_1 326. (Ex. 1005, FIG. 2, 3:23-35, 3:48-51.) The resulting IQ vectors are modulated onto a high frequency carrier by non-linear element 320 (which is an IQ modulator). (*Id.,* 3:11-22; *see also id.,* 1:5-29 (describing the role of an IQ modulator as modulating baseband I and Q components onto a high frequency carrier).) The resulting high frequency signal is transmitted by non-linear element 330 to non-linear element 340 (*id.,* FIG. 2), and as explained above, the signal transmitted by non-linear element 330 is a "calibration RF signal." (Ex. 1002, ¶¶94-95.) Because the "calibration RF signal" is generated by non-linear element 330 from the signal output by non-linear element 320 (which is the last element of the "transmit chain"), *Yellin* discloses that the "calibration RF signal [is] generated in response to and as a function of a signal generated through the transmit chain." (*Id.*, ¶95.)

Yellin further discloses that the "calibration RF signal [is injected] . . . into the receive chain of the transceiver in order to independently calibrate the I-Q gain balance of the both transmit and receive chains in their entirety" as claimed. (Ex. 1002, ¶96.) As is apparent from figure 2, the "calibration RF signal" is injected into the "receive chain of the transceiver."

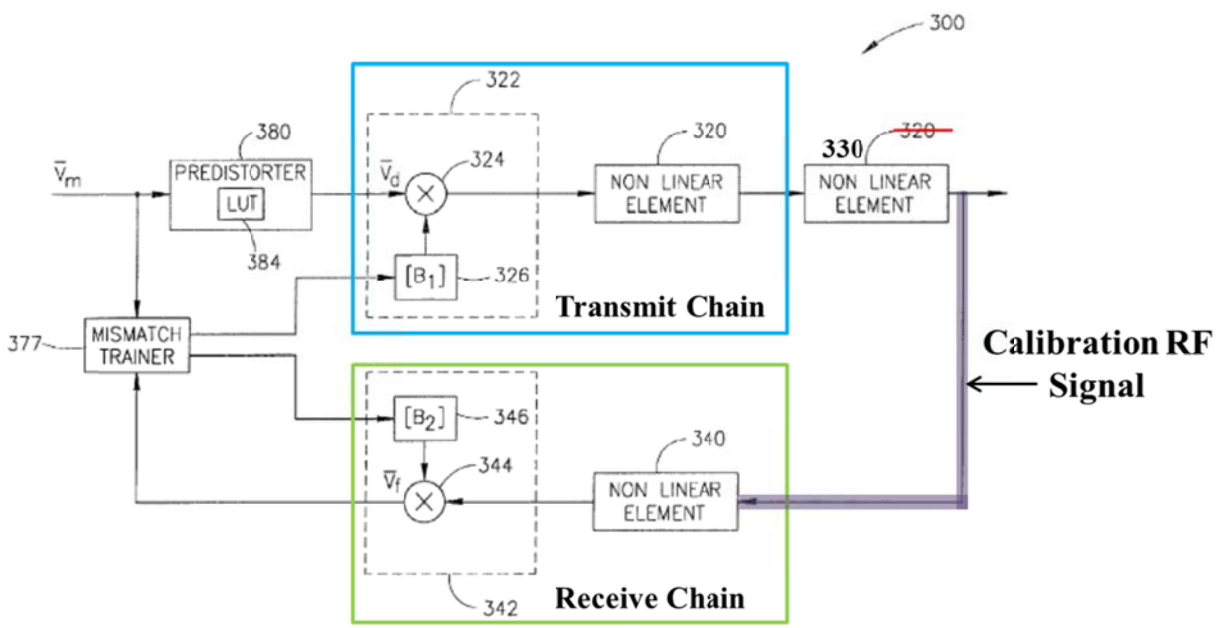

FIG.2

(Ex. 1005, FIG. 2 (annotated); Ex. 1002, ¶96.)

Moreover, *Yellin* discloses that the calibration RF signal is injected into the receive chain "in order to independently calibrate the I-Q gain balance of the both transmit and receive chains in their entirety," as recited in claim element [1.d]. (Ex. 1002, ¶¶97, 59-67.) For instance, IQ vectors V_f are output based on the injected RF signal, and the output IQ vectors V_f are used by mismatch trainer 377 to calibrate (i.e., observe and correct) the matrices B_1 and B_2 in the transmit and receive chains, respectively, by setting the values of θ_1, β_1, θ_2, β_2. (Ex. 1005, 3:64-65, 4:1-5, 4:32-51.) As discussed below, mismatch trainer 377 "independently calibrates the I-Q gain balance of the transmit and receive chains in their entirety" based on how it calibrates θ_1, β_1, θ_2, β_2.

