

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

TRANSCORE, LP

Petitioner,

v.

HAND HELD PRODUCTS, INC.,

Patent Owner

IPR2024-00982

Patent 10,452,968

PETITION FOR *INTER PARTES* REVIEW OF

U.S. PATENT NO. 10,452,968

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TABLE OF CONTENTS

I.	INTRODUCTION.....	1
II.	GROUND FOR STANDING (37 C.F.R. § 42.103(a))	3
III.	IDENTIFICATION OF CHALLENGE (37 C.F.R. § 42.104(b))	3
A.	Citation of Prior Art	3
B.	Statutory Grounds for Challenge	5
C.	Level of Skill in the Art	6
IV.	BACKGROUND – THE ’968 PATENT	6
A.	RFID Tags	6
B.	Backscatter and Signal Modulation	7
C.	Load Impedance and Antenna Reflectance.....	10
D.	The ’968 Patent’s Alleged Discoveries Were Well-Known.....	11
E.	The ’968 Patent’s Prosecution History	12
F.	The Prior Art	13
1.	Boyer	13
2.	RFID Handbook	14
3.	Waldner	15
4.	Kapucu.....	16
V.	Claim Construction	17
VI.	GROUND 1: Claims 11-12, 16-20 were obvious over Boyer in view of RF Handbook.	17
A.	Description of Boyer Embodiment	17
B.	The Combined RFID Tag: Modifying Boyer’s Section II-C Modulator Impedance	20
C.	Motivation for Modifying Boyer’s Z_2 Impedance	23
D.	Boyer in view of RFID Handbook renders claim 11 obvious	27
1.	The combined RFID Tag discloses [11P]	27
2.	The combined RFID Tag discloses [11A].....	28
3.	The combined RFID Tag discloses [11B.1].....	29
4.	The combined RFID Tag discloses [11B.2].....	35

5.	The combined RFID Tag discloses [11C.1].....	38
6.	The combined RFID Tag discloses [11C.2].....	42
7.	The combined RFID Tag discloses [11C.3].....	45
E.	Claim 12 was obvious	47
F.	Claim 16 was obvious	47
G.	Claim 17 was obvious	49
H.	Claim 18 was obvious	51
I.	Claim 19 was obvious	52
J.	Claim 20 was obvious	53
VII.	GROUND 2: Claims 1-5, 11-20 were obvious over Boyer in view of RFID Handbook in further view of Waldner.....	54
A.	The combined system.....	54
B.	Motivation to use Waldner's impedances.....	57
C.	Using separate antenna lengths as the modulation impedance (Z_{mod}) does not affect the reflection property claim terms.....	62
D.	Claim 13 was obvious	64
E.	Claim 14 was obvious	64
F.	Claim 15 was obvious	68
1.	Main Antenna Interpretation	69
2.	Sensor Alternative	71
G.	Claim 1 was obvious	73
1.	Limitation [1P]	73
1.	Limitation [1A].....	73
2.	Limitation [1B]	73
3.	Limitation [1C]	73
4.	Limitation [1D].....	75
5.	Limitation [1E]	76
6.	Limitation [1F]	76
7.	Limitation [1G].....	76
H.	Claim 2 was obvious	76
I.	Claim 3 was obvious	77

J.	Claim 4 was obvious	78
K.	Claim 5 was obvious	78
L.	Claims 11-12, 16-20 were obvious	78
VIII.	GROUND 3: Claims 6-10 are obvious over the Boyer in view of RFID Handbook in further view of Kapucu.	79
A.	Limitations [6P]-[6C] and claim 7 are substantially similar to prior analysis.	79
B.	Limitation [6D] and claim 8 (Duty Cycle)	82
1.	The combined system	83
2.	Motivation to use Kapucu's PWM	85
3.	Claims 6 and 8 were obvious.	87
C.	Claim 9 was obvious	89
D.	Claim 10 was obvious	89
IX.	GROUND 4: Claims 6-10 are obvious over Boyer in view of RFID Handbook, Kapucu, and Waldner under 35 U.S.C. §103.	89
X.	The Board Should Not Exercise Discretion to Deny Institution	90
A.	Fintiv Favors Institution	90
B.	The Becton, Dickinson Factors Favor Institution	90
XI.	CONCLUSION	91
XII.	MANDATORY NOTICES	92
A.	Real Parties-in-Interest Under 37 C.F.R. § 42.8(b)(1)	92
B.	Related Matters Under 37 C.F.R. § 42.8(b)(2)	92
C.	Lead and Back-Up Counsel Under 37 C.F.R. § 42.8(b)(3)	92
D.	Service Information Under 37 C.F.R. § 42.8(b)(4)	92

EXHIBIT LIST	
Exhibit No.	Description
1001	U.S. Patent 10,452,968 to Nikitin, <i>et al.</i> (“the ’968 patent”)
1002	U.S. Patent 10,452,968 File History
1003	Declaration of Professor Sumit Roy
1004	Curriculum Vitae of Professor Sumit Roy
1005	Colby Boyer and Sumit Roy, <i>Backscatter Communication and RFID: Coding, Energy, and MIMO Analysis</i> , IEEE Transactions on Communications, Vol. 62, No. 3 (March 2014) (“Boyer”)
1006	U.S. Publication No. 2005/0237198 (“Waldner”)
1007	Pavel V. Nikitin and K. V. S. Rao, <i>Theory and Measurement of Backscattering from RFID Tags</i> , IEEE Antennas and Propagation Magazine, Vol. 48, No. 6, December 2006 (“Nikitin”)
1008	U.S. Patent 8,022,827 (“Rossman”)
1009	K. Kapucu and C. Dehollain, “Base-station design for passive UHF RFID tags with pulse-width modulated backscattering,” 2014 10th Conference on Ph.D. Research in Microelectronics and Electronics (PRIME), Grenoble, France, 2014, pp. 1-4, doi: 10.1109/PRIME.2014.6872750, (“Kapucu”)
1010	K. Kapucu, J. Panades, and C. Dehollain, <i>Design of a passive UHF RFID tag for capacitive sensor applications</i> , in 9th Conference on Ph.D Research in Microelectronics and Electronics (PRIME 2013), 2013, pp. 213–216.
1011	U.S. Patent 9,471,816 (“Hyde”)
1012	Colby Boyer and Sumit Roy, <i>Backscatter Communication and RFID: Coding, Energy, and MIMO Analysis</i> , IEEE Transactions on Communications, Vol. 62, No. 3 (March 2014) from Northwestern State University library (April 2, 2014).
1013	Colby Boyer and Sumit Roy, <i>Backscatter Communication and RFID: Coding, Energy, and MIMO Analysis</i> , IEEE Transactions on Communications, Vol. 62, No. 3 (March 2014) from Mercer University library (April 2, 2014).
1014	IEEE Webpage (https://ieeexplore.ieee.org/Xplorehelp/ieee-xplore-training/working-with-documents#publication-dates)
1015	Publication Information from IEEE website for Colby Boyer and Sumit Roy, <i>Backscatter Communication and RFID: Coding, Energy, and MIMO Analysis</i> , IEEE Transactions on Communications, Vol. 62, No. 3 (March 2014), https://ieeexplore.ieee.org/document/6685977

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1016	Publication Information from IEEE website for Pavel V. Nikitin and K. V. S. Rao, <i>Theory and Measurement of Backscattering from RFID Tags</i> , IEEE Antennas and Propagation Magazine, Vol. 48, No. 6, December 2006 (https://ieeexplore.ieee.org/document/4118038)
1017	U.S. Patent 7,978,074
1018	IEEE Xplore, 2014 10th Conference on Ph.D. Research in Microelectronics and Electronics (PRIME), Table of Contents, https://ieeexplore.ieee.org/xpl/conhome/6863139/proceeding?isnumber=6872647&sortType=vol-only-seq&pageNumber=1 ;
1019	IEEE Xplore About Page, https://ieeexplore.ieee.org/Xplorehelp/overview-of-ieee-xplore/about-ieee-xplore
1020	Declaration of Dr. Sylvia Hall-Ellis
1021	Daniel Dobkin, <i>The RF in RFID, Passive UHF RFID in Practice</i> , Elsevier Inc. (2008)
1022	S. Thomas and M. Reynolds, QAM Backscatter of Passive UHF RFID Tags
1023	K. Finkenzeller, <i>RFID Handbook</i> , Third Edition (2010), John Wiley & Sons, Ltd.
1024	G. Marrocco, <i>The Art of UHF RFID Antenna Design: Impedance-Matching and Size-Reduction Techniques</i>
1025	Using Electromagnetic Analysis for RFID Antenna Design, Feb. 2006
1026	IEEE, Base-station design for passive UHF RFID tags with pulse width modulated backscattering

I. INTRODUCTION

In passive (backscatter) radio frequency identification (RFID) systems, the tags themselves have no power source. Instead, they rely on radio frequency (RF) signals sent by RFID readers for power (through “power harvesting”) and to transmit data by reflecting portions of the RF signals back to the reader (“backscattering”). The amount of power the tag harvests and the strength of the reflected RF signal are based on the reflectivity of the antenna—the more the antenna reflects the RF signal, the stronger the backscattered signal but the less power is harvested.

U.S. Patent No. 10,452,968 (“the ’968 patent”) purports to identify a new approach in passive RFID tag performance: improved tag range “by sacrificing tag transmission performance.” The inventors claim to have discovered that by reducing the RFID tags reflectance—and thereby reducing the strength of the backscattered signal—RFID tag range actually increases because the tag harvests power *while* also transmitting the reflected signal. The increased power extends “the useable range” of the RFID tag, even though backscattered signal strength is reduced.

But this concept was not new. It was published in a *textbook* nearly a decade earlier: “In early tag designs, it was not uncommon for a tag to start its reply to a reader and then run out of juice in the middle of transmitting its ID . . . *it is helpful to consider trading off some backscattered signal for more tag power.*” Ex-1021,

214. This textbook provided the same solution as the '968 patent: vary the modulation impedances (without shorting the antenna) to reduce antenna reflectance and continually harvest power. Ex-1021, 215-218.

Years later, but long before the '968 patent was filed, Petitioner's expert, Dr. Sumit Roy, published an IEEE paper applying these well-known principals to improve RFID tag performance. Ex-1005. Dr. Roy confirmed that optimum RFID tag performance/range can be achieved by reducing antenna reflectance (without shorting the antenna) because of increased power harvesting during backscatter. He explained why: if the RFID tag does not obtain enough power to remain in an "active state," it must cycle to a "sleep state" in which it cannot transmit *any* data. This "reduces availability for backscatter and reduces uplink throughput." Dr. Roy even showed how tag performance improved with increased power harvesting (Fig. 8).

With the '968 patent's foundational principle already well-known in the art, the only remaining subject matter in the claims are techniques for adjusting the reflectance of the antenna by changing its resonant frequency. But the claimed approaches—such as varying antenna length, changing load impedances, or adjusting duty cycles—were all well-known and conventional in the art. Petitioner, therefore, respectfully requests that this Panel grant institution and cancel claims 1-20 of the '968 patent.

II. GROUNDS FOR STANDING (37 C.F.R. § 42.103(a))

Petitioner certifies the '968 patent is available for *inter partes* review and that Petitioner is not barred or otherwise estopped from requesting *inter partes* review.

III. IDENTIFICATION OF CHALLENGE (37 C.F.R. § 42.104(b))

The '968 patent was filed on June 14, 2017. AIA 35 U.S.C. §§ 102-103 govern this patent. All prior art is asserted pursuant to AIA statutes. *See* MPEP § 21.59.01.

A. Citation of Prior Art

Each asserted reference was publicly available before the '968 patent's filing date of June 14, 2017.

- Colby Boyer and Sumit Roy, *Backscatter Communication and RFID: Coding, Energy, and MIMO Analysis*, IEEE Transactions on Communications, Vol. 62, No. 3 (Ex-1005, "Boyer") is prior art under §102(b) because it was published in the IEEE Transactions on Communications, a well-known and widely circulated industry journal, at least by March 2014 as indicated on the face of the document. Exhibits 1012 and 1013 are date-stamped (April 2, 2014) versions from Northwestern State and Mercer Universities, respectively. Exhibit 1015 shows that Boyer was published in the IEEE database (IEEE Xplore) on December 18, 2013, and Exhibit 1014 explains that "The Date of Publication for Journals and Standards on IEEE Xplore represents the very first instance of public dissemination." Dr.

Sylvia Hall-Ellis confirms its public availability as of December 18, 2013. Ex-1020, ¶¶47-53. Finally, Dr. Roy, one of the co-authors, confirms Boyer was publicly available as of March 2014. Ex-1003, ¶¶85-86.

- Klaus Finkenzeller, *RFID Handbook*, Third Edition (2010) (Ex. 1023, “RFID Handbook”) is a textbook that was published in 2010. It bears copyright notices, ISBN (978-0-470-69506-7), a reference to the Library of Congress, a catalog record in the British Library, and was published by John Wiley & Sons, Ltd. (a reputable publisher). Dr. Hall-Ellis confirms it was publicly available at least by December 17, 2010, and is therefore prior art under §102(b). Ex-1020, ¶¶79-84.

- U.S. Publication No. 2005/0237198 (Ex-1006, “Waldner”), which was filed April 8, 2004 and published on October 27, 2005, is prior art at least under §102(b).

- K. Kapucu and C. Dehollain, “*Base-station design for passive UHF RFID tags with pulse-width modulated backscattering*,” 2014 10th Conference on Ph.D. Research in Microelectronics and Electronics (PRIME), Grenoble, France, 2014, pp. 1-4, doi: 10.1109/PRIME.2014.6872750, (Ex-1009, “Kapucu”) is prior art under §102(b) because it was published in the IEEE Xplore database on August 7, 2014. Ex-1026 (“Date Added to IEEE Xplore: 07 August 2014”). IEEE Xplore is “the flagship digital platform for discovery and access to scientific and technical

content published by the IEEE. Ex-1019. IEEE Xplore shows that Kapucu was published as part of the 2014 10th Conference on Ph.D. Research in Microelectronics and Electronics, from June 30, 2014—July 3, 2014. Ex-1026. Exhibit 1018 is the Table of Contents of that conference showing Kapucu on pdf page 10, further corroborating the IEEE Xplore records. This information matches the face of the document, which identifies “2014 IEEE RFID Technology and Applications Conference (RFID-TA)” and provides an ISBN 978-1-4799-4680-8/14 and a copyright notice from the IEEE of 2014. Dr. Hall-Ellis confirms the public availability at least as of August 7, 2014. Ex-1020, ¶¶61-67.

For the non-patent literature, Petitioner includes evidence from the IEEE and Dr. Hall-Ellis’s declaration confirming their public availability. *Intel Corp. v. FG SRC LLC*, IPR2020-01449, Paper 13 at 43-44 (P.T.A.B. Mar. 3, 2021) (date on IEEE website supported public accessibility); *Cerebras Sys. Inc. v. Rex Computing, Inc.*, IPR2022-00741, Paper 37 at 6–7 (P.T.A.B. Oct. 11, 2023) (date of availability on IEEE Xplore). Each was published by an established publisher creating “a presumption of public accessibility as of the publication date.” *VidStream LLC v. Twitter, Inc.*, 981 F.3d 1060, 1065 (Fed. Cir. 2020).

B. Statutory Grounds for Challenge

Petitioner requests cancellation on the following statutory grounds:

GROUND 1: Claims 11-12, 16-20 are obvious over Boyer in view of RFID Handbook under 35 U.S.C. §103.

GROUND 2: Claims 1-5, 11-20 are obvious over Boyer in view of RFID Handbook in further view of Waldner under 35 U.S.C. §103.

GROUND 3: Claims 6-10 are obvious over Boyer in view of RFID Handbook in further view of Kapucu under 35 U.S.C. §103.

GROUND 4: Claims 6-10 are obvious over Boyer in view of RFID Handbook and Kapucu, in further view of Waldner under 35 U.S.C. §103.

C. Level of Skill in the Art

A POSITA is someone who understands radio communications and systems (including interrogators/readers, transponders, and signal processing components thereof). That person would have a bachelor's degree in electrical engineering, physics, or an equivalent degree and at least two years of experience in a relevant industry. Additional work or research experience can substitute for less or different education, and vice-versa. Ex-1003, ¶¶21-25.

IV. BACKGROUND – THE '968 PATENT

A. RFID Tags

A simple RFID system consists of an RFID reader and one or more RFID tags (sometimes referred to as “transponders”), which receive and respond to the reader

signal. Ex-1003, ¶50. “Passive” RFID tags have no power source, but instead receive power generated by a reader’s interrogation signal. To communicate with a reader, a passive tag reflects back a signal to the reader using a technique called “backscattering.” Ex-1003, ¶¶51-52.

B. Backscatter and Signal Modulation

Dobkin explains fundamental RFID concepts of passive tags, including backscattering (§3.4), power requirements (§3.5.3), antenna reflection coefficients (A4.1), and the design of the tags themselves (Chapter 5). Ex-1021, 51, 195; Ex-1003, ¶¶53-73.

RFID tags tradeoff signal absorption for reflectance, and *vice versa*. Both the antenna and the load can be modeled as having an impedance that has both resistive (real) and reactive (imaginary) components.

Dobkin explains that the antenna load (*e.g.*, the IC connected to the antenna) affects the current through the antenna (and the reflected signal). Therefore, by changing the load impedance, the reflected signal can be modulated. This changes the reflection properties of the antenna and modulates the reflected backscatter signal (*i.e.*, amplitude modulation, phase shifting, or both). *Id.*, 68-69.

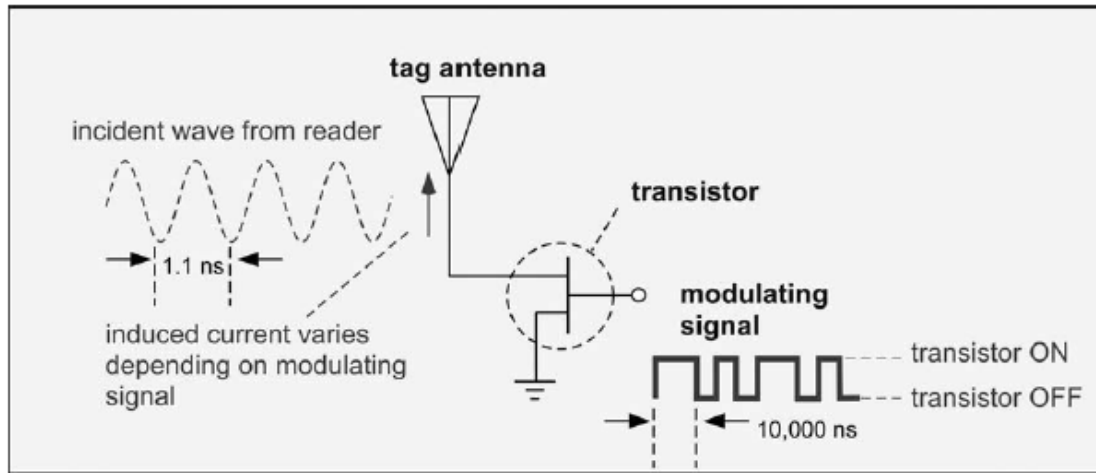


Figure 3.15: Modulated Backscatter Using a Transistor as a Switch.

The state of maximum absorption (and minimum reflectance) is the “matched condition,” which is when the imaginary components of the antenna and load are complex conjugates (*i.e.*, opposites such that they cancel out) and the real components are equal. This is also the condition when 1) the reflectance coefficient (Γ) is 0; 2) the resonant frequency of the RFID tags matches the frequency of the incoming signal; and 3) maximum power can be harvested. Ex-1021, 210; 311.

Dobkin explains the operation of modulation circuits that use open and short circuit configurations, along with a problem:

It is obviously possible to obtain a higher backscattered signal power $2P_{av}$ by switching between an open circuit and a short circuit—but in this case no power at all is delivered to the IC. Such a configuration can be considered for a semipassive tag.

Ex.-1021, 211-214.

Dobkin explains that in early designs, a tag “would start its reply to a reader and then run out of juice in the middle of transmitting its ID.” *Id.* It then proposes a

solution: “it is helpful to consider trading off some backscattered signal for more tag power.” *Id.*

Dobkin explores the tradeoff between power harvesting and backscatter signal strength by analyzing two different binary modulators, neither of which short the antenna: one in which a “resistance in series with the load” (*i.e.*, the IC) in Figure 5.19 and the other when capacitance is placed in parallel shown in Figure 5.20.

