

Case No. IPR 2025-00727  
Petition for *Inter Partes* Review of  
U.S. Patent No. 7,035,345

UNITED STATES PATENT AND TRADEMARK OFFICE

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BEFORE THE PATENT TRIAL AND APPEAL BOARD

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**T-MOBILE USA, INC., AT&T MOBILITY LLC, CELLCO PARTNERSHIP  
D/B/A VERIZON WIRELESS, ERICSSON INC. AND  
NOKIA OF AMERICA CORPORATION**

Petitioners,

v.

**SMART RF INC.**

Patent Owner.

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Case No. IPR2025-00727

U.S. Patent No. 7,035,345

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**PETITION FOR *INTER PARTES* REVIEW OF U.S. PATENT NO. 7,035,345  
UNDER 35 U.S.C. §§ 311-319 AND 37 C.F.R. § 42.100 *ET SEQ.***

## TABLE OF CONTENTS

|       |                                                                                                          |    |
|-------|----------------------------------------------------------------------------------------------------------|----|
| I.    | INTRODUCTION .....                                                                                       | 1  |
| II.   | GROUND FORS STANDING (37 C.F.R. § 42.104(a)) .....                                                       | 1  |
| III.  | IDENTIFICATION OF CHALLENGE (37 C.F.R. § 42.104(B)) AND RELIEF<br>REQUESTED (37 C.F.R. § 42.22(A)) ..... | 2  |
|       | A. Identification of Prior Art .....                                                                     | 2  |
|       | B. Statutory Grounds Upon Which the Challenge is Based .....                                             | 3  |
|       | C. Requested Relief.....                                                                                 | 3  |
| IV.   | OVERVIEW OF DIGITAL PREDISTORTION .....                                                                  | 3  |
|       | A. Power Amplifiers Introduce Distortion .....                                                           | 3  |
|       | B. Predistortion Mitigates the Power Amplifier’s Distortion .....                                        | 7  |
|       | 1. Analog and Digital Predistortion .....                                                                | 8  |
| V.    | OVERVIEW OF THE ’345 PATENT.....                                                                         | 9  |
|       | A. Description of the Alleged Invention .....                                                            | 10 |
|       | B. Prosecution History .....                                                                             | 12 |
| VI.   | LEVEL OF ORDINARY SKILL .....                                                                            | 13 |
| VII.  | CLAIM CONSTRUCTION .....                                                                                 | 14 |
| VIII. | OVERVIEW OF THE PRIOR ART .....                                                                          | 14 |
|       | A. Wright .....                                                                                          | 14 |
|       | B. Booth.....                                                                                            | 15 |
|       | C. Leyendecker.....                                                                                      | 16 |
|       | D. Jin.....                                                                                              | 17 |
| IX.   | THE CHALLENGED CLAIMS ARE UNPATENTABLE .....                                                             | 19 |
|       | A. GROUND 1: Claims 1, 2, 5-8, and 11 Are Obvious Based on Wright ....<br>.....                          | 19 |
|       | 1. Claim 1 .....                                                                                         | 19 |
|       | 2. Claim 2 .....                                                                                         | 31 |
|       | 3. Claim 5 .....                                                                                         | 31 |
|       | 4. Claim 6.....                                                                                          | 35 |
|       | 5. Claim 7.....                                                                                          | 36 |
|       | 6. Claim 8.....                                                                                          | 39 |
|       | 7. Claim 11 .....                                                                                        | 40 |
|       | B. GROUND 2: Claims 3, 4, 9, and 10 Are Obvious Based on Wright and<br>Jin.....                          | 42 |

Case No. IPR 2025-00727  
Petition for *Inter Partes* Review of  
U.S. Patent No. 7,035,345

|       |                                                                                                         |    |
|-------|---------------------------------------------------------------------------------------------------------|----|
| 1.    | Motivation to Combine .....                                                                             | 44 |
| 2.    | Claim 3 .....                                                                                           | 48 |
| 3.    | Claim 4 .....                                                                                           | 51 |
| 4.    | Claim 9 .....                                                                                           | 54 |
| 5.    | Claim 10 .....                                                                                          | 56 |
| C.    | GROUND 3: Claims 1, 2, 5, 6, and 11 Are Obvious Based on Booth in<br>Combination with Leyendecker ..... | 57 |
| 1.    | Motivation to Combine .....                                                                             | 58 |
| 2.    | Claim 1 .....                                                                                           | 65 |
| 3.    | Claim 2 .....                                                                                           | 79 |
| 4.    | Claim 5 .....                                                                                           | 79 |
| 5.    | Claim 6 .....                                                                                           | 85 |
| 6.    | Claim 11 .....                                                                                          | 86 |
| X.    | THE BOARD SHOULD NOT EXERCISE ITS DISCRETION TO DENY<br>INSTITUTION .....                               | 88 |
| A.    | The Board Should Not Deny Review Under 35 U.S.C. § 325(d) .....                                         | 88 |
| B.    | The Board Should Not Deny Review under 35 U.S.C. § 314(a) .....                                         | 89 |
| XI.   | CONCLUSION .....                                                                                        | 91 |
| XII.  | MANDATORY NOTICES .....                                                                                 | 93 |
| A.    | Real Parties In Interest (37 C.F.R. § 42.8(b)(1)) .....                                                 | 93 |
| B.    | Related Matters (37 C.F.R. § 42.8(b)(2)) .....                                                          | 94 |
| C.    | Lead and Back-Up Counsel (37 C.F.R. § 42.8(b)(3)) .....                                                 | 94 |
| D.    | Service Information (37 C.F.R. § 42.8(b)(4)) .....                                                      | 94 |
| E.    | Fee for Inter Partes Review .....                                                                       | 95 |
| XIII. | CERTIFICATE OF SERVICE .....                                                                            | 95 |
| XIV.  | CERTIFICATE OF COMPLIANCE WITH 37 C.F.R. § 42.24 .....                                                  | 97 |

**PETITIONERS' EXHIBIT LIST**

| <b>Exhibit No.</b> | <b>Document</b>                                                                                                                                                                                                                                                 |
|--------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>1001</b>        | U.S. Patent No. 7,035,345 (“the ’345 Patent”)                                                                                                                                                                                                                   |
| <b>1002</b>        | Prosecution History of U.S. Application No. 09/877,608, filed June 8, 2001, which issued as U.S. Patent No. 7,035,345 (“’345 File History”)                                                                                                                     |
| <b>1003</b>        | U.S. Patent No. 6,587,514 (“Wright”)                                                                                                                                                                                                                            |
| <b>1004</b>        | U.S. Patent No. 6,693,974 (“Jin”)                                                                                                                                                                                                                               |
| <b>1005</b>        | U.S. Patent No. 6,512,417 (“Booth”)                                                                                                                                                                                                                             |
| <b>1006</b>        | U.S. Patent No. 5,867,065 (“Leyendecker”)                                                                                                                                                                                                                       |
| <b>1007</b>        | Allen Katz, “Linearization: Reducing Distortions in Power Amplifiers,” IEEE Microwave Magazine, Vol. 2, No. 4, pp. 37-49 (Dec. 2001) (“Katz”)                                                                                                                   |
| <b>1008</b>        | Lei Ding, Raviv Raich, G. Tong Zhou, “A Hammerstein Predistortion Linearization Design Based on the Indirect Learning Architecture,” 2002 IEEE International Conference on Acoustics, Speech, and Signal Processing, Vol. 3, pp. 2689-2692 (May 2002) (“Raich”) |
| <b>1009</b>        | Lei Ding, <i>Digital Predistortion of Power Amplifiers for Wireless Applications</i> , A Thesis Presented to the Academic Faculty, School of Electrical and Computer Engineering, Georgia Institute of Technology (March 2004) (“Ding”)                         |
| <b>1010</b>        | Nazim Ceylan, <i>Linearization of Power Amplifiers by Means of Digital Predistortion</i> , Doctoral Thesis, Friedrich-Alexander-Universität Erlangen-Nürnberg (2005) (“Ceylan”)                                                                                 |

| Exhibit No. | Document                                                                                                                                                                                             |
|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>1011</b> | Alan Oppenheim and Ronald Schaffer, <i>Discrete-Time Signal Processing</i> , Prentice Hall (1989) (“Oppenheim”)                                                                                      |
| <b>1012</b> | L. W. Couch, <i>Digital and Analog Communication Systems</i> , Collier MacMillan, New York (1987) (“Couch”)                                                                                          |
| <b>1013</b> | J. Proakis, et al., <i>Communication Systems Engineering</i> , 2nd Ed., Pearson, (2002) (“Proakis”)                                                                                                  |
| <b>1014</b> | U.S. Patent No. 6,072,364 (“Jeckeln”)                                                                                                                                                                |
| <b>1015</b> | C. Eun & E. J. Powers, “A new Volterra predistorter based on the indirect learning architecture,” <i>IEEE Transactions on Signal Processing</i> , Vol. 45, No. 1, pp. 223-227 (Jan. 1997) (“Eun”)    |
| <b>1016</b> | Agilent AN 1311 Application Note, <i>Understanding CDMA Measurements for Base Stations and their Components</i> , Agilent Technologies (2000) (“Agilent 1311”)                                       |
| <b>1017</b> | TIA/EIA/IS-97, <i>Recommended Minimum Performance Standards for Base Stations Supporting Dual-Mode Wideband Spread Spectrum Cellular Mobile Stations</i> , (Dec. 1997) (“IS-97”)                     |
| <b>1018</b> | W-CDMA TS 25.104 v.3.0.0 3rd Generation Partnership Project (3GPP) Technical Specification Group (TSG) RAN WG4 UTRA (BS) FDD; Radio transmission and Reception (Oct. 1999) (“3GPP”)                  |
| <b>1019</b> | Agilent Application Note 1312, <i>Understanding GSM/EDGE Transmitter and Receiver Measurements for Base Transceiver Stations and their Components</i> , Agilent Technologies (2002) (“Agilent 1312”) |

Case No. IPR 2025-00727  
Petition for *Inter Partes* Review of  
U.S. Patent No. 7,035,345

| Exhibit No. | Document                                                                                                                                                                                                                                                   |
|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>1020</b> | User's Guide HP 8590 E-Series and L-Series Spectrum Analyzers, Hewlett Packard Co. (July 1998) (“HP User’s Guide”)                                                                                                                                         |
| <b>1021</b> | A. Lohtia, P. A. Goud and C. G. Englefield, “Adaptive Digital Linearization of RF Power Amplifiers,” Canadian Journal of Electrical and Computer Engineering, Vol. 20, No. 2, pp. 65-71 (April 1995) (“Lohtia”)                                            |
| <b>1022</b> | J. K. Cavers, “The effect of quadrature modulator and demodulator errors on adaptive digital predistorters for amplifier linearization,” IEEE Transactions on Vehicular Technology, Vol. 46, No. 2, pp. 456-466 (May 1997) (“Cavers 1997”)                 |
| <b>1023</b> | J. K. Cavers, et al., “A DSP-based alternative to direct conversion receivers for digital mobile communications,” GLOBECOM '90: IEEE Global Telecommunications Conference and Exhibition, San Diego, CA, USA, Vol. 3, pp. 2024-2029 (1990) (“Cavers 1990”) |
| <b>1024</b> | U.S. Patent Application Publication 2001/0014592 (“Helms”)                                                                                                                                                                                                 |
| <b>1025</b> | U.S. Patent No. 6,246,286 (“Persson”)                                                                                                                                                                                                                      |
| <b>1026</b> | Declaration of James Proctor, Jr. (“Proctor”)                                                                                                                                                                                                              |
| <b>1027</b> | Curriculum Vitae of James Proctor, Jr.                                                                                                                                                                                                                     |
| <b>1028</b> | Table of Challenged Claims                                                                                                                                                                                                                                 |
| <b>1029</b> | Docket Control Order, <i>Smart RF Inc. v. AT&amp;T Mobility LLC et al.</i> , Case No. 2:24-cv-00195-JRG, Dkt. No. 41 (E.D. Tex. June 21, 2024)                                                                                                             |

Case No. IPR 2025-00727  
Petition for *Inter Partes* Review of  
U.S. Patent No. 7,035,345

| Exhibit No. | Document                                                                                                                                                                                                                                                                     |
|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1030        | Federal Court Management Statistics - Profiles, June 30, 2024, <i>available at</i> <a href="https://www.uscourts.gov/sites/default/files/2024-11/fcms_na_distprofile0630_2024.pdf">https://www.uscourts.gov/sites/default/files/2024-11/fcms_na_distprofile0630_2024.pdf</a> |
| 1031        | Order Granting Nokia’s Motion to Intervene as a Defendant, <i>Smart RF Inc. v. AT&amp;T Mobility LLC et al.</i> , Case No. 2:24-cv-00195-JRG, Dkt. No. 57 (E.D. Tex. Aug. 8, 2024)                                                                                           |
| 1032        | Order Granting Ericsson’s Motion to Intervene as a Defendant, <i>Smart RF Inc. v. AT&amp;T Mobility LLC et al.</i> , Case No. 2:24-cv-00195-JRG, Dkt. No. 56 (E.D. Tex. Aug. 8, 2024)                                                                                        |
| 1033        | March 18, 2025 Letter to Litigation Counsel for Smart RF, Inc. re Petitioners’ <i>Sotera</i> Stipulation (“Stipulation”)                                                                                                                                                     |

## **I. INTRODUCTION**

Petitioners T-Mobile USA, Inc. (“T-Mobile”), AT&T Mobility LLC (“AT&T”), Cellco Partnership d/b/a Verizon Wireless (“Verizon”), Ericsson Inc. (“Ericsson”) and Nokia of America Corporation (“Nokia”) (collectively, “Petitioners”) respectfully request *inter partes* review of claims 1-11 (the “Challenged Claims”) of U.S. Patent No. 7,035,345 (“the ’345 Patent,” EX1001) in accordance with 35 U.S.C. §§ 311-319 and 37 C.F.R. § 42.100 *et seq.* The ’345 Patent generally relates to wireless radio systems and techniques for signal predistortion before amplification and, specifically, to the use of digital receiver technology to convert analog RF feedback signals to digital signals to determine how to perform the predistortion. But these methods were already well-known prior to the ’345 Patent.

This Petition, associated exhibits, and the Declaration of James Proctor, Jr. (EX1026, submitted herewith) establish the unpatentability of the Challenged Claims under 35 U.S.C. § 103(a) (pre-AIA).

## **II. GROUNDS FOR STANDING (37 C.F.R. § 42.104(A))**

Petitioners certify under 37 C.F.R. § 42.104(a) that the ’345 Patent is available for IPR and that Petitioners are not barred or estopped from requesting an IPR challenging the patent claims on the grounds identified in this petition.

**III. IDENTIFICATION OF CHALLENGE (37 C.F.R. § 42.104(B) AND RELIEF REQUESTED (37 C.F.R. § 42.22(A))**

**A. Identification of Prior Art**

**EX1003** – U.S. Patent No. 6,587,514 (“EX1003” or “Wright”) issued on July 1, 2003 with a priority claim to a U.S. provisional patent application filed on July 13, 1999, and is therefore prior art under pre-AIA 35 U.S.C. § 102(a) and (b).

**EX1005** – U.S. Patent No. 6,512,417 (“EX1005” or “Booth”) issued on January 28, 2003 from a U.S. patent application filed May 11, 2001 and claims the benefit of a British patent application filed on May 11, 2000, and is therefore prior art under pre-AIA 35 U.S.C. § 102(a) and (e).

**EX1006** – U.S. Patent No. 5,867,065 (“EX1006” or “Leyendecker”) issued on February 2, 1999 from a U.S. patent application filed May 7, 1997, and is therefore prior art under pre-AIA U.S.C. §§ 102(a) and (b).

**EX1004** – U.S. Patent No. 6,693,974 (“EX1004” or “Jin”) issued on February 17, 2004 from a U.S. patent application filed August 5, 1999, and is therefore prior art under pre-AIA 35 U.S.C. § 102(a) and (b).

None of the above references were evaluated during prosecution of the ’345 Patent.

**B. Statutory Grounds Upon Which the Challenge is Based**

| Ground | Claims            | Basis for Challenge under § 103         |
|--------|-------------------|-----------------------------------------|
| 1      | 1, 2, 5-8, and 11 | Wright (EX1003)                         |
| 2      | 3, 4, 9, and 10   | Wright and Jin (EX1004)                 |
| 3      | 1, 2, 5-6, and 11 | Booth (EX1005) and Leyendecker (EX1006) |

**C. Requested Relief**

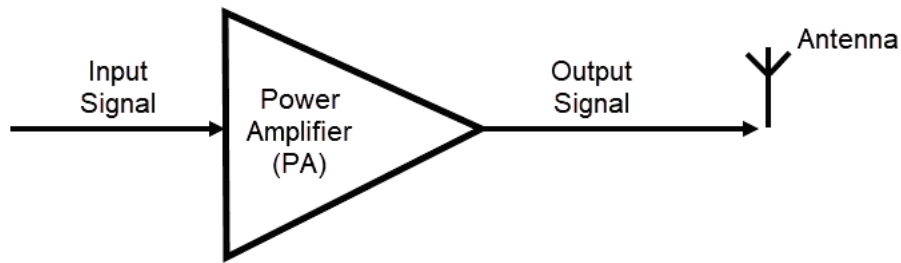
Petitioners respectfully request institution of an *inter partes* review pursuant to 37 C.F.R. § 42.108 and cancellation of the Challenged Claims of the '345 Patent.

**IV. OVERVIEW OF DIGITAL PREDISTORTION**

Radios take input information and produce modulated radio frequency signals that are amplified to a higher power level before transmission over antennas to receivers. (Proctor, ¶34.) The amplification step uses a power amplifier (“PA”), which may cause distortion of the signal. (*Id.*) “Predistortion” is a technique used to counteract the PA’s signal distortion before transmission by the antenna. (*Id.*)

**A. Power Amplifiers Introduce Distortion**

Wireless transmitters use PAs to increase the power at which a signal is transmitted. (*Id.* at ¶35) PAs are typically noted as triangles in circuit diagrams, such as the one below:



(*Id.*) An input signal’s power level is amplified to a higher power level after it passes through the PA to create an output signal. (*Id.*) After this amplification, the output signal is transmitted using an antenna. (*Id.*)

All PAs suffer a common problem: when they amplify a signal, they distort that signal to some degree. (*Id.* at ¶36) That distortion may take the form of (1) spectrum spreading or spectral regrowth (i.e., the signal input to the PA is spread across frequencies beyond the channel(s) over which it is permitted to be transmitted, which results in so-called adjacent channel power (“ACP”) or adjacent channel interference (“ACI”)); or (2) in-band distortion (or more accurately called “in-channel distortion”) within the frequencies of the signal itself, which damages the signal’s quality. (*Id.*)

Below is a figure showing spectrum spreading:

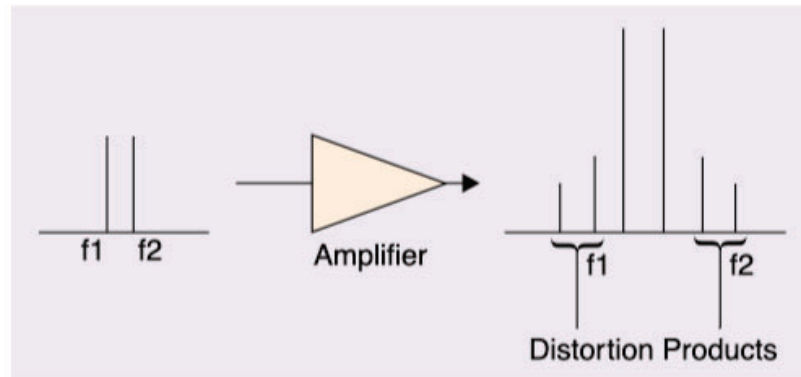
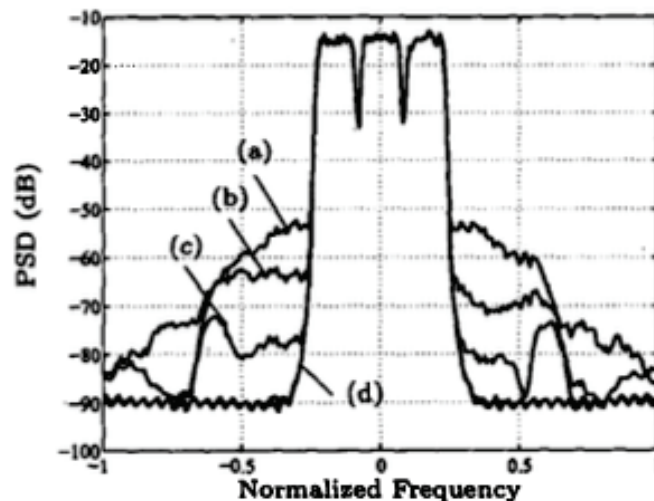


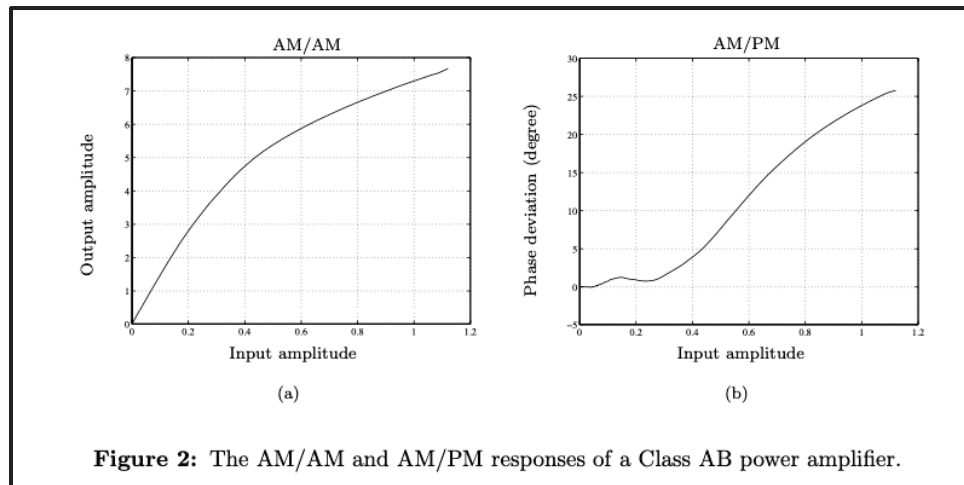
**Figure 1.** When  $\geq 2$  signals are amplified, distortion products appear in the vicinity of the desired signals.

(Katz (EX1007), at Fig. 1; Proctor, ¶37.) Above, two signals  $f_1$  and  $f_2$  are input to the power amplifier, which causes distortions: the signals appearing outside of their intended frequency channels. (Proctor, ¶37.)

The same effect occurs for modulated input signals composed of multiple frequencies within a given channel, as shown in the following figure:



(Raich (EX1008), Fig. 3; Proctor, ¶38.) In the above figure, the input signal is labeled (d), while the output of the amplifier with distortion is labeled (a).<sup>1</sup> (Proctor, ¶38.) When charted, these distortions can also appear as non-linear curves, where the non-linear curvature represents the distortions that the PAs introduce:



(Ding (EX1009), Fig. 2.) The above figures depict the relationship of a PA's output to the input signals' amplitude. (Proctor, ¶38.) An ideal PA would proportionally increase the amplitude of a signal, referred to as the amplifier's "gain," to produce a perfectly straight-sloped line in Plot (a), rather than the depicted curved line, which results in different amplification levels depending upon the input level. (*Id.*) Such an amplifier might multiply the input amplitude by a factor of ten as a signal changes

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<sup>1</sup> Plots (b) and (c) show different pre-distortion schemes attempting to compensate for the distortions to "linearize" the amplifier. (Proctor, ¶38.)