(1) "calibrat[ing] the I-Q gain balance of the both transmit and receive chains in their entirety"

Yellin explains that non-linear elements 320 and 340 suffer from "IQ mismatch distortions" that can be modeled by equation 1. (Ex. 1005, 3:15-20, 1:17-29.)

$$\bar{V}_q = \begin{pmatrix} I_q \\ Q_q \end{pmatrix} = \begin{bmatrix} \cos(\varphi) & \sin(-\varphi) \\ b\sin(-\varphi) & b\cos(\varphi) \end{bmatrix} \begin{pmatrix} I_d \\ Q_d \end{pmatrix}$$

Yellin states that in the above equation "(ϕ, b) are constants which describe the IQ mismatch . . . ." (*Id.,* 1:17-29.) A POSITA would have understood that equation (1) models the I-Q *gain* and phase imbalance introduced by each of non-linear elements 320 and 340. (Ex. 1002, ¶¶98-99; *see also* Ex. 1005, 6:14-17 (expressing the mismatch for non-linear elements 320 and 340 in dB (which represents gain) and degrees (which represents phase)).) Specifically, a POSITA would have understood that the term "b" refers to the Q channel gain if the I channel gain is assumed as "1." (Ex. 1002, ¶99.) Therefore, the gain imbalance between the I and Q channels as modeled in equation (1) is "1-b." (*Id.*) As explained below, *Yellin* discloses that the phase and *gain* imbalances introduced by non-linear elements 320 and 340 are corrected. (Ex. 1002, ¶¶99, 59-67; Ex. 1005, 3:15-17, 3:23-26.)

Specifically, *Yellin* explains that "IQ correction units 322 and 342 comprise respective multipliers 324 and 344 which correct the distortions of the respective modulator/demodulator," i.e., non-linear element 320 (modulator) and non-linear element 340 (demodulator). (Ex. 1005, 3:23-26.) Multiplier 324 multiplies the input I-Q vectors V_d by a matrix B_1 having variables θ_1 and β_1 while multiplier 344 multiplies the output I-Q signal of non-linear element 340 by a matrix B_2 having variables θ_2 and β_2. (*Id.,* 3:26-35, FIG. 2.) *Yellin* explains that mismatch trainer 377 iteratively adjusts the value of matrices B_1 and B_2 by iteratively changing the values of θ_1, β_1, θ_2, β_2 such that the IQ *gain* and phase imbalance in both the transmit and receive chains is corrected. (Ex. 1005, 3:35-47, 4:16—5:29, FIG. 3; Ex. 1002, ¶¶100, 59-67.) For instance, mismatch trainer 377 selects values for θ_1 and β_1 such that the transmit chain (which includes IQ correction unit 322 and non-linear element 320) has virtually no gain or phase imbalance because the IQ correction unit 322 (more specifically, multiplier 324) cancels out the phase and gain imbalance of non-linear element 320. (Ex. 1005, 3:35-47 ("the distortion of non-linear element[] 320 . . . [is] substantially compensated for, as $A_iB_i \approx I$ (I being the 2x2 identity matrix) for i = 1 . . . .").) Similarly, mismatch trainer 377 selects values for θ_2 and β_2 such that the receive chain of IQ correction unit 342 and non-linear element 340 has virtually no gain or phase imbalance because the IQ correction unit 342 (more specifically, multiplier 344 therein) cancels out the phase and gain imbalance of non-linear element 340. (*Id.*, 3:35-47 ("the distortion of non-linear element[] . . . 340 . . . [is] substantially compensated for, as $A_iB_i \approx I$ (I being the 2x2 identity matrix) for i = []2."); Ex. 1002, ¶¶100, 59-67.)

Therefore, *Yellin* discloses "calibrating the I-Q gain balance of the both transmit and receive chains" because the I-Q gain balance of both of the transmit and receive chains is iteratively adjusted by the mismatch trainer 377 until the gain imbalance is effectively zero in both chains. (Ex. 1002, ¶101.) Specifically, the I-Q gain imbalance in both the transmit and receive chains is calibrated to be effectively zero by calibrating θ_1, β_1, θ_2, β_2 (and therefore, matrices B_1 and B_2) to the appropriate values. (*Id.*; *see also* Ex. 1005, 3:40-47.)

Yellin further discloses that the I-Q gain balance of the transmit chain and receive chain is calibrated in "their entirety" because the total I-Q gain balance of both chains is adjusted or calibrated by *Yellin*. (Ex. 1002, ¶102.) As explained above, mismatch trainer 377 iteratively adjusts θ_1, β_1, θ_2, β_2 such that the total I-Q gain imbalance in each of the transmit and receive chains becomes effectively zero. (*Id.*)

(2) "***independently*** calibrat[ing] the I-Q gain balance of the both transmit and receive chains in their entirety"

Yellin further discloses that the mismatch trainer 377 "independently" calibrates the I-Q gain balance of the both transmit and receive chains in their entirety. (Ex. 1002, ¶¶103-04, 59-67.) *Yellin* discloses that mismatch trainer 377 collects a predetermined number of vector pairs (V_m, V_f), estimates values of θ_1, β_1, θ_2, β_2 that minimize a cost function for the collected vector pairs, and assigns the estimated value of θ_1, β_1, θ_2, β_2 to the respective matrices B_1 (associated with the transmit chain) and B_2 (associated with the receive chain). (Ex. 1005, 4:32-51.)