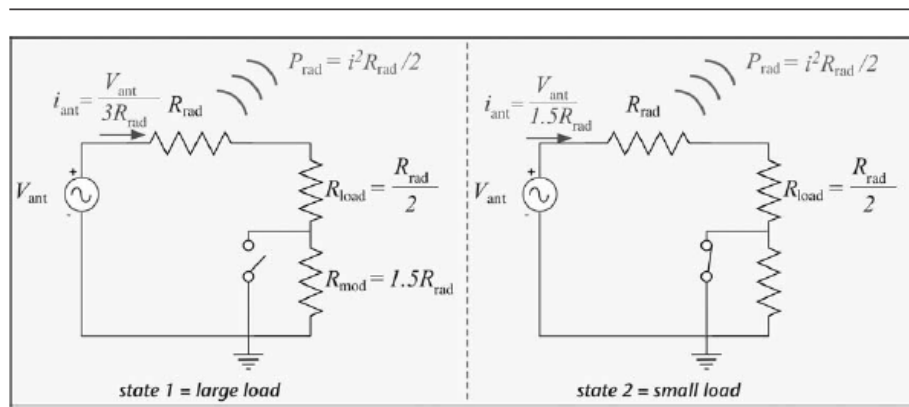


Figure 5.19: Modulation Using a Resistive Circuit in Place of a Short (Resistive Amplitude-Shift Keying).

Id., 215.

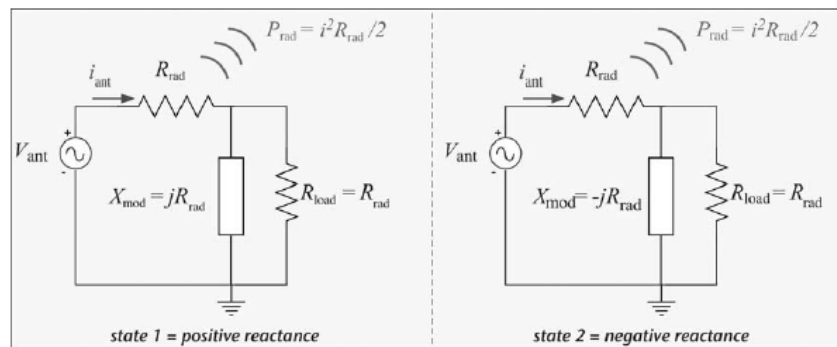


Figure 5.20: Modulation Using Reactance Rather than Resistance.

Id., 216.

Dobkin summarizes his analysis showing both circuits increased power harvesting compared to short circuits, and concluded modulators with “reactive” components (*e.g.*, capacitors and inductors) provide better power harvesting with less loss of backscatter signal:

Table 5.1: Modulation Approaches.			
	Approach	Backscattered Power	IC Power
Short Circuit	Match $\Leftrightarrow$ Open	$P_{av}/2$	$P_{av}/2$
	Match $\Leftrightarrow$ Short	$P_{av}/2$	$P_{av}/2$
Alternative Impedances	Resistive ASK	$0.22 P_{av}$	$0.55 P_{av}$
	Reactive PSK	$0.32 P_{av}$	$0.8 P_{av}$

Ex-1021, 218.

C. Load Impedance and Antenna Reflectance

Backscattering happens by matching and unmatching the tag’s antenna and integrated circuit (IC) impedances, which varies the reflectance coefficient and the resonant frequency. Ex-1003, ¶¶63-64; Ex-1007, 213. Dobkin explains the fundamentals in Appendix 4. Ex. 1021, 477.

The energy reflected corresponds to the tag’s reflection coefficient, which is represented by the following equation:

$$\rho_i = \frac{(z_i - z_a^*)}{(z_i + z_a^*)}$$

where Z_a is the antenna impedance and Z_i is the IC impedance. Ex-1003, ¶¶65-67;

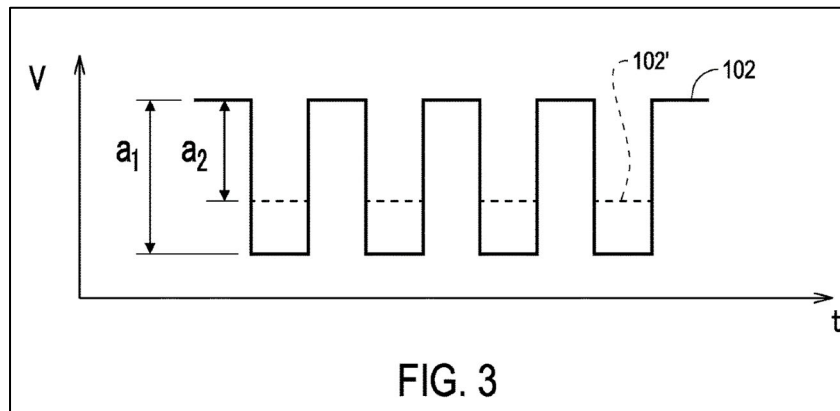
Ex-1005, 772; Ex-1021, 477; '968 patent, 4:62-67.

D. The '968 Patent's Alleged Discoveries Were Well-Known

The '968 patent purports to improve passive RFID systems by “sacrific[ing] backscatter signal strength in order to provide additional received power to the tag 100.” *Id.*, 4:18-24. It asserts that the prevailing belief was “that a reduction in tag transmission performance would reduce the range of the tag.” *Id.*, 1:40-45; 4:18-23. It further contends that in prior art RFID tags, the backscatter “signal is designed to have the *maximum* strength to maximize the range of the tag 100”—*i.e.*, a short circuit or close to it. *Id.*, 1:40-45; 3:60-65; Ex-1003, ¶¶74-82.

This was not true. Dobkin, a textbook from nearly a decade earlier, explained that “it was not uncommon for a tag to start its reply to a reader and then run out of juice in the middle of transmitting its ID” and therefore “it is helpful to consider trading off some backscattered signal for more tag power.” Ex-1021, 214; Ex-1003; ¶74.

The '968 patent illustrates reducing the backscatter signal in Figure 3, “allow[ing] for steady transmission of a (weakened) signal 102’ at the fringes of the tag range, which modern readers are able to read.” *Id.*, 4:23-28.



Rather than “reflecting substantially all of the signal and substantially none of the signal during different transmission periods, antenna 104 has periods of relatively high reflectance and relatively low reflectance.” *Id.*, 4:24-34. The ’968 patent contends this “expands the useable range of the tag, by allowing the antenna to continuously harvest power while transmitting the reflected signal 102” *Id.*, 4:47-51.

The ’968 patent then employs well-known concepts of “add[ing] or subtract[ing] one or more impedances 620 from antenna 104” to change “the resonant frequency and reflectance properties without shorting the antenna 104.” *Id.*, 5:43-57; Figures 5 and 7.

E. The ’968 Patent’s Prosecution History

During prosecution, the Applicant distinguished the prior art based on amendments directed to reducing the reflectance of the main antenna “without shorting the main antenna.” Ex-1002, 34-36; *id.*, 13-14.

F. The Prior Art

1. Boyer

Boyer published two years before the '968 patent and discusses the same problem (reduced tag availability from insufficient power harvesting) and the same solution (power harvesting throughout backscatter communication). Ex-1003, ¶¶88-93.

Boyer explains that “[i]f the (average) power harvested by the tag is greater than the (average) power consumed in its active state, then the tag is operational 100 percent of the time. If not, the tag undergoes a duty cycling behavior between an active state and a sleep state; *clearly this reduces availability for backscatter and reduces uplink throughput.*” *Id.*, 775, 776.

Boyer teaches embodiments that maximize tag performance by power harvesting throughout the entire active state (when the RFID tag is modulating the reflected signal)—exactly as discussed in the '968 patent. *Id.*, 775-776 (Section II-C). Indeed, Boyer expressly states that the modulation impedance, Z_2 , is “*between* an open ($Z_2 = \infty$) and *short state* ($Z_2 = 0$)” and that as the value approaches a short circuit, the “harvested power during backscatter P_{back} decreases.” *Id.*, 775.

Boyer concludes that while increasing the reflectance increases the signal strength (shown by the bit error rate “BER”), it reduces the amount of power harvested (P_{back}) and reduces the amount of time the tag remains available to transmit

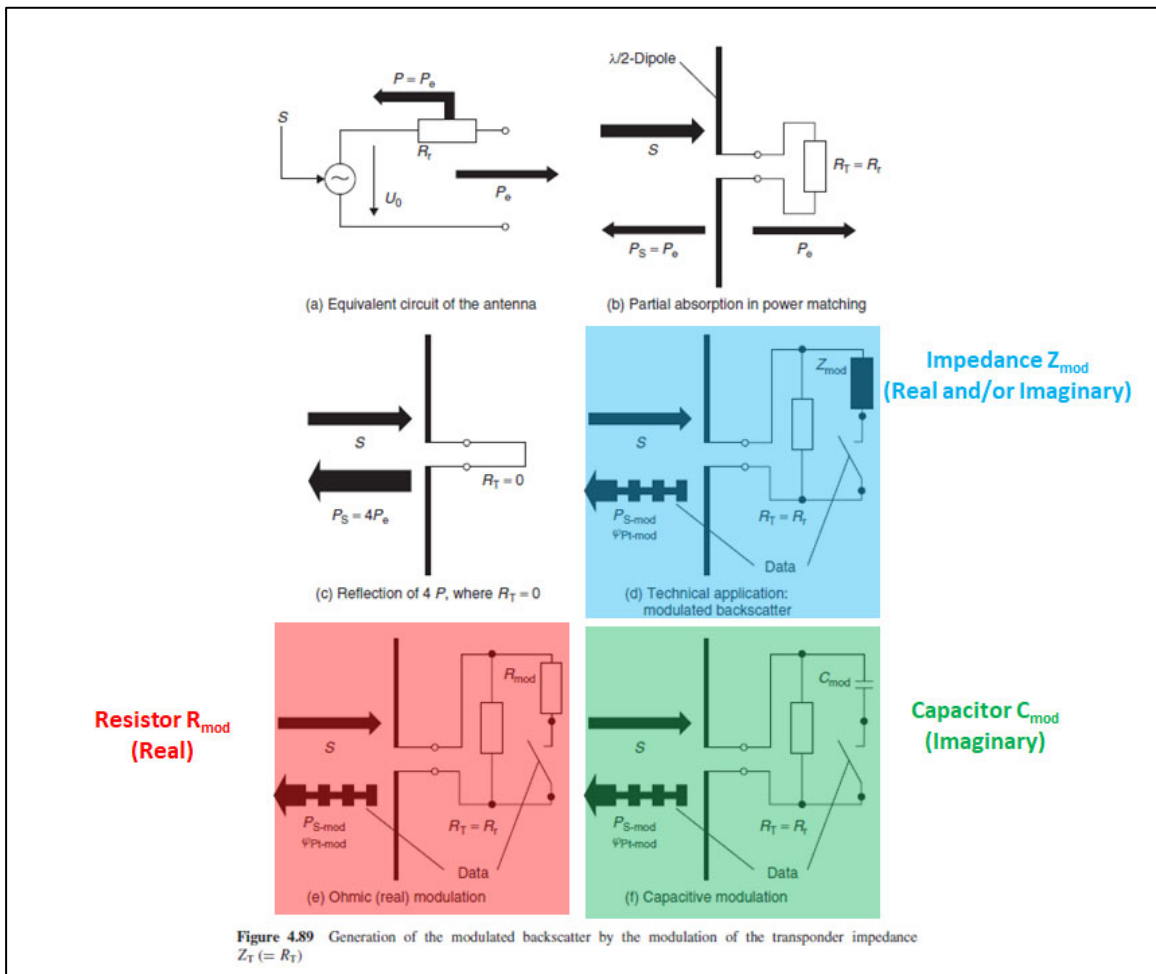
data (“ D_{cycle} ”). This in turn reduces data throughput and ultimately limits the range of the tag. *Id.* (“[b]y increasing $|\Gamma_{1,2}|$ the BER improves, but P_{back} and the corresponding tag duty cycle D_{cycle} decreases.”) Ex-1005, 776.

2. RFID Handbook

RFID Handbook was published 7 years before the '968 patent. It provides the fundamentals of RFID passive tags and backscatter transmission. Ex. 1023, 22-23, 39-40, 47-48, 114-141; Ex-1003, ¶¶94-97.

Figure 4.89 depicts the structure for several conventional binary modulators, as well as the absorbed (P_e) and reflected ($P_{s\text{-mod}}$) signals, including:

1. an impedance modulator (4.89(d) using impedance Z_{mod});
2. an ohmic modulator (4.89(e) using a resistor R_{mod}); and
3. a capacitive modulator (4.89(f) using a capacitor C_{mod}).



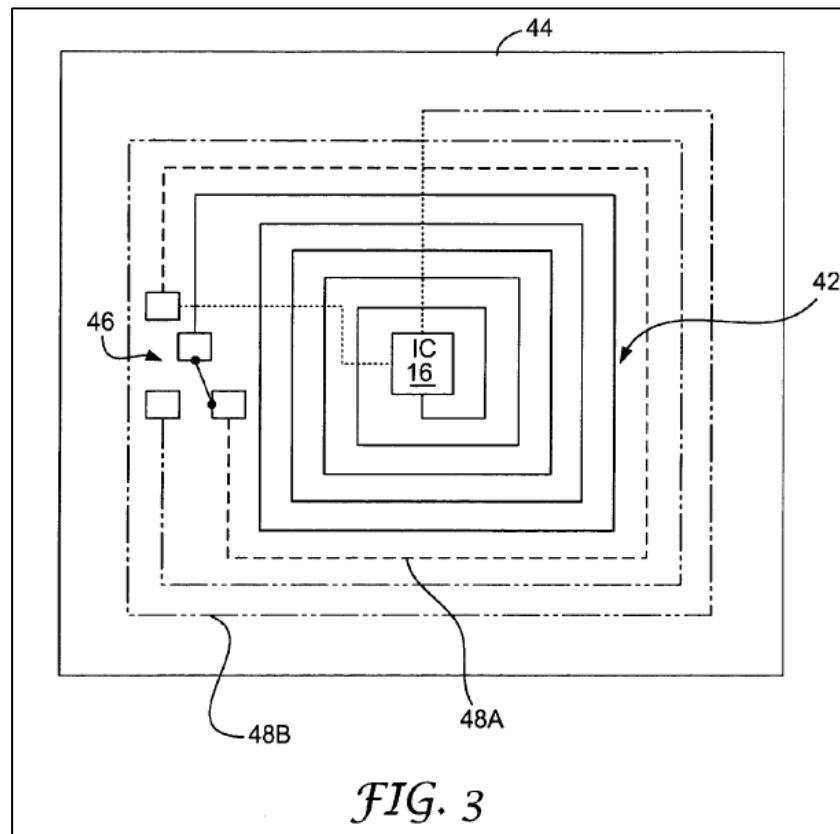
Id., 140.

3. Waldner

Waldner discloses an RFID tag that dynamically adjusts its resonant frequency to reduce potential effects of electromagnetic “tag-to-tag coupling.” Waldner, Abstract; ¶21. An RFID tag can vary its “resonant frequency” by “selectively coupl[ing] electrical elements, such as capacitive elements, inductive elements, or combinations thereof.” Waldner, Abstract, ¶¶14, 43; Ex-1003, 98-100.

Figure 3 shows “switch 46 ... switches between inductive elements 48A and

48B in order to selectively include inductive elements 48A and 48B as additional loops for an antenna 42” or “completely separate antennas.” *Id.*, ¶¶37-38.



4. Kapucu

Kapucu (Ex. 1009) discloses a design “for passive UHF RFID tags that use pulse-width modulation (PWM) in backscattering communication.” Kapucu, 1; Ex-1003, ¶101-103. Kapucu specifically addresses RFID tags with “phase-locked loop (PLL) based sensor interfaces [that] can be used in RFID tags with capacitive sensors

to reduce the power consumption of the tags.” *Id.*¹ “[T]he output of the sensor interface is a pulse train whose duty cycle is proportional to the variation in the sensor capacitance value.” *Id.* “The pulse train signal controls the backscattering switches that short the antenna terminals. This way the sensor value information is pulse-width modulated and sent to the base station (reader) by backscattering.” *Id.*

V. Claim Construction

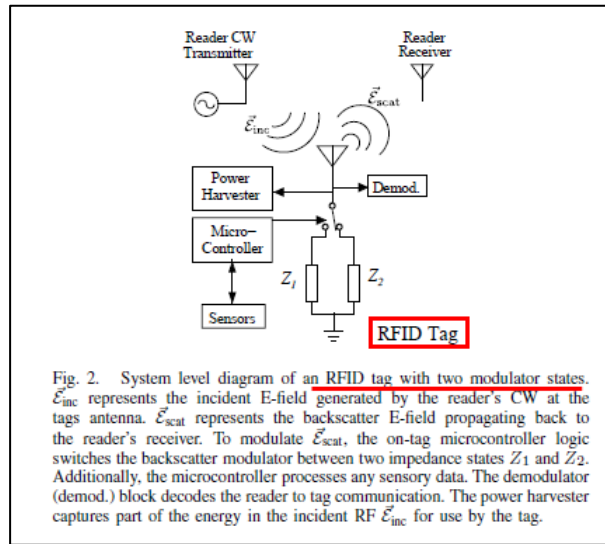
Petitioner does not believe any terms of the claims need to be construed. Nevertheless, Petitioner reserves the right to respond should Patent Owner disagree.

VI. GROUND 1: Claims 11-12, 16-20 were obvious over Boyer in view of RF Handbook.

A. Description of Boyer Embodiment

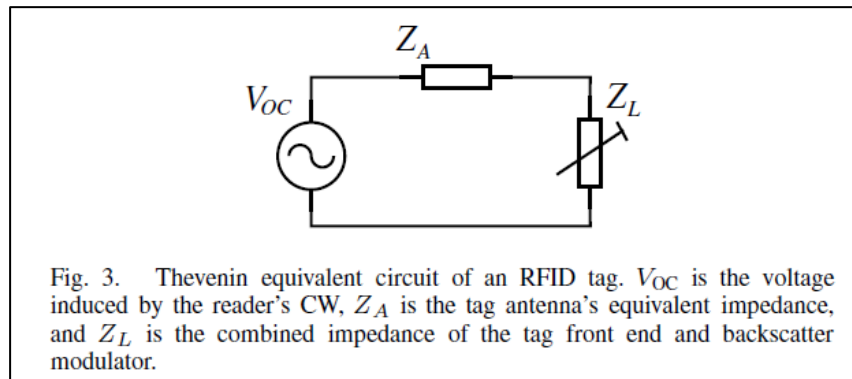
Boyer discloses a conventional passive RFID tag comprising a “binary” impedance modulator (*i.e.*, two states corresponding to Z_1 and Z_2):

¹ Kapucu cites to a companion article, Ex-1010, which describes the RFID and sensor interface in more detail.

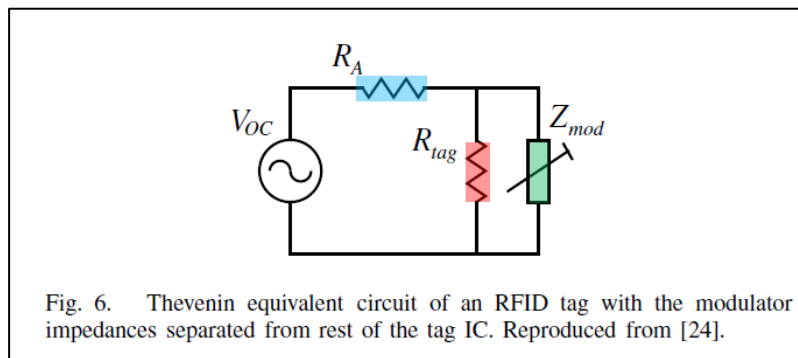


Ex-1005, 772; Ex-1003, ¶¶108-114.

Figure 3 shows an equivalent circuit (called a “Thevenin” circuit) for analyzing RFID tags like the switched modulator in Figure 2 (*i.e.*, Z_L is shown as varying).