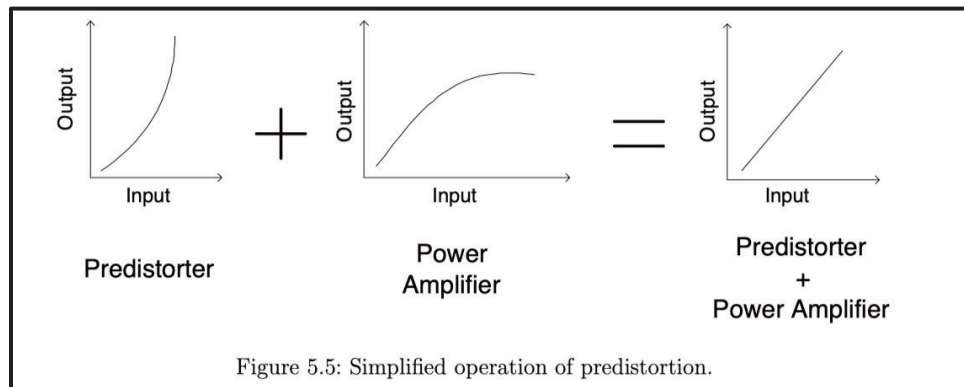
its amplitude independent of input level. (*Id.*) The nonlinear curve shown in Plot (a) will produce “amplitude modulation” that results in distortion of the output signal referred to as “AM-to-AM.” (*Id.*)

Plot (b) depicts the phase imparted to the output signal based upon the input signal’s amplitude. (Proctor, ¶39.) Here, an ideal PA would have a flat line such that any additional phase imparted to the output signal would be constant—not depending upon the input level. (*Id.*) The depicted curved line indicates that the additional phase added to the signal will change depending on the input signal’s amplitude modulation, causing phase modulation (“PM”) in the output signal, called “AM-to-PM” distortion. (*Id.*)

## **B. Predistortion Mitigates the Power Amplifier’s Distortion**

To mitigate PA distortion, radios will *predistort* the input signals before they are sent to the PA. (Proctor, ¶40.) The predistortion begins by “modeling” the PA’s distortion effects. (*Id.*) Using knowledge of what kind of distortion a given PA is likely to introduce, a radio can predistort input signals such that their later distortion is largely canceled in the output signal. (*Id.*) Because distortion introduces a non-linear gain curve to an input signal, and predistortion seeks to linearize that curve, predistorting input signals is sometimes called “linearization.” (*Id.*)

This figure illustrates a predistorter’s operation in a simplified way:



(Ceylan (EX1010), Fig. 5.5; Proctor, ¶41.) The figure shows AM-AM correction done by a predistorter. (*Id.*) The AM-AM curve of the predistorter is designed so that it compensates for the AM-AM curve of the power amplifier resulting in a linearized power amplifier output (a straight-sloped line). (*Id.*)

In general, a similar correction is also done for phase (AM-PM), discussed above, by adding a phase to the input signal opposite of the phase shift due to the PA. (Proctor, ¶42.) Any additional phase imparted to the output signal should be a constant (flat line), independent of the input signal's amplitude. (*Id.*)

### 1. Analog and Digital Predistortion

Predistortion may be implemented digitally (“digital predistortion” or “DPD”) or using analog circuitry (“analog predistortion” or “APD”). (Proctor, ¶43.) While there are numerous differences between analog and digital predistortion, a key distinction is the manner in which these systems model PA distortion. (*Id.*) For example, a conventional analog predistorter using polar or rectangular feedback approaches may perform predistortion using RF feedback signals corresponding to

the input and output of the PA. (*Id.*) Analog circuitry, such as envelope detectors or phase detectors, may then be used to determine the differences between the RF feedback signals. (*Id.*) An error signal resulting from these differences corresponding to the distortion produced by the PA would then be combined with the original RF input in order to generate an RF predistorted signal. (*Id.*) Thus, conventional approaches predistort signals in the RF domain and do not require D/A or A/D converters which are needed in a DPD system. (*Id.*)

Digital predistortion, by contrast, may model PA distortion in the baseband or digital domain using sophisticated algorithms and mathematical models that are implemented in digital hardware such as a Field Programmable Gate Array (FPGA), or software using a digital signal processor (“DSP”). (Proctor, ¶44.) DPD may still make use of RF feedback from the PA; however, one or more digital receivers are needed to translate the RF feedback signals to digital baseband or an intermediate frequency (“IF”) in order to model the distortion. (*Id.*, Oppenheim (EX1011), at 86. *See also*, Proctor, ¶¶45-55, Couch (EX1012), at 204-206.)

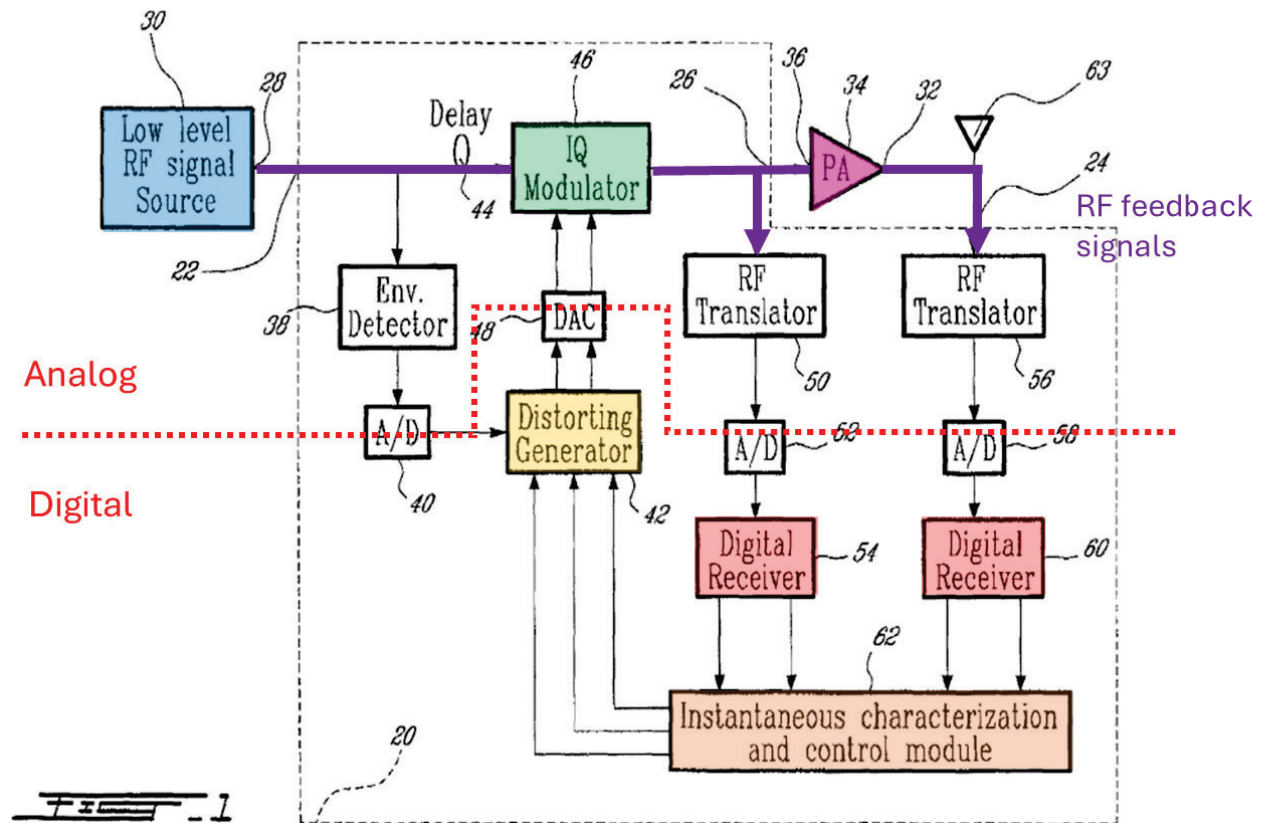
## **V. OVERVIEW OF THE ’345 PATENT**

The ’345 Patent is entitled “Adaptive predistortion device and method using digital receiver.” The ’345 Patent issued on April 25, 2006 from U.S. Patent Application No. 09/877,608, which was filed on June 8, 2001.

**A. Description of the Alleged Invention**

The '345 Patent relates to systems and methods for predistorting an RF modulated signal from a signal source to a PA in order to produce an amplified output signal. (EX1001, 2:54-59.) The '345 Patent states that, although predistortion techniques for both analog and digital implementations were well-known at the time, “[i]n most cases, linearizer designers have no access to baseband signal; hence they found themselves confined to use traditional Radio-frequency (hereinafter ‘RF’) analog predistortion techniques.” (*Id.* at 1:62-2:23, 2:27-31.) The claimed predistortion device and methods purport to address this concern of only having access to the analog RF signal—not the digital baseband signal—“[b]y taking advantage of the digital receiver technology to digitally translate signal [sic] from RF to baseband” such that “the predistorting device of the invention performs the instantaneous characterization of the memoryless nonlinearity in baseband to supply a correlated predistortion function.” (*Id.* at 2:49-50, 5:8-13.)

Figure 1 depicts an exemplary embodiment of the claimed predistorting device:



(*Id.* at Fig. 1 (annotated).) As shown in Figure 1, the claimed digital receivers 54 and 60 (red) can be implemented in predistortion systems having an analog, RF signal source (blue). (*Id.*) The digital receivers are used to process the analog feedback signals (purple) corresponding to (1) the RF signal provided to the PA input 36, and (2) the RF output signal of the PA (second input 24). (*Id.*)

The instantaneous characterization and control module 62 (orange) then compares the feedback signals to determine the PA's distortion effects. (*Id.* at 5:48-51, Fig. 1.) More specifically, the module 62 correlates the amplitude and phase characteristics of the PA input and output signals in order to yield the PA's

predistortion function. (*Id.*, 5:66-6:13.) The module 62 then updates the amplitude and phase LUT of the distorting generator 42 (yellow) so the quadrature modulator 46 (green) correctly pre-distorts future RF signals. (*Id.* at 6:13-20; Fig. 1.) This characterization process is adaptively performed to ensure that the PA efficiently and adequately reproduces the amplified signal at higher powers. (*Id.* at 8:12-19.)

## **B. Prosecution History**

The application that resulted in the '345 Patent was filed on June 8, 2001. On January 12, 2005, the Examiner issued a first non-final Office Action rejecting pending claims 1-3, 8, 16 and 17 as obvious in view of U.S. Patent Application Publication 2001/0014592 (“Helms”), and further in view of U.S. Patent No. 6,246,286 (“Persson”). (EX1002 ('345 File History) at 75-76.) The Examiner explained that “Helms discloses all of the subject matter . . . except for specifically teaching the look-up tables which is an *amplitude and phase* look-up table.”<sup>2</sup> (EX1002, 77, 79.) The Examiner explained that it would have been obvious to modify the look-up table (“LUT”) of Helms with Persson’s teachings of an “amplitude” and “phase” LUT in order to more effectively compensate for distortion effects of a PA while simultaneously decreasing power consumption. (*Id.* at 77.) Pending dependent claims 4-7 and 9-15 were also rejected—but the Examiner

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<sup>2</sup> Unless otherwise indicated, all emphasis in citations has been added.

indicated that these claims would have been allowed if rewritten in independent form. (*Id.* at 80.)

In its July 12, 2005 Response, Applicant sought to distinguish Helms on the grounds that “[t]he claimed invention calls for the synthesis of the predistorted signal using only one LUT for the whole communication signal . . . in sharp contrast with Helms’ method of generating the predistorted signal using multiples LUT [sic], i.e. one LUT per carrier.” (*Id.* at 101.) Additionally, Applicant sought to distinguish Persson arguing, *inter alia*, that Persson’s method extracts the amplitude and phase characteristics of the distorted signal using analog circuits, whereas the claimed methods perform this characterization digitally. (*Id.* at 101-02.)

In a September 6, 2005 Final Rejection, the Examiner rejected these arguments. (*Id.* at 111.) The Applicant cancelled the rejected claims and amended pending claims 4-7 and 9-15 to include all of the limitations of the base independent claims, after which the Office issued a Notice of Allowance.<sup>3</sup> (*Id.* at 143-48.)

## **VI. LEVEL OF ORDINARY SKILL**

A person of ordinary skill in the art (“POSITA”) at the time of the earliest priority date of the ’345 Patent would have been someone with at least (1) a

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<sup>3</sup> Pending claims 4, 6, 9, 11, 13 and 15 correspond to independent claims 1, 3, 5, 7, 9, and 11, respectively.

bachelor's degree in electrical engineering or a related field, and (2) either (a) a master's degree in electrical engineering or a related field, or (b) two or more years of work or research experience in wireless communications and, in particular, power amplification of radio signals. (Proctor, ¶30.)

## VII. CLAIM CONSTRUCTION

All claim terms should be construed according to the *Phillips* standard. *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005) (*en banc*); 37 C.F.R. § 42.100. Petitioners do not believe it is necessary for the Board to expressly construe any term for the purpose of this IPR proceeding. *See Vivid Techs., Inc. v. Am. Sci. & Eng'g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999).

Petitioners reserve the right to respond to any constructions offered by Patent Owner or adopted by the Board. Additionally, Petitioners reserve the right to pursue different constructions before the district court.

## VIII. OVERVIEW OF THE PRIOR ART

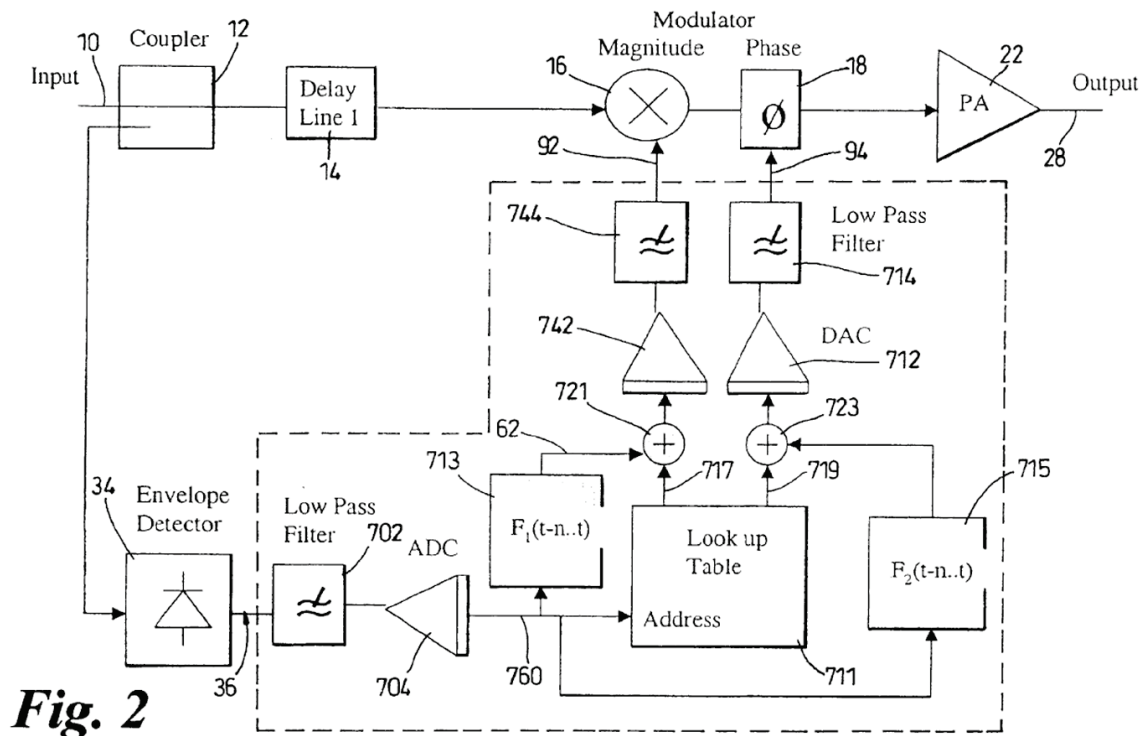
### A. Wright

Wright discloses improved systems and methods for digitally predistorting wideband signals. (Wright, Abstract, 1:22-30.) Wright explains that then-existing predistortion systems failed to accurately account for distortion effects based on the past inputs to the PA ("memory effects"), which may be caused by, among other things, fluctuations in the PA's temperature variations. (*Id.* at 2:9-17.) Wright

discloses using a compensation circuit, including a Digital Compensation Signal Processor (“DCSP”) and Adaptive Control Processing and Compensation Estimator (“ACPCE”), that indexes the predistorter’s LUT based on the input transmission signal, which allows the accuracy of the predistortion model to be increased. (*Id.* at 2:35-3:7.) Wright’s predistortion technique could be adapted for both systems having a digital baseband input signal as well as those having an analog RF input signal. (*Id.* at 43:33-39.)

## **B. Booth**

Booth discloses an improved digital predistortion system for analog RF transmitters. (Booth, Abstract, 2:40-51.) Booth teaches a digital predistortion system that considers both instantaneous distortion effects as well as memory effects to more accurately predistort the signal. (*Id.* at 2:40-62.) Booth explains that the memory effects can be greatly mitigated while adding little additional cost to the PA’s arrangement. (*Id.*)



(Booth, 7:5-32, Fig. 2.)

### C. Leyendecker

Leyendecker discloses an improved predistortion system for wireless transmitters. (Leyendecker, 2:57-60, 2:66-3:5.) Leyendecker recognized that predistorting a signal using only the instantaneous power or magnitude does not completely reflect the distortion caused by an amplifier. (*Id.* at 9:4-18.) Leyendecker teaches a dynamic, “memory effect” model that considers past power or magnitude of PA inputs to more accurately model distortion. (*Id.*)

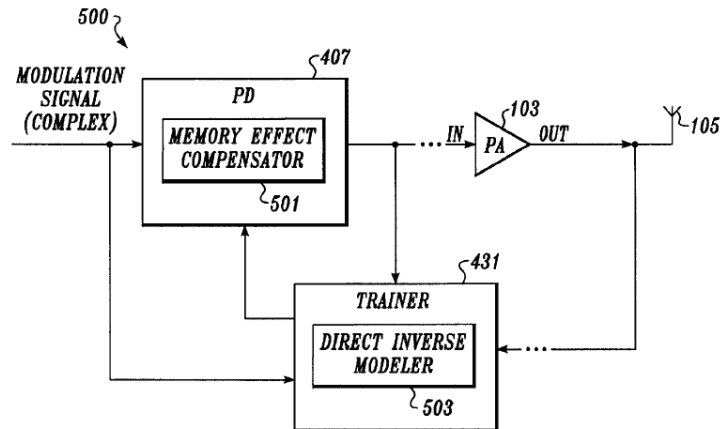


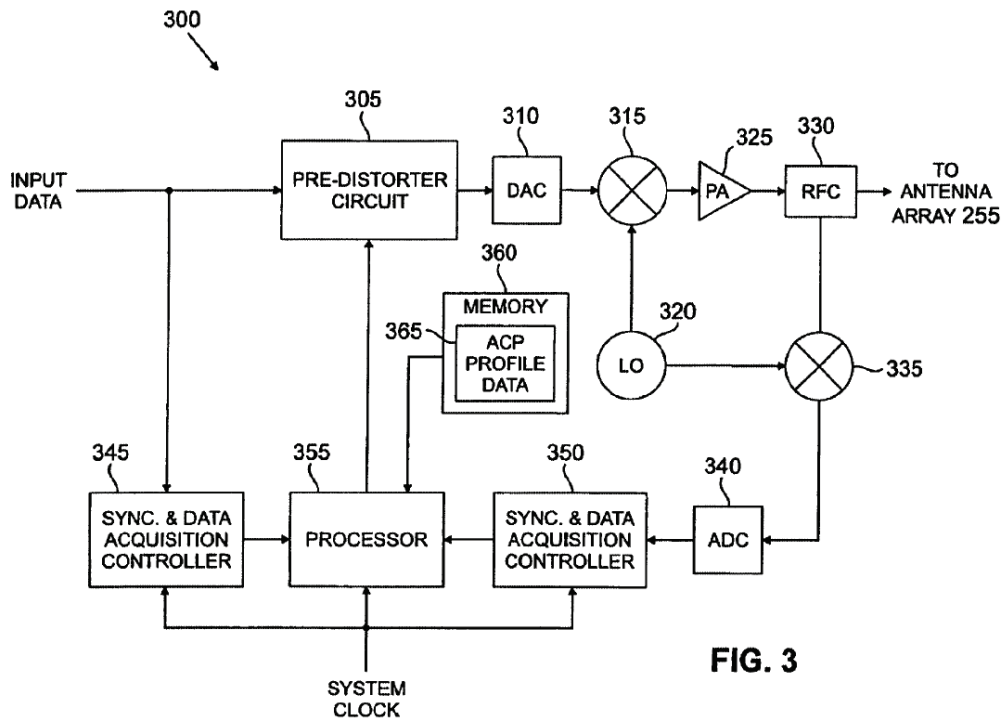
*Fig. 5*

(*Id.* at Fig. 5.)

Leyendecker also teaches using digital receivers to convert signals from analog to digital to aid the digital predistortion. (*Id.* at 6:13-41.) For example, a digital receiver downconverts, digitizes and demodulates the RF signal to digital baseband in order to produce the signal’s complex envelope that is used in the predistortion. (*Id.*) Leyendecker also explains that the digital receivers may provide additional digital filtering and/or decimation processes. (*Id.* at 6:66-7:8.)

#### **D. Jin**

Jin discloses an adaptive digital predistorter for use in an RF transmitter. (Jin, 1:19-21.) More specifically, Jin discloses a “pre-distortion adjustment circuit . . . that optimizes the ACP profile of an RF power amplifier to fully use the ACP profile under the applicable RF communication standard.” (*Id.* at 2:30-33.)



(*Id.* at Fig. 3.)

Jin explains that “[g]enerally speaking, the actual ACP profile of an RF PA is not the same as the ACP profile required by the standard[,]” so “there is a need for RF power controllers that make RF power amplifiers more efficient by utilizing the available ACP noise margins.” (*Id.* at 1:62-64, 2:22-25.) To resolve this problem, Jin discloses an ACP minimization sub-step “that samples the RF transmitter input and output signals, and synchronizes and compares the samples to each other and to the ACP profile of an applicable standard.” (*Id.* at 6:4-9.)

**IX. THE CHALLENGED CLAIMS ARE UNPATENTABLE**

**A. GROUND 1: Claims 1, 2, 5-8, and 11 Are Obvious Based on Wright**

Claims 1, 2, 5-8, and 11 are directed to the use of two or more digital receivers to perform digital predistortion on an analog, RF input signal. The '345 Patent concedes that both analog predistortion and digital predistortion were well-known in the art. (EX1001, 1:51-2:23.) As discussed below, Wright discloses the concept of using digital receivers to create a complex representation of an RF signal and teaches every limitation of Claims 1, 2, 5-8, and 11.