This process of accumulation, estimation, and assignment is "repeated for a predetermined number of repetitions." (*Id.,* 4:57-59, FIG. 3.) During each repetition (i.e., accumulation, estimation, and assignment) "mismatch trainer 377 . . . adjusts the values of θ_1, β_1, θ_2, β_2 . . . ." (*Id.,* 4:1-5.) *Yellin* discloses that as an alternative to adjusting all four parameters (θ_1, β_1, θ_2, β_2) concurrently in a single repetition, "only a sub group of parameters (θ_1, β_1, θ_2, β_2) are adjusted while others are kept constant during that repetition." (*Id.,* 5:3-8.) For instance, during a first repetition or a sequence of first repetitions, "parameters (θ_1, β_1) are adjusted" while (θ_2, β_2) are kept constant, and during a second repetition or a sequence of second repetitions, "parameters (θ_2, β_2) are adjusted" while (θ_1, β_1) are kept constant. (*Id.,* 5:8-15.) Therefore, *Yellin* discloses "independently" calibrating transmit chain parameters (θ_1, β_1) and receive chain parameters (θ_2, β_2) because *Yellin* discloses keeping the transmit chain parameters constant while varying the receive chain parameters, and vice-versa. (Ex. 1002, ¶103.)

As explained above, by calibrating θ_1 and β_1 the I-Q gain imbalance in the transmit chain is minimized or eliminated, and similarly by calibrating θ_2 and β_2, the I-Q gain imbalance in the receive chain is minimized or eliminated. Given that *Yellin* discloses calibrating (θ_1, β_1) and (θ_2, β_2) independently, *Yellin* discloses "independently calibrat[ing] the I-Q gain balance of the both transmit and receive chains in their entirety." Moreover, because this calibration occurs based on the received calibration RF signal, *Yellin* discloses that that the "calibration RF signal [is injected] . . . into the receive chain of the transceiver in order to independently calibrate the I-Q gain balance of the both transmit and receive chains in their entirety." (Ex. 1002, ¶104.)

e) [1.e] "wherein the calibration RF signal includes a calibration cycle, and the calibration cycle determines transmitter I-Q gain settings which minimize an observable indicator while holding receive I-Q gain settings constant, and which in turn determines receiver I-Q gain settings which minimizes the observable indicator while holding the transmit I-Q gain settings constant."

The combined *Yellin-Su* system discloses or suggests this feature. (Ex. 1002, ¶¶105-14.) As discussed above in Section IX.A.1(d), *Yellin* discloses calibrating the transmit chain parameters θ_1, β_1, θ_2, β_2 using the calibration RF signal. As also discussed above in Section IX.A.1(d), calibrating or changing the transmit chain parameters (θ_1, β_1) calibrates the IQ gain imbalance in the transmit chain and similarly, calibrating or changing the receive chain parameters (θ_2, β_2) calibrates the IQ gain imbalance in the receive chain. (Ex. 1002, ¶¶105, 59-67.) *Yellin* discloses the specific example in which the transmit chain parameters (θ_1 and β_1) are calibrated while the receive chain parameters (θ_2 and β_2) are held constant, followed by calibration of the receive chain parameters (θ_2 and β_2) while the transmit chain parameters (θ_1 and β_1) are held constant. (*See id.*; Ex. 1005, 5:3-15.)

Yellin discloses that this calibration of the transmit and receive chain IQ gain imbalances is iterative. (*See supra* Section IX.A.1(d); Ex. 1002, ¶106.) *Yellin* repeats the cycle of calibrating transmit chain parameters (θ_1, β_1), thereby calibrating the transmit chain gain imbalance, followed by calibrating receive chain parameters (θ_2, β_2), thereby calibrating the receive chain gain imbalance. (Ex. 1005, 5:16-18 ("additional repetitions are performed thereafter, in which parameters (θ_1, β_1) and/or (θ_2, β_2) are re-adjusted, for example, alternately.").)