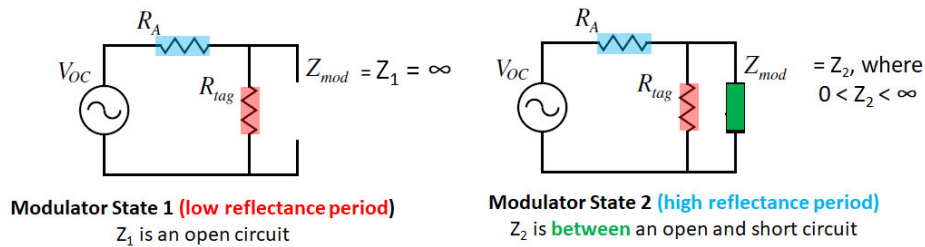
In Figure 6,² the circuit is assumed to be in a “matched” state such that the reactive (imaginary) components of the antenna and integrated circuit (IC) impedances are complex conjugates and cancel, leaving only the resistive (real) components to consider. Ex-1005, fn. 7 (“the inductive and capacitive components of antenna and tag IC are tuned out by matching.”). The “modulator impedance Z_{mod} is placed in parallel to the tag IC with equivalent resistance R_{tag} , and the antenna has equivalent resistance R_A .”³



² Ex-1005 774; Ex.1003, ¶¶109-114 (explaining the relationship between Figures 2 and 6 and Section II-C).

³ In the Figure 6 equivalent circuit, the load impedance Z_L is split into its constituent components: the impedance of the tag front end (R_{tag} since its complex conjugates are matched with the antenna) and backscatter modulator impedance (Z_{mod}), which are connected in parallel.

Boyer then describes a specific example of this embodiment in Section II-C, “where Z_{mod} (as in Fig. 6) has two states Z_1 and Z_2 , which are strictly resistive.” *Id.*, 775. “One modulator state remains in the matched condition (*i.e.*, Z_1 is an open circuit) and the other state has the value Z_2 ,” which can be varied “between an open ($Z_2 = \infty$) and short state ($Z_2 = 0$).” *Id.* This embodiment is illustrated in the modified figures below by their equivalent circuits shown in two states:



Boyer Figure 6 (annotated, duplicated, and modified to show two modulation states);
Ex-1003, ¶114.

B. The Combined RFID Tag: Modifying Boyer’s Section II-C Modulator Impedance

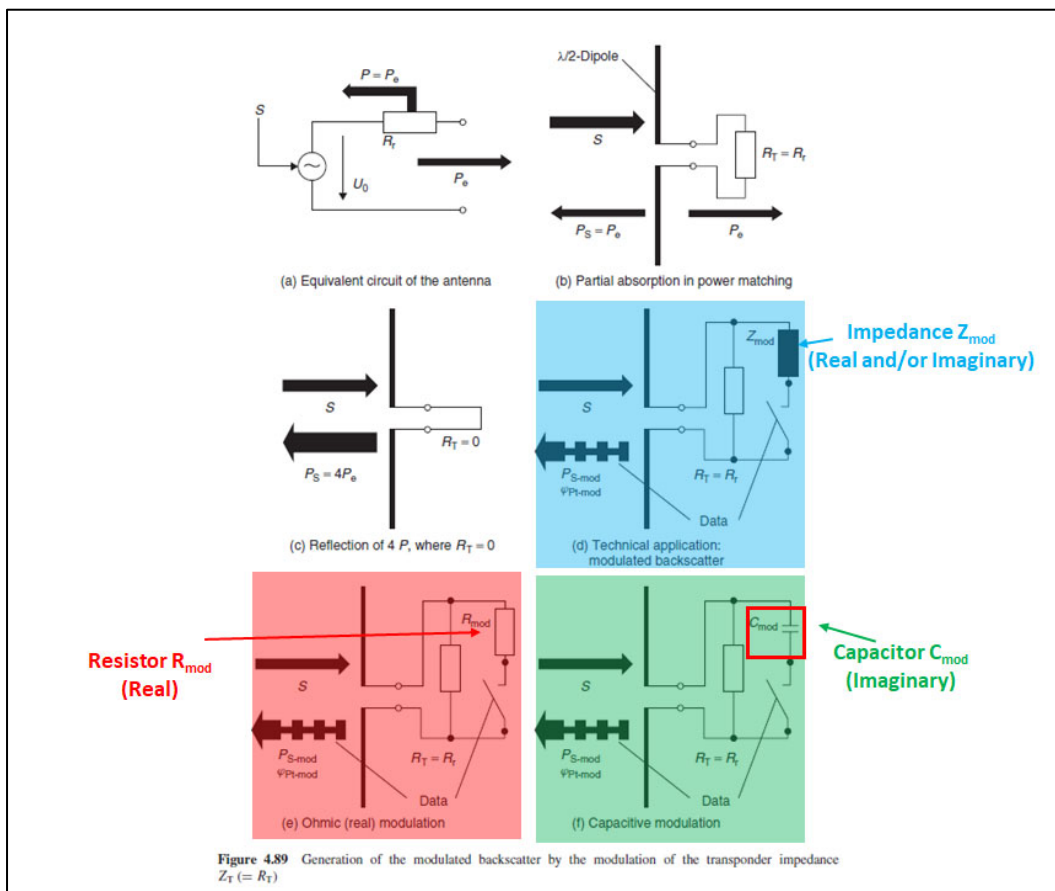
The combined RFID tag comprises a simple substitution of a capacitor (C_{mod}) for Boyer’s resistive modulator impedance (Z_2) in the Section II-C embodiment.

Boyer’s Section II-C embodiment provides an example of a conventional binary modulator in which the modulation impedances Z_{mod} “are strictly resistive.” Ex-1003, 775. Since Z_1 is an open circuit and Z_2 is resistive, Boyer’s modulator is therefore a basic “Ohmic” or “Real” modulation circuit as shown in the RFID

Handbook below. Ex-1023, 140 (Figure 4.89(e), shown in red); Ex-1003, ¶116.

However, it would have been obvious to a POSITA to use any suitable impedance in Boyer's conventional binary modulator, including an impedance with reactance (imaginary components). The RFID Handbook describes two other conventional and well-known modulators (in addition to the Ohmic modulator):

1. an impedance modulator (4.89(d) using impedance Z_{mod}) in blue; and
2. a capacitive modulator (4.89(f) using a capacitor C_{mod}) in green.



Id., 140

While the general impedance embodiment (Figure 4.89(d), blue) can apply to any underlying electrical components (resistor, inductor, capacitor, or a combination) and the analysis would be the same, for the purposes of the following analysis and for simplicity, the combined system will substitute the RFID Handbook's capacitor C_{mod} from the “capacitive modulation” circuit shown in Figure 4.89(f) for Boyer's Z_2 impedance in its Section II-C embodiment. No other changes are needed. Ex-1003, ¶¶117-118.

Therefore, in the combined system, impedance Z_1 remains an open circuit and impedance Z_2 is still varied between an “open” and a “short” circuit as taught by both Boyer and RFID Handbook.

The reflection coefficient (Γ) of the RFID tag is given by the following equation:

$$\Gamma = \frac{Z_L - Z_A^*}{Z_L + Z_A^*} \text{ is the (complex) reflection coefficient between the antenna and load;}$$

Ex-1003, ¶120; Ex-1005, 772.

In the modulation state for Z_1 (switch is open), Γ_1 is 0 because Boyer's circuit is in a matched condition ($Z_L = Z_A^*$) and therefore the numerator in the above equation is 0.

In the modulation state for Z_2 , Boyer varies Γ_2 *between* 0 (*i.e.*, open circuit

matched condition) and 1 (short circuit, where $Z_L = 0$ and $\Gamma = Z_A^*/Z_A^* = 1$).

The following table provides a summary of the RFID tag for the analysis below:

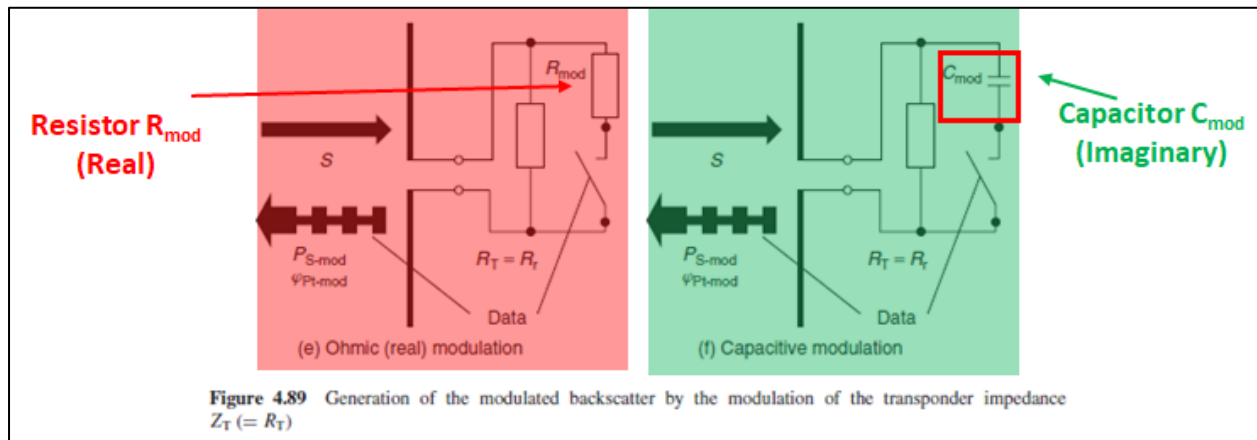
Reflectance Period	Modulation Impedance (Z_{mod})	Modulation Impedance Value	Reflection Coefficient (Γ)
State 1: First (High)	$Z_2 = C_{\text{mod}}$	Between short and open circuit ($0 < Z_2 < \infty$)	$0 < \Gamma_2 < 1$
State 2: Second (Low)	$Z_1 = \text{Open switch}$	Open circuit (∞)	$ \Gamma_1 = 0$

Ex-1003, ¶¶120-123.

C. Motivation for Modifying Boyer's Z_2 Impedance

A POSITA would have been motivated to use a reactive or complex impedance—such as modulation capacitor C_{mod} as taught in RFID Handbook—in place of Boyer's “strictly resistive” Z_2 in the Section II-C embodiment.

First, Boyer's resistive Z_2 and a conventional C_{mod} impedance are used for the same purpose and perform the same function: they are switched on and off in an RFID passive tag to modulate the backscatter signal by mismatching the antenna and load impedances. Ex-1003, ¶125. As such, both circuit elements were well-known and conventionally used in these types of circuits. Indeed, RFID Handbook expressly shows both configurations *side-by-side* as conventional binary modulation circuits:



Ex-1023, 140.

No other changes to Boyer's circuit are required to operate for its intended purpose of backscatter modulation if the variable load impedance has a complex value. Ex-1003, ¶126.

Therefore, the combined system would have represented a “simple substitution of one known element [*i.e.*, a conventional capacitive modulation impedance C_{mod}] for another [Boyer's conventional resistive modulation impedance Z_2] to obtain predictable results [*i.e.*, a conventional capacitive modulator circuit, just as shown in RFID Handbook Figure 4.89(f), that is switched on/off to change the reflective characteristics of the RFID tag to modulate the reflected signal, with no changes to how Boyer currently operates.]” *KSR*, 550, 415-421; Ex-1003, ¶127.

Second, Boyer motivates the modification. Throughout Boyer, Z_{mod} is described in terms of a general impedance, teaching that backscatter modulation is achieved via modulation of a complex load impedance. It is never suggested that a

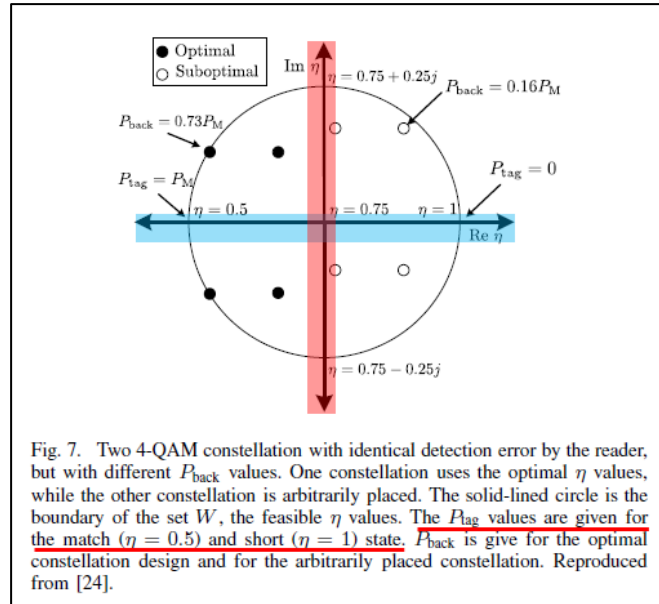
resistive modulation impedance is required to take advantage of the underlying principle: *i.e.*, optimizing tag performance by sacrificing transmission power for more power harvesting. Thus, like the RFID Handbook Figure 4.89(d) disclosure of a modulation impedance of “ Z_{mod} ,” a POSITA would have understood that the designer of the circuit would choose—based on the design parameters and system purpose—the type of impedance, including potentially with some reactance. Ex-1003, ¶128.

In fact, Boyer teaches “that switching between symbols [impedance modulation states] by ***changing only the real component*** of η [corresponding to the resistive part of the modulation impedances] ***tends to be less efficient in terms of power harvesting than changing the imaginary component*** of η [corresponding to the reactive components of the modulation impedances].”⁴ *Id.*, 774. A POSITA would have therefore understood that the selection of Z_2 as “resistive” was for illustration purposes and would have been motivated by Boyer to investigate the use of complex impedances, including capacitors and inductors. Ex-1003, ¶129.

In fact, Boyer’s Figure 7 shows that for a 4-state modulator, maximum power

⁴ Boyer introduced a design parameter, η , which “corresponds to Z_{mod} value.” Ex-1003, 774.

harvesting (P_{tag}) corresponds to a constellation of impedances—the cluster on the left-side of the graph—having both real (the component of each point on the x-axis, highlighted in blue) and imaginary (the component of each point on the y-axis, highlighted in red) components:



Id., 774 Ex-1003, ¶130.

Boyer also explains that “detection performance depends on the Euclidean distance between the two reflection coefficients states via $|\Gamma_{1,2}| = |\Gamma_1| - |\Gamma_2| \dots$ ” Ex-1005, 772. And Figure 8 shows tag performance based on the absolute value (magnitude) of the difference in the reflectance values $|\Gamma_{1,2}|$. Thus, a POSITA would have known that the impedances are typically complex and would have been strongly motivated to try them as it would *enable additional degrees of design freedom* to meet the desired condition on the magnitude of the difference of

reflection coefficient $|\Gamma_{1,2}|$ in pursuit of enhanced RFID tag performance. Ex-1003, ¶131.

Textbooks confirm that a POSITA possessed the necessary background of backscatter modulation using variable complex load impedances and knew the benefits thereof. For example, when addressing the same transmission power/power harvesting trade-off, Dobkin showed that a binary modulator circuit where Z_{mod} is only capacitive has better power harvesting and backscatter transmission than a strictly resistive binary modulator. Ex-1021, 214-218 (Table 5.1, comparing modulators in Figures 5.19 and 5.20); Ex-1003, ¶132.

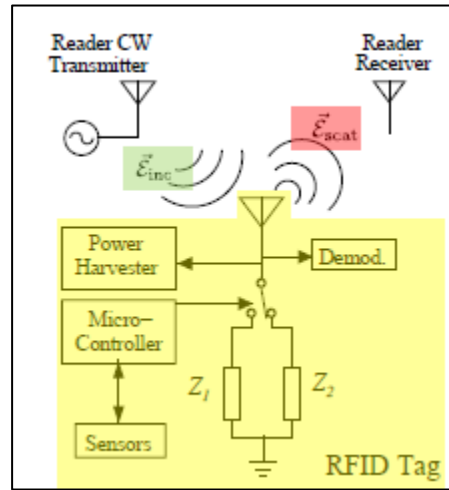
Therefore, the combined system would have represented “[u]se of known technique to improve similar devices [RFID tags] in the same way.” *KSR*, 550, 415-42. At the very least, a POSITA would have recognized this as a design choice and found it obvious to try a complex modulation impedance (*e.g.*, a capacitor C_{mod}) since there are only a finite number of choices—resistive, reactive, or a combination of the two. Ex-1003, ¶133.

D. Boyer in view of RFID Handbook renders claim 11 obvious

1. The combined RFID Tag discloses [11P]

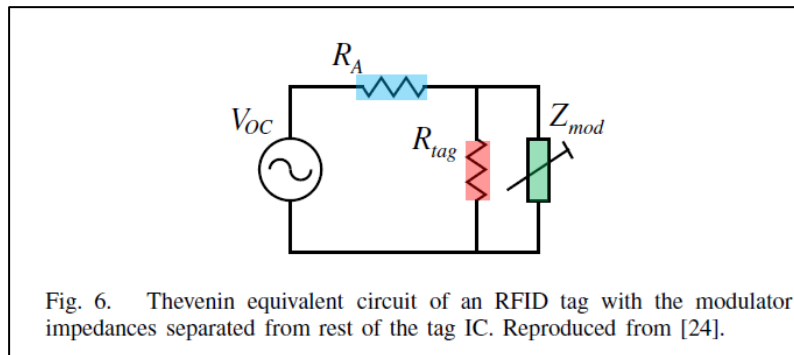
Boyer discloses “a *radio-frequency identification (RFID) tag*” [11P]. For example, Boyer explains that a “backscatter communication system consists of two components: *a RFID tag* (backscatter node) and a RFID reader

(transmitter/receiver).” Ex-1005 772.



Boyer, Figure 2 (“*an RFID tag*” (shown in yellow)).

Figure 6 shows the Thevenin equivalent circuit for an embodiment of the “RFID tag” with a binary backscatter modulator analyzed herein.

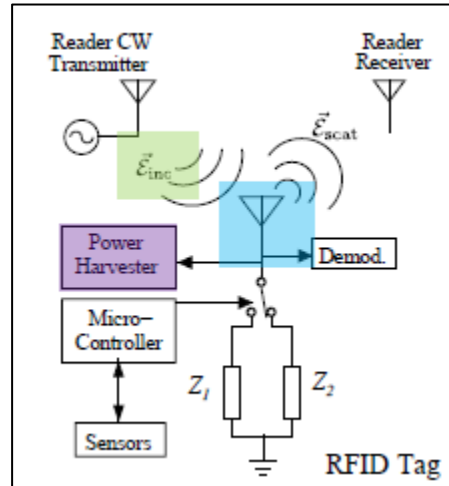


Ex-1003, ¶¶134-136.

2. The combined RFID Tag discloses [11A]

Boyer discloses “a main antenna that receives a radio-frequency (RF) signal from an RFID reader and wirelessly harvests power from the RF signal” [11A]. The RFID tag includes at least the antenna (blue) that receives the RF signal $\vec{E}_{inc}$ (green)

from the RFID reader (“Reader CW Transmitter”) in Figure 2 below.



Boyer, 772.

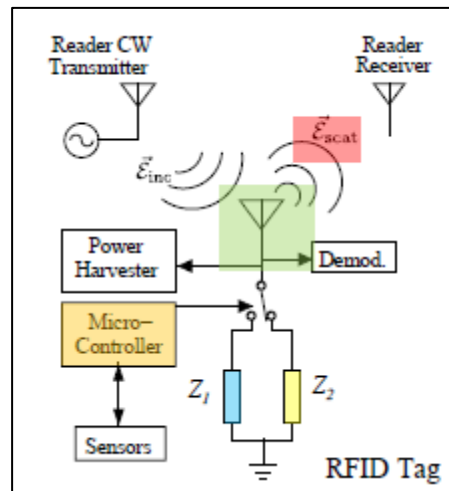
The “ $\vec{E}_{inc}$ ” represents the *incident E-field* generated by the reader’s CW at the *tags [sic] antenna.*” *Id.*, 772. “The power harvester” (purple above) “captures part of the energy in the incident RF $\vec{E}_{inc}$ for use by the tag.” *Id.*

Further, “[a]ny tag within range of the reader’s downlink CW signal will backscatter a portion back to the source (the reader), while the remainder *is harvested* to assist powering the on-tag integrated circuit (IC).” *Id.*, 771; 775 (“Passive RFID tags must rely on harvesting a portion of the reader’s CW incident energy”). Ex-1003, 134-142. *See* the analysis of [11C.2] below.