**1. Claim 1**

- a. 1[pre]: An adaptive method for predistorting an RF modulated signal, to be transmitted, supplied by a signal source to an input of a power amplifier having an output for delivering an amplified output signal, said method comprising the steps of:**

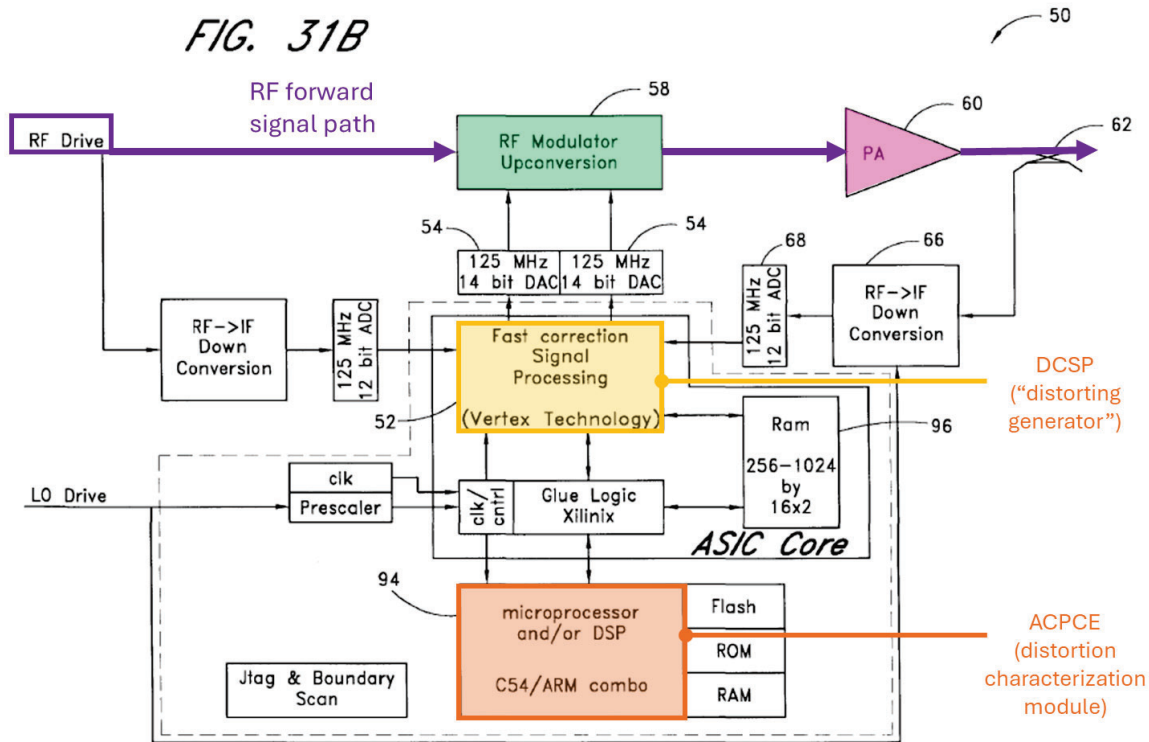
If the preamble is limiting, then Wright teaches 1[pre]. (Proctor, ¶78.) Wright teaches “a wideband predistortion system and associated methods for compensating for nonlinear characteristics of a power amplifier.” (Wright, 2:23-27.) Wright explains that its predistortion system may process multiple feedback signals in order to generate correction signals, which are in turn used to predistort the RF input to cancel the PA’s distortion. (*Id.* at 8:18-28, 43:34-39, Fig. 31B; Proctor, ¶78.)

- b. 1[a]: predistorting the RF modulated signal to be transmitted using an I/Q modulator interposed between the signal source and the input of the power amplifier, and controlled by means of amplitude and phase look-up tables stored in a distorting generator;**

Wright discloses generating a predistorted RF signal based on feedback received from an RF input signal as well as feedback from the input and output of the PA. (Wright, 8:18-28; Proctor, ¶79.) Wright’s “I/Q modulator” is the “RF Modulator Upconversion” block shown below in green. (Wright, 12:21-40, 43:33-39, Fig. 31B; Proctor, ¶79.) As Wright explains, in a system having a RF-input signal, the DCSP<sup>4</sup> (yellow) outputs correction coefficients to the I/Q modulator (green), which applies these vectors to the RF signal (purple) in order to generate a RF predistorted signal. (*Id.*) The RF predistorted signal is then supplied to the PA (pink). (*Id.*)

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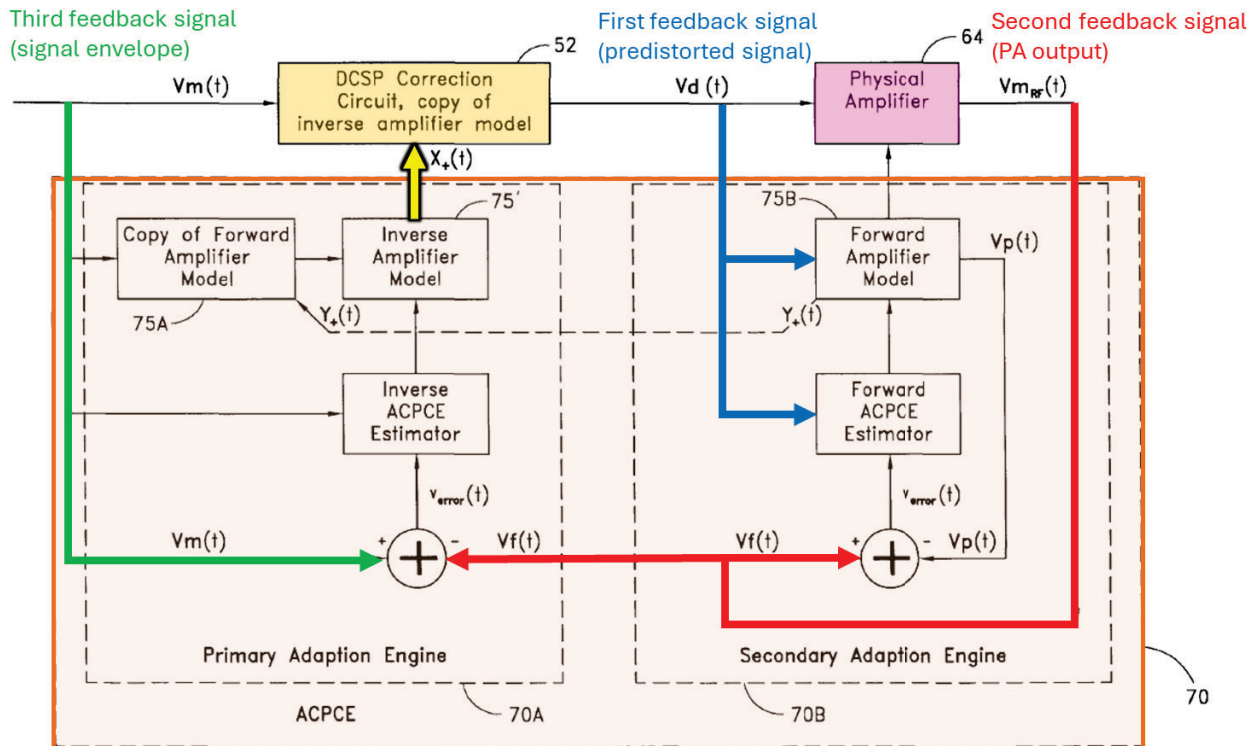
<sup>4</sup> The “DCSP” is the Digital Compensation Signal Processor, which uses a LUT indexed by multiple dimensions of an input signal (e.g., instantaneous magnitude (amplitude) and phase characteristics). (Wright, 10:45-49, 11:41-12:7, 12:30-40; Proctor, ¶80.)



(Wright, 11:41-12:7, 12:28-37, 43:33-39, Fig. 31B (annotated).)

- c. 1[b]: producing, via a first digital receiver, a first feedback signal in response to the RF predistorted signal;

Wright teaches that the digital predistortion system may utilize three feedback signals in order to model the PA nonlinearity. (Wright, 41:44-42:47, Fig. 30; Proctor, ¶81.) These signals are translated into a complex baseband signal (i.e., the in-phase (*I*) and quadrature (*Q*) signal components representing the signal's real and imaginary values, respectively) for the modeling step. (Wright, 9:38-44, 10:30-44, 41:44-57; Proctor, ¶¶81, 51-55.)



(Wright, 41:44-42:47, Fig. 30 (annotated).) Wright explains that the predistorted signal (“first feedback signal,” blue) is supplied to the Adaptive Control Processing and Compensation Estimator (“ACPCE,” orange), which estimates the distortion parameters and updates the DCSP (yellow). (Wright, 17:32-36, 41:44-42:47; Proctor, ¶81.) The ACPCE may be implemented in a system having an RF-input. (Wright, 8:39-48, 43:33-39 (explaining that, for an RF embodiment, “the core DCSP and ACPCE processes are identical with a few minor modifications to accommodate the imperfections of the input downconversion process and the digital drive circuitry.”), 60:15-21, Fig. 31B; Proctor, ¶81.)

**i. Wright Renders Obvious a First Digital Receiver**

Although Wright does not expressly disclose that the first feedback signal is supplied to the ACPCE using a digital receiver, this step would have been obvious to a POSITA. (Proctor, ¶82.) In an RF-in/RF-out system (such as in Wright’s Fig. 31B), the RF signal samples (e.g., the RF predistorted signal) must be converted to its complex baseband representation before processing. (Wright, 9:38-44, 43:33-39, Fig. 31B; Proctor, ¶¶82, 46-55.) This is because the ACPCE is implemented digitally and cannot accept an analog input. (Wright, 41:44-57, 43:33-39, Figs. 30, 31B; Proctor, ¶82.)

A POSITA would have known that this conversion could be achieved in only one of two ways: using an analog I/Q demodulator or using a digital receiver. (Proctor, ¶83.) *KSR Intern. Co. v. Teleflex Inc.*, 550 U.S. 398, 420 (2007) (“[A]ny need or known problem . . . can provide a reason for combining the elements”). Further, it was well-known to a POSITA that using an analog I/Q demodulator may introduce additional distortion not attributed to the PA, but digital receivers avoid this problem. (Proctor, ¶83. *See* Section IX.C.1.b., *infra*.) Thus, it would have been obvious to use digital receiver to convert the RF signal to complex baseband and a POSITA would have been motivated to do so. (Proctor, ¶83.) *KSR*, 550 U.S. at 421 (“When there is a design need . . . to solve a problem and there are a finite number

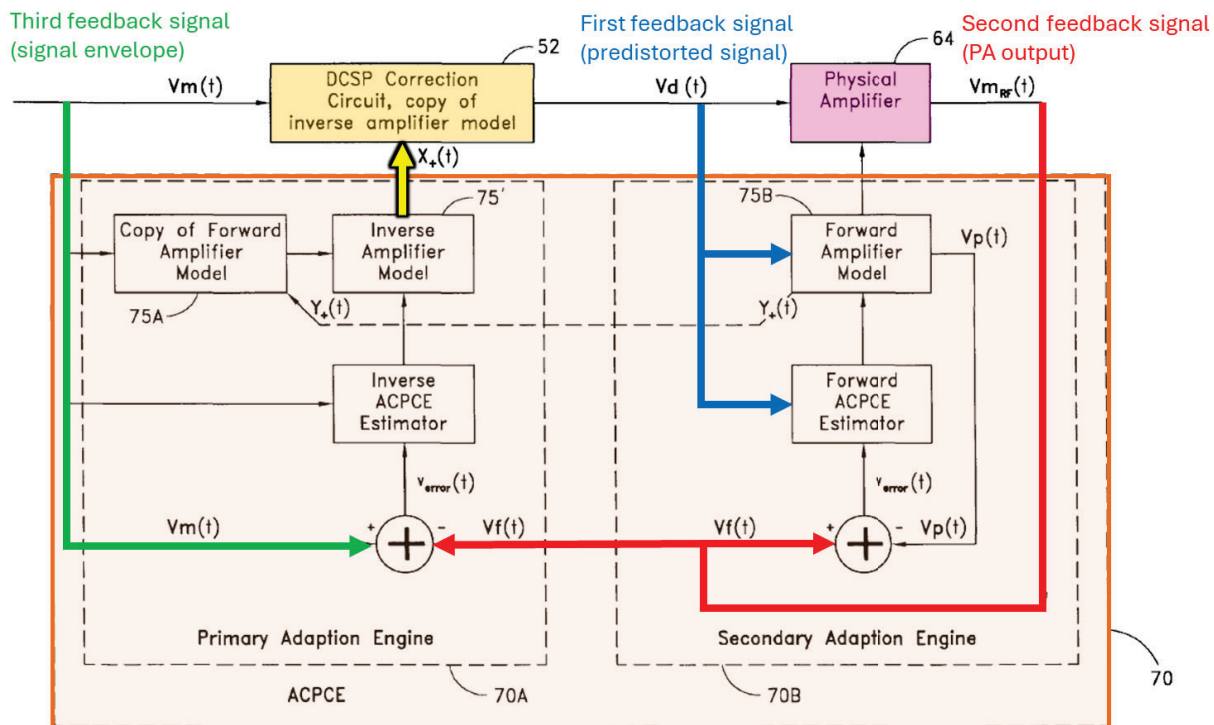
of identified, predictable solutions, a person of ordinary skill has good reason to pursue the known options within his or her technical grasp.”).

Wright even supplies the digital receiver, which it uses to translate RF signals to complex baseband elsewhere. (Wright, 10:30-44 (“Thus, the real RF passband signal,  $V_{m_r}(t)$ , is translated to a complex baseband equivalent signal,  $V_f(t)$ , which may be used by the ACPCE 70.”), 43:22-33 (“The output of the downconversion block 66 is appropriately sampled by the ADC 68 to capture IF data, and is converted to complex baseband by digital quadrature conversion circuitry (not shown)”); Proctor, ¶84.) More specifically, Wright teaches downconverting the RF signal to IF, performing analog-to-digital conversion, and using digital quadrature conversion circuitry (“digital receiver”) to produce a complex baseband signal. (Wright, 43:22-39; Proctor, ¶84.) Thus, like the ’345 Patent, Wright uses a digital receiver to translate RF signals to complex baseband. (Proctor, ¶84; EX1001 at Fig. 1.)

A POSITA would have understood that Wright’s digital receiver would be (and indeed needed to be) applied to the ACPCE process shown in Figure 30 to digitally translate the RF predistorted signal in the exemplary hardware of Figure 31B to produce the “first feedback signal.” (Proctor, ¶85; Wright, 8:39-48 (explaining Fig. 31B depicts a hardware implementation of the DCSP and ACPCE processes), 43:33-39.) Thus, Wright teaches this element. (Proctor, ¶85.)

- d. 1[c]: producing, via a second digital receiver, a second feedback signal in response to the RF amplified output signal from the power amplifier;

Wright discloses using a digital receiver to convert the real RF passband signal,  $V_{m_{rf}}(t)$  (“second feedback signal,” red) to complex baseband. (Wright, 9:38-10:9, 10:30-42, 43:22-33; Proctor, ¶¶51-55, 86; see Section IX.A.1.c.)

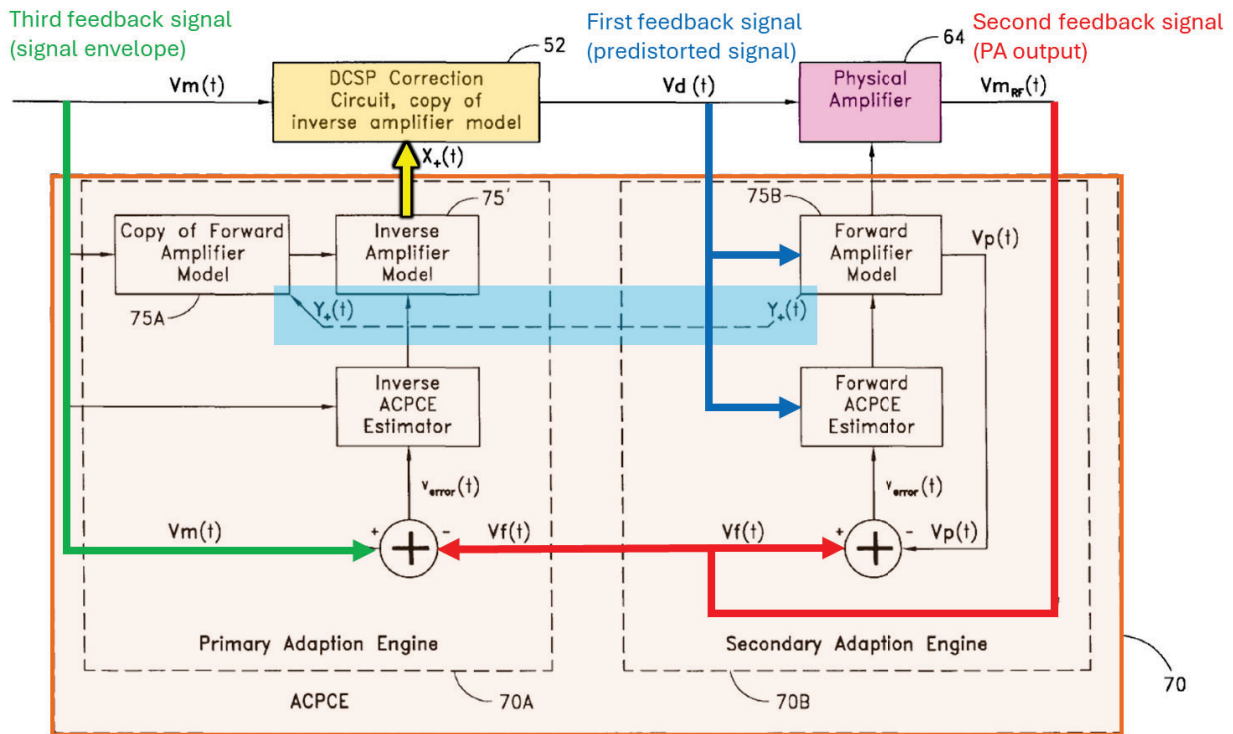


(Wright, 41:44-42:47, Fig. 30 (annotated).)

- e. 1[d]: modeling the power amplifier in response to the first and second feedback signals; and

Wright discloses that the ACPCE models the PA using the feedback signals. (Wright, 9:11-20 (“The ACPCE uses these samples to compute compensation

parameters that are provided to the DCSP along an update and control path 86.”),  
10:45-49; Proctor, ¶87.)



(Wright, 41:44-42:47, Fig. 30 (annotated).) As shown in Figure 30, the ACPCE’s secondary adaptation engine 70B compares the amplifier’s output signal  $V_f(t)$  (“second feedback signal,” red) with the predistorted signal  $V_d(t)$  (“first feedback signal,” blue) via a Forward Amplifier Model 75B, Forward ACPCE Estimator, and subtraction junction (purple). (*Id.* at 41:52-57; Proctor, ¶87.) The subtraction junction models the PA by estimating the error signal ( $V_{error}(t)$ ) between the first and second feedback signals that is then used to adapt the “Forward Amplifier Model” 75B. (*Id.*; Proctor, ¶87) The secondary adaptation engine 70B then provides

information from the Forward Amplifier Model to the primary adaptation engine 70A, which uses this information (signal “ $Y_t(t)$ ”, light blue) to determine the predistortion coefficients that will compensate for any PA nonlinearity. (Wright, 41:58-63; Proctor, ¶87.) The updated predistortion coefficients are then supplied to the DCSP correction circuit (“distorting generator,” yellow). (*Id.*)

**f. 1[e]: updating the predistortion amplitude and phase look-up tables in response to said modeling of the power amplifier,**

Wright discloses that the predistortion coefficients determined by the ACPCE during the modeling stage are provided to the DCSP, and are then used to update the amplitude and phase LUT(s). (Wright, 41:58-63; Proctor, ¶88.)

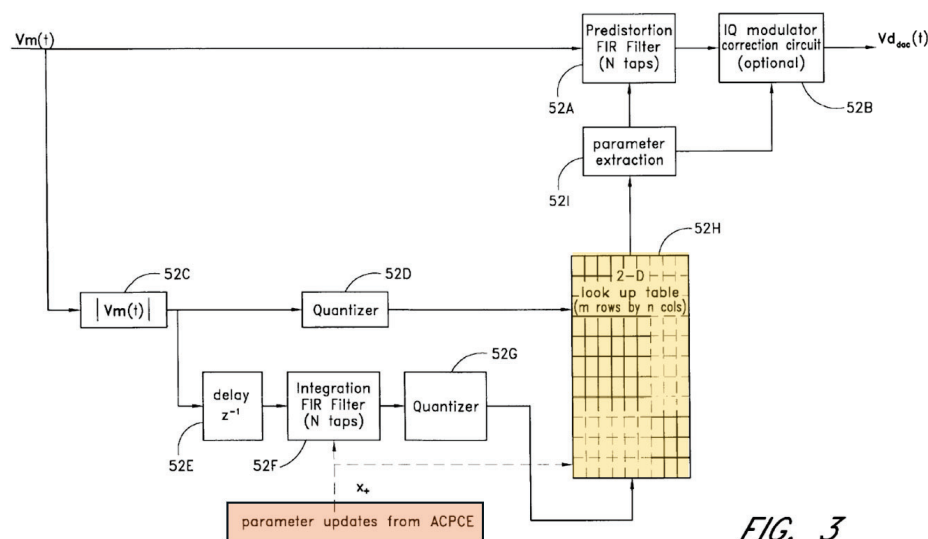


FIG. 3

(Wright, 11:41-62 (“FIG. 3 illustrates the various functional units of the DCSP 52. ... An important aspect of the design is the use of *a multi-dimensional look up table*

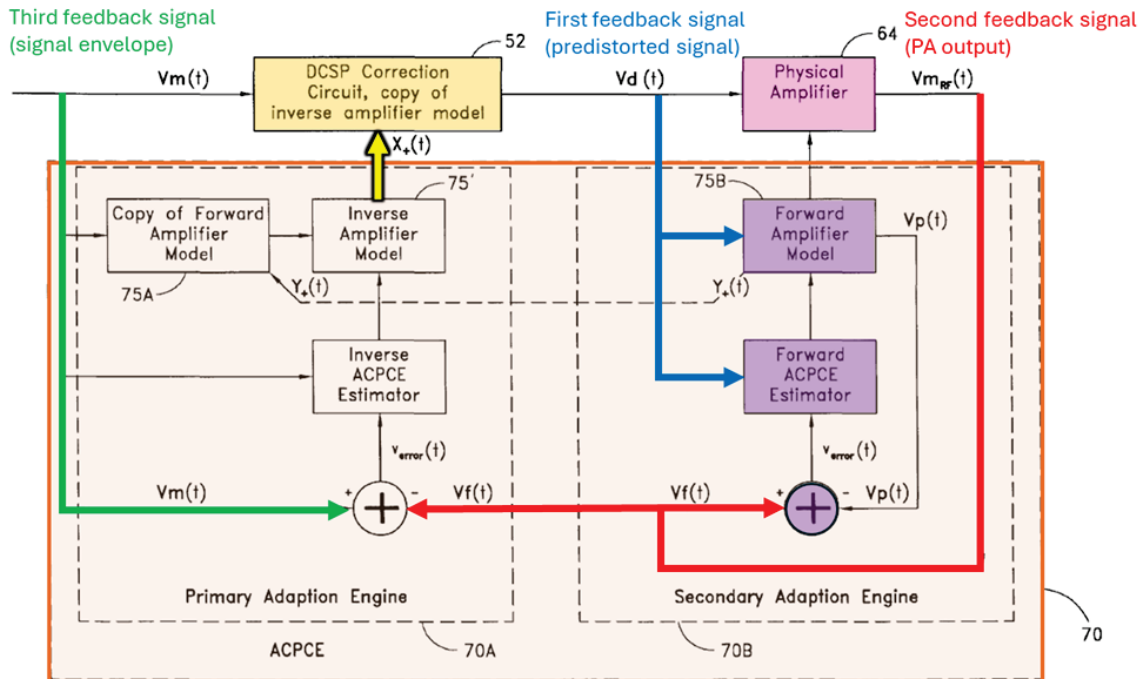
**52H to store correction coefficients...**”), 13:51-54 (“As depicted by the vector  $X_t$  in FIG. 3, the ACPCE 70 periodically **updates the correction coefficients stored within the look-up table 52H**”), Fig. 3 (annotated).) To the extent this claim is understood to require only one LUT, Wright discloses this as well. (*Id.*; Proctor, ¶¶80, 88.) Thus, Wright discloses updating the LUT(s) (yellow) of the DCSP in response to the predistortion coefficients calculated by the ACPCE (orange) during the modeling stage. (Proctor, ¶88.)

- g. 1[f]: wherein said second feedback signal includes the complex envelope of the RF amplified output signal, and**

Wright discloses producing, via a digital receiver, a second feedback signal  $V_f(t)$  (the complex envelope of the RF amplified output signal) in response to the PA output. (Wright, 10:30-49 (“Thus the real RF passband signal,  $V_{f_r}(t)$  [“RF amplified output”], is translated to a complex baseband equivalent signal,  $V_f(t)$  [“second feedback signal”], which may be used by the ACPCE 70.”); Proctor, ¶89, 51-55, 86. *See also* Section IX.A.1.d.) The “complex baseband equivalent signal” is the RF amplified signal’s complex envelope. (Proctor, ¶89.)