In view of the above, *Yellin* discloses a "calibration cycle," as recited in claim 1, because it discloses a cycle in which the transmit chain IQ gain imbalance is calibrated followed by calibration of the IQ gain imbalance in the receive chain, where that cycle is repeated. (Ex. 1002, ¶107.) This conclusion is consistent with the '313 patent, which discloses that a single "calibration cycle" includes varying the transmit and receive chain gains. (Ex. 1001, 11:17-23 ("convergence of the [calibration] process might require several basic cycles of calibration, each comprising a transmit and a receive variation of gain").) The conclusion is also consistent with the language of claim 1, in which the "calibration cycle determines transmitter I-Q gain settings . . . while holding receive I-Q gain settings constant, and . . . determines receiver I-Q gain settings . . . while holding the transmit I-Q gain settings constant." *Yellin's* cyclical calibration where a cycle includes transmit chain calibration followed by receive chain calibration is consistent with the calibration cycle of transmit chain calibration followed by receive chain calibration recited in claim 1. Moreover, *Yellin* discloses that the "calibration RF signal includes a calibration cycle" because as discussed above in Section IX.A.1(d), the transmit and receive chain gain imbalances are calibrated using the data received in the calibration RF signal. (Ex. 1002, ¶108.) *Yellin* also discloses that the calibration RF signal "includes" a calibration cycle for additional reasons. (*Id.*, ¶¶109-11.)

Yellin also discloses that the "the calibration cycle determines transmitter I-Q gain settings . . . , and . . . determines receiver I-Q gain settings . . . ." (Ex. 1002, ¶112.) As discussed above, changing (θ_1, β_1) calibrates the I-Q gain imbalance of the transmit chain, and changing (θ_2, β_2) calibrates the I-Q gain imbalance of the receive chain. Therefore, (θ_1, β_1) are "transmitter I-Q gain settings" while (θ_2, β_2) are "receiver I-Q gain settings," as recited in claim element 1(e).

Furthermore, *Yellin* discloses that mismatch trainer 377 determines values for θ_1, β_1, θ_2, and β_2 that minimize a cost function ("observable indicator"). (Ex. 1005, 4:41-48.) *Yellin* performs this determination in the "estimation (104)" step, which is part of a single repetition. (*Id.*, 4:41-58; *see also id.,* FIG. 3; *supra* Section IX.A.1(d).) As an alternative to determining all four parameters (θ_1, β_1, θ_2, β_2) concurrently, *Yellin* discloses determining (θ_1, β_1) that minimizes the cost function while holding (θ_2, β_2) constant. (*Supra* Section IX.A.1(d).; Ex. 1005, 5:4-15 (explaining that the "estimation (104)" step is implemented on a subset of θ_1, β_1, θ_2, and β_2).) Therefore, *Yellin* discloses that "the calibration cycle determines transmitter I-Q gain settings which minimize an observable indicator while holding receive I-Q gain settings constant." (Ex. 1002, ¶113.)

After determining (θ_1, β_1), the mismatch trainer 377 determines (θ_2, β_2) that minimizes the cost function while holding (θ_1, β_1) constant. (Ex. 1005, 5:11-15; *see* discussion above and in Section IX.A.1(d).) Therefore, *Yellin* discloses that "the calibration cycle . . . in turn determines receiver I-Q gain settings which minimizes the observable indicator while holding the transmit I-Q gain settings constant." (Ex. 1002, ¶114.)

2. Claim 2

a) [2.a] "A transceiver system according to claim 1, wherein the calibration signal originates at baseband in the transmit channel, and is observed at baseband in the receive channel."

The combined *Yellin-Su* system discloses or suggests this feature. (Ex. 1002, ¶¶115-16.) As discussed above with respect to claim 1, the calibration RF signal is generated by, for example, modulation of baseband I-Q signals by the non-linear element 320. (*Supra* Section IX.A.1(d).) Specifically, the calibration RF signal is generated by non-linear element 320 based on I-Q vectors V_d (*see* Ex. 1005, FIG. 2), which are predistorted versions of IQ vectors V_m. Both V_d and V_m are I-Q vectors at baseband. (*Id.*, 1:5-11 ("The base band values may be complex values having real and imaginary components which are traditionally referred to as I and Q components, respectively.); *see also id.,* 3:11-15 ("A vector of signals $V_m=(I_m,Q_m)$, formed of a real part I_m and an imaginary part Q_m is provided to a sequence of non-linear elements 320, 330 and 340 which includes a signal processing path."), 3:48-51.) Therefore, the calibration RF signal, which represents IQ vector V_m "originates at baseband in the transmit channel" because vector V_m represents baseband values. (Ex. 1002, ¶115.) Indeed, a POSITA would have understood that the modulation from baseband to higher frequency (e.g., RF) occurs at non-linear element 320 (which *Yellin* describes as an IQ modulator) and therefore, the IQ vectors being transmitted through predistorter 380 and IQ correction unit 322 must be at baseband. (*Id.*)

Similarly, non-linear element 340 demodulates the received calibration RF signal to produce IQ vectors V_f, which are also baseband values. (Ex. 1005, 3:64-66.) Again, a POSITA would have understood that non-linear element 340 (which *Yellin* describes as an IQ demodulator) demodulates the received signal from a high frequency (e.g., RF) to baseband and therefore, the IQ vectors output by non-linear element 340 to IQ correction unit 342 must be at baseband. (Ex. 1002, ¶116.) As a result, IQ vectors V_f must also be at baseband ("is observed at baseband in the receive channel") because the IQ correction unit 342 is merely a multiplier that corrects IQ distortion. (*Id.*)

3. Claim 3

a) [3.a] "A transceiver system according to claim 1, wherein the transceiver is a direct-conversion transceiver."