3. The combined RFID Tag discloses [11B.1]

Boyer discloses “a circuit that is configured to vary a reflection coefficient of the main antenna to transmit a reflected signal to the RFID reader” [11B.1]. In

Figure 2, the “integrated **circuit**” (IC) includes a microcontroller [orange] that modulates the *reflected signal* $\vec{\epsilon}_{scat}$ [red] to the *RFID reader* [“Reader Receiver”] by switching between impedances Z_1 [blue] and Z_2 [yellow] on the antenna, thereby changing (*i.e.*, “vary[ing]”) its *reflection coefficient* (Γ). *Id.*, 771- 772.



For example, the “microcontroller”—*i.e.*, a part of the IC and hence a “circuit”—includes logic that “switches the backscatter modulator between two impedance states Z_1 and Z_2 ” to modulate the backscattered signal $\vec{\epsilon}_{scat}$. *Id.*, 772; 771 (“**IC** modulates information onto the backscattered CW **by controlling the front-end impedance loading.**”). A POSITA would have understood that the IC and microcontroller are “circuits” because they comprise circuit elements to perform logic—including the switching to perform modulation. Ex-1003, ¶145.

Boyer further explains that “the tag”—via the IC and microcontroller—“switches the modulator impedance between Z_1 and Z_2 resulting in the

corresponding reflection coefficients Γ_1 and Γ_2 , respectively.” *Id.*, 772. Boyer sets forth the well-known relationship between the antenna impedance (Z_A), load impedance (Z_L , “combined impedance of the tag front end and backscatter modulator”—*i.e.*, either Z_1 or Z_2 , whichever is connected), and the reflection coefficient of the antenna:

$$\Gamma = \frac{Z_L - Z_A^*}{Z_L + Z_A^*} \text{ is the (complex) reflection coefficient between the antenna and load;}$$

Id., 772; Ex-1003, ¶¶146-149.⁵

The '968 patent provides the *same* equation for its “*reflection coefficient of the antenna*,” where Z_L and Γ in Boyer are the same as Z_i and ρ in the '968 patent, respectively:

explained in the following equations (1)-(4) and Table 1. The reflection coefficient ρ is described according to equation (1).

$$\rho_i = \frac{(z_i - z_a^*)}{(z_i + z_a^*)}, \quad (1)$$

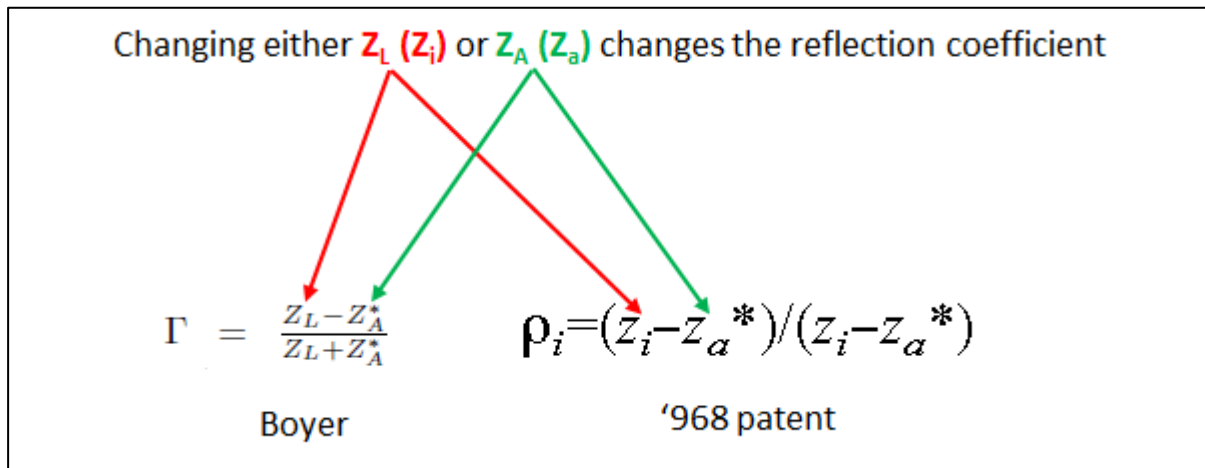
where z_a is the antenna impedance.

⁵ Where Z_A^* is equal to the complex conjugate of the antenna's impedance, Z_A .

'968 patent, 5:64-67.⁶

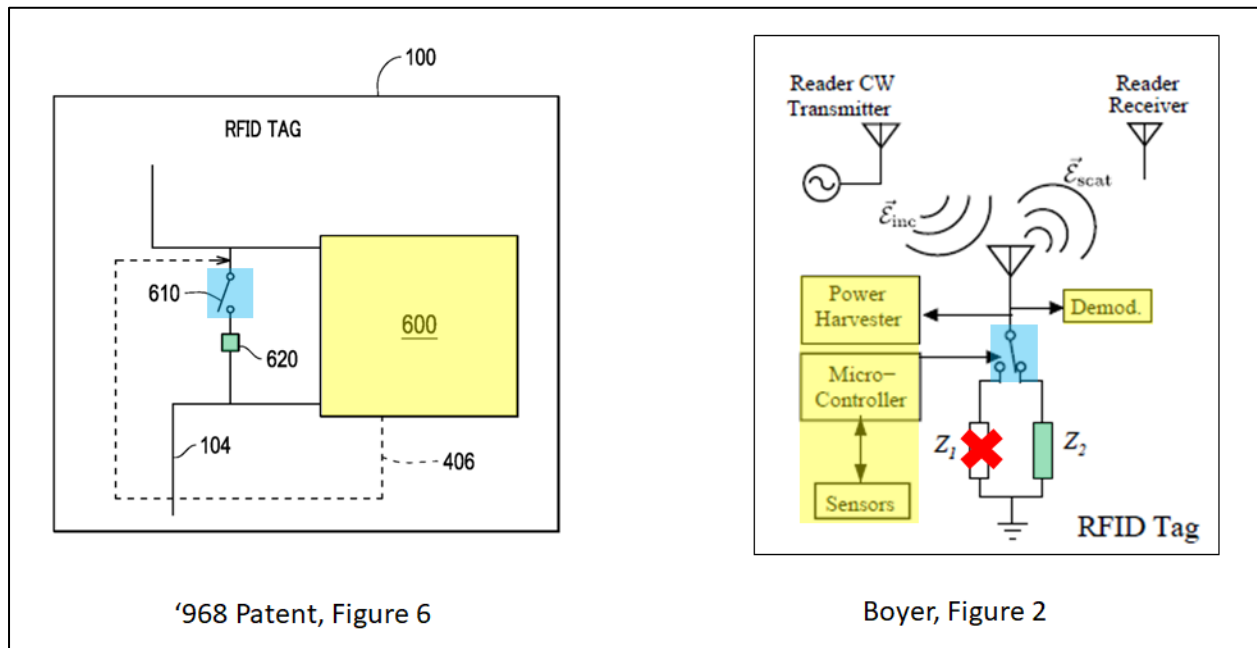
That the equation in the '968 patent for the “*reflection coefficient*” of the “*main antenna*” expressly considers **both** the antenna impedance (Z_a) and the load impedance (Z_i) confirms the understanding of a POSITA that the “*reflection coefficient of the antenna*” is affected by changes in the load, which in turn is affected by changing modulating impedances like Boyer’s Z_1/Z_2 . Indeed, it is not uncommon to refer to the reflectance properties of an RFID tag as properties of the antenna. But the reflectance properties (*e.g.*, reflectance, resonant frequency, etc.) of the RFID antenna (and hence the tag) are affected by the load impedance, which the '968 patent confirms. Said another way, if the same antenna conductor (*e.g.*, same material, length, etc.) is connected to two different loads, it will have a different reflection coefficient.

⁶ The equation recited in the '968 patent includes a typographical error. The denominator should reflect the **sum** of the antenna’s and integrated circuit’s impedance, not the difference. Ex-1003, ¶¶66, 150.



The '968 patent confirms that changing the modulating impedance connected to the antenna as taught by Boyer changes the “reflectance properties” of the “*main antenna*.” The '968 patent explains that “Electrical-reduced backscatter signal strength and increased tag power efficiency are achieved and controlled via choosing a *different modulating impedance within tag circuitry*.” '968 patent, 5:51-54. “In these embodiments, an ASIC or processor 600 controls one or more switches 610 to *add or subtract one or more impedances 620 from antenna 104. This changes the resonant frequency and reflectance properties without shorting the antenna 104.*” *Id.*, 5:55-59.

The above describes the binary modulator in Boyer, which shows Z_1 (open circuit) and Z_2 (green) connected directly to the antenna by the switch (blue), just like Figure 6 from the '968 patent. Boyer, 771, 772 (“ Z_L is the combined impedance of the tag front end *and backscatter modulator*”).



Ex-1003, ¶¶151-152.

The claims confirm that the '968 patent uses “*main antenna*” and the combination of the antenna and IC (or tag circuit) interchangeably for these concepts. For example, claim element [11A] recites the “*main antenna*” “*harvests power from the RF signal.*” See also [11C.2]. Of course, a POSITA would have understood that power harvesting (rectification, *i.e.*, conversion of RF to DC) can only be done in the IC (*e.g.*, through Boyer’s “power harvester”); power harvesting cannot be done by the antenna alone. Ex-1023, 129-137; Ex-1003, ¶151.

In Section II-C, impedances Z_1 (“open circuit”) and Z_2 (“between an open ($Z_2 = \infty$) and short state ($Z_2 = 0$)”) are different, resulting in different reflectance coefficients $|\Gamma_1|$ and $|\Gamma_2|$, respectively ($|\Gamma_1| = 0$; $0 < |\Gamma_2| < 1$). Boyer, 775. This analysis

does not change whether Z_2 is a resistor, a capacitor (as in the modified system), an inductor, or combination thereof. Ex-1003, ¶153.

Finally, as explained for element [11B.2], the reflection coefficient (Γ) determines the reflected E-field at the reader ($\vec{\epsilon}_{scat}$). Therefore, the IC and microcontroller are “*configured to vary a reflection coefficient of the main antenna to transmit a reflected signal to the RFID reader*” [11B.1].

4. The combined RFID Tag discloses [11B.2]

Boyer discloses “*the reflected signal having a **first reflectance period** and a **second reflectance period** when an amount of reflectance by the main antenna of the RF signal is different than during the **first reflectance period***” [11B.2].

As shown for element [11B.1], the “tag switch[ing] the modulator impedance between Z_1 and Z_2 result[s] in the corresponding reflection coefficients Γ_1 and Γ_2 , respectively.” *Id.*, 772; Ex-1003, ¶¶156-157. “By altering the tag’s antenna impedance loading” (*i.e.*, switching between load impedances Z_1 and Z_2), “a return signal with different phase and amplitude is backscattered to the reader.” *Id.*, 772. Boyer defines the reflected E-field “signal at the reader,” $\vec{\epsilon}_{scat}$, as a function of the reflection coefficient Γ .

$$\vec{\epsilon}_{scat} = \vec{\epsilon}_{scat}^M - \Gamma I_M \frac{\vec{\epsilon}_a}{I_a}$$

Id., 772 (equation (1)). This is the “*reflected signal*.”

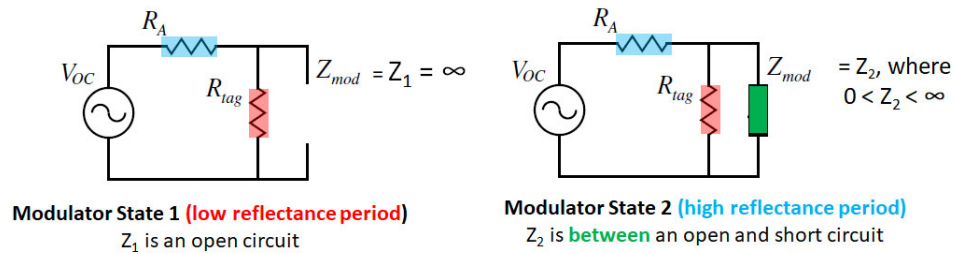
Therefore, Γ_2 and Γ_1 are the antenna reflection coefficients corresponding to the periods when the IC switches the modulator impedances between Z_2 and Z_1 . This in turn changes the “*amount of reflectance by the main antenna,*” providing the *first reflectance period* (i.e., high reflectance corresponding to Γ_2 and an “ON” modulation period) and the *second reflectance period* (i.e., low reflectance period corresponding to Γ_1 and an “OFF” modulation period) of the resulting backscattered electric field at the reader (e.g., to achieve ON-OFF keying):

$$\vec{\mathcal{E}}_{scat} = \vec{\mathcal{E}}_{scat}^M - \Gamma_1 I_M \frac{\vec{\mathcal{E}}_a}{I_a}; \quad \vec{\mathcal{E}}_{scat} = \vec{\mathcal{E}}_{scat}^M - \Gamma_2 I_M \frac{\vec{\mathcal{E}}_a}{I_a}$$

**Reflected Signal During *Second/Low* (Γ_2 and Z_2) /
First/High (Γ_1 and Z_1) Reflectance Periods**

Id., 772; Ex-1003, ¶¶158-160. Therefore, the amount of RF signal that is reflected by the antenna is proportional to Γ .

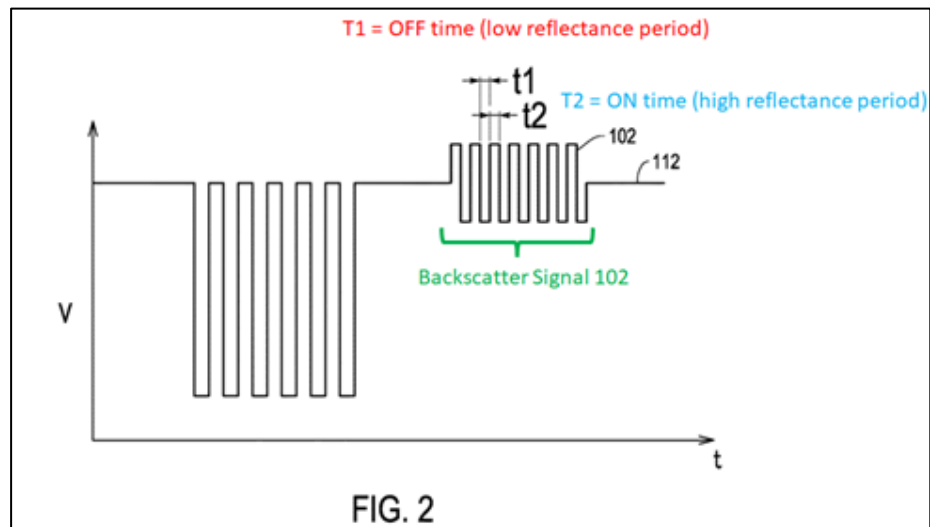
In Section II-C, the binary backscatter modulator switches between the two states by changing the modulation impedance, Z_{mod} , between Z_1 (open circuit for the *low reflectance period* with matched condition, where $\Gamma_1 = 0$) and Z_2 (having a value between an open and short circuit for the *high reflectance period*, where $0 < |\Gamma_2| < 1$). *Id.*, 775; Ex-1003, ¶161.



Boyer Figure 6 (annotated, duplicated, and modified to show two modulation states).

Since Γ_1 and Γ_2 are different, the “*amount of reflectance of the RF signal*,” which if not the reflection coefficient themselves, is at least proportional to the reflection coefficient as shown above, is therefore varied to modulate the signal.

The '968 patent confirms that the **first** (high) and **second** (low) *reflectance periods* includes the ON and OFF periods of the backscatter signal as shown in Boyer.



'968 patent, 3:65-4:3.

Finally, for the same reasons explained above for [11B.1], the “*amount of*

reflectance” is “*by the main antenna.*” A POSITA would have understood that the antenna reflectance properties are dependent on the load connected to the antenna at least because the equation for Γ depends on both impedances. Ex-1003, ¶¶151-152; see limitation [11B.1].

5. The combined RFID Tag discloses [11C.1]

Boyer discloses “*wherein a reflectance of the main antenna is reduced below a predefined amount during the first reflectance period without shorting the main antenna*” [11C.1].

As explained for elements [11B.1]-[11B.2], a binary system that switches modulator impedances Z_{mod} between Z_1 and Z_2 provides different antenna reflection coefficients, Γ_1 and Γ_2 . This in turn yields different amounts of the reflected electric field (the RF signal), $\vec{E}_{\text{scat}}$, by the antenna during different periods of the reflected signal (e.g., for ON-OFF keying). Boyer, 771-773; Ex-1003, ¶¶165-170.

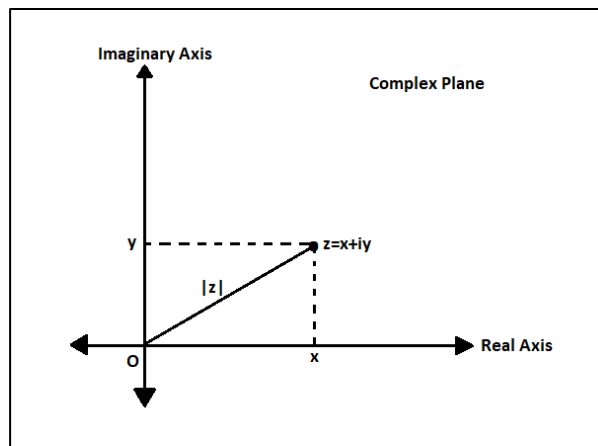
Since the RFID tag in Section II-C has one state (when $Z_{\text{mod}} = Z_1$) set to a “matched condition” (i.e., Z_L is equal to Z_A), a POSITA would have understood that corresponds to the *second (low) reflectance period* when 1) maximum power harvesting and minimal reflection occurs; and 2) Γ_1 is equal to 0, as set forth in this equation from above:

$\Gamma = \frac{Z_L - Z_A^*}{Z_L + Z_A^*}$ is the (complex) <u>reflection coefficient</u> between the antenna and load;

Ex-1003, ¶¶171-173.

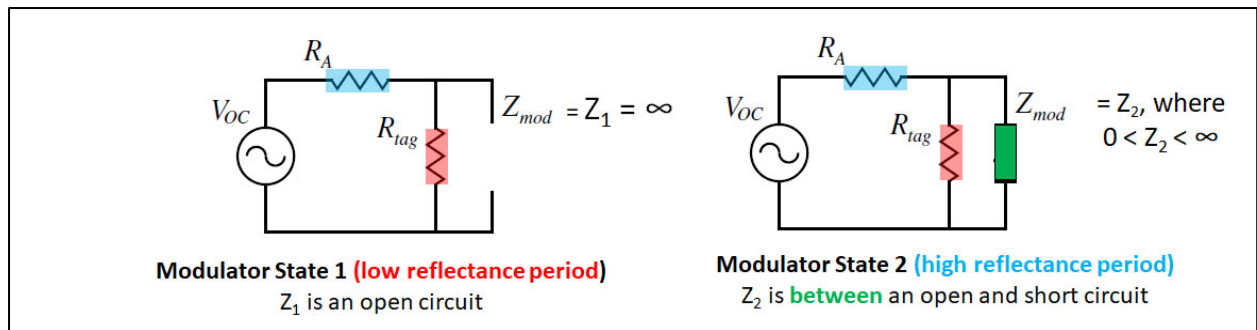
Similarly, since setting $Z_{\text{mod}} = Z_2$ determines the reflectance of the antenna in the *first (high) reflectance period*, a POSITA would have understood that the reference to a “short state” is a short circuit of the antenna. Therefore, a POSITA would have understood that selecting $Z_{\text{mod}} = Z_2$ “between” an “open” and “short state” means that 1) antenna reflection coefficient $|\Gamma_2|$ will be greater than 0 and less than 1; 2) the antenna will *not* be shorted since Z_2 is *between* an open *and a short*; and 3) since the antenna is not shorted, $|\Gamma_2|$ is below a “*predefined amount*” (for example, less than 1, but also potentially any amount within the disclosed range of 0 to 1). Ex-1003, ¶¶174.

Although in the combined system Γ_2 will have a complex value, its magnitude will still be greater than 0 and less than 1. The magnitude of a complex number (z) is given by: $|z| = |x + jy| = \sqrt{x^2 + y^2}$ (i.e., the vector from the origin to the point in the complex plane):



Therefore, since $Z_2 = C_{\text{mod}}$ in the modified RFID tag, it has a corresponding reactance value and a non-zero magnitude, and the same analysis applies. Ex-1003, ¶¶175-176; Ex-1021, 460.