- h. 1[g]: wherein said modeling step includes the discrimination of the complex envelope of the first feedback signal referenced to the complex envelope of the second feedback signal to yield a predistortion function correlated to a behaviour of the power amplifier including nonlinearities and memory effects.**

Wright discloses that the system converts the RF feedback signals to complex baseband using digital receivers. (*See* Section IX.A.1.c.-d.; Wright, 9:38-54, 43:22-33; Proctor, ¶¶90, 51-55, 81-86.) Wright further explains that the ACPCE compares the complex envelopes of the first and second feedback signals (i.e., the complex baseband equivalent signals) in order to yield a predistortion function of the PA. (*See* Section IX.A.1.e.; Proctor, ¶90.) For example, Wright discloses that the secondary adaptation engine of the ACPCE includes “a subtraction junction [purple] that generates an error signal between the physical amplifier’s output signal  $V_f(t)$  [“second feedback signal,” red] and the forward amplifier model’s output signal  $V_p(t)$ ” based upon the first feedback signal ( $V_d(t)$  via Forward Amplifier Model 75B, blue). (Wright, 41:52-57; Proctor, ¶90.)



(Wright, 41:44-42:47, Fig. 30 (annotated).) As Wright explains, the error signal is used to adaptively model the PA and update the primary adaptation engine 70A, which in turn generates the inverse amplifier model coefficients to send to the DCSP (“distorting generator,” yellow) to account for the PA’s nonlinearities. (*Id.*; Proctor, ¶¶90.) Wright further explains that the ACPCE updates the parameters used by the integration filter 52F in order to accurately compensate for past stimulus to the PA (memory effects). (Wright, 2:9-17, 8:49-54, 13:51-54, 13:17-21, 14:24-42; Proctor, ¶¶91-93.)

Thus, Wright renders obvious each element of claim 1.

**2. Claim 2**

**a. 2. An adaptive method as recited in claim 1, wherein said modeling step is done in real time.**

Wright renders claim 1 obvious. (Proctor, ¶94; *see* Section IX.A.1.) Further, Wright discloses that the modeling step is performed “in real time.” (Wright, 9:11-20 (“[T]he ACPCE 70 receives signal samples along two *real time* data paths . . . The ACPCE uses these samples to compute compensation parameters that are provided to the DCSP.”), 11:41-45, 13:51-61 (“The term ‘correction parameters’ references generally to filter coefficients and any other dynamic values that are used in the *real-time predistortion process*”); Proctor, ¶94)

Thus, Wright renders obvious claim 2.

**3. Claim 5**

**a. 5[pre]-5[e]**

While claim 5 recites a “device” and claim 1 recites a “method,” all of claim elements 5.pre.-5.e. are substantially similar to corresponding limitations for claim 1.<sup>5</sup> (Proctor, ¶¶96-98.) For the reasons discussed above, elements 5.pre.-5.e. are taught by Wright. (*See* Sections IX.A.1.a.-IX.A.1.f.; Proctor, ¶¶78-88.)

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<sup>5</sup> The initial limitations of claim 5 that correspond to those in claim 1 are:

5[pre]: An adaptive device for predistorting an RF modulated signal to be transmitted, supplied by a signal source to an input of a power amplifier having an output for delivering an amplified output signal, said adaptive device comprising:

[5.a] an I/Q modulator interposed between the signal source and the input of the power amplifier;

[5.b] a distorting generator including predistortion amplitude and phase look-up tables; said distorting generator controlling said I/Q modulator to predistort the RF modulated signal to be transmitted in amplitude and in phase;

[5.c] a first digital receiver producing a first feedback signal in response to the RF predistorted signal from said I/Q modulator;

[5.d] a second digital receiver producing a second feedback signal in response to the RF amplified output signal from the power amplifier;

[5.e] a control module receiving said first and second feedback signals from said first and second digital receivers; said control module being so configured as to model the power amplifier in response to the first and second feedback signals and to update said amplitude and phase look-up tables of said

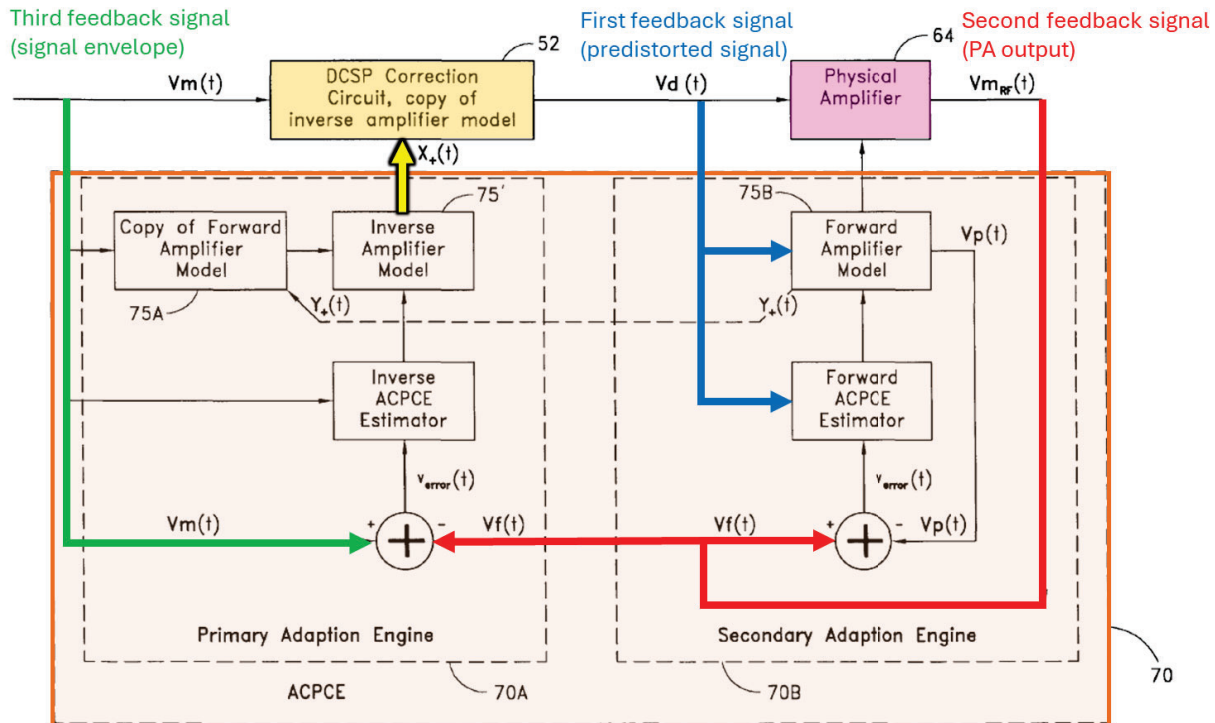
- b. 5[f]: wherein said look-up tables of said distorting generator are indexed by an envelope detector that detects the envelope of the signal to be transmitted before predistortion.**

Wright explains that the DCSP distorting generator's LUT(s) store predistortion coefficients, "with each dimension indexed by a different respective characteristic of the input signal  $V_m(t)$ " (e.g., "table 52H is preferably indexed in one dimension (e.g., rows) by the instantaneous magnitude (amplitude) of the input signal  $V_m(t)$ "). (Wright, 11:53-62; Proctor, ¶¶99.) A POSITA would have understood that the "instantaneous magnitude" or "amplitude" of a signal is the "envelope of the signal." (Proctor, ¶¶99, 49-50.)

Wright discloses generating a third feedback signal (shown below in green) corresponding to the input signal  $V_m(t)$ . (Wright, 41:44-42:47; Proctor, ¶¶100.)

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distorting generator in response to a dynamic modeling of the power amplifier[.]



(Wright, 41:44-42:47, Fig. 30 (annotated).)

With reference to Figure 3 (DCSP) below, a rectification block 52C (“envelope detector,” purple) determines the envelope of the input signal  $V_m(t)$ . (Wright, 11:41-62, 12:54-67 (“To compute the lookup table addressing indices, the magnitude (or power) [“envelope”] of the input signal  $V_m(t)$  is initially computed in block 52C.”); Proctor, ¶101.)

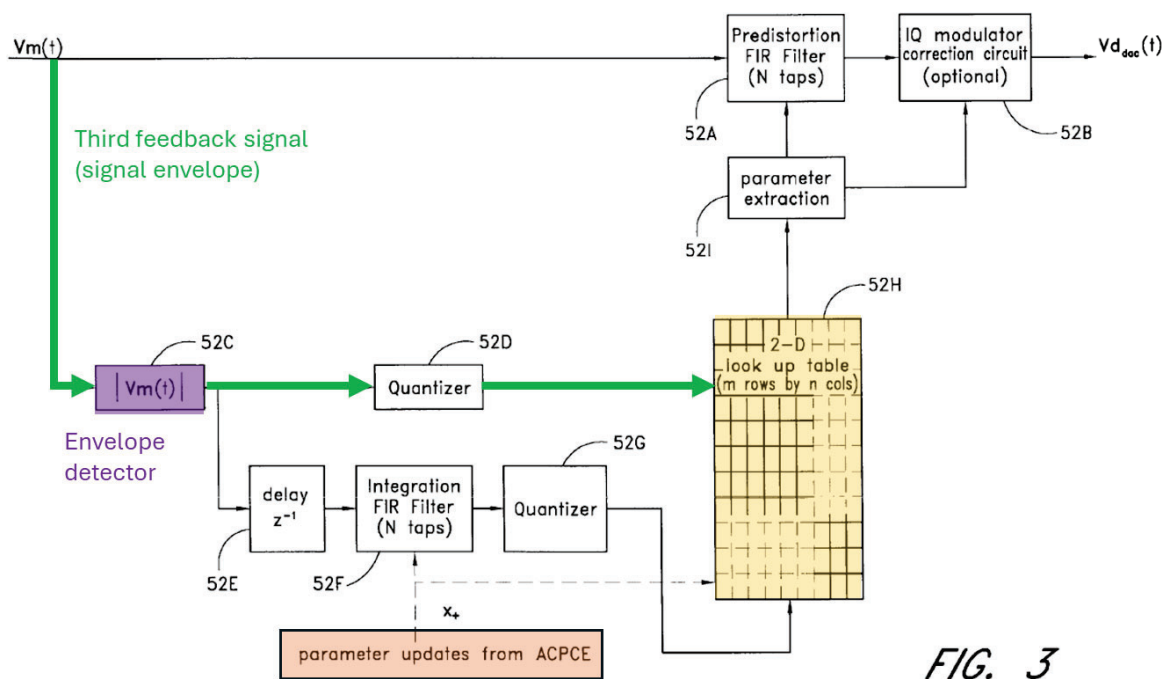


FIG. 3

(Wright, 11:41-62, Fig. 3 (annotated).) Quantizers 52D and 52G use this information from the envelope detector to index the LUT(s). (Wright, 13:3-16; Proctor, ¶101.)

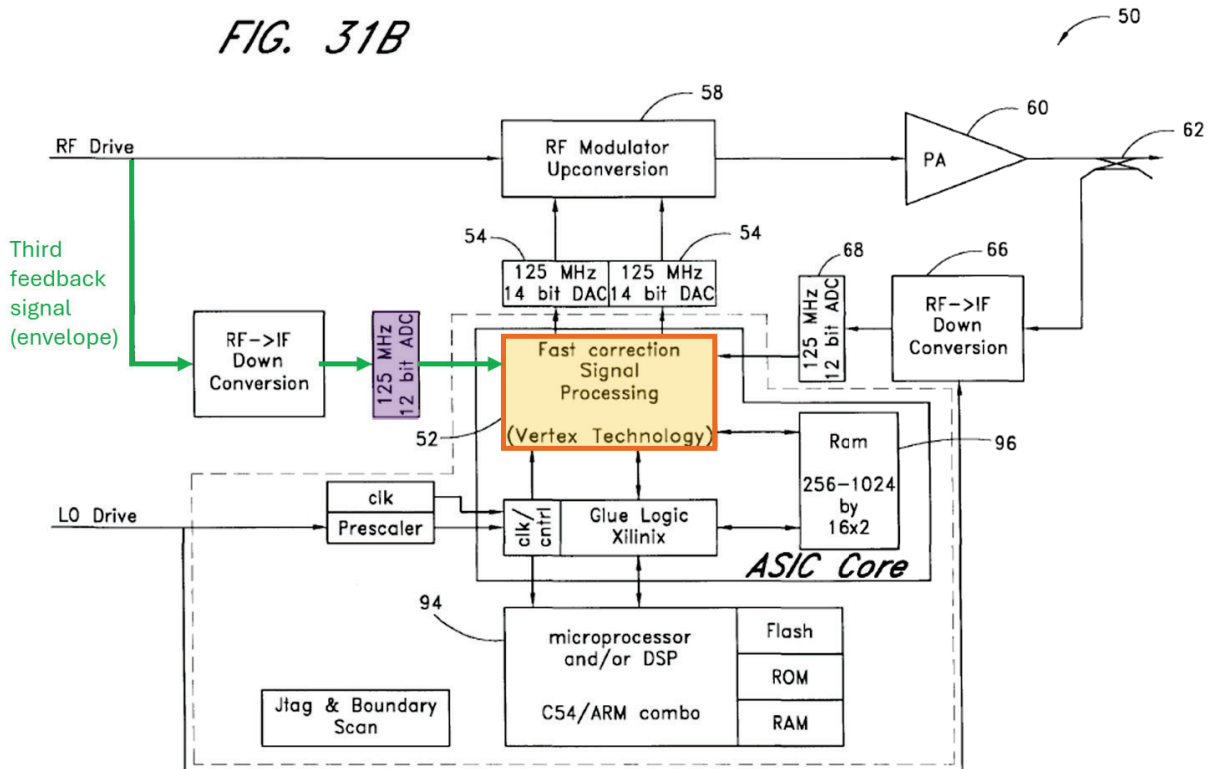
Thus, Wright renders obvious claim 5.

#### 4. Claim 6

- a. **6. An adaptive device as recited in claim 5, wherein said envelope detector indexes the distorting generator via an analog to digital converter.**

Wright renders claim 5 obvious. (See Section IX.A.3.; Proctor, ¶103.) Wright further discloses that the envelope detector indexes the predistorter LUT *via an analog to digital converter*. (Proctor, ¶103.) Wright teaches that the third feedback signal passes through an ADC (purple) before it is used to index the distorting generator. (*Id.*; Wright, Fig. 31B.)

*FIG. 31B*



(Wright, 11:53-62, 43:33-39, Fig. 31B.) As discussed above, the envelope detector receives the digitized third feedback signal from the ADC and uses it to index the distorting generator's LUT. (See Section IX.A.3.b.)

## 5. Claim 7

**a. 7[pre]-7[e]:**

Claim elements 7.pre.-7.e. are identical to the corresponding limitations for claim 5.<sup>6</sup> For the reasons discussed above, elements 7.pre.-7.e. are taught by Wright. (See Sections IX.A.1.a.-IX.A.1.f., IX.A.3.a; Proctor, ¶¶104, 78-88, 96-98.)

<sup>6</sup>The initial limitations of claim 7 that correspond to those in claims 1 and 5 are:

7[pre]An adaptive device for predistorting an RF modulated signal to be transmitted, supplied by a signal source to an input of a power amplifier having an output for delivering an amplified output signal, said adaptive device comprising:

[7.a] an I/Q modulator interposed between the signal source and the input of the power amplifier;

[7.b] a distorting generator including predistortion amplitude and phase look-up tables; said distorting generator controlling said I/Q modulator to predistort the RF modulated signal to be transmitted in amplitude and in phase;

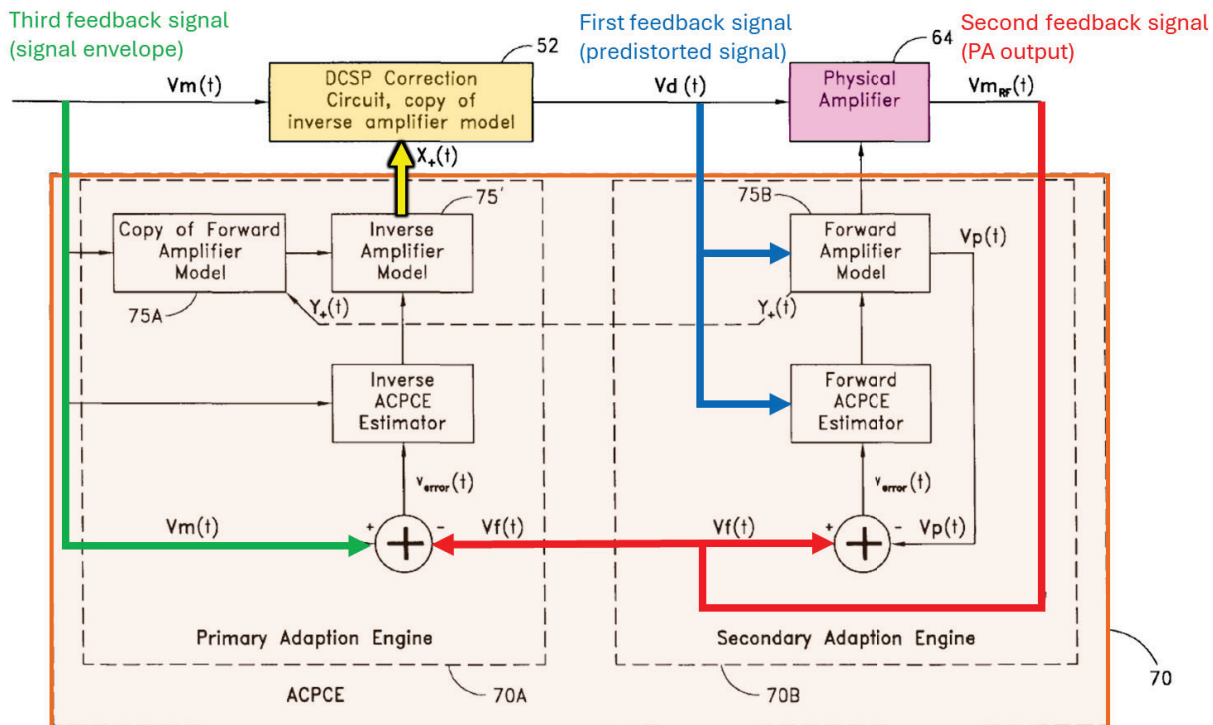
[7.c] a first digital receiver producing a first feedback signal in response to the RF predistorted signal from said I/Q modulator;

[7.d] a second digital receiver producing a second feedback signal in response to the RF amplified output signal from the power amplifier;

[7.e] a control module receiving said first and second feedback signals from said first and second digital receivers; said control module being so configured as to model the power amplifier in response to the first and second feedback signals and to update said amplitude and phase look-up tables of said

- b. 7[f]: wherein said look-up tables of said distorting generator are indexed by data from a third digital receiver that down-converts the signal to be transmitted to baseband.

Wright teaches that the digital predistortion system may utilize three feedback signals to model the PA nonlinearity, and that the third feedback signal is used to index the LUT with the input signal's instantaneous magnitude (or envelope). (See Sections IX.A.1.c. and IX.A.3.b.; Proctor, ¶105.)



(Wright, 41:44-42:47, Fig. 30 (annotated).)

distorting generator in response to a dynamic modeling of the power amplifier[.]

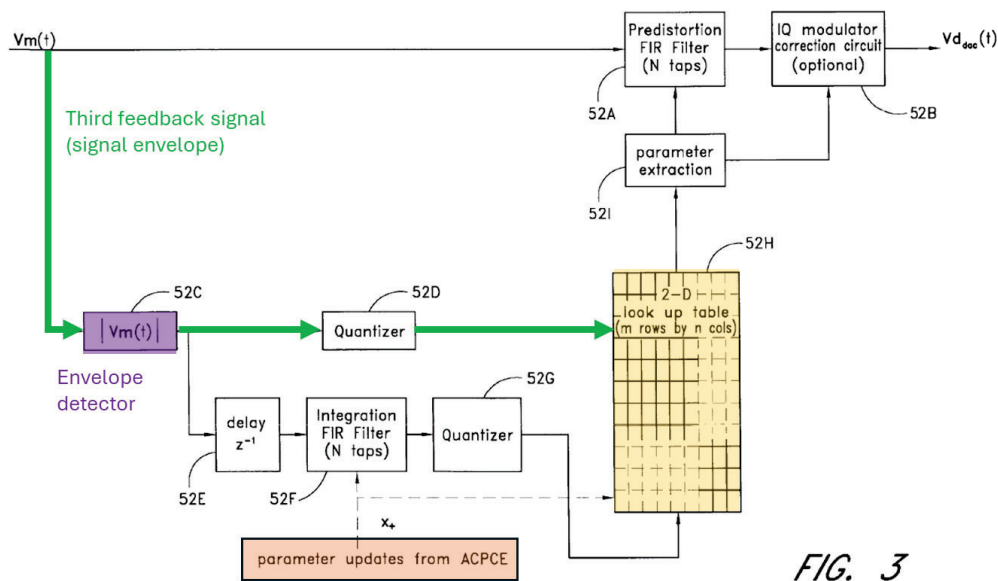
**i. Wright Renders Obvious the LUT(s) Being Indexed by Data From a Third Digital Receiver**

Although Wright does not expressly disclose that the third feedback signal is supplied to the ACPCE (“control module”) using a digital receiver, a POSITA would understand this step would be obvious for the reasons previously addressed. (Proctor, ¶106; *see* Section IX.A.1.c.i.; *KSR*, 550 U.S. at 420-21.) Thus, Wright teaches using a third digital receiver to generate the complex baseband signal and index the LUT(s) and renders claim 7 obvious. (Wright, 11:53-62, 43:33-39; Proctor, ¶106.)

**6. Claim 8**

**a. 8. An adaptive device as recited in claim 7, wherein the data from said third digital receiver is supplied to said control module that indexes said distorting generator accordingly.**

Wright discloses that the ACPCE (“control module”) indexes the DCSP distorting generator’s LUT(s) using a third feedback signal via a digital receiver. (*See* Section IX.A.5.b.) Wright additionally explains that a rectification block 52C (“envelope detector”) determines the instantaneous magnitude of the input signal  $V_m(t)$ , which is then passed on to the quantizers 52D and 52G that use this information to index the LUT(s). (Wright, 11:41-62, 12:54-67, 13:3-16; Proctor, ¶107.)



(Wright, 11:41-62, Fig. 3 (annotated).)

Wright renders claim 8 obvious.

## 7. Claim 11

### a. 11[pre]-11[e]:

Claim elements 11.pre.-11.e. are identical to the corresponding limitations for claim 5.<sup>7</sup> For the reasons discussed above, elements 11.pre.-11.e. are taught by Wright. (See Sections IX.A.1.a.-IX.A.1.f., IX.A.3.a.; Proctor, ¶¶109, 78-88, 96-98.)

<sup>7</sup> The initial limitations of claim 11 that correspond to those in claims 1 and 5 are:

11[pre] An adaptive device for predistorting an RF modulated signal to be transmitted, supplied by a signal source to an input of a power amplifier

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having an output for delivering an amplified output signal, said adaptive device comprising:

[11.a] an I/Q modulator interposed between the signal source and the input of the power amplifier;

[11.b] a distorting generator including predistortion amplitude and phase look-up tables; said distorting generator controlling said I/Q modulator to predistort the RF modulated signal to be transmitted in amplitude and in phase;

[11.c] a first digital receiver producing a first feedback signal in response to the RF predistorted signal from said I/Q modulator;

[11.d] a second digital receiver producing a second feedback signal in response to the RF amplified output signal from the power amplifier;

[11.e] a control module receiving said first and second feedback signals from said first and second digital receivers; said control module being so configured as to model the power amplifier in response to the first and second feedback signals and to update said amplitude and phase look-up tables of said distorting generator in response to a dynamic modeling of the power amplifier[.]