The combined *Yellin-Su* system discloses or suggests this feature. (Ex. 1002, ¶¶117-24.) As discussed above in Section IX.A.1(a), *Yellin*'s apparatus 300 is a "transceiver," but to the extent Patent Owner contends that *Yellin*'s apparatus 300 is not a "transceiver," it would have been obvious to implement *Yellin*'s apparatus 300 as a "transceiver" in view of *Su*. (Ex. 1002, ¶117.) As also discussed above, non-linear element 320 in apparatus 300 receives IQ vectors at baseband and modulates the received baseband IQ vectors onto an RF (i.e., "radio frequency") carrier. (*See supra* Sections IX.A.1(d), IX.A.2.) Similarly, non-linear element 340 in apparatus 300 demodulates an injected RF signal to IQ vectors at baseband. (*See supra* Sections IX.A.1(d), IX.A.2.) *Yellin* is, however, silent on the internal details of non-linear elements 320 and 340, and does not explicitly state whether the non-linear elements 320 and 340 convert directly between baseband and RF, or whether they use an intermediate frequency while converting between baseband and RF. (Ex. 1002, ¶117.) A POSITA would have understood that because an intermediate conversion stage is not shown in non-linear elements 320 and 340, i.e., there is no mention of an intermediate frequency, non-linear elements 320 and 340 perform a *direct* conversion between baseband and RF, and therefore, apparatus 300 is a direct-conversion transceiver. (*Id.*) Indeed, a direct-conversion transceiver is simply one where a baseband signal is converted directly to RF and vice-versa without an intervening conversion to an intermediate frequency (IF). (*Id.*)

To the extent Patent Owner contends that apparatus 300 is not a "direct-conversion transceiver," it would have been obvious to implement *Yellin*'s apparatus 300 as a "direct-conversion transceiver" in view of *Su*. (Ex. 1002, ¶¶118-23.)

The Background of the ’313 patent confirms that a POSITA would have understood that “[d]irect conversion receivers, as the name implies, convert directly between RF and baseband and hence have become popular for Integrated Circuits (ICs) to be used in low-cost equipment.” (Ex. 1001, 1:21-24.) The Background of the ’313 patent contrasts such a direct-conversion transceiver with a “heterodyne” transceiver. (*Id.*, 1:15-21 (“Traditional heterodyne transceivers, for example, employ most of the required gain at an Intermediate-Frequency (IF), between the Radio Frequency (RF) and base band. While very attractive for high-performance applications, heterodyne transceivers require IF components, which cannot be integrated on-chip, thereby increasing the cost.”).) As the ’313 patent confirms, both direct-conversion and heterodyne transceivers were well known in the art before the alleged invention date for the ’313 patent. (Ex. 1001, 4:47-48 (“FIGS. 1*a* and 1*b* show a typical prior art direct-conversion transceiver block diagram”), 4:50-51 (“FIGS. 2*a* and 2*b* show a typical prior art heterodyne-conversion transceiver block diagram”), FIGS. 1*a*, 1*b*, 2*a*, 2*b*; Ex. 1002, ¶119.) Moreover, as confirmed by the ’313 patent, both “direct-conversion” and “heterodyne” transceivers were known to suffer from IQ mismatch. (Ex. 1001, 1:37-45.)

Su discloses a “direct-conversion transceiver” in figures 2A and 2B but notes that the transceiver can also have a “super heterodyne architecture.” (Ex. 1006, 4:35-40.) A POSITA would have found it obvious to implement apparatus 300 in *Yellin* as a direct-conversion transceiver in view of *Su*. (Ex. 1002, ¶120.) As discussed above, a POSITA would have looked to *Su* to refine the teachings of *Yellin*. (*Supra* Section IX.A.1(a).) Having looked to *Su*, a POSITA would have recognized that apparatus 300 in figure 2 of *Yellin* could be implemented as a direct-conversion transceiver without deviating from *Yellin's* IQ mismatch correction technique. (Ex. 1002, ¶120.)