Again, these states (corresponding to $Z_{\text{mod}} = Z_1$ or Z_2) are illustrated by the two states of Figure 6:

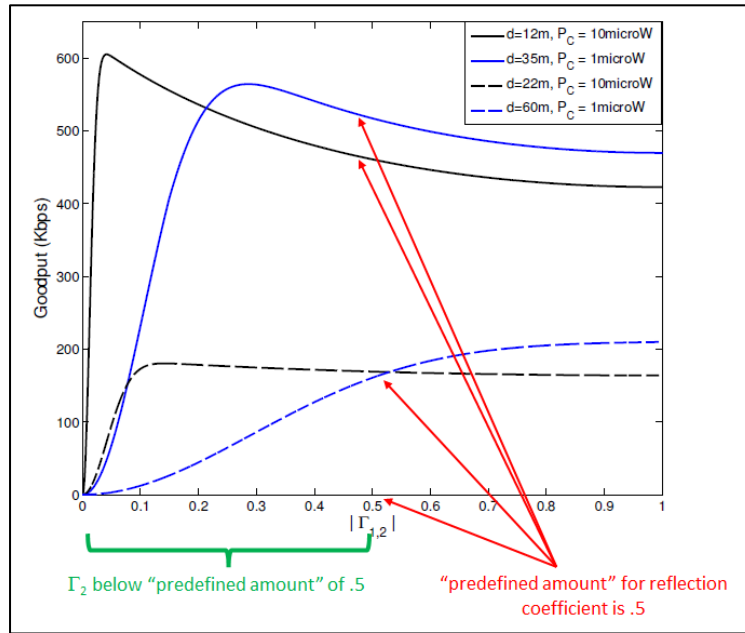


Boyer Figure 6 (annotated, duplicated, and modified to show two modulation states).

That the reflectance of the main antenna corresponding to $|\Gamma_2|$ is less than a “*predefined amount*” and the antenna is not shorted is confirmed in Figure 8, which models reflectance coefficient values for $|\Gamma_{1,2}|$ of the antenna that range from 0 to 1, and hence include instances where $|\Gamma_2|$ ⁷ is below a *predefined amount* (*i.e.* less than

⁷ Claim 3 indicates the “*predefined amount*” concerns the “*reflection coefficient*.” Claims 2, 3, and 7 also appear to equate the “*reflectance*” with the “*reflection coefficient*.” To the extent the “*reflectance of/by the main antenna*” means the

1, less than .1, less than .2, less than .3, etc.).⁸ Examples are highlighted below for the Section II-C embodiment with $|\Gamma_2|$ between 0 and .5 (in green) and thus below, for example, a “*predefined amount*” equal to .5. Also, the points in red show each RFID tag performance when $|\Gamma_2| = .5$.



Boyer, 775-776.

Finally, for the same reasons explained above for [11B.1], the “*reflectance*”

amount of signal reflected, as shown above, that is proportional to Γ . Petitioner reserves the right to argue all claims are indefinite because of the ambiguity.

⁸ For the RFID tag described in Section II-C, a POSITA would have understood $|\Gamma_{1,2}|$ is equal to $|\Gamma_2|$, since $\Gamma_1 = 0$. Ex-1003, ¶177.

is “*of the main antenna.*” A POSITA would have understood that the antenna reflectance properties are dependent on the load connected to the antenna. Ex-1003, ¶¶151-152.

6. The combined RFID Tag discloses [11C.2]

Boyer discloses that the reflectance is reduced below a predefined level “*to enable the main antenna to continuously harvest power while transmitting the reflected signal to the RFID reader*” [11C.2]. As explained above in Section IV.F.1, Boyer expressly applies the principal of reducing backscatter transmission power to increase power harvesting during backscatter.

In the RFID tag in Section II-C, since the modulation impedance Z_2 is not a “short state” and therefore $|\Gamma_2|$ is less than 1, at least some of the incident RF field that is not reflected is harvested for power. Boyer, 775-776; Ex-1003, ¶¶179-181. Indeed, Boyer states in its “Fundamentals” section that while part of the incident RF electrical field is backscattered, “[*t*]*he remaining power is assumed harvested by the tag*, i.e. dissipated by the modulator impedances Z_1, Z_2 .” Boyer, 771.

Boyer teaches that the amount of power harvested during backscatter, P_{back} , is a function of the impedance load during the *entire* backscatter period. Boyer, 775-776; Ex-1003, ¶182.

For example, Boyer teaches that when “[o]ne modulator state remains in the matched condition (i.e., Z_1 is an open circuit) and the other state has the value Z_2 ,”

“[b]y varying the value of Z_2 between an open ($Z_2 = \infty$) and short state ($Z_2 = 0$), ***the harvested power during backscatter P_{back} decreases but link reliability improves.***”

Ex-1005, 776. A POSITA would therefore have understood that the selection of Z_2 affects the amount of power harvested during backscatter in the ***first (high) reflectance period*** because as Z_2 approaches a short circuit: the antenna reflectance (Γ_2) increases, (meaning less signal to harvest) and therefore P_{back} decreases. And of course, if no power was harvested during the ***first (high) reflectance period***, then the impedance of Z_2 would have no impact on P_{back} . Ex-1003, ¶182.

Boyer represents the power harvested during backscatter as:

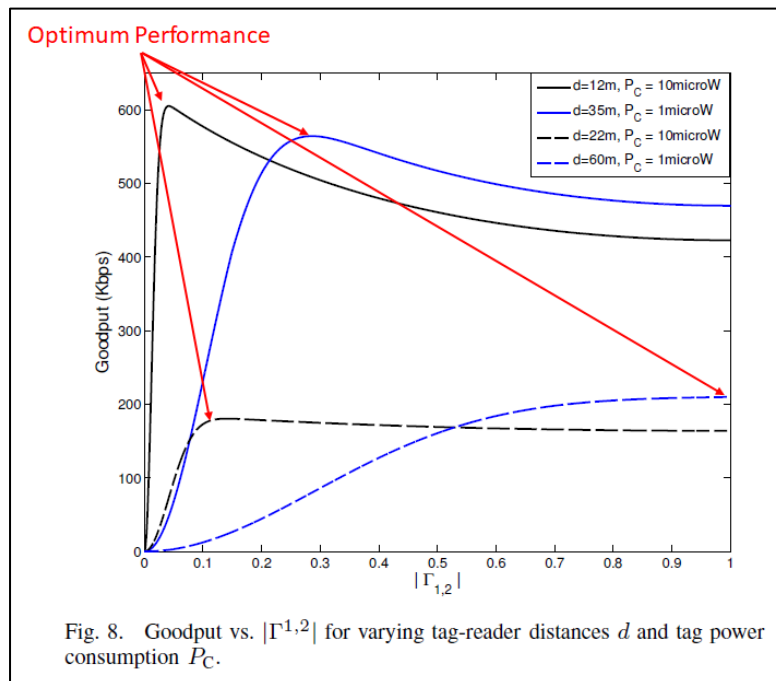
$$P_{back} = P_M \frac{1 + (1 - |\Gamma_{1,2}|)^2}{2}$$

where the constraints of Z_1 and Z_2 translate to $|\Gamma_{1,2}| \leq 1$ in the Section II-C embodiment.⁹ Boyer, 775-776. Boyer explains that as the reflectance difference $|\Gamma_{1,2}|$ increases, “ ***P_{back}*** and the tag duty cycle D_{cycle} decreases.” Boyer, 776. In other words, the closer Z_2 is to a short state ($Z_2 = \infty$), the less power the tag will harvest during backscatter. Ex-1003, ¶183. Thus, Boyer teaches not shorting the antenna during the ***first (high) reflectance period*** “*to continuously harvest power while*

⁹ For this embodiment, $|\Gamma_{1,2}|$ is equal to $|\Gamma_2|$.

transmitting the reflected signal to the RFID reader.”

In Figure 8, Boyer identifies the optimum performance values for different distances and tag power consumption levels, all but one of which corresponds to a difference in reflectivity $|\Gamma_{1,2}|$ of less than 1 (where the antenna is short circuited).



Boyer, 776; Ex-1003, 184.

Textbooks confirm that a POSITA would have known that power harvesting occurs during backscatter: “it is helpful to consider trading off some backscattered signal for more tag power.” Ex-1021, 214. Dobkin analyzes resistive and capacitive binary modulation circuits in Figures 5.19 and 5.20, respectively, allowing “the component values . . . to vary from those corresponding to a very small modulated signal to the limit of open and short circuits,” and found increased power harvesting

during backscatter in both circuits when the antenna is not shorted. Ex-1021, 214-218; Ex-1003, ¶185.

7. The combined RFID Tag discloses [11C.3]

Boyer discloses “*wherein the reflectance of the main antenna is reduced based on a change in a resonant frequency of the main antenna*” [11C.3].

As explained for elements [11B.1]-[11B.2], Boyer varies the reflection coefficient of the main antenna by switching the modulating impedance Z_{mod} between Z_1 and Z_2 . This changes the RFID tag from a “matched” to an “unmatched” state.

In the modified RFID tag, Z_2 has a reactive component (*e.g.*, it is capacitor C_{mod}). Since resonant frequency is “inversely proportional to the product of inductance and capacitance,” (Ex-1021, 217), a POSITA would have known that adding (or subtracting) a reactance from the antenna of the RFID tag changes the resonant frequency:

$$f_{\text{res}} = \frac{1}{2\pi\sqrt{LC}}$$

Ex-1021, 473 (resonant frequency); Ex-1003, ¶187-189.

Indeed, a POSITA would have known that changing an antennas reflectance by “couple[ing] electrical elements, such as *capacitive elements*, inductive elements,

or combinations thereof, [would] vary the *resonant frequency* of the RFID tag.” Ex-1006, Abstract. Here, as shown in Boyer Figure 2 and 6, Z_{mod} (Z_2) is coupled to the antenna, has a reactance component, and therefore changes the total reactance and therefore “*resonant frequency*.” Ex. 1021, 477; Ex-1003, ¶¶188-189.

For the same reasons explained for limitations [11B.1], [11B.2], and [11C.1], a POSITA would have understood that changing the reactance of the load (*e.g.*, the IC or the modulation impedance) changes the resonant frequency “*of the main antenna*.” First, a POSITA would have known that the LC value in the equation above comprises the L and C from both the antenna and the load (including modulation impedance). Ex-1003, ¶¶190-195.

Second, it is not unusual to refer to the reflection properties of an RFID tag as properties of the “antenna,” since that is the component that receives and radiates the RF signals. Of course, the reflectance properties (*e.g.*, reflectance, resonant frequency) of the RFID antenna are affected by the load impedance. When connected as an RFID tag, the antenna and tag have the same resonant frequency. Ex-1003, ¶¶196-197; Ex. 1021, 477.

The ’968 patent confirms that changing the modulating impedance connected to the antenna as taught by Boyer changes the resonant frequency of the main antenna. In the “electrical” embodiment, the ’968 patent explains that “choosing a

different modulating impedance *within tag circuitry* . . . changes the *resonant frequency* . . .” *Id.*, 5:51-59. This describes the binary modulator in Boyer and the RFID Handbook. Ex-1003, ¶198.

E. Claim 12 was obvious

Boyer discloses that IC with microcontroller (the circuit) “*changes the resonant frequency of the main antenna to generate the first and second reflectance period*” as recited in claim 12. *See* limitations [11B.1], [11B.2] and [11C.3].

In brief, the IC via microcontroller switches the modulation impedances Z_{mod} between Z_1 and Z_2 , which changes the antenna’s reflection coefficient, Γ_1 and Γ_2 , and, with it, the *resonant frequency* of the antenna. This creates the *first* (high or ON, $Z_{\text{mod}} = Z_2$) and *second* (low or OFF, $Z_{\text{mod}} = Z_1$) reflectance periods of the reflected signal because it brings the antenna and IC into and out of resonance (matched):

$$\vec{\mathcal{E}}_{\text{scat}} = \vec{\mathcal{E}}_{\text{scat}}^M - \Gamma_1 I_M \frac{\vec{\mathcal{E}}_a}{I_a} ; \vec{\mathcal{E}}_{\text{scat}} = \vec{\mathcal{E}}_{\text{scat}}^M - \Gamma_2 I_M \frac{\vec{\mathcal{E}}_a}{I_a}$$

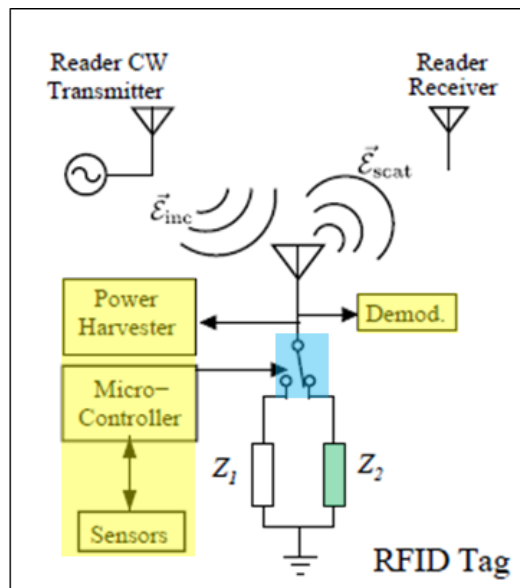
**Reflected Signal During *Second* (Γ_2 and Z_2) /
First (Γ_1 and Z_1) Reflectance Periods**

Boyer, 772, 775; Ex-1003, ¶¶200-202.

F. Claim 16 was obvious

Claim 16 requires “*a switch controlled by the circuit that connects an RF impedance to the main antenna during the first reflectance period.*” As explained

for element [11B.1] and claim 12, Boyer includes an IC with a microcontroller (yellow) that controls a switch (blue) connecting modulation impedances ($Z_{\text{mod}} = Z_1$ or Z_2) to the main antenna. Boyer, 772 (“microcontroller logic *switches* the backscatter modulator between two impedance states Z_1 and Z_2 .”).



Boyer, Figure 2

Ex-1005, Fig. 2 (annotated).

As explained for element [11B.2], Z_2 (green) is connected through a switch during the *first reflectance period*—e.g., during the ON modulation of the backscatter period. A POSITA would have understood that impedance Z_2 is an “*RF impedance*” because connects to the antenna to affect the RF properties. Ex-1003, ¶¶203-205.

G. Claim 17 was obvious

Claim 17 further requires “*wherein the amount of reflectance by the main antenna of the RF signal is greater than the predetermined amount during the **first reflectance period**, and the amount of reflectance by the main antenna of the RF signal is lower than the predetermined amount during the **second reflectance period**.*” To the extent this claim is understandable, Boyer discloses this limitation.¹⁰

As explained above and for elements [11C.1] and [11C.2], in Section II-C:

- the **second (low) reflectance period** corresponds to the modulation state for $Z_{\text{mod}} = Z_1$ (open circuit), and $|\Gamma_1|$ is 0;
- the **first (high) reflectance period** corresponds to the modulation state $Z_{\text{mod}} = Z_2$ (varies between an open and short state), and $|\Gamma_2|$ varies **between** 0 (*i.e.*, open circuit matched condition) and 1 (short circuit).

Boyer, 772,774-775.

Therefore, a POSITA would have understood that there is an “*amount of reflectance*” between $Z_{\text{mod}} = Z_1$ ($|\Gamma_1| = 0$) and $Z_{\text{mod}} = Z_2$ ($0 < |\Gamma_2| < 1$)—*i.e.*, a

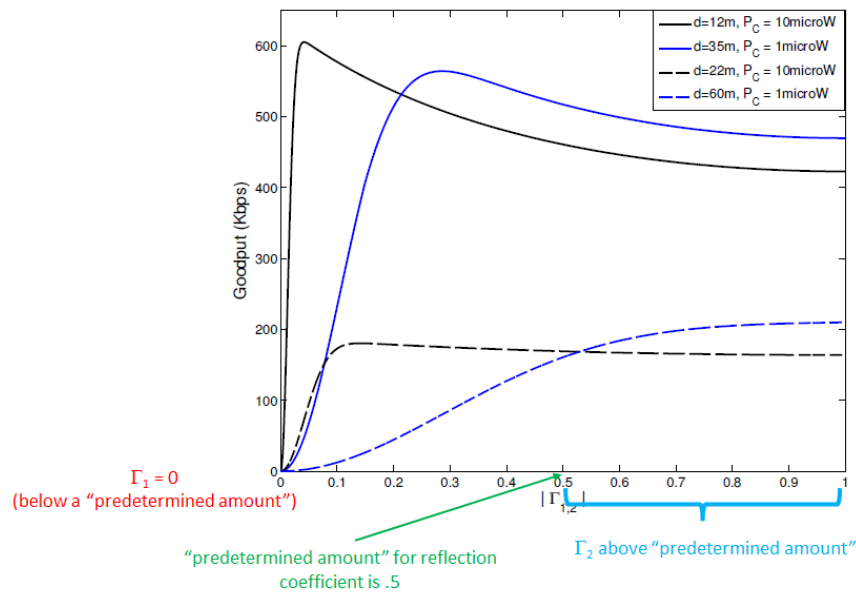
¹⁰ Petitioner reserves the right to argue that claim 17 is indefinite at least because 1) the “predetermined amount” has no antecedent basis; and 2) it contradicts the use of “predefined amount.”

“*predetermined amount*”—that is greater than 0 (such that the “*amount of reflectance by the main antenna of the RF signal is lower than the predetermined amount during the **second reflectance period***”) while also being less than $|\Gamma_2|$ (such that “*the amount of reflectance by the main antenna of the RF signal is greater than the predetermined amount during the **first reflectance period***.”) Ex-1003, ¶¶206-210.¹¹

For example, Boyer’s Figure 8, which models reflectance values that range from 0 to 1 for $|\Gamma_2|$,¹² and hence any value below $|\Gamma_2|$ and greater than 0 is the “*predetermined amount*.” An example would include a value of .5, where Γ_2 (in blue) is greater than .5.

¹¹ As noted above, to the extent “*amount of reflectance*” refers to the amount of reflected RF signal, rather than the reflection coefficients, then the same analysis applies because the reflected RF signal strength is proportional to Γ .

¹² As noted above, in this embodiment, $|\Gamma_{1,2}|$ is equal to Γ_2 .



Boyer, 776.

Each of the values on the x-axis provides a “*predetermined amount*” at least because the designers had to select the antenna, chip impedance, and Z_1/Z_2 values to set the desired reflectance coefficients for each period of the modulated backscatter signal, including the value during the **high** and **low** reflectance period corresponding to Γ_1 and Γ_2 . Ex-1003, ¶¶211-212.

H. Claim 18 was obvious

For claim 18, the analysis for limitations [11B.2], [11C.1], claim 17 applies.

In short, Γ_2 (reflectance during the **first reflectance period**) is between 0 and 1, and Γ_1 (reflectance during the **second reflectance period**) is 0 in Boyer’s Section II-C embodiment. Boyer, 775-776; Ex-1003, ¶¶213-215.

I. Claim 19 was obvious

For claim 19, while Boyer does not expressly refer to IC as an “*ASIC*,” it would have been obvious to use an ASIC for Boyer’s IC. First, ASICs were conventional components for RFIDs, including backscatter passive RFID tags. Ex. 1021, 195. Even the inventor recognized years earlier that “*typical* passive tag consists of an antenna and an *application specific integrated circuit (ASIC) chip*.” Ex. 1007, 212. This would have been a “[s]imple substitution of one known element for another to obtain predictable results.” *KSR*, 550 U.S. 415-421. Ex-1003, ¶¶216-218.

Second, a POSITA would have been motivated to use an ASIC as taught by RFID Handbook so that the tag could be used in a wide range of applications.

Table 3.6 Overview of the power consumption of various RFID-ASIC building blocks (Atmel, 1994).
The minimum supply voltage required for the operation of the microchip is 1.8 V, the maximum permissible voltage is 10 V (Atmel, 1994)

	Memory (bytes)	Write/read distance(cm)	Power consumption	Frequency	Application
ASIC#1	6	15	10 µA	120 kHz	Animal ID
ASIC#2	32	13	600 µA	120 kHz	Goods flow, access check
ASIC#3	256	2	6 µA	128 kHz	Public transport
ASIC#4	256	0.5	<1 mA	4 MHz*	Goods flow, public transport
ASIC#5	256	<2	~1 mA	4/13.56 MHz	Goods flow
ASIC#6	256	100	500 µA	125 kHz	Access check
ASIC#7	2048	0.3	<10 mA	4.91 MHz*	Contactless chip cards
ASIC#8	1024	10	~1 mA	13.56 MHz	Public transport
ASIC#9	8	100	<1 mA	125 kHz	Goods flow
ASIC#10	128	100	<1 mA	125 kHz	Access check

*Close-coupling system.