**b. 11[f]: wherein said control module is further configured as to insert an adequate delay between the first feedback signal and the second feedback signal.**

Wright teaches inserting a delay into the first feedback loop to ensure the first feedback signal is synchronized with the second feedback signal. (Proctor, ¶110.) Wright teaches that the ACPCE (“control module”) models the PA by calculating the delay between the reference signal  $V_m(t)$  (“third feedback signal”) and the amplified output signal  $V_f(t)$  (“second feedback signal”). (Wright, 29:35-39, 11:47-52, Fig. 3 (“delay” block 52E); Proctor, ¶110.) The calculated delay is then used to “ensure[] that the predicted amplifier model’s output waveform,  $V_p(t)$  [based upon “first feedback signal”  $V_d(t)$  via Forward Amplifier Model 75B], is synchronized in time and matched in amplitude and phase with the output of the external amplitude and phase with the output of the external amplifiers signal  $V_f(t)$  [“second feedback signal”].” (Wright, 30:48-61; Proctor, ¶110.)

Thus, Wright renders claim 11 obvious.

**B. GROUND 2: Claims 3, 4, 9, and 10 Are Obvious Based on Wright and Jin**

Claims 3, 4, 9, and 10 (the “ACP Claims”) each pertain to the concept of using Adjacent Channel Power (“ACP”) as a linearity metric to control predistortion. (’345 Patent, 1:17-30, 7:61-63, cls. 3, 4, 9, 10; Proctor, ¶112.) The ACP Claims

perform the predistortion based on an Adjacent Channel Power Ratio (“ACPR”) measurement sub-step. (*Id.*)

As discussed below, the concept of ACP and ACPR was well-known in the art at the time, and contemporaneous wireless communication protocols (i.e., the IS-95 CDMA2000 or WCDMA standards) placed strict limits on the permissible amount of ACP that a transmitter may produce. (Proctor, ¶¶113, 59-61.) Moreover, the use of an ACP/ACPR measurement sub-step in a digital predistortion system was well-known to a POSITA at the time.<sup>8</sup> (Proctor, ¶113.) For example, it was well-known that the use of an ACP “mask” helped ensure that the transmitter’s ACP levels were maintained within the limits established by the standard. (*Id.*; Jin, 1:30-38.)

Jin discloses an ACP measurement sub-step designed for use in digital predistortion systems, such as Wright’s digital predistorter. (Jin, 6:5-16; Proctor, ¶114.) Jin teaches measuring the ACP present in feedback signals and updating the predistorter to ensure that the signal maximizes the ACP limits available under an applicable wireless standard. (*Id.*) In this way, Jin explains that the power efficiency of the PA can be improved while still conforming to the standard. (*Id.*)

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<sup>8</sup> At the time, the terms ACP and ACPR were used interchangeably, particularly in the context of CDMA systems. (Proctor, ¶113, 59-61.)

## 1. Motivation to Combine

A POSITA would have been motivated to combine the teachings of Jin with Wright. (Proctor, ¶115.) More specifically, it would have been obvious to incorporate Jin’s teachings regarding an adaptive ACPR measurement sub-step into the digital predistortion techniques of Wright. (*Id.*)

Wright and Jin attempt to solve the same problem: using digital predistortion techniques to compensate for PA distortion, including distortion attributed to past inputs to the PA (i.e., memory effects). (*Id.* at ¶116; Wright, 2:9-20; Jin, 1:19-21 (describing “an adaptive digital pre-distortion circuit for use in an RF transmitter”); *see* Sections VIII.A., IX.A.1.h.) *Tokai Corp. v. Easton Enterprises, Inc.*, 632 F.3d 1358, 1371 (Fed. Cir. 2011) (“We have consistently stated that courts may find a motivation to combine prior art references in the nature of the problem to be solved[.]”) (citations omitted); *In re Kurzweil*, 4 F. App’x 823, 826 (Fed. Cir. 2001).)

A POSITA would have looked to Jin to supplement Wright because the requirement that RF transmitters comply with regulatory standards regarding the ACP permissible levels was a well-known problem at the time, which Wright acknowledges. (Proctor, ¶117; Wright, 1:35-38 (“[S]uch distortion products typically extend outside the bandwidth originally occupied by the signal, ***potentially causing interference in adjacent channels.***”).) Indeed, even before the introduction

of DPD linearization techniques, POSITAs understood that it was critical for RF linearizers to follow regulatory requirements. (Proctor, ¶¶117, 59-61.) Jin provides a solution to meet RF regulations. (*Id.*; Jin, Abstract, 2:28-41.)

A POSITA would have also been motivated to combine Jin with Wright because Jin discloses how to optimize the PA's power consumption while staying within defined ACP limits. (Proctor, ¶118; Jin, 1:24-38.) A POSITA would have understood that then-existing predistortion techniques that utilize ACP masks, while effective at maintaining power below the ACP limits, resulted in a PA output that is dictated by the most stringent frequency points while other frequencies under the ACP profile remained underutilized. (Proctor, ¶118; Jin, 2:9-16.) Jin would have provided a solution to a POSITA by teaching an ACP measurement sub-step that determines the pre-distortion adjustment needed to optimize the PA output while maintaining ACP noise within the ACP limits defined by the standard. (Proctor, ¶118; Jin, 6:4-16.)

While Wright discloses improved techniques to more precisely model distortion within an RF transmitter, it does not directly provide a solution for optimizing ACP noise margins as described by Jin. (Proctor, ¶119; Jin, 2:9-25.) As a result, a POSITA would have recognized that even in the improved predistortion systems of Wright, "there may still be relatively large ACP noise margins at many

other frequencies,” such that the power amplifier “is not optimized to make full usage of the ACP profile under the applicable standard.” (Jin, 2:12-15; Proctor, ¶119.) Thus, a POSITA would have been motivated to combine Jin’s disclosure with the predistortion teachings of Wright. (Proctor, ¶119; *Intel Corp. v. PACT XPP Schweiz AG*, 61 F.4th 1373, 1380 (Fed. Cir. 2023) (“‘[U]niversal’ motivations known in a particular field to improve technology provide ‘a motivation to combine prior art references *even absent any hint of suggestion* in the references themselves’ . . . Similarly, ‘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.’” (citations omitted; emphasis original)).)

A combination of Jin with Wright would have been well within the capability of a POSITA because the combination requires only using prior art elements according to their established functions. (Proctor, ¶120; *Intel Corp.*, 61 F.4th at 1380 (“[I]f there’s a known technique to address a known problem using ‘prior art elements according to their established functions,’ then there is a motivation to combine.”).) As with Wright, Jin’s solution is intended for use in digital predistortion systems. (Jin, 6:4-16 (explaining the present invention “may be implemented in any type of digital modulation scheme”), 6:57-59 (“Those skilled in

the art will recognize that the above-described modulation and amplification steps are common operations in conventional RF transmitters.”); Proctor, ¶120.) Further, Jin’s ACP measurement technique simply involves evaluating an additional characteristic of a feedback signal—namely, ACP—using a Fast Fourier Transform (FFT), which was a well-known signal processing technique. (Jin, 8:1-5; Proctor, ¶120.) A POSITA would have known that the use of FFT spectrum analyzers to convert a time-domain waveform into its corresponding frequency domain components was well-known and had been widely used in DPD transmitters since at least the early 1990s. (Proctor, ¶120.) Thus, it would have been simple and well-within the capabilities of a POSITA to configure the DSP to implement any digital signal filters needed for the processor to compare the feedback signals with the ACP profile data as described by Jin. (Proctor, ¶120.)

Thus, it would have been obvious to a POSITA to combine Jin’s teaching with Wright. (Proctor, ¶121.)

**2. Claim 3**

**a. 3[pre]-3[e]:**

Claim elements 3.pre.-3.e. are identical to the corresponding limitations for claim 1.<sup>9</sup> For the reasons discussed above, elements 3.pre.-3.e. are taught by Wright. (See Sections IX.A.1.a.-IX.A.1.f.; Proctor, ¶¶122, 78-88.)

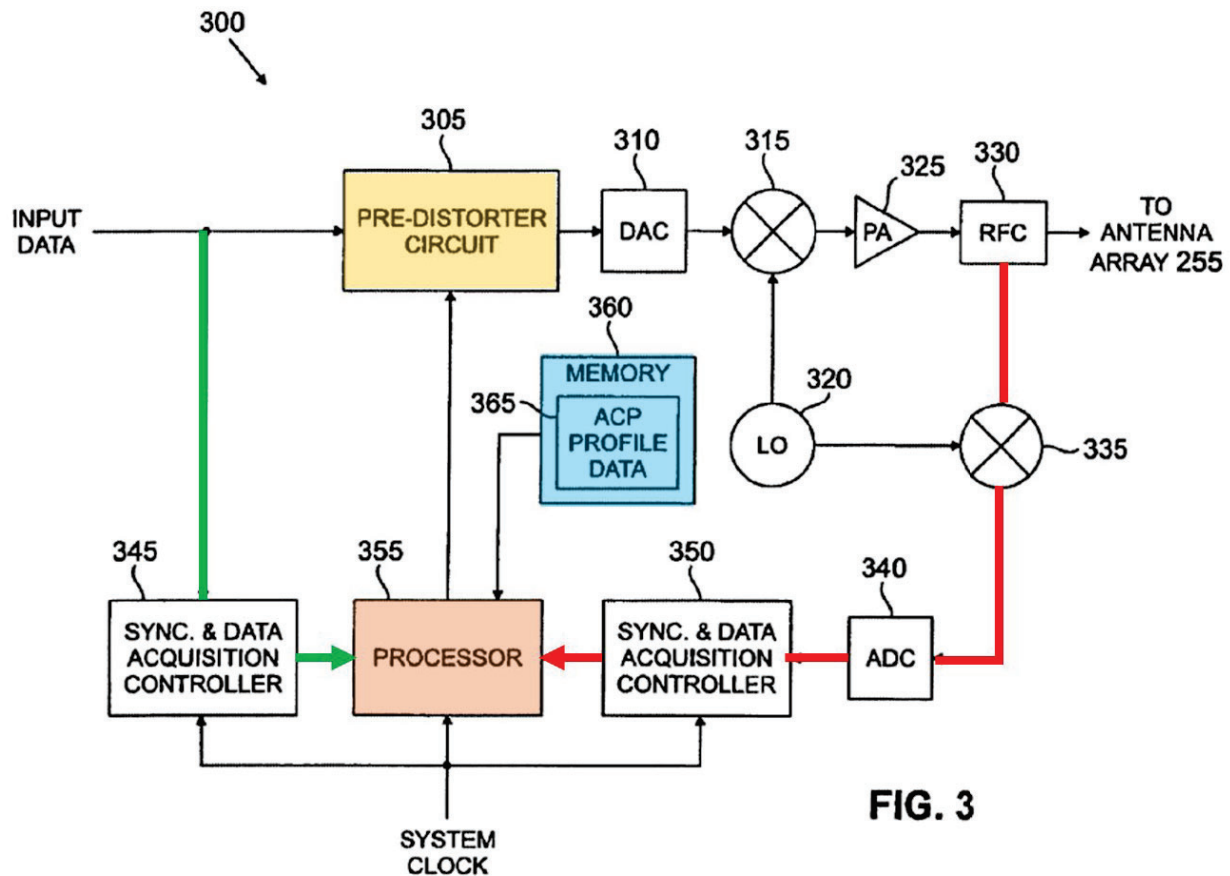
**b. 3[f]: wherein said updating step is done when a linearity metric adjacent channel power ratio (ACPR) measurement sub-step indicates that the predistorting step is not adequate to meet predetermined ACPR standards.**

Jin discloses an ACPR measurement sub-step that updates the predistorter when the predistorting step is insufficient to comply with ACPR requirements. (Jin, 6:26-43; Proctor, ¶123.) Jin explains that the RF transmitter includes “a pre-distortion adjustment feedback loop that samples the input data signal and a corresponding part of the RF output signal, *compares the samples to each other and to the accepted ACP profile*, and generates a pre-distortion adjustment signal that is added to subsequent samples of the input signal data.” (Jin, 6:26-32; Proctor, ¶124.) Jin further teaches that ACP profile data (corresponding to the ACPR requirements

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<sup>9</sup> Because Limitations 3.pre.-3.e. are identical to Limitations 1.pre.-1.e., those elements are not repeated here. The entirety of Claim 3 is stated in EX1028 (“Table of Challenged Claims”).

of the applicable standard—e.g., IS-95 CDMA) is stored in memory for use in the measurement sub-step. (Jin, 6:32-43; Proctor, ¶124. *See* Section IX.B.3., *infra.*)



(Jin, 6:17-43, Fig. 3 (depicting “memory 360” (annotated in blue) for storing ACP profile data).)

As Jin explains, ACP measurement feedback signals corresponding to the PA input and output (green and red arrows) are received by an “input synchronization and data acquisition controller 345” and “output synchronization and data acquisition controller 350.” (Jin, 6:32-38; Proctor, ¶125.) Processor 355 (orange)

first compares the feedback signals to determine the scaling factor of the PA. (Jin, 7:63-67; Proctor, ¶125.) Next, the processor compares the feedback signals with the ACP profile data stored in memory 360 (blue). (Jin, 7:63-67; Proctor, ¶125.) This may be accomplished using a FFT to determine the ACP values of the feedback signal at a discrete set of frequency points corresponding to the particular standard. (Jin, 8:1-5; Proctor, ¶125.) Using this information, the processor calculates a “predistortion adjustment value” that is provided to the predistorter (yellow). (Jin, 7:63-67; Proctor, ¶125.) The predistorter then adjusts the original input signal so that the PA “may be saturated to the point with the adjacent channel power noise is driven close to, but not over the limits allowed in the ACP profile.” (Jin, 9:26-30; Proctor, ¶125.)

Jin also discloses updating the predistorter using the “predistortion adjustment value” when the measured ACP indicates that the predistortion is not adequate to meet predetermined ACP standards. (Jin, 7:63-67, 8:58-9:37; Proctor, ¶126.) For example, Jin explains that using the feedback signals, the processor determines whether the out-of-band distortion of the amplified output signal is within the specified ACP profile limits. (Jin, 10:4-30; Proctor, ¶126.) The processor then executes a series of functions to determine an optimization algorithm and produce a “distortion adjustment parameter” that adjusts the signal to be transmitted so that the

PA is driven close to (but not over) the ACP profile limits. (Jin, 8:58-9:37; Proctor, ¶126.) As Jin explains, the adjustment parameters are updated in order to adaptively control the predistortion in response to changes in the RF transmitter over time. (Jin, 9:38-64, Fig. 5; Proctor, ¶126.) Thus, Jin discloses this element. Wright in view of Jin renders claim 3 obvious.

### 3. Claim 4

- a. **4. An adaptive method as recited in claim 3, wherein said linearity metric ACPR measurement sub-step is done via a digital receiver that includes a first channel tuned to a mean frequency and a second channel that is tuned to a predetermined offset frequency, said linearity metric ACPR measurement sub-step including comparing an average power at the mean frequency and at the predetermined offset frequency.**

Jin, either in combination with Wright and/or further in view of the knowledge of a POSITA, renders obvious each and every limitation of claim 3. (*See* Section IX.B.2.; Proctor, ¶128.) Wright discloses or, at minimum, renders obvious using digital receivers to capture the predistorted input to the PA (first feedback signal) and amplified output of the PA (second feedback signal). (*See* Section IX.A.1.c.-d.; Proctor, ¶128.) In addition, Jin discloses or renders obvious performing the ACPR measurement sub-step by comparing an average power at a mean frequency and at an offset frequency. (Proctor, ¶128.)

**i. Single Reference Obviousness**

To determine the ACP “noise margin” and derive an ACP optimization function, Jin performs a FFT on the feedback signals to compare the feedback signals to each other and the ACP profile at a set of frequency points specified by the communication standard. (Proctor, ¶129; Jin, 8:1-5; *see* Section IX.B.2.b.) Neither Jin nor Wright expressly discloses that these frequency points include a “mean frequency” and a “predetermined offset frequency;” but a POSITA would have considered this element to be obvious in view of Jin’s teachings. (Proctor, ¶129.)

A POSITA would have understood that the required ACP mask (or ACPR standard) is defined by industry standards and government regulations. (Proctor, ¶¶130, 59-61.) For instance, the IS-97 standard defines the required ACP mask for the IS-95 standard (*see* Jin, 6:38-43; EX1001, 9:47-53) and identifies the ACPR limits for the main and offset channels as follows:

**10.5.1.3 Minimum Standard**

**10.5.1.3.1 Suppression Inside Cellular Band**

**For all frequencies within the cellular base station transmit band between 869 and 894 MHz which are also within the specific bands allocated to the operator’s system, the total spurious emissions measured in a 30 kHz resolution bandwidth shall be attenuated below the mean output power level in accordance with the following schedule:**

- (a) For offset frequencies greater than 750 kHz from the CDMA Channel center frequency, at least 45 dB**
- (b) For offset frequencies greater than 1.98 MHz from the CDMA Channel center frequency, at least 60 dB**

(Proctor, ¶130, EX1017 (“IS-97”) at 10-7.)

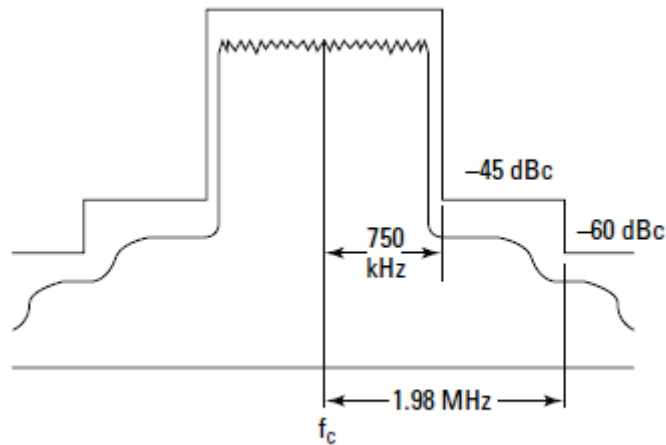


**Figure 20. IS-97 spurious emissions test limits**

(Proctor, ¶130, EX1016 (“Agilent 1311”) at 24 (explaining that the IS-95 standard specifies relative values (e.g., dBc or dB) that the spurious emissions must stay below).) As shown above, and explained by Jin, the ACP profile is divided into multiple frequency blocks (starting from the center channel  $f_c$ ) over which the permissible power density varies. (*Id.*; Jin, 2:3-8.) Using IS-95 as an example, Jin teaches measuring the ACP at each block defined by the standard, including the main transmit channel (“a first channel tuned to a mean frequency”) and the predetermined offset frequencies (“a second channel” tuned to a “predetermined offset”) in order to determine whether the PA is operating within the specified ACPR limits. (Proctor, ¶130; Jin, 6:4-9, 6:38-43, 6:66-7:6, 7:63-8:5.)

Indeed, this technique for determining ACPR for RF transmitters was well-known in the art. (Proctor, ¶131.) As a result, a POSITA would have known to compare the average power of the ACP profile’s main transmit channel to the

measured value of an adjacent channel in order to evaluate whether the ACPR complies with the applicable wireless standard, as discussed by Jin. (*Id.*; Jin, 8:1-23.) At a minimum, a POSITA would have known that comparing the average power of the main transmit channel to the measured value of an adjacent channel was a standard technique for measuring ACPR, such as for the purpose of determining compliance with the IS-95 standard. (Proctor, ¶131.)

Thus, Jin together with Wright discloses and render obvious claim 4.

#### 4. Claim 9

Claim elements 9.pre.-9.e. are identical to the corresponding limitations for claim 5.<sup>10</sup> For the reasons discussed above, elements 9.pre.-9.e. are taught by Wright. (See Sections IX.A.1.a.-IX.A.1.f., IX.A.3.a.; Proctor, ¶¶133, 78-88, 96-98.)

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<sup>10</sup> Claim 9 recites:

9.[pre] An adaptive device for predistorting an RF modulated signal to be transmitted, supplied by a signal source to an input of a power amplifier having an output for delivering an amplified output signal, said adaptive device comprising:

[9.a] an I/Q modulator interposed between the signal source and the input of the power amplifier;

[9.b] a distorting generator including predistortion amplitude and phase look-up tables; said distorting generator controlling said I/Q modulator to predistort the RF modulated signal to be transmitted in amplitude and in phase;

[9.c] a first digital receiver producing a first feedback signal in response to the RF predistorted signal from said I/Q modulator;

[9.d] a second digital receiver producing a second feedback signal in response to the RF amplified output signal from the power amplifier;

[9.e] a control module receiving said first and second feedback signals from said first and second digital receivers; said control module being so configured as to model the power amplifier in response to the first and second feedback signals and to update said amplitude and phase look-up tables of said distorting generator in response to a dynamic modeling of the power amplifier,

[9.f] wherein said control module is so configured as to update said amplitude and phase look-up tables when an adjacent channel power ratio (ACPR) measurement indicates that the predistortion made by said predistorting generator is not adequate to meet predetermined ACPR standards.

While claim 9 recites a “device” and claim 3 recites a “method,” claim element 9.f. is substantially similar to corresponding limitations for claim element 3.f. For the reasons discussed above, Jin discloses this element. (*See* Sections IX.B.2.b. and IX.B.3.; Proctor, ¶¶134-136, 123.)

## **5. Claim 10**

While Claim 10 recites a “device” and claim 4 recites a “method,” claim 10 is substantially similar to corresponding limitations for claim 4.<sup>11</sup> For the reasons discussed above, Jin discloses this element. (*Id.* *See* Sections IX.B.2.b., IX.B.3., IX.B.4.; Proctor, ¶¶137-139, 128-132.)

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<sup>11</sup> Claim 10 recites:

An adaptive device as recited in claim 9, wherein said ACPR measurement is done via said second digital receiver that includes a first channel tuned to a mean frequency and a second channel that is tuned to a predetermined offset frequency, said ACPR measurement including comparing an average power at the means frequency and at the predetermined offset frequency.

**C. GROUND 3: Claims 1, 2, 5, 6, and 11 Are Obvious Based on Booth in Combination with Leyendecker.**

Claims 1, 2, 5, 6, and 11 are directed to the use of two or more digital receivers to perform digital predistortion on an analog, RF input signal. (Proctor, ¶140.) Booth likewise discloses performing digital predistortion on an analog, RF input signal. (Booth, Abstract.) Booth explains that the performance achievable in conventional predistortion systems “has been limited by the difficulty of matching the complex distortion characteristics of typical power amplifier devices with simple analogue pre-distortion networks.” (Booth, 1:66-2:3; Proctor, ¶140.) To solve this problem, Booth provides improved techniques for performing digital predistortion on analog input signals to achieve low system cost and high efficiency. (Booth, 2:31-36; Proctor, ¶140.)

Leyendecker describes a “direct inverse” (or indirect modeling) digital predistortion method that compensates for PA distortion and memory effects. (Leyendecker, 2:66-3:21, 9:1-3, 13:45-51, Figs. 12, 15; Proctor, ¶¶141, 56-58.) The indirect modeler digitally translates RF feedback signals into their respective complex (i.e., digital) signal envelopes to increase the accuracy of the predistortion. (*Id.* at 19:56-64, 20:40-64; Proctor, ¶141.) Leyendecker explains that indirect modeling avoids the computational complexity of conventional schemes, and

“serves to free up resources and reduce processing time and power consumption.”  
(Leyendecker, 3:8-16.)

As explained below, it would have been obvious to a POSITA to try the simple modification of including Leyendecker’s indirect modeler and digital receivers into Booth’s predistortion system. (Proctor, ¶142.) As a result, Booth in view of Leyendecker renders obvious claims 1, 2, 5, 6, and 11.

### **1. Motivation to Combine**

A POSITA would have been motivated to combine the teachings of Leyendecker with Booth. (*Id.* at ¶143.)