A POSITA would have recognized that direct-conversion transceivers and heterodyne transceivers were design choices for transceivers, and that it was known that both types of transceivers suffer from IQ gain mismatch. (*Id.*, ¶121.) *Yellin* discloses that the apparatus of figure 2 can be used with "any other apparatus which suffers from IQ mismatch" (Ex. 1005, 3:8-11), and the '313 patent confirms that direct-conversion transceivers, which were well known in the art, suffer from IQ mismatch. (Ex. 1001, Abstract; Ex. 1002, ¶121.)

Accordingly, it would have been obvious to a POSITA to implement the apparatus in figure 2 of *Yellin* as a direct-conversion transceiver like in *Su*, because a direct-conversion transceiver was a known design choice and combining the teachings of *Su* and *Yellin* would have produced the expected result of reducing I-Q mismatch in a direct-conversion transceiver. *KSR,* 550 U.S. at 416-421. Indeed, a modification of *Yellin* based on *Su* such that *Yellin*'s apparatus 300 is implemented as a "direct-conversion transceiver" would have simply constituted the application of a known technique (*Yellin*'s IQ mismatch correction) to a known device (a direct-conversion transceiver like in *Su*) according to known methods (implementing direct conversion between baseband and RF in *Yellin*'s apparatus 300) to yield predictable results (I-Q gain imbalance reduction in a direct-conversion transceiver) and hence, would have been obvious to a POSITA. (Ex. 1002, ¶122.) *See KSR,* 550 U.S. at 416-17. It is clear that the selection of a transceiver type is nothing more than a design choice, as the choice of a well-known direct-conversion or heterodyne transceiver is independent of *Yellin's* calibration subsystem in the same manner as the choice between such transceivers is independent of the calibration subsystem in the '313 patent. (Ex. 1002, ¶122.)

Furthermore, a POSITA would have been motivated to use a direct-conversion transceiver (as in *Su*) with the apparatus of figure 2 of *Yellin* because at the time of the alleged invention, it was known that direct-conversion receivers could be integrated on chip and were popular for integrated circuits to be used in low-cost equipment. (Ex. 1002, ¶123; *see also* Ex. 1001, 1:15-24.)

Accordingly, *Yellin* combined with *Su* discloses or suggests that the transceiver is a direct-conversion transceiver. (Ex. 1002, ¶124.)

4. Claim 4

a) [4.a] "A transceiver system according to claim 1, wherein the transceiver is a heterodyne-conversion transceiver."

The combined *Yellin-Su* system discloses or suggests this feature. (Ex. 1002, ¶¶125-27.) While *Yellin* does not explicitly disclose that the apparatus of figure 2 is a "heterodyne-conversion transceiver," *Su* discloses such a transceiver and it would have been obvious for a POSITA to implement apparatus 300 in figure 2 of *Yellin* as a "heterodyne-conversion transceiver." (*Id.*)

As discussed above with respect to claim 3, *Su* discloses both direct-conversion and heterodyne-conversion transceivers. (*Supra* Section IX.A.3.) Moreover, as the '313 patent confirms, both direct-conversion and heterodyne-conversion transceivers were well known in the art before the alleged invention date for the '313 patent. (Ex. 1002, ¶126.) As also discussed above, a POSITA would have recognized that using a direct-conversion transceiver or a heterodyne-conversion transceiver was merely a design choice and that both types of transceivers suffer from IQ gain mismatch. (*Supra* Section IX.A.3.) Therefore, for reasons similar to those discussed above with respect to claim 3, it would have been obvious to a POSITA to use the apparatus in figure 2 of *Yellin* with a heterodyne-conversion transceiver as disclosed in *Su*, at least because a heterodyne-conversion transceiver was a known design choice and the modification would have produced the expected result of IQ gain mismatch reduction in the transceiver. (Ex. 1002, ¶126.) *See KSR,* 550 U.S. at 416-21.

Furthermore, a POSITA would have been motivated to implement apparatus 300 of figure 2 of *Yellin* as a heterodyne-conversion transceiver because, for example, it was known to a POSITA that heterodyne-conversion transceivers are attractive for high-performance applications and heterodyne-conversion transceivers reduce the amount of gain required at baseband. (Ex. 1002, ¶127; *see also* Ex. 1001, 1:15-21.)

5. Claim 5

a) [5.a] "A transceiver system according to claim 1, further including a channel gain adjuster for varying the differential I-Q gain in the transmit and receive chains independently in response to the calibration signal being injected into the receiver chain. "

The combined *Yellin-Su* system discloses or suggests this feature. (Ex. 1002, ¶¶128-29.) *Yellin*'s mismatch trainer 377 corresponds to the claimed "channel gain adjuster." (*Id.*) As discussed above, *Yellin* explains that mismatch trainer 377 adjusts or calibrates the values of θ_1, β_1, θ_2, β_2 such that IQ correction units 322 and 342 eliminate or minimize the IQ *gain* and phase imbalance in both the transmit and receive chains. (Ex. 1005, 3:35-47, 4:16—5:29, FIG. 3; *see also supra* Section IX.A.1(d).; Ex. 1002, ¶128.) The IQ gain imbalance correction in the transmit and receive chains constitutes a varying of the differential I-Q gain because the gain difference between the I and Q channels in each of the transmit and receive chains is calibrated down to zero. (*See supra* Section IX.A.1(d).) Therefore, *Yellin* discloses "a channel gain adjuster for varying the differential I-Q gain in the transmit and receive chains."