Ex-1023, 42; *id.*, xiii (defining “ASIC”).

Third, a POSITA would have known of benefits of using an ASIC, such as

reduced cost and size at scale. Ex. 1021, 195; Ex-1003, ¶¶219.

J. Claim 20 was obvious

For claim 20, while Boyer does not expressly describe the antenna as “*linearly polarized*,” such antennas were well-known and conventional in the art at the time the ’968 patent was filed. One example is a dipole antenna, which “is a linear polarised antenna in which the electric field lines run parallel to the dipole axis.” Ex-1023, 114; Ex-1003, ¶¶220-221; Ex-1007, 216 (using a “linearly polarized transmitting antenna” for the measurements of the RFID chip.) RFID Handbook shows that the antennas in its modulation circuits shown in Figure 4.89(a)-(f) are “ $\lambda/2$ *Dipole*.” Ex-1023, 140. Even the ’968 patent admits that such RFID tags were “prevailing on RFID market.” ’968 patent, 5:32-35.

Because Boyer is agnostic as to the details of the antenna, a POSITA would have selected any suitable antenna for Boyer’s RFID tag, including a conventional “linearly polarized antenna” like a dipole antenna. A POSITA would have also known of the benefits of using a linearly polarized antenna like a dipole antenna, such as increased energy transfer when the transmitting/receiving antennas have the same direction. Ex-1023, 114. This modification would have been a “[s]imple substitution of one known element for another to obtain predictable results” or, at the very least, “use of known technique to improve similar devices in the same way.”

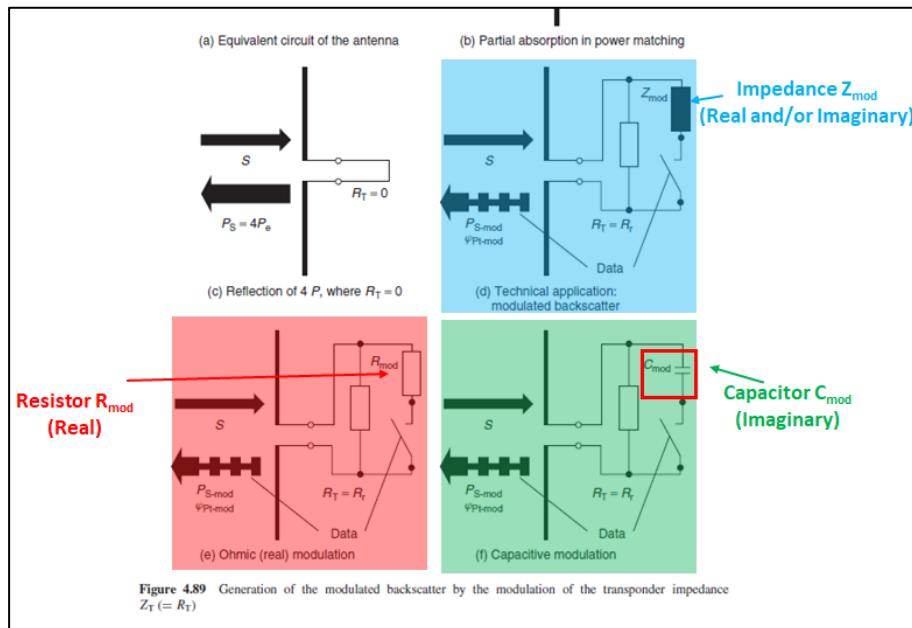
KSR, 550 U.S. at 415-421. Ex-1003, ¶222.

**VII. GROUND 2: Claims 1-5, 11-20 were obvious over Boyer in view of
RFID Handbook in further view of Waldner.**

Claims 1-5, 13-15 are similar to claim 11 except they claim the use of “*separate length of antenna*” as the impedance that is switched onto the antenna. However, this was a well-known way of varying the load impedance (and therefore the reflectivity) of an RFID tag antenna.

A. The combined system

The combined system of Boyer in view of RFID Handbook is an RFID tag with “binary backscatter modulator” that includes an impedance Z_2 having a reactance—in the example for claim 11, a capacitance C_{mod} . However, as explained in Sections VI.A-VI.C, a POSITA would have known that the modulation impedance Z_{mod} could have any value and comprise any suitable circuit element depending on the system design. Indeed, Boyer refers throughout to Z_{mod} , without reference to its composition until Section II-C, and only then to illustrate the principle power harvesting/backscatter power tradeoff. And RFID Handbook discloses a modulator with impedance Z_{mod} (blue) alongside the Ohmic (red) and Capacitive (green) modulation circuits.

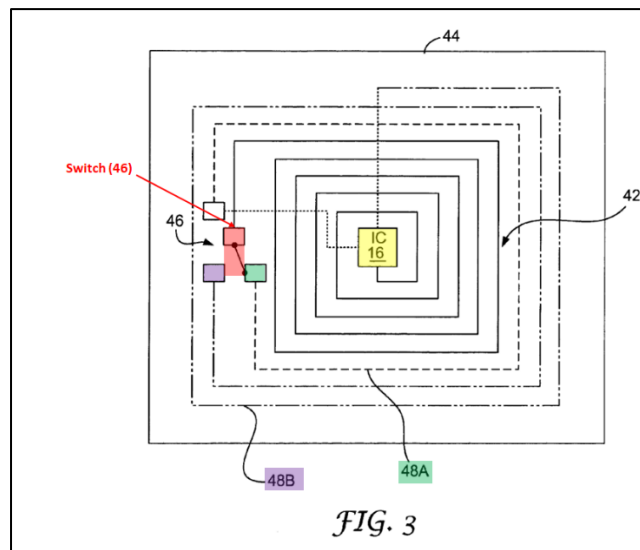


Since Boyer and RFID Handbook teach modulation impedances (Z_{mod}) can vary to optimize RFID performance, such techniques were well-known in the art. Ex-1003, ¶¶224-226; Ex. 1023, 120-121 (“The scatter aperture [corresponding to reflectance] can thus take on any desired value in the range 0 [matched condition] – $4 A_e$ [short condition].”)

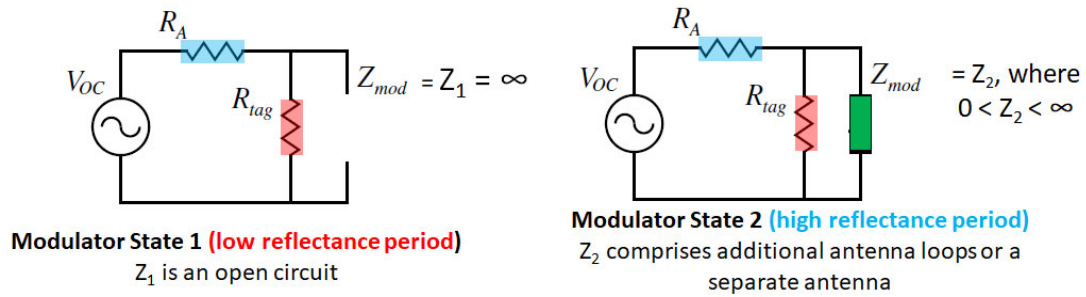
One example of an impedance used in RFID tags is Waldner (Ex. 1006). Waldner is directed to a passive RFID tag that “includes a main antenna tuned to a first resonant frequency, and switching circuitry that dynamically changes the *resonant frequency of the main antenna*” by “selectively coupl[ing] electrical elements, such as capacitive elements, inductive elements, or combinations thereof” Waldner, Abstract.

Figure 3 shows that switch 46 alternates between two inductive elements 48A

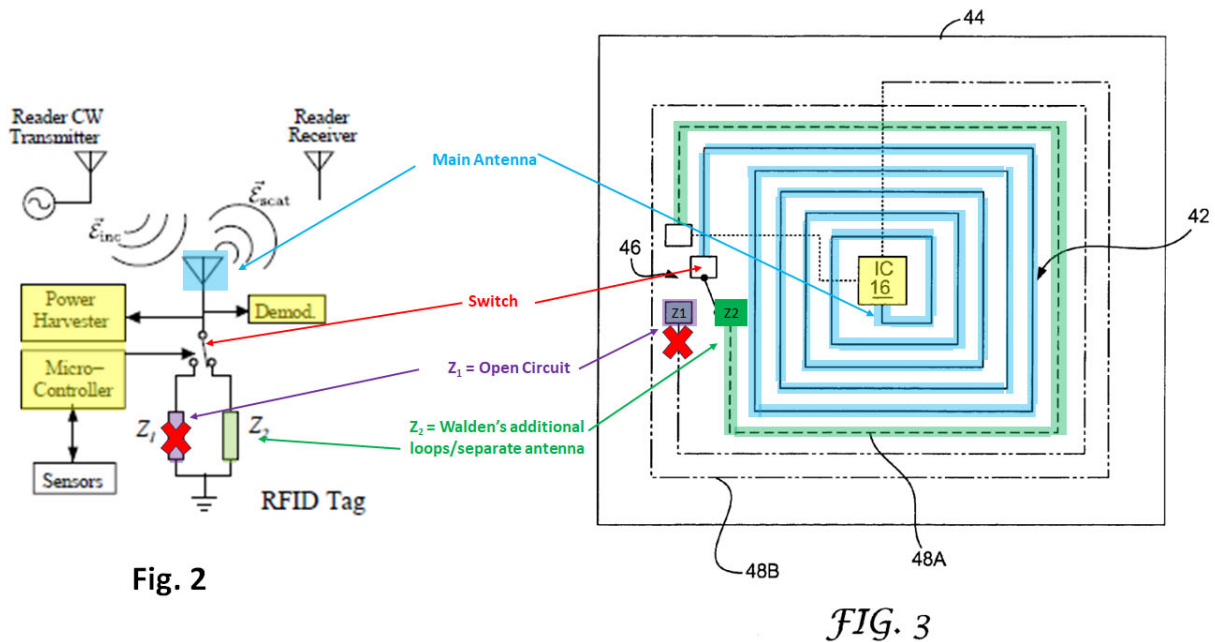
and 48B. Waldner, ¶37. “Inductive elements 48A and 48B [green and purple below] comprise portions of conductive traces fabricated to form *additional loops of antenna 42*” or “any component with an inductance, or completely *separate antennas*.” Waldner, ¶38.



For the combined system for these claims, Boyer’s embodiment in Section II-C—in which the modulator impedance Z_{mod} “has two states Z_1 and Z_2 ”—as further modified by RFID Handbook such that Z_2 has a reactive impedance, is further modified with Waldner’s teaching of circuit elements that can be used as such an impedance, including “additional loops” of the main antenna or a “completely separate antenna.” Waldner, Abstract; ¶38. Waldner’s circuit components are specifically used for the impedance Z_2 (since Z_1 is an open circuit). Boyer, 775; Ex-1003, ¶¶227-230.



Boyer, Figure 6 (further modified to show Z_2 as antenna loops/separate antenna).



Boyer Figure 2 (left) and Waldner Figure 3 (right) (annotated to show how additional antenna loops/antenna would have been implemented as Boyer's Z_2).

B. Motivation to use Waldner's impedances

A POSITA would have been motivated to use Waldner's "additional loops" of antenna, or entirely "separate antenna," as the impedance Z_2 in Boyer.

First, Boyer, RFID Handbook, and Waldner are directed to the same field and

address similar functionality—switching connections to impedances to change the antenna reflectance properties in RFID backscatter tags. Waldner, ¶¶7 (“... by changing the resonant frequency at which the RFID tag *backscatters* radio frequency energy”); 23 (“*backscatters RF energy*”). Further, like Boyer and RFID Handbook, Waldner’s tag includes “switching circuitry that dynamically changes the resonant frequency of the main antenna . . . [by] selectively coupl[ing] electrical elements, such as capacitive elements, inductive elements, or combinations thereof, to vary the resonant frequency of the RFID tag.” *Id.*, Abstract, ¶¶8, 10, 23-36, 37, 38-39, 44; Ex-1003, ¶232.

Therefore, a POSITA studying Boyer and the RFID Handbook would look towards teachings of impedances that can be switchably connected to the antenna to change its reflectivity (*i.e.*, by changing the resonant frequency), and found Waldner. At the very least, the combined system was a “simple substitution of one known element [*i.e.*, Waldner’s switchable impedances comprising antenna loops] for another [Boyer’s switchable impedance Z_2] to obtain predictable results [*i.e.*, a switchable impedance that connects to an RFID backscatter tag antenna to change its reflectivity.]” *KSR*, 550, 415-421; Ex-1003, ¶233.

Second, even though Waldner selectively couples/decouples its additional impedances to tune the antenna frequencies to address interference, a POSITA

would have recognized that Waldner's switchable impedances would have been a suitable implementation in Boyer's binary backscatter modulator. Specifically, a POSITA would have recognized that Waldner's inductance elements 48A and/or 48B, *e.g.*, with additional lengths of antenna, would have resulted in a different impedance load (Z_2) and therefore different reflectance (Γ_2), as taught by Boyer. Ex-1003, ¶234.

The fact that Boyer switches impedances to change the antenna reflectivity for modulation, whereas Waldner changes the impedances for tuning, would not have dissuaded a POSITA from utilizing Waldner's teaching of impedances in modulation. Boyer switches impedances to change the reflection coefficient of the antenna. Waldner does the same. A POSITA would have known that any suitable impedance could have been used in Boyer so long as it changed the reflection coefficient and enabled continuous power harvesting. An additional loop of antenna, or a separate antenna, as well as other inductance elements (or capacitive elements for that matter), would have been suitable for that purpose. Waldner itself teaches the interchangeability of load impedances to change resonant frequency. Ex-1006, ¶36 ("capacitive element in parallel/series," "short out a capacitive element," "switch in an inductive element in either series or parallel," "or combinations thereof, to change the resonant frequency of main antenna."). Ex-1003, ¶235.

The '968 patent does not provide any explanation as to *why* using a separate antenna length was unconventional, or any specific benefits it provides over other impedances. At the very least, Waldner's use of dynamically switchable antenna lengths to change the antenna reflective properties constituted "[k]nown work" in the RFID backscatter field that would have prompted variations of it for use in other aspects of an RFID tag, including as an impedance in a modulator circuit. *KSR*, 550 U.S. at 415-421. Ex-1003, ¶236.

Third, a POSITA would have been motivated to use an additional length of antenna or separate antenna for the Z_2 impedance in Boyer because it would have provided known advantages. For example, it would have increased the amount of the RF signal that could be received, thereby increasing power harvesting at the RFID tag. RFID Handbook, 119 (discussing radar cross-section and power density). Moreover, an additional antenna loop/separate antenna would have been relatively simple to manufacture on an RFID, since the main antenna components would also have to be fabricated at the same time. Ex-1003, ¶237.

Further, as taught by Waldner, using antenna loops or a separate antenna would have provided a level fidelity for tuning the impedances to optimize the performance (as taught by Boyer's Figure 8) that a capacitive or resistive load alone may not have provided. Therefore, using Waldner's switchable antenna loops in

place of Boyer's generic switchable Z_2 impedance would have constituted "applying a known technique to a known device ready for improvement to yield predictable results." *KSR*, 550 U.S. at 415-421; Ex-1003, ¶238.

A POSITA would also have known that using antenna/antenna loops would have provided the benefit of changing both the real and imaginary components of the antenna reflectance, since they typically comprise both an inductance and resistance as shown by their equivalent circuits. Ex-1023, 119 (Figure 4.65). Boyer teaches that "switching between symbols [corresponding to impedances] by changing *only the real* component of η tends to be less efficient in terms of power harvesting than changing the imaginary component of η ." Ex-1005, 774. Therefore, using an antenna or antenna loop is an efficient means by which additional design freedom is provided—*i.e.*, the ability to vary both resistance and reactance of the antenna. Ex-1003, ¶¶239-240.

Finally, a POSITA would have found it obvious to try implementing an additional loop of antenna (or a sperate antenna) as taught by Waldner as the switchable Z_2 impedance in Boyer. There are only a finite number of ways to achieve these different results, and one way is conductive traces that form antennas. Ex-1003, ¶241.

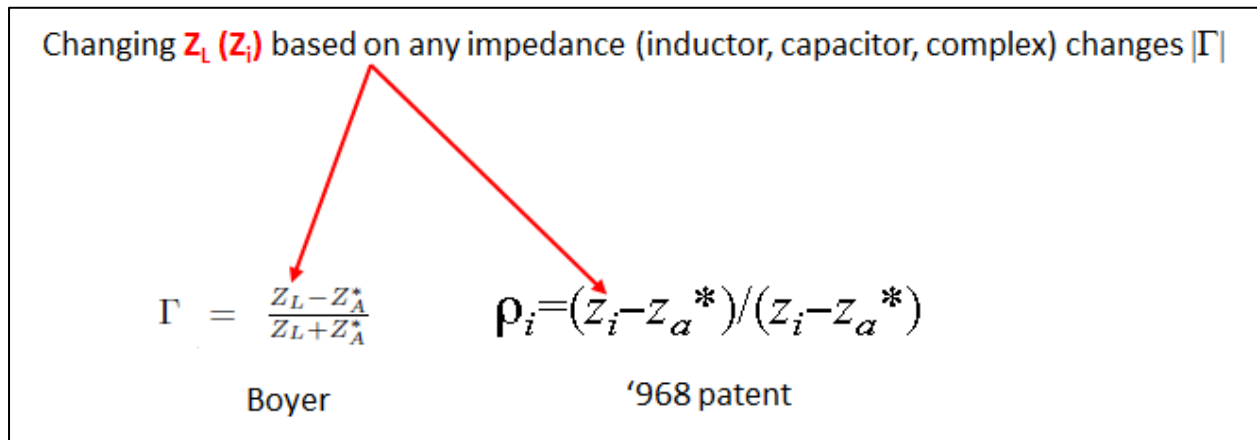
C. Using separate antenna lengths as the modulation impedance (Z_{mod}) does not affect the reflection property claim terms

The claims recite various reflectance properties “*of*” or “*by*” the “*main antenna*.” Although the analysis for Ground 1 used as an example a capacitor (C_{mod}) as the modulation impedance, the analysis is the same if a length of antenna is connected/disconnected to the antenna (as taught in Waldner) to modulate the signal.¹³

In the combined system for Ground 2, Z_2 is Waldner’s separate length of antenna. The equations analyzing the reflective properties “*of/by the antenna*” are all agnostic as to the specifics of the impedance used—including where or how it is connected to the antenna—as are Boyer’s and Dobkin’s teachings of power harvesting throughout the backscatter communication. Ex-1003, ¶¶242-243.

As to terms 1) “*reflection coefficient*” [11B.1]/[1D]/[6B]; 2) “*amount of reflectance*” [11B]/[1D]/[6B]; and 3) “*reflectance*” [11C.1]/[1D]/[6C], those values are all provided by the reflection coefficient equation (or at the very least are proportional to it):

¹³ A POSTIA would have understood an antenna length will have a reactive impedance (inductance) and perhaps a resistive component. Ex-1003, ¶¶242.



Thus, since $Z_{\text{mod}} = Z_2$ has an inductive value (or is complex), the reflection coefficient $|\Gamma_2|$ will be different than $|\Gamma_1|$ (which remains 0 for the matched condition in Boyer), since $|\Gamma_2|$ is **between** 0 and 1 (*i.e.*, no short circuit).