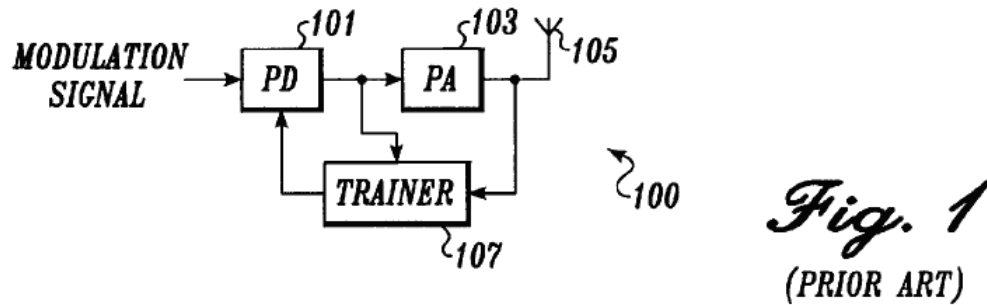
Both references identify the same problem: how to compensate for distortion in RF transmitters, including distortion attributed to past inputs to the PA. (*Id.* at ¶144.) *Tokai Corp.*, 632 F.3d at 1371; *In re Kurzweil*, 4 F. App’x at 826. Specifically, both references explain that past inputs to the PA negatively affect the accuracy of the predistortion. (Booth, 2:52-55 (“As well as exhibiting instantaneous amplitude and/or phase distortion effects a power amplifier will generally exhibit distortion effects based on the past history of the input signal.”); Leyendecker, 2:26-30 (“modeling the power amplifier transfer characteristic using only the instantaneous power or magnitude does not completely accurately predict the distortion caused by the power amplifier”), 9:18-22; Proctor, ¶144.) Further, Booth expressly identifies Leyendecker as relevant prior art. (Booth, (56).)

Booth and Leyendecker identify the same solution: accounting for the PA's memory effects, or using information regarding the past signal inputs to the PA in order to improve the predistortion. (Proctor, ¶145; Booth, 8:63-9:4 (explaining that samples of the signal envelope are used to address the predistorter LUT to “compensate for memory dependent distortion effects in the amplifier”); Leyendecker, 9:40-46 (disclosing a predistorter that “provides the predistortion functionality as a function of both the instantaneous power or magnitude envelope and the power or magnitude envelopes of previous modulation signal samples.”).)

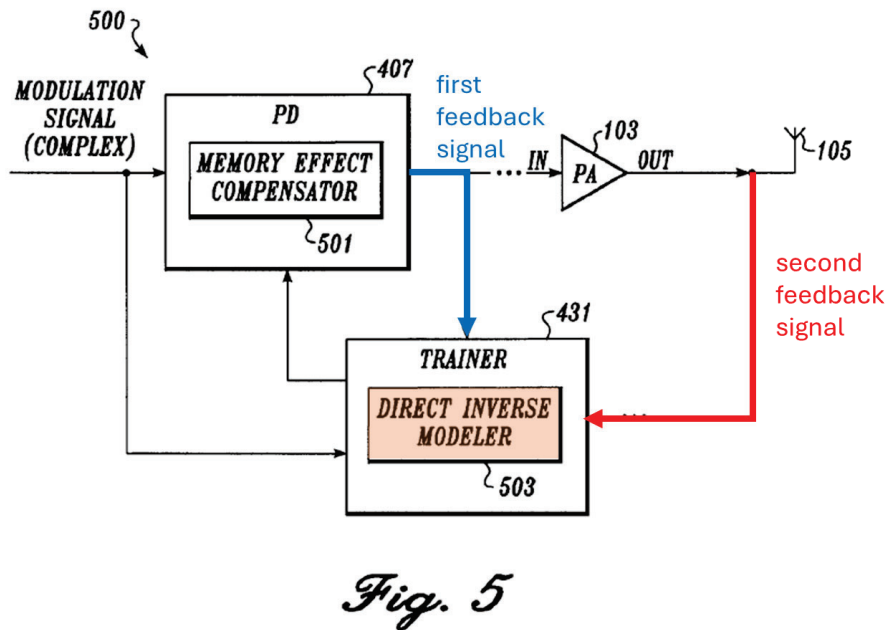
Leyendecker adds two elements that Booth does not explicitly disclose: (1) a “direct inverse modeler” (hereafter, “indirect model”) subsystem, and (2) the use of digital receivers for translating RF signals to complex baseband signals. (Leyendecker, 9:55-10:15, 20:19-39; Proctor, ¶146.) As explained below, a POSITA would have been motivated to combine each of these features into Booth and could have done so successfully.

**a. Combining Booth with Leyendecker's indirect model**

A POSITA would have been motivated to incorporate Leyendecker's indirect model into Booth's predistortion system given the well-known advantages indirect models provide over direct models. (Proctor, ¶147; Leyendecker, 1:38-58 (explaining that indirect models were well-known in the art), Fig. 1.)



(Leyendecker, 1:38-58, Fig. 1 (“Prior art” indirect model).)

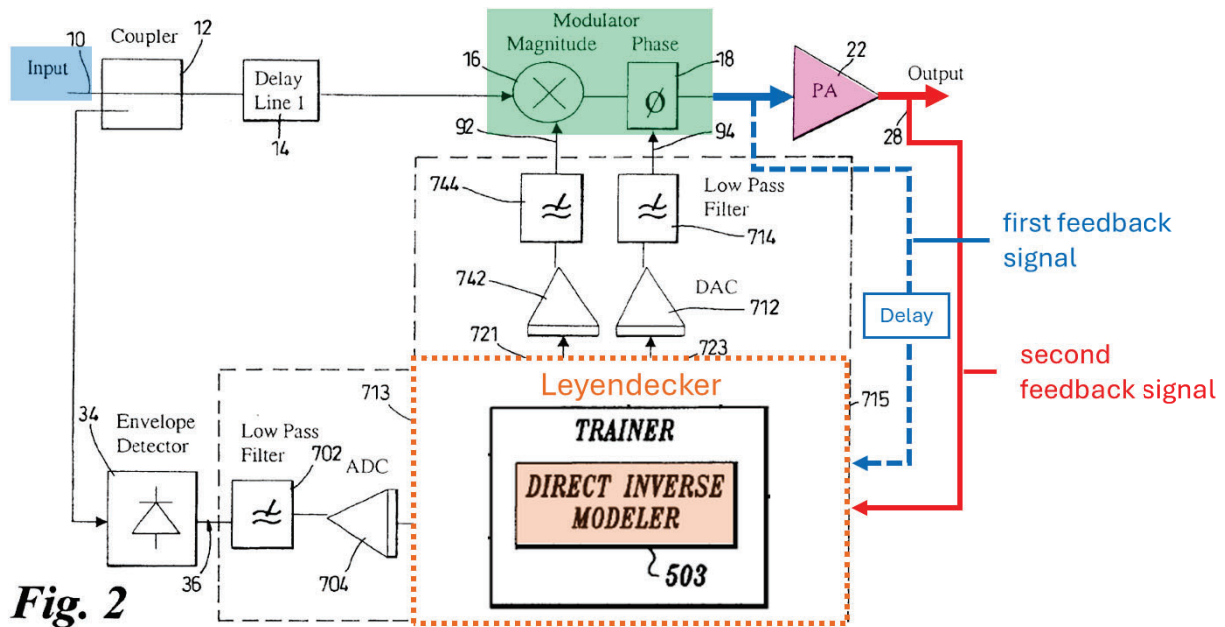


(Leyendecker, 9:55-10:15, Fig. 5 (annotated).) For example, a POSITA would have known that indirect modeling avoids the “computationally intensive mathematical inversion process,” and “enable[es] the trainer to calculate the inverse characteristic of the power amplifier at a relatively high sample rate in real time.” (See Leyendecker, 10:5-9, 13:56-59; Proctor, ¶147.) *Ruiz v. A.B. Chance Co.*, 234 F.3d 654, 665 (Fed. Cir. 2000) (“A motivation to combine may be found in the prior art

references themselves:”); *In re Gorman*, 933 F.2d 982, 986 (Fed. Cir. 1991) (“When the references are all in the same or analogous fields, knowledge thereof by the hypothetical person of ordinary skill is presumed, [] and the test is whether the teachings of the prior art, taken as a whole, would have made obvious the claimed invention.” (citations omitted)). Leyendecker confirms that indirect modeling was “conventional” in digital predistortion systems (Leyendecker, 1:42-58), and a POSITA would have been motivated to use indirect modeling in Booth’s predistortion system to achieve the advantages described by Leyendecker—e.g., to reduce processing time and enable “real-time” predistortion. (Proctor, ¶147.) *Intel Corp.*, 61 F.4th at 1380-81 (“There is a motivation to combine when a known 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’” (citations omitted)).

This modification would have been simple for a POSITA to implement. (Proctor, ¶148.) As an initial matter, Booth implicitly confirms that its predistorter may be modified to include multiple feedback signals *in addition to* the envelope feedback signal. (*Id.*; Booth, 2:63-65 (“It should be noted that the pre-distortion processor may take into account other inputs than the [envelope feedback] linear function when distorting the input signal.”).) Further, Booth already teaches

sampling the RF output of the PA. (Booth, 11:5-15, Proctor, ¶148.) Thus, the only modification to Booth's transmitter needed to implement Leyendecker's indirect model is a way to sample the RF predistorted signal ("first feedback signal," blue), as shown below:



(Booth, 7:5-22, Fig. 2 (as modified by Leyendecker); Proctor, ¶148.) It would have been well-within the abilities of a POSITA to make the necessary changes to implement Leyendecker's indirect model in Booth's transmitter. (Proctor, ¶148.) *KSR*, 550 U.S. at 420 ("[I]n many cases[,] a person of ordinary skill will be able to fit the teachings of multiple patents together like pieces of a puzzle.").

For example, a POSITA would have known how to implement a directional coupler to sample Booth's predistorted RF signal. (Proctor, ¶149; Booth, 7:5-9.) A

POSITA also would have known how to implement a “delay” in the predistorted RF feedback signal to ensure that the first and second feedback signals are synchronized. (Proctor, ¶149; Booth, 7:18-22; Leyendecker, 9:40-46.) And, as discussed below, a POSITA would have known how to use a digital receiver to convert the RF predistorted signal (first feedback signal) and RF output of the PA (second feedback signal) to complex baseband in order to implement Leyendecker’s indirect modeler. (Proctor, ¶149; Leyendecker, 20:19-39.)

Thus, the disclosures of Booth, Leyendecker, and the knowledge of a POSITA provide all the information necessary to implement Leyendecker’s indirect trainer model in Booth’s predistorter, such that a POSITA would have been able to successfully implement this modification. (Proctor, ¶150.)

**b. Combining Booth with Leyendecker’s Digital Receiver**

It also would have been obvious to a POSITA to use Leyendecker’s digital receiver to translate feedback signals from RF to complex baseband signals. (Proctor, ¶151.) It was well-known to a POSITA that analog components in an RF feedback signal path (e.g., I/Q demodulators, down-converters, and filter components) may introduce distortion not attributed to the PA. (*Id.* at ¶¶83, 151.) *Intel Corp.*, 61 F.4th at 1380. Leyendecker explains, for example, that “intermodulation products and other distortion . . . located in the desired broadcast

RF channel . . . adversely affects the training of the predistorter,” and that this distortion “is not only generated by the nonlinearity of the power amplifier, but also from other low frequency sources.” (Leyendecker, 19:31-38; Proctor, ¶151.) Leyendecker solves this issue using a digital receiver that removes the in-band distortion from an RF feedback signal using a combination of digital demodulation, filtering, and other digital signal processing steps. (Leyendecker, 19:56-64, 20:40-64; Proctor, ¶151.)

Booth’s predistorter design, as modified by Leyendecker’s indirect modeler (described above), would require sampling and converting multiple RF signals (namely, the input and output of the PA) to complex baseband in order to characterize the PA nonlinearity. (Proctor, ¶¶152, 56-58. *See* Section IX.C.1.a.) A POSITA would have been motivated to implement Leyendecker’s digital receiver in Booth’s system to avoid the well-known distorting effects associated with analog demodulation and filtering techniques, thereby further improving the accuracy of the predistortion. (Proctor, ¶152.) *Intel Corp.*, 61 F.4th at 1380-81. A POSITA would have understood that this modification was particularly suitable where Booth has been modified to include the indirect trainer of Leyendecker. (Proctor, ¶152.) Under such circumstances, a POSITA would have considered it obvious to include

Leyendecker’s digital receivers to simplify the integration of Leyendecker’s trainer into Booth’s predistortion system. (*Id.*)

Modifying Booth to incorporate Leyendecker’s digital receiver would have been simple and achieved with a reasonable expectation of success. (*Id.* at ¶153.) As Leyendecker explains, the digital receiver merely adds routine processing steps on a received RF signal in order to minimize intermodulation products and other sources of in-band distortion. (*Id.*; Leyendecker, 19:31-64.) Leyendecker explains that a POSITA would have known how to implement these processing steps using conventional DSP circuitry. (Leyendecker, 18:58-19:11; Proctor, ¶153.) A POSITA would thus be reasonably likely to succeed in incorporating Leyendecker’s digital receiver into Booth’s transmitter. (Proctor, ¶153.)

## 2. Claim 1

- a. **1[pre]: An adaptive method for predistorting an RF modulated signal, to be transmitted, supplied by a signal source to an input of a power amplifier having an output for delivering an amplified output signal, said method comprising the steps of:**

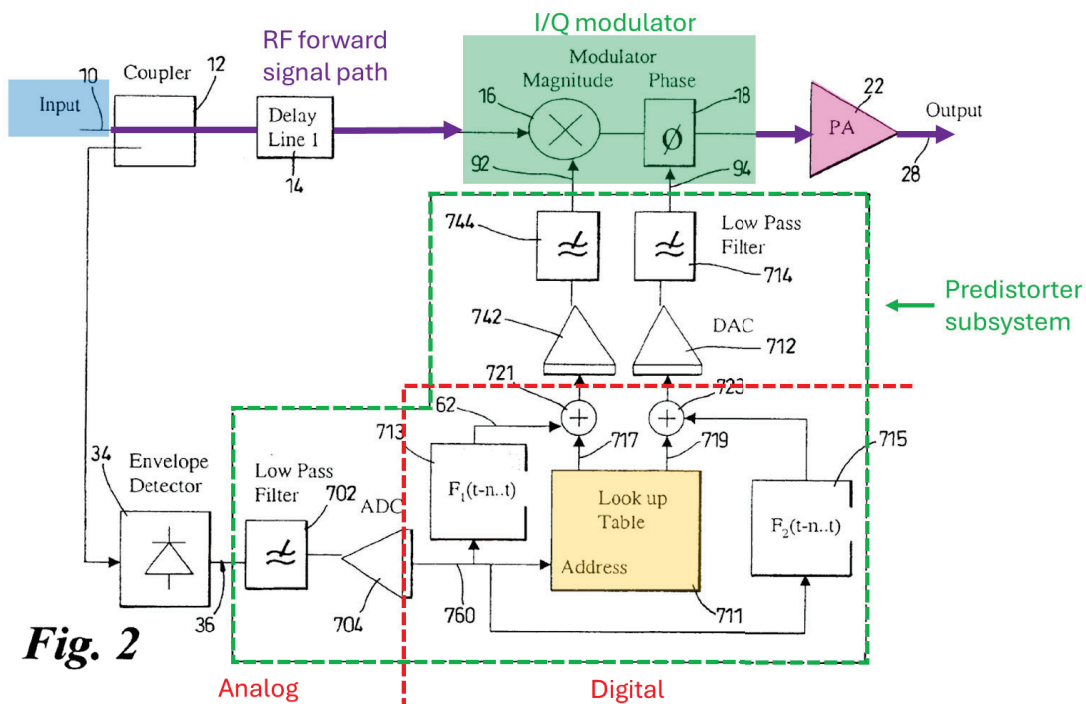
If the preamble is limiting, then Booth discloses 1[pre]. (Proctor, ¶154.) Booth teaches “an amplifier arrangement for amplifying an input radio frequency (RF) signal to generate an output RF signal” that utilizes an adaptive digital predistorter to compensate for distortion. (Booth, 1:5-6, 2:40-51, 5:6-48, Fig 2.) Booth explains that the predistortion system processes multiple feedback signals to

generate “correction signals,” that in turn are used to predistort the RF input to compensate for PA distortion. (*Id.* at 7:5-32; Proctor, ¶154.)

- b. 1[a]: predistorting the RF modulated signal to be transmitted using an I/Q modulator interposed between the signal source and the input of the power amplifier, and controlled by means of amplitude and phase look-up tables stored in a distorting generator;**

Booth discloses a digital predistortion system that generates amplitude and phase correction signals based on feedback received from the RF input and output signals of the PA for predistorting the input signal. (Booth, 7:13-22; Proctor, ¶155.)

Figure 2, below, generally depicts the input signal's path:



(Booth, 7:5-32, Fig. 2 (annotated).) The RF input signal (blue) is initially split via a directional coupler into a delay line and a feedback signal. (*Id.*; Proctor, ¶155.) The

feedback signal passes through an envelope detector 34 and then to the predistorter sub-system (green dashes). (Booth, 7:33-36; Proctor, ¶155.) The predistorter compares the signal envelope to a second feedback signal corresponding to the PA output (not shown) and generates error correction signals 92 and 94 using an amplitude and phase lookup table (yellow). (Booth, 8:47-59, 11:5-19; Proctor, ¶155.) An I/Q modulator (green) uses the error correction signals to predistort the RF input signal. (Booth, 7:23-32; Proctor, ¶155.) The predistorted RF signal is then supplied to the PA (pink). (Booth, 7:5-9, Fig. 1; Proctor, ¶155.)

Thus, Booth discloses this element.

**c. 1[b]: producing, via a first digital receiver, a first feedback signal in response to the RF predistorted signal;**

Booth discloses using an I/Q modulator to generate a predistorted RF modulated signal. (Proctor, ¶157; *see* Section IX.C.2.b.) Leyendecker discloses sampling the output of the predistorter (input to the PA) and providing that predistorted signal (first feedback signal) to the trainer in order to calculate the inverse transfer characteristics of the PA. (Leyendecker, 9:52-10:5, Fig. 5; Proctor, ¶157.)

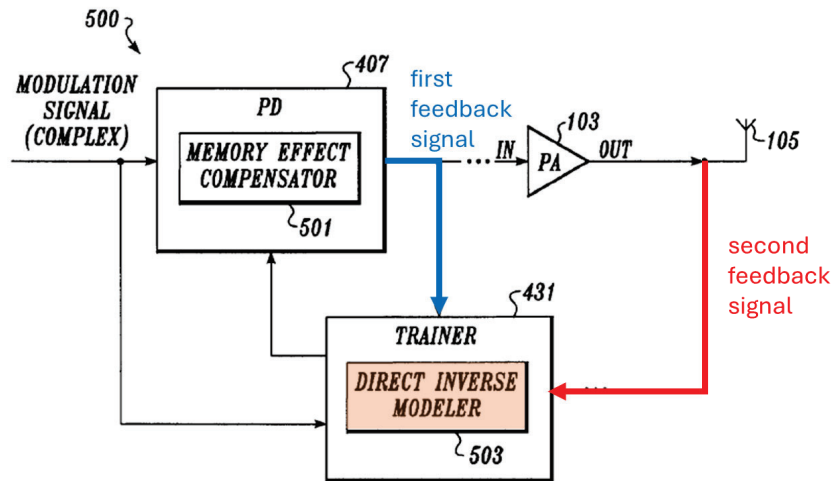
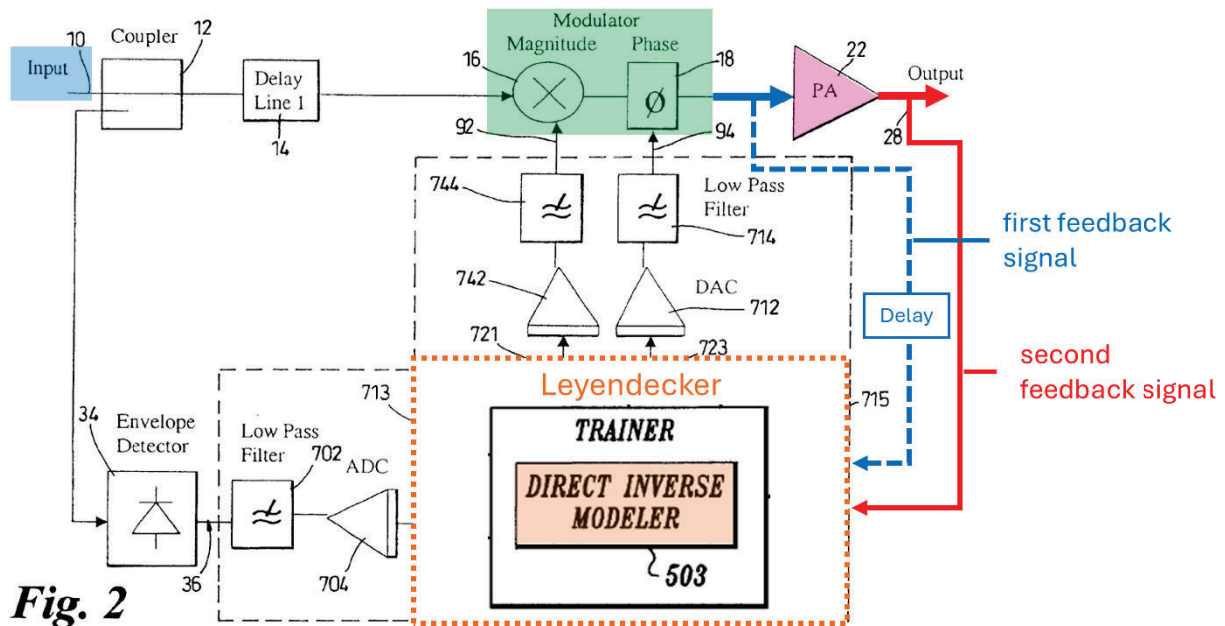


*Fig. 5*

(Leyendecker, 9:55-10:15, Fig. 5 (annotated).) Thus, Leyendecker discloses producing a first feedback signal in response to the RF predistorted signal. (Proctor, ¶157.)

A POSITA would have understood that implementing Leyendecker’s indirect modeler in Booth’s predistortion system would require sampling the RF predistorted signal (“first feedback signal,” blue) as shown below:



(Booth, 7:5-22, Fig. 2 (annotated and modified by Leyendecker); Proctor, ¶158.) See Section IX.C.1.a. Leyendecker discloses using a digital receiver to produce an RF feedback signal. (Leyendecker, 8:28-45; Proctor, ¶158.) The RF feedback loop utilizes a coupler to redirect a portion of the RF signal to an analog downconverter, which translates the RF feedback signal to IF. (Leyendecker, 6:12-30; Proctor, ¶158.) The IF signal is then converted to digital “using a conventional A-D converter 424.” (Leyendecker, 6:32-38; Proctor, ¶158.) Next, digital demodulation and decimation is performed on the digital feedback signal using conventional, commercially-available circuitry. (Leyendecker, 6:38-41, 8:33-38 (“In a preferred embodiment, the digital quadrature demodulator is implemented using a Xilinx 4003

field programmable gate array (FPGA) that has been configured to perform the digital quadrature demodulation.”), 8:39-45; Proctor, ¶158.)

Figure 4 depicts using Leyendecker’s digital receiver to produce a feedback signal with respect to the amplified output of the PA. (Leyendecker, 6:12-41, 6:66-7:8, Fig. 4; Proctor, ¶159.)