As discussed above in Section IX.A.1(d), the IQ gain imbalance of the transmit and receive chains is calibrated or varied "independently in response to the calibration signal being injected into the receiver chain" because the transmit chain parameters (θ_1, β_1 associated with the IQ correction unit 322) and receive chain parameters (θ_2, β_2 associated with the IQ correction unit 342) are calibrated independently in response to the received RF calibration signal. Therefore, *Yellin* discloses that mismatch trainer 377 varies the differential I-Q gain in the transmit and receive chains "independently in response to the calibration signal being injected into the receiver chain." (Ex. 1002, ¶129.)

Patent Owner may argue that it is improper for Petitioner to map mismatch trainer 377 to "channel gain adjuster" in claim 5, while also relying on mismatch trainer 377 as being included in the "calibration subsystem" in claim 1. But such an argument would conflict with claim 7 of the '313 patent, which explicitly includes the "channel gain adjuster" in the "calibration subsystem." (*See also* Ex. 1001, claims 16, 22.) Moreover, the specification of the '313 patent would not support Patent Owner's argument because the specification does not provide any disclosure suggesting that the "calibration subsystem" would not overlap with the "channel gain adjuster." (*See generally* Ex. 1001.) In fact, the '313 patent does not use the terms "calibration subsystem" and "channel gain adjuster" outside of the claims. (*See generally* Ex. 1001.)

6. Claim 6

a) [6.a] "A transceiver system according to claim 1, further including a channel gain adjuster for varying the differential I-Q gain in the imbalanced chain in response to the calibration signal being injected into the receiver chain."

The combined *Yellin-Su* system discloses or suggests this feature. (Ex. 1002, ¶¶130-31; *supra* Section IX.A.5.) Claim 6 is like claim 5, except that claim 6 recites "varying the differential I-Q gain in the *imbalanced chain*." Although there is no antecedent basis for "the imbalanced chain," it is assumed to be referring to either the transmit chain or the receive chain, and as explained in Section IX.A.5, *Yellin* discloses varying the differential I-Q gain in each of the transmit and receive chains independently and therefore would disclose this feature.

7. Claim 38

a) [38.pre] "A method of calibrating a transceiver system for transmitting and receiving data using both I and Q channels and including a transmit chain and a receive chain; the method comprising;"

The combined *Yellin-Su* system discloses or suggests this feature for the reasons discussed above in Sections IX.A.1(a)-(c). (Ex. 1002, ¶132.)

b) [38.b] "injecting a calibration RF signal, generated in response to and as a function of a signal generated through the transmit chain, into the receive chain of the transceiver in order to independently calibrate the I-Q gain balance of the both transmit and receive chains in their entirety;"

The combined *Yellin-Su* system discloses or suggests this feature for the reasons discussed above in Section IX.A.1(d). (Ex. 1002, ¶133.)

c) [38.c] "wherein the calibration RF signal includes a calibration cycle, and further including using the calibration cycle so as to determine transmitter I-Q gain settings so as to minimize an observable indicator while holding receive I-Q gain settings constant, and determining receiver I-Q gain settings so as to minimize the observable indicator while holding transmit I-Q gain settings constant."

The combined *Yellin-Su* system discloses or suggests this feature for the reasons discussed above in Section IX.A.1(e). (Ex. 1002, ¶134.)

8. Claim 39

a) [39.a] "A method according to claim 38, wherein the calibration RF signal originates at baseband in the transmit channel, and is observed at baseband in the receive channel."

The combined *Yellin-Su* system discloses or suggests this feature for the reasons discussed above in Section IX.A.2. (Ex. 1002, ¶135.)

9. Claim 40

a) [40.a] "A method according to claim 38, wherein the transceiver is a direct-conversion transceiver."

The combined *Yellin-Su* system discloses or suggests this feature for reasons similar to those discussed above in Section IX.A.3. (Ex. 1002, ¶136.)

10. Claim 41

a) [41.a] "A method according to claim 38, wherein the transceiver is a heterodyne-conversion transceiver."

The combined *Yellin-Su* system discloses or suggests this feature for reasons similar to those discussed above in Section IX.A.4. (Ex. 1002, ¶137.)

11. Claim 42

a) [42.a] "A method according to claim 38, further including adjusting the channel gain[5] so as to vary the differential I-Q gain in the transmit and receive chains independently in response to the calibration RF signal being injected into the receiver chain."