Similarly, for “*resonant frequency*” [11C.3]/[1G]/[6C], that value is provided by the equation below, which changes regardless of whether Z_2 is a capacitive, inductive, or complex impedance (*e.g.*, Waldner’s antenna lengths), as any reactive load will change the L or C values. This will in turn change the reflection properties:

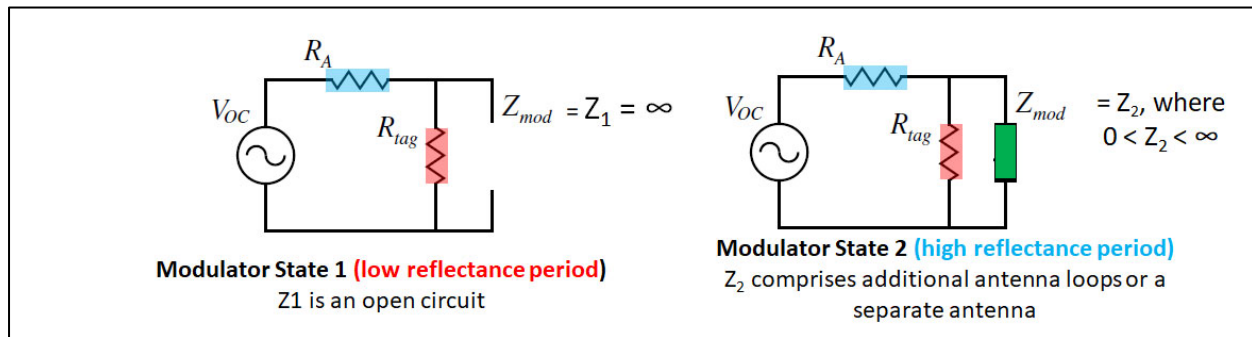
$$f_{\text{res}} = \frac{1}{2\pi\sqrt{LC}}$$

The remaining analysis is equally applicable since none of claims 11-12, 16-20 (or as shown below, claims 6-10) have limitations that depend on the type of reactive modulation impedance used nor the location of the switch that modulates the signal (so long as it connects to the antenna). Ex-1003, ¶¶242-247.

D. Claim 13 was obvious

Claim 13 further requires “*the circuit adds a separate length of antenna to the main antenna during the first reflectance period.*”

In the combined system, impedance Z_2 comprises Waldner’s “additional loops of antenna 42” or “completely separate antennas,” either of which is a “*separate length of antenna.*” Waldner, ¶38. Thus, as explained for claim 16, the circuit (Boyer’s IC with microcontroller) controls the switch between impedances Z_1 and Z_2 to add the “*separate lengths of antennas*” (as taught by Waldner). When Z_2 is connected, that is the **first (high) reflectance period**. Ex-1003, ¶¶248-249.



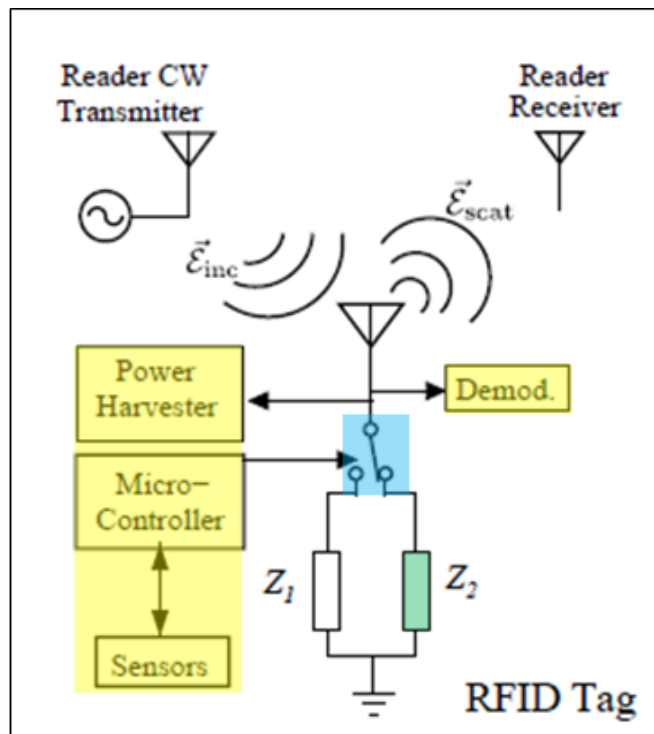
Boyer, Figure 6 (further modified to show Z_2 as antenna loops/separate antenna).

E. Claim 14 was obvious

The combined system discloses “*a switch that adds the separate length of antenna by connecting the separate length of antenna to the main antenna during the first reflectance period*” [14A].

As discussed above for claim 16, Boyer discloses *a switch* (i.e., the switch

shown in Figure 2 in blue below) that is “controlled by the circuit that connects an RF impedance to the main antenna during the first reflectance period” (i.e., the switch is controlled by the IC via microcontroller and “switches the backscatter modulator between two impedance states Z_1 and Z_2 ”).



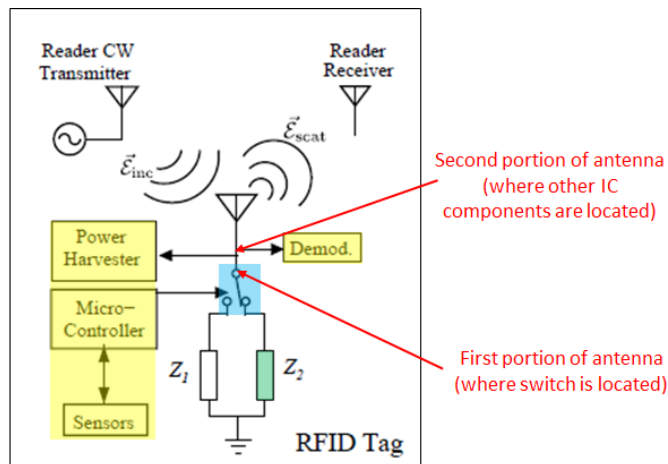
Boyer, Figure 2.

Moreover, as explained for claim 13, in the combined system, the impedance Z_2 (shown in green above) comprises either additional loops of antenna or a separate antenna (either of which would comprise a “*separate length of antenna*”) as taught by Waldner, and the switch connects Z_2 to the main antenna during the *first reflectance period*—i.e., during the high period of the backscatter modulation. Ex-

1003, ¶¶250-252.

The combined system also discloses “*the switch being located on a first portion of the main antenna and the circuit being located on a second portion of the main antenna, wherein the first portion of the main antenna is different than the second portion of the main antenna*” [14B].¹⁴

First, Boyer discloses that its IC includes additional components—such as power harvester (“rectifier”), sensors, and demodulator—that are connected to the antenna in different locations (and hence different “portions”) than the switch (which is controlled by the microcontroller):

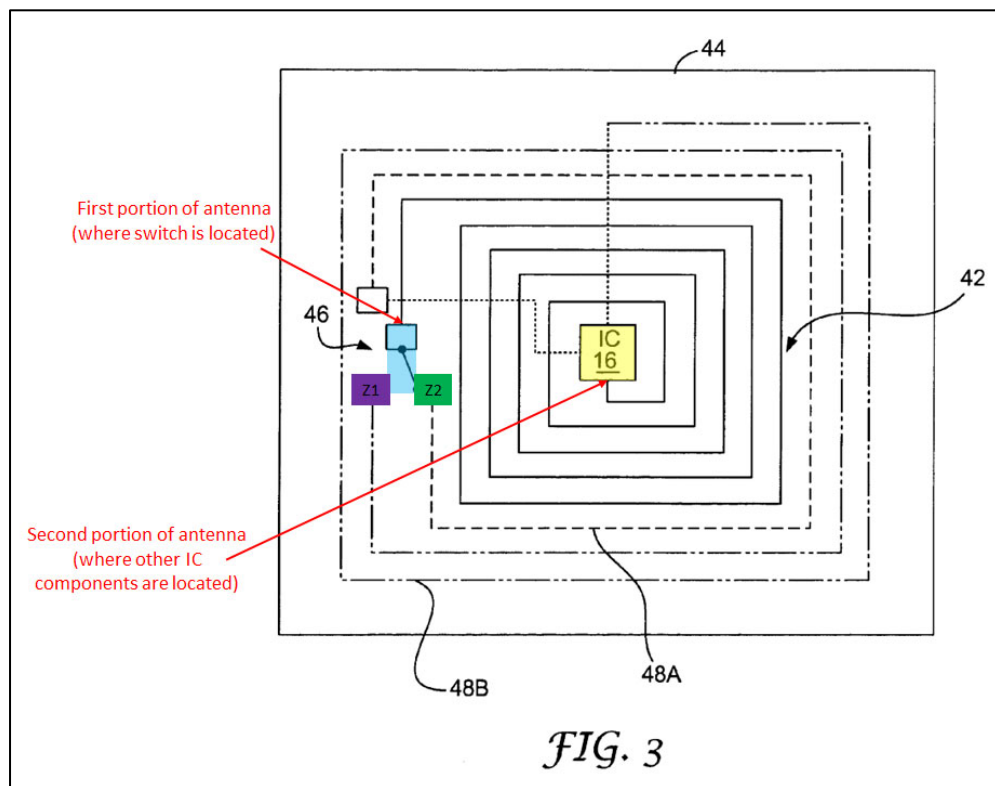


Boyer, 770.

¹⁴ Petitioner reserves the right to argue that this claim limitation is indefinite because the term “located on” is ambiguous.

Indeed, a POSITA would have understood that Boyer's rectifier circuit (*i.e.*, part of the power harvester) would have a separate connection to the antenna because it needs to operate in both the active and idle state for the RFID to harvest power. At the very least it would have been obvious based on the teachings in Boyer's Figure 2. *Id.*, 770; Ex-1003, ¶¶253-254.

Second, Waldner expressly teaches how to implement its variable load impedances comprising additional loops of antenna/separate antenna in Figure 3, reproduced below. As shown, Waldner's IC 16 (yellow) is connected to a second portion of the antenna, and the switch (blue) that connects additional loops (Z_2 , green) is connected to a first portion of the antenna.



Waldner Figure 3.

For the same reasons explained above for why a POSITA would have been motivated to implement Waldner's antenna impedances into Boyer's modulator (Z_2) impedances, a POSITA would have been equally motivated to implement those impedance in the same way taught by Waldner. Ex-1003, ¶¶255-256. Indeed, depending on the length of the separate antenna, a POSITA would have found Waldner's layout an efficient means of utilizing the substrate space available. And a POSITA would have known that the IC would still be capable of controlling the switch to modulate the signal.

In the alternative, it would have been obvious in the combined system of Boyer in view of Waldner to connect the IC and switch to different portions of the main antenna. First, it would have been a simple design choice since 1) the IC in Boyer's RFID passive tag must be connected to the antenna somewhere so that it can harvest power and demodulate the incoming signal. Second, it would have been obvious to try since there are only two options: connect at the same or to different portions of the main antenna. *KSR*, 550 U.S. at 415-421. Ex-1003, ¶257.

F. Claim 15 was obvious

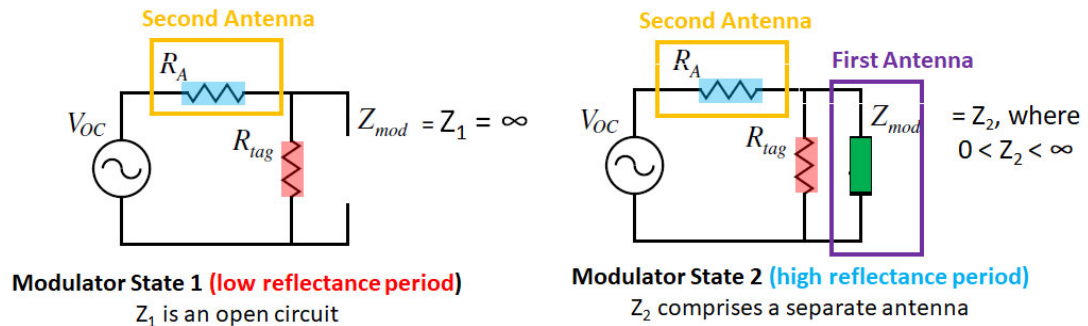
The combined RFID tag renders obvious "*the main antenna includes a first antenna for receiving the RF signal, and a second antenna for receiving power, and the second antenna continues to absorb a portion of the RF signal during the first*

reflectance period and the *second reflectance period* to generate a low reflectance to enable wireless power harvesting during both the *first reflectance period* and the *second reflectance period*” in at least two ways.

1. Main Antenna Interpretation

First, the main antenna and Waldner’s additional length of antenna (or separate antenna) for Z_2 represent the first and second antennas.

The “*second antenna*” is the portion of the main antenna corresponding to the impedance (R_A , shown in blue below) in the combined system that remains connected to the chip in both the *second* (low) and *first* (high) reflectance periods.



The “*second antenna*” in the combined system is shown in Figure 3 of Waldner (blue):

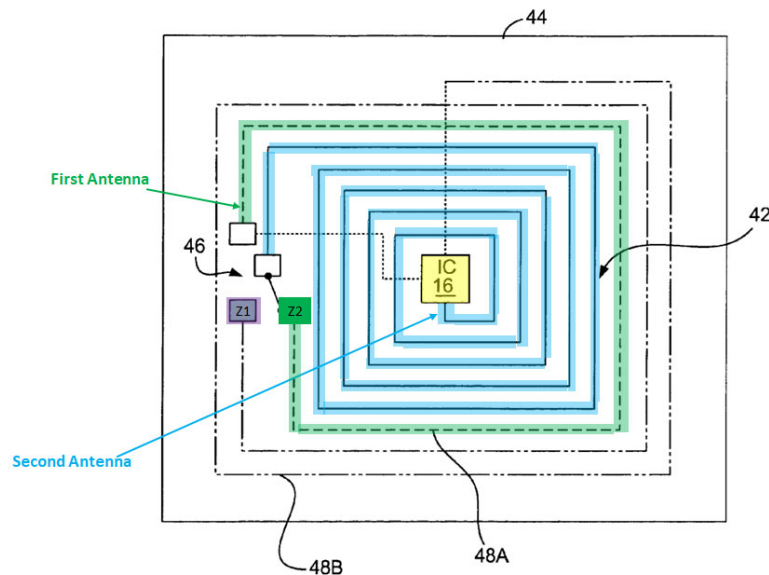
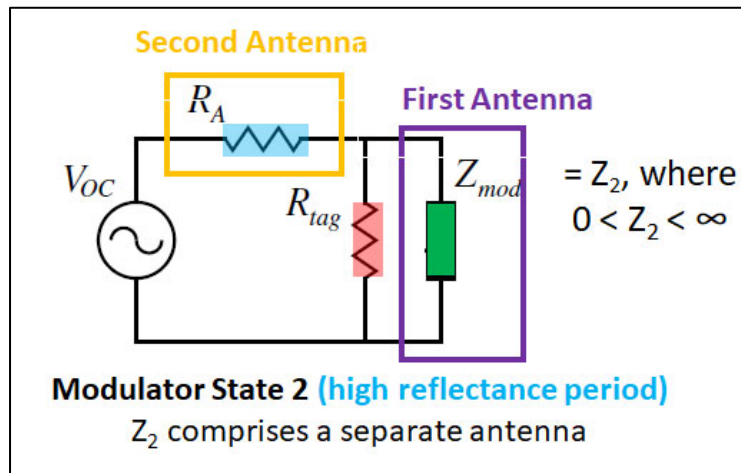


FIG. 3

As explained for claim [11C], Boyer harvests power in both the *high* and *low* periods of the backscatter signal, and this portion of the tag antenna continues to receive the reader RF signal (whether or not connected to Z_2). Ex-1003, ¶¶259-262.

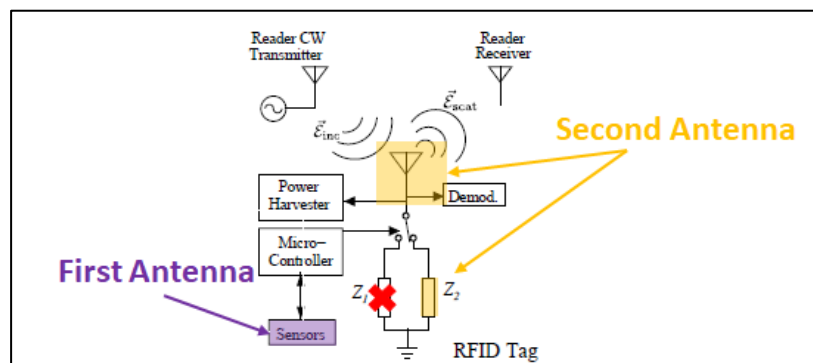
The “*first antenna*” of the “*main antenna*” is at least Waldner’s separate antenna providing the modulation impedance Z_2 , shown in green above. That separate antenna, Z_2 , “*receiv[es] the RF signal*” at least when connected to the main antenna during the *first (high)* reflectance period, and reflects a portion of the RF signal back while absorbing the remaining portion of RF signal for harvesting.



Ex-1003, ¶¶263.

2. Sensor Alternative

In the alternative, Boyer's "sensors" in Figure 2 are modified to include the "sensing" antenna in Waldner. Ex. 1006, Abstract ("The RFID tag may include a sensing circuit that determines when to selectively couple the electrical element to the main antenna to adjust the resonant frequency of the main antenna"); Figure 1 (element 20).



Boyer, Figure 2 (modified to show Z_1 is an open circuit; labels for antennas)

Such a modification to Boyer would have been obvious because Boyer is

agnostic about the sensors that may be included. A POSITA would therefore have included any useful and well-known sensors, including Waldner's sensing antenna, which can be used to determine if there is interference, enable the tag to make any necessary adjustments to RF signals in its environment, or find a different frequency to use (if multiple frequencies are in use). Ex-1006, ¶ 25 ("sensing antenna 20 may be viewed as determining or sensing whether there is tag-to-tag coupling.") In addition to using the sensing antenna to potentially tune the antenna as Waldner teaches, a POSTIA would have known that it could be used for other purposes, such as to detect movement relative to the reader or measure signal strength. This would have constituted use of a known technique to improve similar devices in the same way and/or applying a known technique to a known device ready for improvement to yield predictable results. *KSR*, 550 U.S. at 415-421; Ex-1003, ¶¶264-265.

The "*first antenna*" is "*for receiving the RF signal.*" Waldner explains that "sensing antenna 20 may be tuned to the operating frequency of the RFID system." Ex. 1006, ¶ 25

The "*second antenna*" is the combination of the main antenna and the modulation impedance (Z_2), which combined both receive the reader signal and harvest power in both states (*i.e.*, when Z_2 is connected and disconnected). *See* claim [11C.1]-[11C.3]; Ex-1003, ¶¶266-267.

G. Claim 1 was obvious

Claim 1 includes limitations that are substantively the same as claims 11, 13, and 14. Ex-1003, ¶268. The same support and arguments set forth above apply to each of these claim limitations. The section below will address any differences in the claims.¹⁵

1. Limitation [1P]

For limitation [1P], the analysis for limitation [11P] applies.

1. Limitation [1A]

For limitation [1A], the analysis for limitation [11A] applies.

2. Limitation [1B]

For limitation [1B], the analysis for claim 14 applies. Ex-1003, ¶271.

3. Limitation [1C]

For limitation [1C], the analysis for claim 14 applies, where a circuit that is “*located on*” a portion of the main antenna is also “*connected to*” that portion.

¹⁵ See Appendix 1 for a listing of claims providing the identifiers for the corresponding claim language.