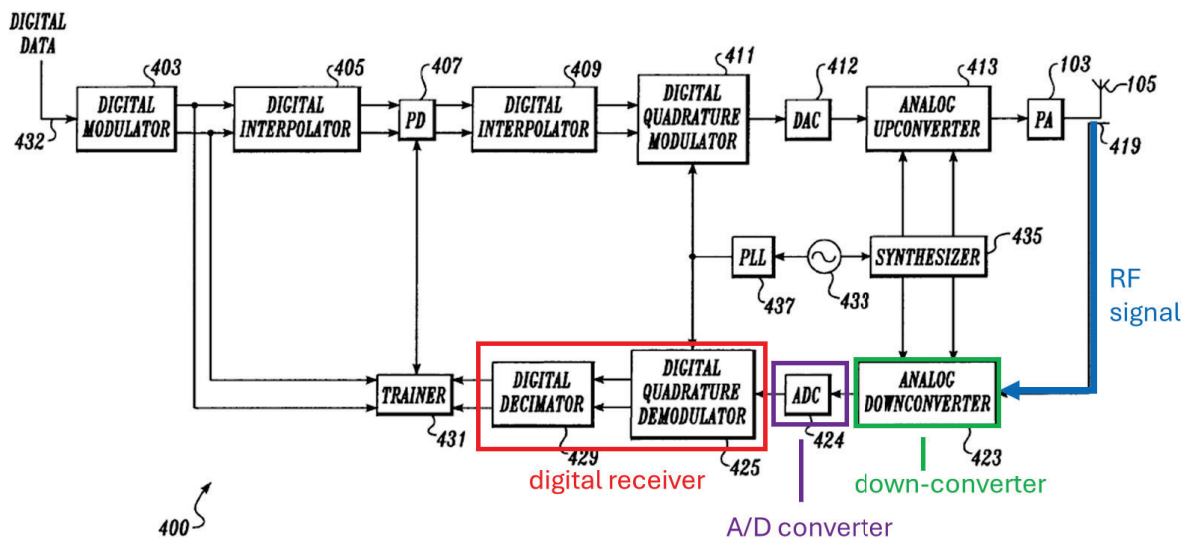


*Fig. 4*

(Leyendecker, Fig. 4 (annotated); Proctor, ¶159.) This is the same RF signal sampling process described by the '345 Patent. (Proctor, ¶159; EX1001, 5:59-62, 6:29-31, 14:16-22.)



(EX1001, Fig. 1 (annotated).)

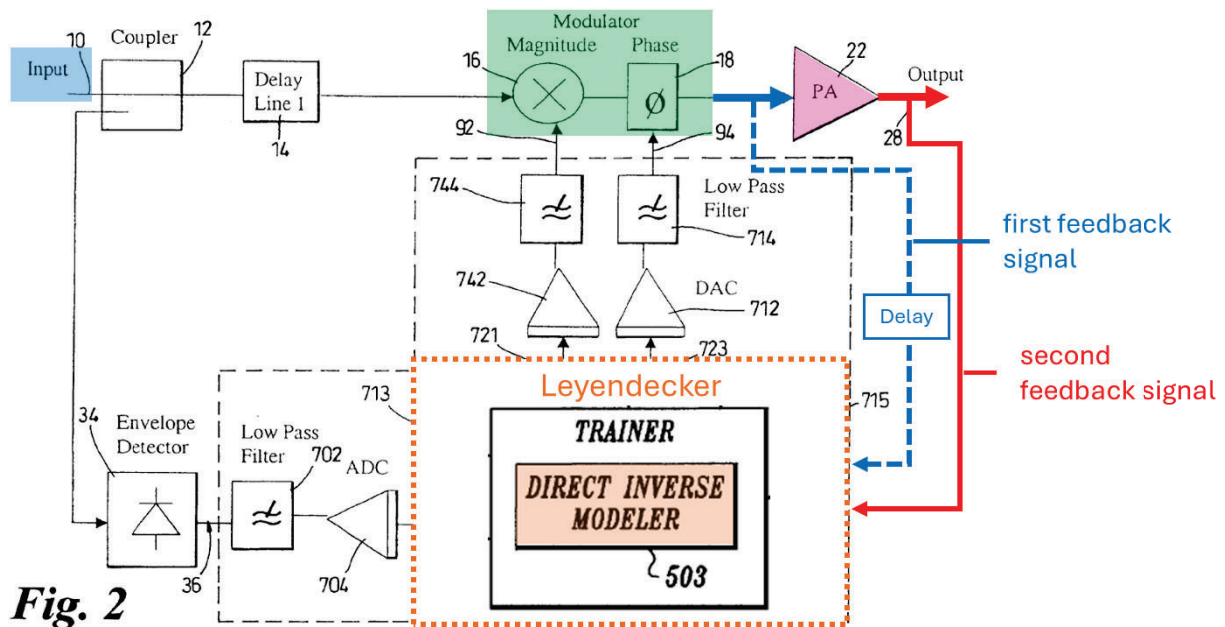
As explained above, a POSITA would have known that Leyendecker’s digital receiver would be obvious to include to generate the complex baseband signal for the RF predistorted signal (first feedback signal) required by Leyendecker’s indirect predistortion model. (Proctor, ¶160.) *See* Section IX.C.1.b.

Thus, the combination of Booth and Leyendecker discloses this element.

- d. 1[c]: producing, via a second digital receiver, a second feedback signal in response to the RF amplified output signal from the power amplifier;**

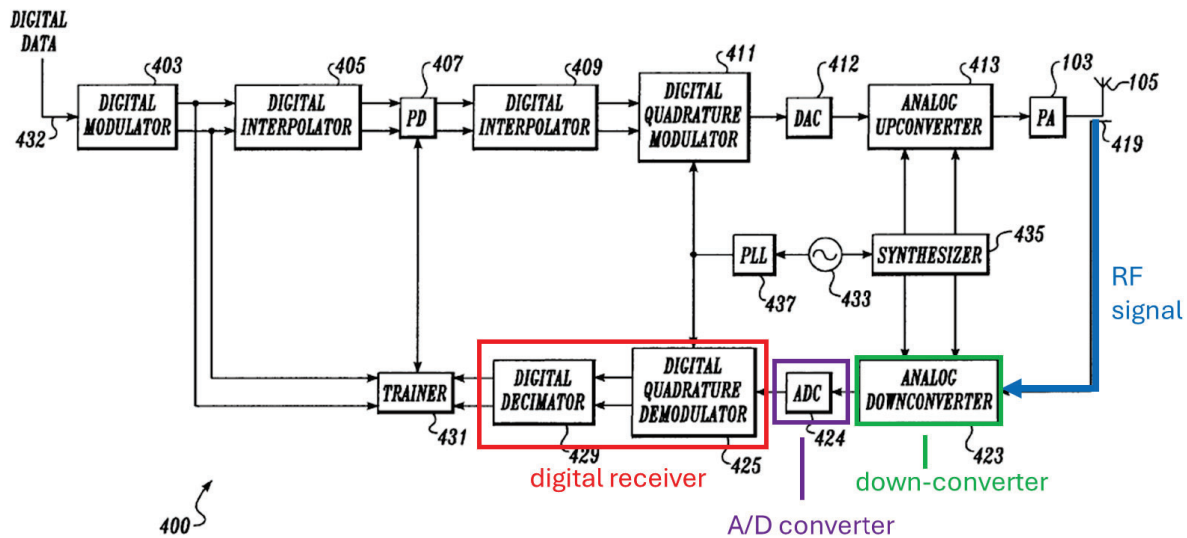
As discussed above, Booth discloses sampling the RF amplified output of the PA using a directional coupler and providing corresponding feedback (“second

feedback signal”) to the predistortion system. (Booth, 11:5-15, Fig. 7; Proctor, ¶162.) See Section IX.C.2.b.



(Booth, 7:5-22, Fig. 2 (as modified by Leyendecker); Proctor, ¶162.)

Leyendecker also teaches that the trainer “receives and stores from the digital decimator . . . *complex digital signals that are scaled down, downconverted, and digitized samples of the power amplifier output signals.*” (Leyendecker, 13:45-49; Proctor, ¶163.) As discussed above, Leyendecker teaches using a digital receiver to translate the RF amplified output of the PA into the complex baseband signal to be used by the trainer. (Leyendecker, 8:28-50; Proctor, ¶163. See Section IX.C.2.c.)



(Leyendecker, 8:28-50, Fig. 4.) Thus, Leyendecker discloses this element.

**e. 1[d]: modeling the power amplifier in response to the first and second feedback signals; and**

Leyendecker explains that its trainer subsystem 605 “periodically receives ‘batches’ of data containing the modulation signal samples, power amplifier input signal samples [first feedback signal] and power amplifier output signal samples [second feedback signal]” that it uses to model the PA and generate an inverse signal. (Leyendecker, 10:26-39; Proctor, ¶164.) The trainer comprises a “solver” that processes this feedback signal data “to generate the complex parameters used to update the LUT of the predistorter.” (Leyendecker, 13:66-14:1, 13:40-42, 14:55-59; Proctor, ¶164.)

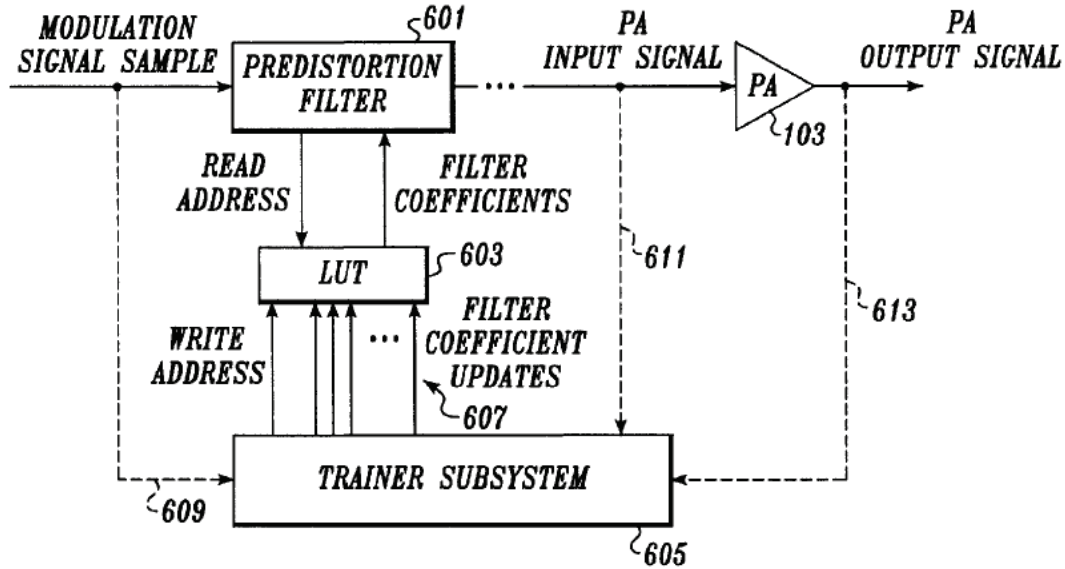


*Fig. 6*

(Leyendecker, 10:16-39, Fig. 6.)

Thus, Leyendecker discloses this element.

- f. 1[e]: updating the predistortion amplitude and phase look-up tables in response to said modeling of the power amplifier,

Leyendecker discloses that “the trainer subsystem 605 ... periodically updates the inverse characteristics of the power amplifier 103 by providing a write address and updated filter coefficients to the LUT 603,” as shown below:

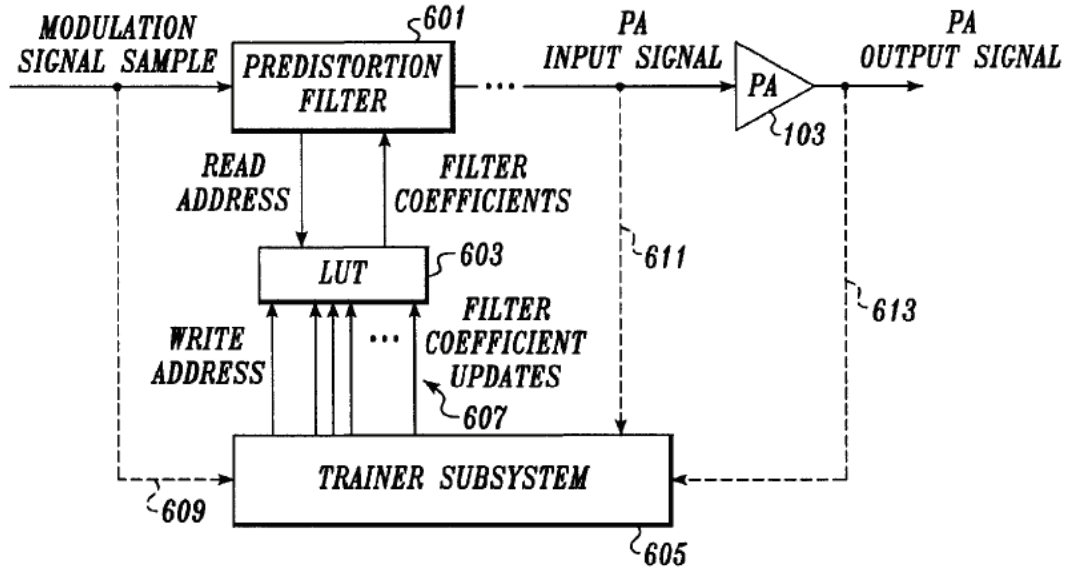


*Fig. 6*

(Leyendecker, 10:16-39, Fig. 6.) Leyendecker further explains that the LUT(s) may be indexed by amplitude and phase. (Leyendecker, 2:33-55, 11:10-28 (“the LUT 603 is indexed by the instantaneous power or magnitude [amplitude] of the modulation samples . . . [T]he LUT 603 may include additional dimensions or tables [and] . . . different tables may be used for different modulation schemes.”); Proctor, ¶166.)

- g. 1[f]: wherein said second feedback signal includes the complex envelope of the RF amplified output signal, and**

Leyendecker discloses that that the trainer’s indirect modeler utilizes the complex envelopes (i.e., the *I* and *Q* signal components) of the first and second feedback signals in order to model the PA nonlinearity. (Leyendecker, 8:46-50,

13:45-65; Proctor, ¶167.) “The trainer 431 also receives and stores from the digital decimator 429 (FIG. 4) *complex digital signals* that are scaled down, downconverted and digitized samples *of the power amplifier output signals*. These signals are referred to as the PA<sub>out</sub> samples.” (Leyendecker, 13:45-49, 13:50-57 (explaining the trainer additionally receives the complex envelope of the PA<sub>in</sub> samples (first feedback signal).) Leyendecker teaches that the complex envelope of the PA<sub>out</sub> feedback signal is generated by the digital receiver. (*Id.* at 8:28-50; Proctor, ¶167.)

- h. 1[g]: wherein said modeling step includes the discrimination of the complex envelope of the first feedback signal referenced to the complex envelope of the second feedback signal to yield a predistortion function correlated to a behaviour of the power amplifier including nonlinearities and memory effects.**

Leyendecker discloses that its trainer’s indirect model utilizes the complex envelopes of the first and second feedback signals to model the PA nonlinearity. (Leyendecker, 8:46-50, 13:45-65; Proctor, ¶168. *See* Section IX.C.2.g.) For example, Leyendecker discloses that the trainer’s “solver 1201” cross-references the PA<sub>in</sub> and PA<sub>out</sub> samples using a “parameter calculator 1311” in order to calculate the complex parameters that are used to update the predistorter LUTs. (Leyendecker, 15:22-57, Fig. 13; Proctor, ¶168.)

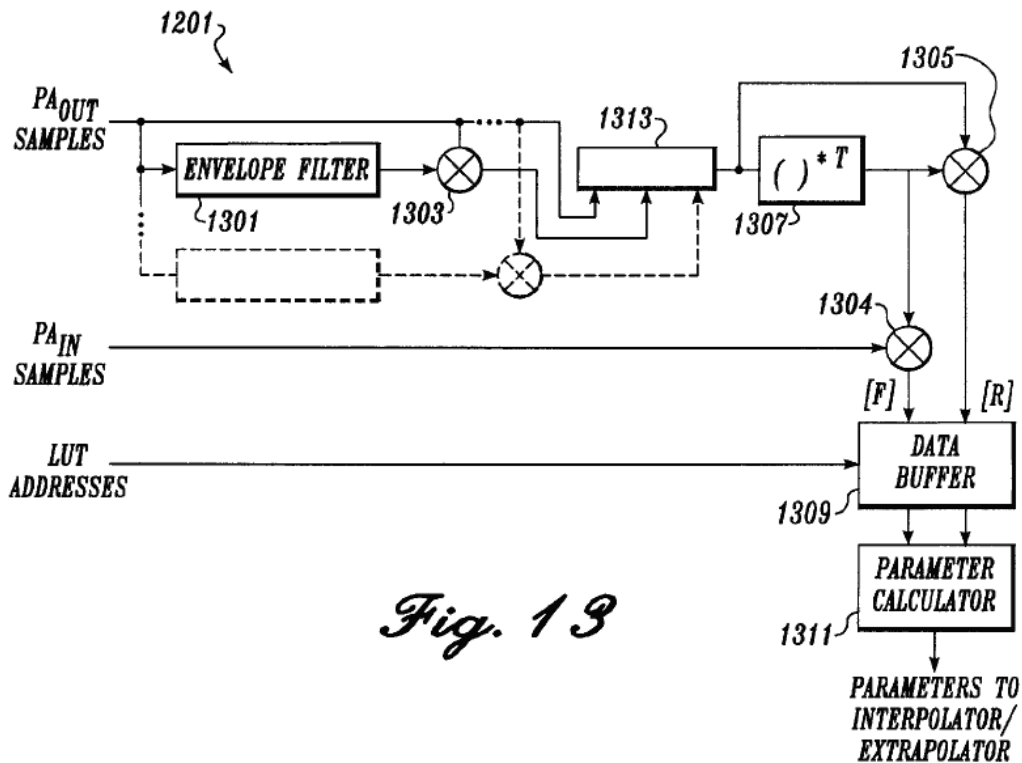


*Fig. 13*

(Leyendecker, 15:22-65, Fig. 13.)

Leyendecker further explains that the trainer compensates for “memory effects.” (Proctor, ¶169; Leyendecker, 9:18-32.) More specifically, Leyendecker discloses that the trainer matches the  $PA_{in}$  (first feedback signal) and  $PA_{out}$  (second feedback signal) samples to the original modulation samples in order to model the PA distortion and memory effects. (Leyendecker, 13:40-65, 15:28-41; Proctor, ¶169.) Using the data that the trainer updates into the LUTs, a “predistortion filter 601 provides the predistortion functionality as a function of both the instantaneous power or magnitude envelope of the current modulation signal sample and *the power*

*of magnitude envelopes of previous modulation signal samples* [i.e., memory effects].” (Leyendecker, 10:22-26, Fig. 6; Proctor, ¶169.)

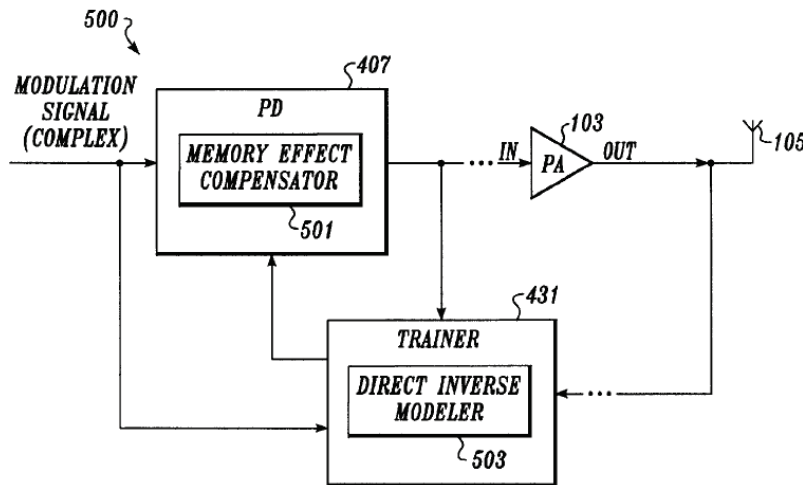


*Fig. 5*

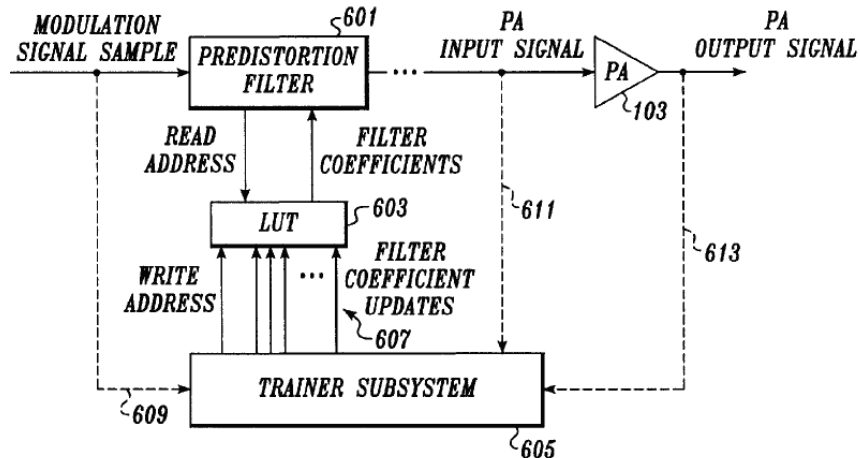


*Fig. 6*

(Leyendecker, 10:16-39, Fig. 5 (high-level diagram of memory effect compensator) and Fig. 6 (predistortion system of Fig. 5).)

Accordingly, Booth in view of Leyendecker renders claim 1 obvious.

**3. Claim 2**

**a. 2. An adaptive method as recited in claim 1, wherein said modeling step is done in real time.**

Booth and Leyendecker in combination renders claim 1 obvious. (Proctor, ¶171; *see* Section IX.C.2.) Further, Leyendecker discloses that the modeling step is performed “in real time.” (Proctor, ¶171.) As previously discussed, Leyendecker explains that an indirect model “enabl[es] the trainer to calculate the inverse characteristic of the power amplifier at a relatively high sample rate *in real time*.” (Leyendecker, 10:5-9, 13:56-59; Proctor, ¶171.) Indeed, as previously discussed, the real-time processing capability of Leyendecker’s indirect model is one of the primary reasons a POSITA would have been motivated to implement this model in Booth’s predistortion system. (Proctor, ¶171; Leyendecker, 3:8-16.)

Accordingly, Booth in view of Leyendecker renders obvious claim 2.

**4. Claim 5**

**a. 5[pre]-5[e]:**

While claim 5 recites a “device” and claim 1 recites a “method,” all of claim elements 5.pre.-5.e. are substantially similar to corresponding limitations for claim 1.<sup>12</sup> For the reasons discussed above, elements 5.pre.-5.e. are taught by Booth in

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<sup>12</sup> The initial limitations of claim 5 that correspond to those in claim 1 are:

5[pre]: An adaptive device for predistorting an RF modulated signal to be transmitted, supplied by a signal source to an input of a power amplifier having an output for delivering an amplified output signal, said adaptive device comprising:

[5.a] an I/Q modulator interposed between the signal source and the input of the power amplifier;

[5.b] a distorting generator including predistortion amplitude and phase look-up tables; said distorting generator controlling said I/Q modulator to predistort the RF modulated signal to be transmitted in amplitude and in phase;

[5.c] a first digital receiver producing a first feedback signal in response to the RF predistorted signal from said I/Q modulator;

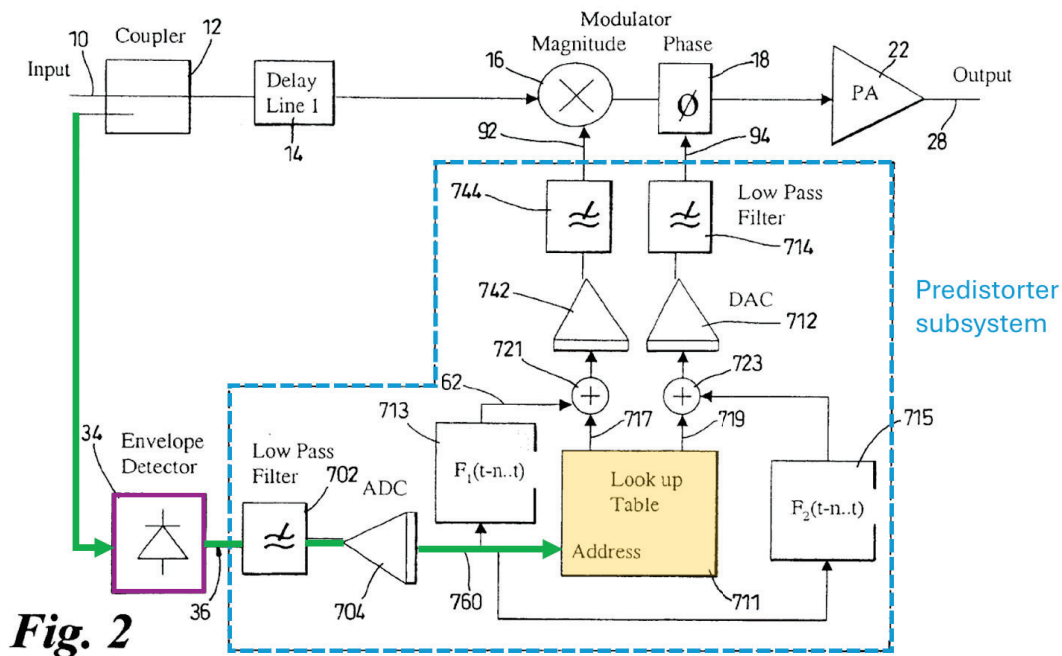
[5.d] a second digital receiver producing a second feedback signal in response to the RF amplified output signal from the power amplifier;

[5.e] a control module receiving said first and second feedback signals from said first and second digital receivers; said control module being so configured as to model the power amplifier in response to the first and second feedback signals and to update said amplitude and phase look-up tables of said

view of Leyendecker. (See Sections IX.C.2.a.-IX.C.2.f.; Proctor, ¶¶173, 96-97, 154-166.)