The combined *Yellin-Su* system discloses or suggests this feature for the reasons discussed above in Section IX.A.5. (Ex. 1002, ¶138.) As explained in sections IX.A.5, the IQ correction units 322 and 342 vary the gain of the transmit

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[5] The term "channel gain" has no antecedent basis. Petitioner assumes for purposes of this proceeding that "the channel gain" refers to the gain of the I-Q channel in the transmit and/or receive chains.

and receive chains, respectively, such that the I-Q gain imbalance in those chains is essentially zero. (*See also supra* Section IX.A.1(d).)

12. Claim 43

a) [43.a] "A method according to claim 38, further including adjusting the channel gain[6] so as to vary the differential I-Q gain in the imbalanced chain in response to the calibration RF signal being injected into the receiver chain."

The combined *Yellin-Su* system discloses or suggests this feature for the reasons discussed above in Section IX.A.6. (Ex. 1002, ¶139.) As explained in Section IX.A.5, the IQ correction units 322 and 342 vary the gain of the transmit and receive chains, respectively, such that the I-Q gain imbalance in those chains is essentially zero. (*See also supra* Section IX.A.1(d).)

X. INSTITUTION SHOULD NOT BE DENIED BASED ON § 325(d)

The Board previously denied an IPR petition challenging the claims at issue here. *See Unified Patents Inc. v. Red Rock Analytics, LLC*, IPR2017-01490, Paper No. 18 at 20 (Dec. 20, 2017)). Although under 35 U.S.C. § 325(d) the Board may in its discretion deny institution if "the same or substantially the same prior art or

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[6] The term "channel gain" has no antecedent basis. Petitioner assumes for purposes of this proceeding that "the channel gain" refers to the gain of the I-Q channel in the transmit and/or receive chains.

arguments previously were presented to the Office," that is not the situation here. The instant petition relies on *Yellin* as the primary reference while the denied petition relied on a different prior art reference (U.S. Patent 6,940,916 to Warner *et al.*). Moreover, the previous petition was filed by a different petitioner. *General Plastic*, IPR2016-01357, Paper No. 19 at 16 (factor #1 for the § 314(a) analysis). The remaining factors related to exercise of discretion under § 314(a) are inapplicable here, because this is not a follow-on petition regarding the same patent by a previously unsuccessful petitioner.

XI. CONCLUSION

For the reasons given above, Petitioner requests institution of IPR for claims 1-6 and 38-43 of the '313 patent based on each of the grounds specified in this petition.

Respectfully submitted,

Dated: February 5, 2018 By: /Naveen Modi/
Naveen Modi (Reg. No. 46,224)

CERTIFICATE OF COMPLIANCE

Pursuant to 37 C.F.R. § 42.24(d), the undersigned certifies that the foregoing Petition for *Inter Partes* Review of U.S. Patent No. 7,346,313 contains, as measured by the word-processing system used to prepare this paper, 9,726 words. This word count does not include the items excluded by 37 C.F.R. § 42.24 as not counting towards the word limit.

Respectfully submitted,

Dated: February 5, 2018

By: /Naveen Modi/
Naveen Modi (Reg. No. 46,224)
Counsel for Petitioner

CERTIFICATE OF SERVICE

I hereby certify that on February 5, 2018, I caused a true and correct copy of the foregoing Petition for *Inter Partes* Review of U.S. Patent No. 7,346,313 and supporting exhibits to be served via express mail on the Patent Owner at the following correspondence address of record as listed on PAIR:

EDELL, SHAPIRO & FINNAN, LLC
9801 Washingtonian Blvd.
Suite 750
Gaithersburg MD 20878

A courtesy copy was also sent electronically to Patent Owner's litigation counsel listed below:

Leslie V. Payne - lpayne@hpcllp.com
Miranda Y. Jones - mjones@hpcllp.com
R. Allan Bullwinkel - abullwinkel@hpcllp.com
J. Boone Baxter - bbaxter@hpcllp.com
Alden G. Harris - aharris@hpcllp.com
HEIM, PAYNE &CHORUSH, LLP
1111 Bagby St. Ste. 2100
Houston, Texas 77002

T. John Ward, Jr. - jw@wsfirm.com
Claire Abernathy Henry - claire@wsfirm.com
WARD, SMITH& HILL, PLLC
1507 Bill Owens Pkwy.
Longview, Texas 75604

S. Calvin Capshaw, III - ccapshaw@capshawlaw.com
Elizabeth L. DeRieux - ederieux@capshawlaw.com
D. Jeffrey Rambin - jrambin@capshawlaw.com
Capshaw DeRieux LLP
114 E. Commerce Avenue

By: /Naveen Modi/
Naveen Modi (Reg. No. 46,224)