- b. 5[f]: wherein said look-up tables of said distorting generator are indexed by an envelope detector that detects the envelope of the signal to be transmitted before predistortion.

Booth discloses that its RF modulated input signal is transmitted to an envelope detector via a directional coupler. (Booth, 7:5-12, Fig. 2; Proctor, ¶174.)



distorting generator in response to a dynamic modeling of the power amplifier[.]

(Booth, 7:5-41, Fig. 2 (annotated).) The envelope detector (purple) detects the magnitude of the RF modulated signal (“envelope of the signal,” green), which is provided to the digital predistorter (“distorting generator,” blue) and used to index the LUT (yellow). (*Id.* at 7:33-41; Proctor, ¶174.) Thus, Booth explains that before predistortion, “samples of the envelope  $|x(t)|$  of the input (10) . . . are used to address the LUT (711).” (Booth, 8:63-67; Proctor, ¶174.)

Leyendecker also indexes the predistorter LUT(s) using the signal envelope. (Proctor, ¶175.) For example, Leyendecker explains that “the direct inverse modeling scheme of the present invention ***indexes the LUT using the modulated input signals*** instead of the potentially noisier output signals, which helps to increase the accuracy of the predistortion.” (Leyendecker, 3:16-21.) Leyendecker explains that “the trainer updates the predistorter with the ‘output sample-to-input sample’ gain and phase of the power amplifier, ***indexed by the instantaneous power or magnitude of the modulation signal sample.***” (*Id.* at 9:66-10:5, 11:11-18.)

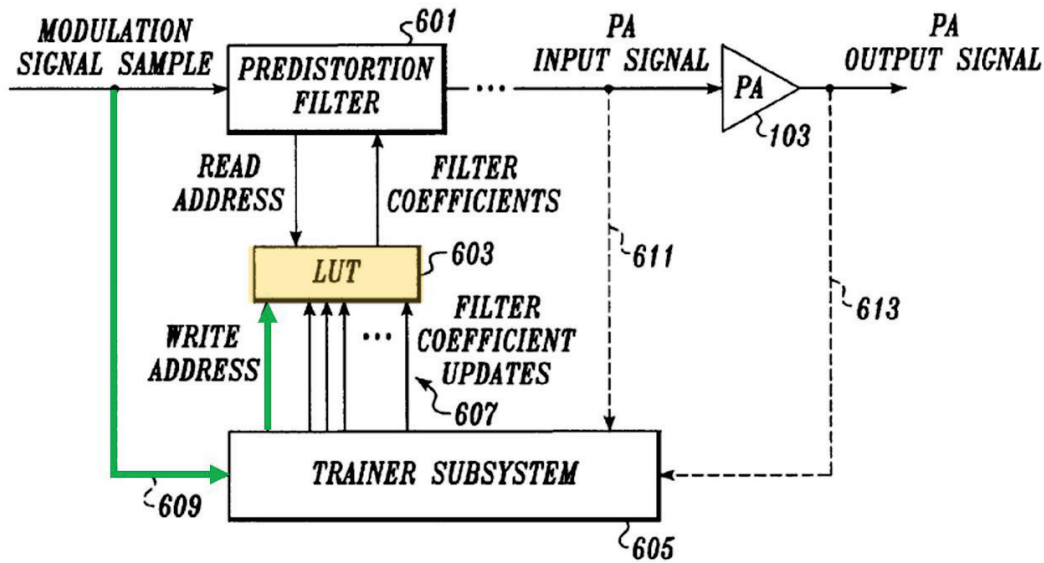
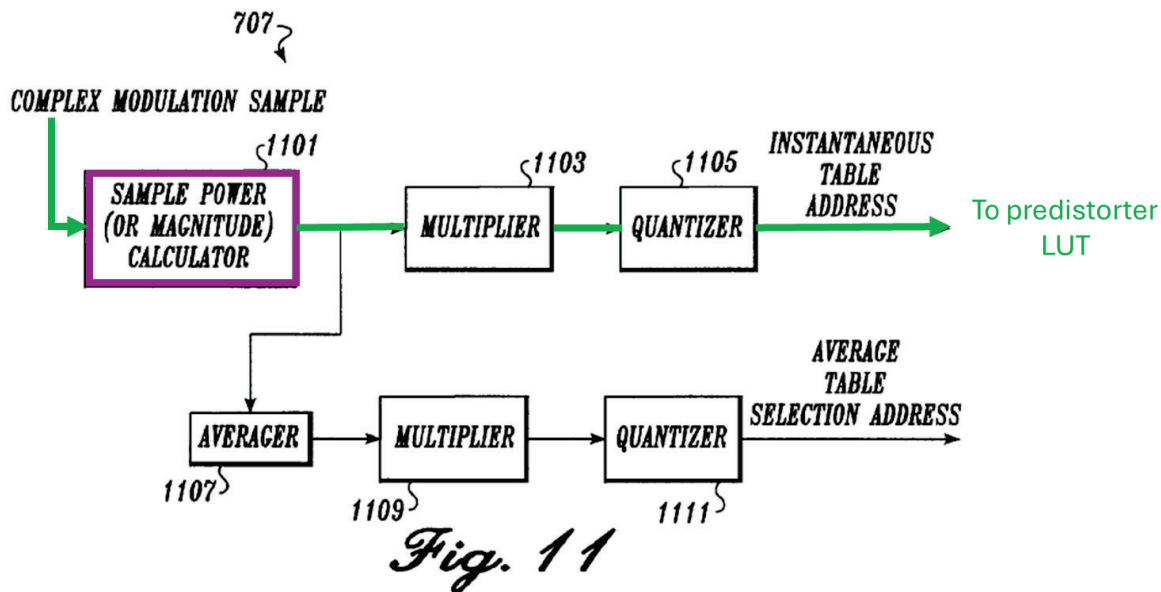


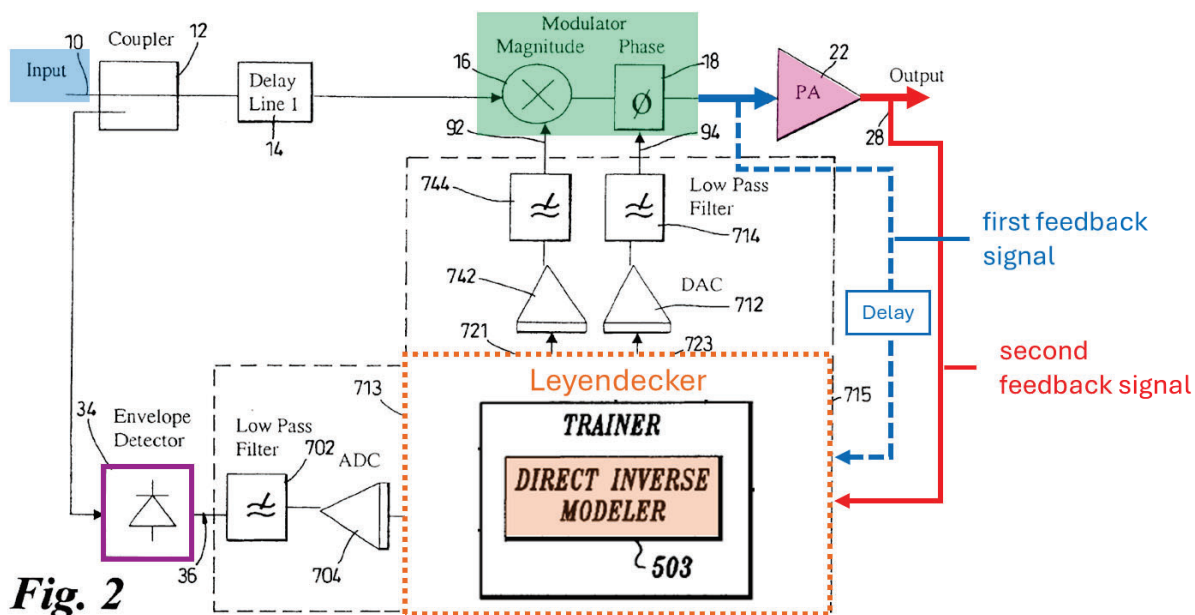
*Fig. 6*

(*Id.* at 10:16-26, Fig. 6 (annotated).) The “instantaneous power or magnitude of the modulation signal sample” is the signal envelope. (Proctor, ¶175.) In order to generate the instantaneous power or magnitude of the modulation signal sample (“envelope of the signal,” green) from the complex modulation sample, Leyendecker teaches using a sample power or magnitude calculator (“envelope detector”). (Leyendecker, 12:58-67, Fig. 11; Proctor, ¶¶175, 49-50.)



(Leyendecker, 12:58-67, Fig. 11 (annotated; “envelope detector” in purple).)

Thus, both Booth and Leyendecker disclose using an envelope detector to index the predistorter LUT with the RF modulated input signal envelope. (Proctor, ¶176.)



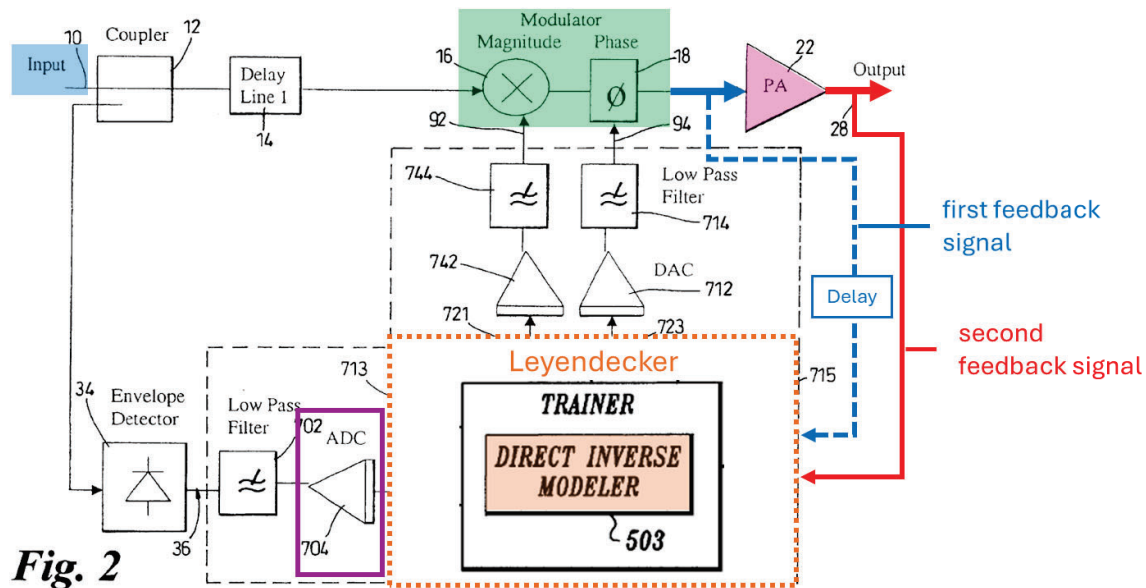
(Booth, 7:5-22, Fig. 2 (as modified by Leyendecker; “envelope detector” in purple); Proctor, ¶176.) As previously discussed, it would have been well-within the abilities of a POSITA to implement this step in the combination of Leyendecker’s indirect model with Booth’s transmitter. (Proctor, ¶¶176, 147-150. *See* Section IX.C.1.a.)

Thus, Booth in view of Leyendecker renders obvious claim 5.

**5. Claim 6**

- a. 6. An adaptive device as recited in claim 5, wherein said envelope detector indexes the distorting generator via an analog to digital converter.**

Booth in view of Leyendecker renders claim 5 obvious. (Proctor, ¶178.) *See* Section IX.C.4. Booth further discloses that the envelope detector indexes the predistorter LUTs *via an analog to digital converter*. (Proctor, ¶¶178, 49-50.) For example, Booth discloses that “the output of the envelope detector is connected to a digital pre-distortion sub-system.” (Booth, 7:11-13.) As shown in Booth Figure 2, the signal from the envelope detector is converted from analog (RF) to digital via an ADC (purple) so that the predistorter can process the data. (*Id.* at 7:5-13, Fig. 2; Proctor, ¶178.)



(Booth, 7:5-36 (“The signal (36) from the envelope detector 34 is . . . digitised by an analogue to digital converter (ADC) (704).”), Fig. 2 (as modified by Leyendecker).)

Thus, Booth in view of Leyendecker renders claim 6 obvious.

## 6. Claim 11

### a. 11[pre]-11[e]:

Claim elements 11.pre.-11.e. are identical to the corresponding limitations for claim 5.<sup>13</sup> For the reasons discussed above, elements 11.pre.-11.e. are taught by

<sup>13</sup> The initial limitations of claim 11 that correspond to those in claims 1 and 5 are:

11[pre] An adaptive device for predistorting an RF modulated signal to be transmitted, supplied by a signal source to an input of a power amplifier

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having an output for delivering an amplified output signal, said adaptive device comprising:

[11.a] an I/Q modulator interposed between the signal source and the input of the power amplifier;

[11.b] a distorting generator including predistortion amplitude and phase look-up tables; said distorting generator controlling said I/Q modulator to predistort the RF modulated signal to be transmitted in amplitude and in phase;

[11.c] a first digital receiver producing a first feedback signal in response to the RF predistorted signal from said I/Q modulator;

[11.d] a second digital receiver producing a second feedback signal in response to the RF amplified output signal from the power amplifier;

[11.e] a control module receiving said first and second feedback signals from said first and second digital receivers; said control module being so configured as to model the power amplifier in response to the first and second feedback signals and to update said amplitude and phase look-up tables of said distorting generator in response to a dynamic modeling of the power amplifier[.]

Booth in view of Leyendecker. (See Sections IX.C.1.-IX.C.2.f., IX.C.4.a.; Proctor, ¶¶180, 96-97, 154-66.)

**b. 11[f]: wherein said control module is further configured as to insert an adequate delay between the first feedback signal and the second feedback signal.**

Leyendecker's trainer subsystem ("control module") inserts a delay into the first feedback loop to ensure the first feedback signal is synchronized with the second feedback loop. (Leyendecker, 8:51-60, 9:35-46 ("Because the timing and sampling is synchronized, the trainer 431 matches (by taking into account the delay through the intervening circuitry the input digital sample with the corresponding sample of the power amplifier output signal."), Fig. 5; Proctor, ¶181.) Leyendecker explains that this delay is necessary to compensate for the delay through the analog and digital stages, including the PA. (Leyendecker, 8:51-60, 13:59-65 ("The trainer 431 provides the proper delays and synchronization to match the  $PA_{in}$  samples and  $PA_{out}$  samples with the originating modulation signal samples."); Proctor, ¶181.)

Thus, Booth in view of Leyendecker renders claim 11 obvious.

**X. THE BOARD SHOULD NOT EXERCISE ITS DISCRETION TO DENY INSTITUTION**

**A. The Board Should Not Deny Review Under 35 U.S.C. § 325(d)**

None of the references relied upon herein was cited, discussed or applied in the '345 Patent's prosecution history, nor are the references the same or substantially

the same as those considered during prosecution. (*See* EX1024, EX1025.)

Accordingly, the Board should not exercise its discretion under Section 325(d).

**B. The Board Should Not Deny Review under 35 U.S.C. § 314(a)**

Under *Fintiv*, the Board takes a holistic view of whether efficiency, fairness, and the merits support the exercise of authority to deny institution in view of an earlier trial date in a parallel proceeding. *Apple Inc. v. Fintiv, Inc.*, Case IPR2020-00019, Paper 11 at 6 (March 20, 2020). Because Challenged Claims have never been tested against the most relevant prior art, the Board should not exercise that discretion here.

**Factor 1** is neutral because no request for stay has been filed.

**Factor 2** is neutral. A scheduling order sets trial for November 17, 2025. (EX1029.) However, according to the most recent statistics on median time-to-trial for civil actions, the median time to trial in the Eastern District of Texas is 21.6 months, which would push the trial date to around January 2026 (EX1030, 35). Further, Smart RF filed three separate cases (now consolidated for discovery), asserting five patents with a total of 73 claims. The cases also involve multiple intervenors. These facts make it unlikely for the cases to proceed according to the Court's initial schedule. But even if jury selection were to proceed on November 17, 2025, the trial would decide only one of the three cases. Each of the defendant

Petitioners are entitled to separate trials, which will necessarily proceed on separate dates to be set by the court at a later time and likely spreading well into 2026. As such, there are explicit and inherent uncertainties for this case given the number of parties involved and the number of trials regarding this patent. And at minimum, because much can change in eight months, the current trial date does not support denial. *See Dish Network v. Broadband iTV*, IPR2020-01280, Paper 17 at 16 (PTAB Feb. 4, 2021).

**Factor 3** weighs against discretionary denial. The district court has not issued any substantive rulings in any case with respect to the '345 Patent, and the claim construction hearing is not scheduled until May 30, 2025, at the earliest. Further, the Court will not consider motions for summary judgment until after the likely August or September 2025 deadline for an institution decision in this case. (EX1029, 5-6.)

**Factor 4** weighs against discretionary denial. Petitioners stipulate that if the IPR is instituted, they will not pursue in the Related Litigation any ground raised or that reasonably could have been raised in this Petition. (EX1032 (“Stipulation”).) *Sotera Wireless, Inc. v. Masimo Corp.*, IPR2020-01019, Paper 12 (Dec. 1, 2020).

Under **Factor 5**, Petitioners are defendants (or intervenors) in the Related Litigation, which might weigh in favor of discretionary denial; however, Factors 1,

2, and 5 collectively are neutral. *See HP Inc. v. Slingshot Printing LLC*, IPR2020-01084, Paper 13 at 9.

Assessing *Fintiv* Factors 1-5, the Board should find that discretionary denial is not supported. Nevertheless, if the Board reaches the compelling merits question, the merits of the Petition are particularly strong.

Under **Factor 6**, and as described in Grounds 1-3, the merits of this Petition are particularly strong and compelling. For example, the prior art relied upon herein unquestionably establishes the allegedly novel concept of using a digital receiver to translate an analog RF signal to a corresponding complex baseband representations was in-fact well-known. The evidence presented, if unrebutted in trial, would plainly lead to a conclusion that one or more claims are unpatentable by a preponderance of the evidence.

When viewed holistically, the timing of the present Petition is reasonable and the efficiency, fairness, and the compelling merits support instituting review.

## **XI. CONCLUSION**

Petitioners have presented evidence that the subject matter of Claims 1-11 of the '345 Patent was known in the art prior to the '345 Patent's priority date. There is a reasonable likelihood that Petitioners will prevail as to each of these claims. *Inter partes* review of Claims 1-11 is therefore respectfully requested.

Case No. IPR 2025-00727  
Petition for *Inter Partes* Review of  
U.S. Patent No. 7,035,345

Dated: March 18, 2025

Respectfully submitted,

/s/ Jacob K. Baron

Jacob K. Baron (Reg. No. 48,961)

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## **XII. MANDATORY NOTICES**

### **A. Real Parties In Interest (37 C.F.R. § 42.8(b)(1))**

Petitioners T-Mobile, AT&T, Verizon, Ericsson and Nokia are real parties-in-interest (“RPIs”). In an abundance of caution, only for purposes of this proceeding, and only to the extent that Patent Owner contends that they should be named an RPI, Petitioners also identify the following entities as potential RPIs without conceding that they would satisfy the factually intensive RPI test: Sprint LLC, Sprint Solutions LLC, Sprint Spectrum LLC, T-Mobile USA, Inc., AT&T Services, Inc., AT&T Enterprises LLC,<sup>14</sup> Verizon Corporate Services Group Inc. and Telefonaktiebolaget LM Ericsson. In addition, some of the entities listed above out of an abundance of caution are holding companies that are legally and factually distinct from their subsidiaries (that may also be listed above and which maintain their own independent corporate status, identity, and structure) and have not provided any products or services that might be at issue in the underlying patent infringement lawsuit.

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<sup>14</sup> Related-Matter Defendant AT&T Corp. has undergone a corporate transaction and is now merged and converted into AT&T Enterprises, LLC.

**B. Related Matters (37 C.F.R. § 42.8(b)(2))**

The '345 Patent is asserted in the following co-pending litigations, all of which are in the District Court for the Eastern District of Texas:<sup>15</sup>

| Case Caption                                     | Case No.              |
|--------------------------------------------------|-----------------------|
| <i>Smart RF Inc. v. AT&amp;T Mobility LLC.</i>   | 2:24-cv-00195-JRG-RSP |
| <i>Smart RF Inc. v. Verizon Wireless et al.</i>  | 2:24-cv-00196-JRG-RSP |
| <i>Smart RF Inc. v. T-Mobile US, Inc. et al.</i> | 2:24-cv-00197-JRG-RSP |

**C. Lead and Back-Up Counsel (37 C.F.R. § 42.8(b)(3))**

Lead counsel: Jacob K. Baron (Reg. No. 48,961; [Jacob.Baron@hklaw.com](mailto:Jacob.Baron@hklaw.com)).

Backup counsel: Jacob W. S. Schneider (*pro hac vice* motion forthcoming; [Jacob.Schneider@hklaw.com](mailto:Jacob.Schneider@hklaw.com)) and Robert K. Jain (Reg. No. 78,927; [Robert.Jain@hklaw.com](mailto:Robert.Jain@hklaw.com)).

The mailing address for all PTAB correspondence is Holland & Knight LLP, 10 St. James Ave., 11th Floor, Boston, MA 02116.

**D. Service Information (37 C.F.R. § 42.8(b)(4))**

Please address all correspondence to lead counsel at the address above. Petitioners consent to electronic service at: [Jacob.Baron@hklaw.com](mailto:Jacob.Baron@hklaw.com) and Client [ClientTeamSmartRFLitigation@hklaw.com](mailto:ClientTeamSmartRFLitigation@hklaw.com).

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<sup>15</sup> Ericsson and Nokia were not sued, but later joined as intervenor-defendants in the district court litigations against AT&T, Verizon and T-Mobile. (EX1031, EX1032.)

**E. Fee for Inter Partes Review**

The Director is authorized to charge the fee specified by 37 CFR § 42.15(a) to Deposit Account No. 50-2324.

**XIII. CERTIFICATE OF SERVICE**

The undersigned certifies that a complete copy of this Petition for *Inter Partes* Review of U.S. Patent No. 7,035,345 and all Exhibits and other documents filed together with this Petition were served on the official correspondence address for U.S. Patent No. 7,035,345 shown in Patent Center and Smart RF Inc.'s current litigation counsel:

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Case No. IPR 2025-00727  
Petition for *Inter Partes* Review of  
U.S. Patent No. 7,035,345

via FEDERAL EXPRESS overnight delivery, on March 18, 2025.

Dated: March 18, 2025

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**XIV. CERTIFICATE OF COMPLIANCE WITH 37 C.F.R. § 42.24**

I hereby certify that this Petition complies with the word count limitation of 37 C.F.R. § 42.24(a)(1)(i) because the Petition contains 13,970 words, excluding the cover page and the parts of the Petition exempted by 37 C.F.R. § 42.24(a)(1).

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