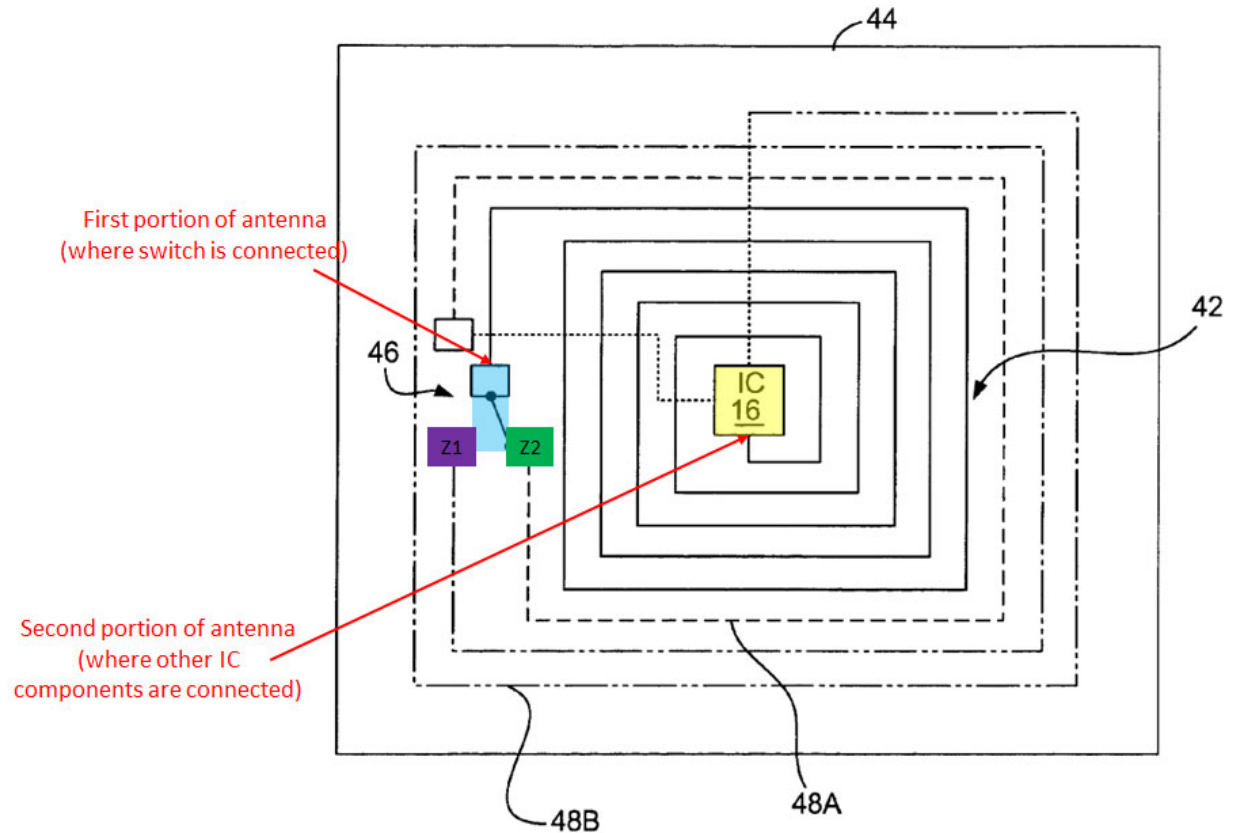
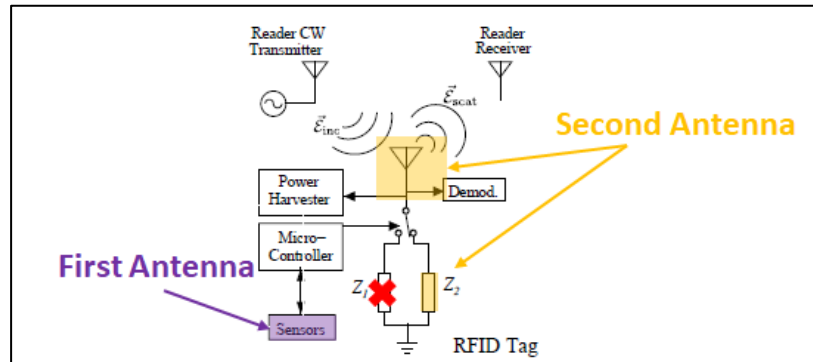


FIG. 3

Waldner, Figure 3 (annotated)

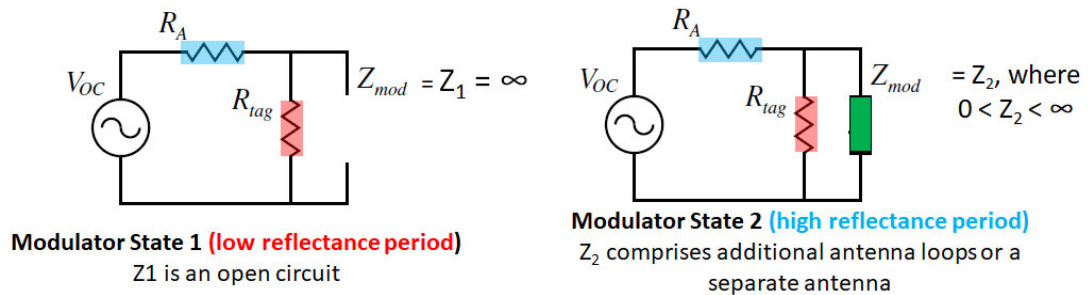
Separately, the analysis for claim 15 applies, where the combined system has a main antenna with a “*first*” and “*second*” antenna, including for example, Waldner’s sensory antenna as one of Boyer’s “sensors.” A POSITA would have understood that the IC would have had a separate connection to the sensory antenna (as well as any other sensors as shown in Figure 2).



Boyer, Figure 2 (modified to show Z_1 is an open circuit); Ex-1003, ¶¶272-274.

4. Limitation [1D]

For limitation [1D], the analyses of limitation [11B.1]-[11B.2], [11C.1]-[11C.2], and claim 17 apply, where 1) the **second reflectance period**—when Z_1 (an open circuit) is connected—is the **low reflectance period** because it is the “matched” condition and $|\Gamma_1| = 0$, and 2) the **first reflectance period**—when Z_2 , which has an impedance **between** an open and short circuit, is connected—is the **high reflectance period** because that is when $|\Gamma_2|$ is greater than 0 but less than 1. Ex-1003 ¶¶275-279.



Boyer, Figure 6 (modified to show Z_2 as antenna loops/separate antenna)

5. Limitation [1E]

For limitation [1E], the analysis for claim 16 (Boyer’s “*switch controlled by the circuit...*”), as well as limitation [1B] and claim 13 (adding “*separate length of antenna*”) apply.

The switching that connects Z_2 (Waldner’s length of antenna) to the main antenna is “*intermittent*” at least because the switch (controlled by the IC) connects and disconnects Z_2 to modulate the signal—*i.e.*, to create the first (high) and second (low) reflectance periods—in accordance with the data and modulating schemes, neither of which will be regular nor continuous. Ex-1003 ¶¶280-282.

6. Limitation [1F]

For limitation [1F], the analysis for limitation [11C.3] and claims 12, 13, and 16 apply.

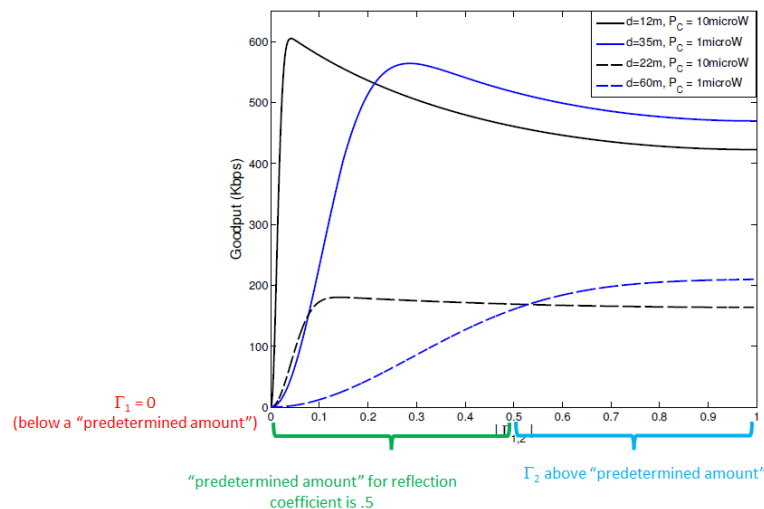
7. Limitation [1G]

For limitation [1G], this limitation is substantively identical to claim limitation [11C] addressed above, where the “*first reflectance period*” is the “*high reflectance period*”—*i.e.*, the period when the switch connects the impedance Z_2 , and the main antenna has reflectance Γ_2 . Ex-1003 ¶286.

H. Claim 2 was obvious

For claim 2, the analysis for limitation [1D] and claim 17 applies. Although claim 17 did not specify the “*predetermined amount*,” Boyer discloses that Z_2

(connected in the *high reflectance period*) can have a reflectance magnitude $|\Gamma_2|$ anywhere between 0 and 1, which a POSITA would have understood includes values equal to or greater than .5. Since Γ_1 (when Z_1 is connected during the *low reflectance period*) is 0, it will be lower than any “predetermined amount” in that range. And as explained for limitation [11C.1], the fact that the impedance is reactive (here inductive rather than capacitive) does not change the analysis because it will still have a non-zero magnitude.

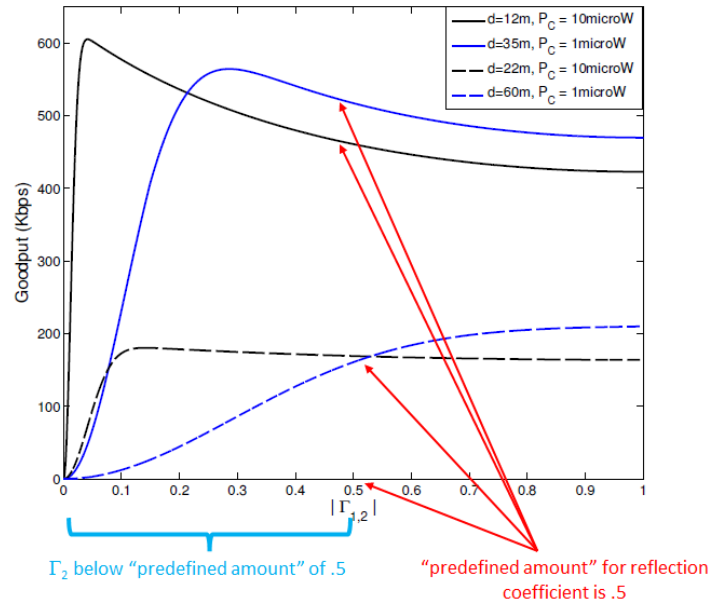


Boyer, 776; Ex-1003, ¶287.

I. Claim 3 was obvious

For claim 3, the analysis for limitations [11C.1] and [11C.2] applies. Boyer also discloses or at least renders obvious this limitation since $|\Gamma_2|$ can be varied between 0 and 1. Therefore, as shown in Figure 8, there are instances when $|\Gamma_2|$ is

below .5:¹⁶



Boyer, 776; Ex-1003 ¶288.

J. Claim 4 was obvious

For claim 4, the analysis for claim 19 applies.

K. Claim 5 was obvious

For claim 5, the analysis for claim 20 applies.

L. Claims 11-12, 16-20 were obvious

Although as shown above in Section VI, claims 11-12 and 16-20 are rendered obvious over Boyer in view of RF Handbook alone, to the extent Patent Owner

¹⁶ As explained above, in this embodiment, $|\Gamma_{1,2}|$ is equal to $|\Gamma_2|$.

argues that these claims require that a separate length of antenna must be used to vary the “*reflection coefficient*” [11B.1]/[1D]/[6B]; 2) “*amount of reflectance*” [11B]/[1D]/[6B]; 3) “*reflectance*” [11C.1]/[1D]/[6C], and/or 4) “*resonant frequency*” [11C.3]/[1G]/[6C] “*of/by the “main antenna,”*” then those claims would have been obvious in the combined system (Boyer in view of RFI Handbook, in further view of Waldner) as described above for Claims 1-5 and 13-15. As explained above in Section VII.A-VII.C, Z_2 is Waldner’s separate antenna or separate length of antenna, and the analysis of these reflection properties is the same regardless of the reactive (or complex) value of the impedance.

VIII. GROUND 3: Claims 6-10 are obvious over the Boyer in view of RFID

Handbook in further view of Kapucu.

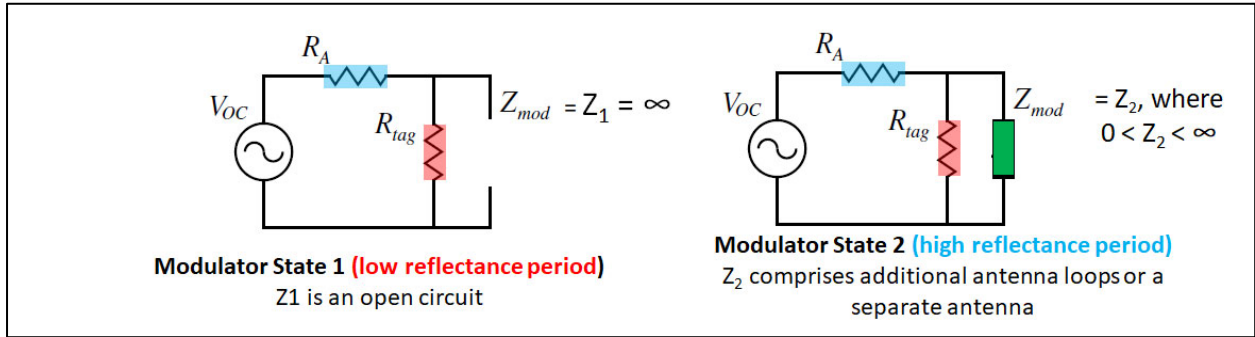
A. Limitations [6P]-[6C] and claim 7 are substantially similar to prior analysis.

As shown in the chart below, limitations [6P]-[6C] and claim 7 are substantially the same as claims 2, 3, 11, and 17 with only minor differences highlighted and discussed below. Therefore, Petitioner incorporates and applies the analysis of those prior limitations for these claims.

Claims 6 and 7 ¹⁷	Claim Limitations Analysis Incorporated by Reference
[6P]	11[pre]; 1[pre]
[6A]	11[A]/1[pre]
[6B]	11[B]/[1D] Claim 17
[6C]	11[C]/[1G]
[6D]	See below
Claim 7	Claim 2

For limitations [6B]-[6C], the limitations recite “high” and “low” rather than “first” and “second” reflectance periods. However, the *second reflectance period*, when Z_1 (an open circuit) is connected, is the *low reflectance period* because it is the “matched” condition and Γ_1 is 0, and the *first reflectance period*, when Z_2 (which has an impedance *between* an open and short circuit) is connected, is the *high reflectance period* because Γ_2 is greater than 0. See limitations [11C.1]-[11C.3]/[1G]; Ex-1003, ¶292.

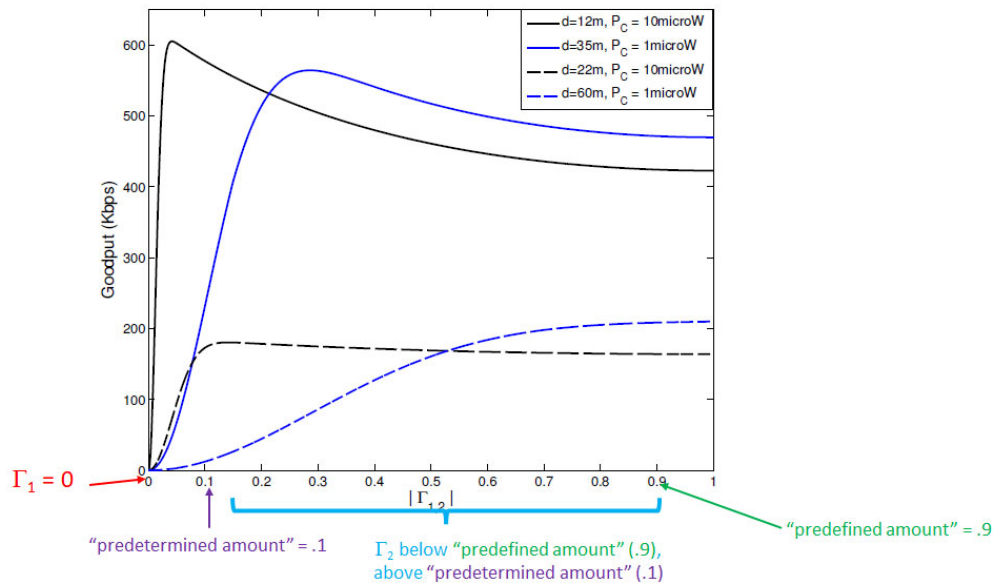
¹⁷ See Appendix 1 for a listing of claims providing the identifiers for the corresponding claim language.



Boyer, Figure 6 (further modified to show Z_2 as antenna loops/separate antenna).

Limitation [6C] recites “*during the high reflectance period.*” However, the analysis in [11C.1]-[11C.3] applies since the “*reflectance*” $|\Gamma_2|$ is the antenna reflection coefficient (or proportional to it) throughout (“*during*”) the **first (high)** reflectance period.

In addition, the combination of [6B] and [6C] requires $|\Gamma_2|$ greater than a “*predetermined amount*” but below a “*predefined amount,*” and $|\Gamma_1|$ to be below the “*predetermined amount.*” As explained above, a POSITA would have chosen any suitable value of Γ_2 for their system, which a POSITA would have met the “*predefined*” and “*predetermined*” limitations, such as the following example where the “*predetermined amount*” is .1 and the “*predefined amount*” is .9:



Ex-1003, ¶294.

Finally, for claim 7, the “*predetermined amount*” is a reflection coefficient magnitude of between “0.25 and 1.” Claim 2 required an amount “*between 0 and .5.*” However, the same analysis applies since Boyer in view of RFID Handbook discloses $|\Gamma_2|$ can have a value between 0 and 1. Moreover, the ranges between claims 2 and 7 overlap between .25 and .5. Ex-1003, 295.

B. Limitation [6D] and claim 8 (Duty Cycle)

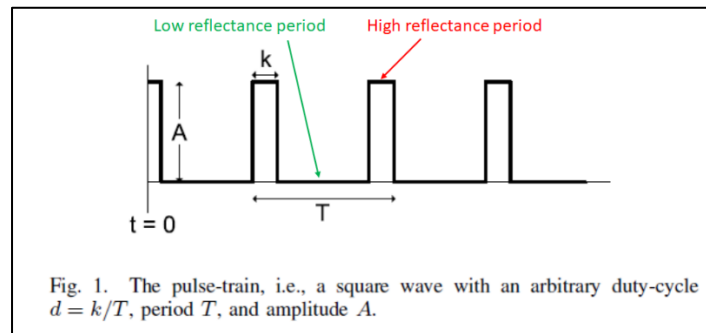
Limitation [6D] recites “*wherein the circuit increases a duty cycle of the low reflectance periods and decreases a duty cycle of the high reflectance periods to increase a time period of wireless power transmission.*” Claim 8 further recites “*wherein the circuit increases the duty cycle of the low reflectance periods to greater*

than 50%.” As explained below, these claims are obvious over Boyer in view of RFID Handbook in further view of Kapucu.

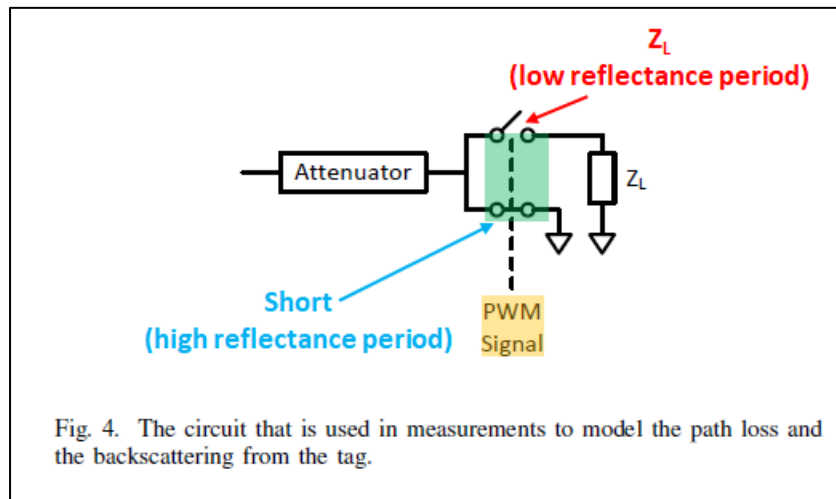
1. The combined system

While Boyer does not expressly discuss the duty cycles of the high and low reflectance periods in the binary modulator, Kapucu discloses a “passive UHF RFID tags that use pulse-width modulation (PWM) in backscattering communication.” Ex-1009, 1 (Abstract). It would have been obvious to modify Boyer to include this feature.

Kapucu describes RFID tags that have a “phase-locked loop (PLL) based sensor interface” to work “with capacitive sensors to reduce the power consumption of the tags.” *Id.* The “output of the sensor interface is a pulse train whose duty cycle is proportional to the variation in the sensor capacitance value” and the “pulse train signal controls the backscattering switches that short the antenna terminals.” *Id.* “This way the sensor value information is pulse-width modulated and sent to the base station (reader) by backscattering.” *Id.* Kapucu shows an example of a pulse-train that has an “arbitrary duty-cycle,” but that still shows that the high reflectance period is shorter than the low reflectance period. *Id.* at 2.

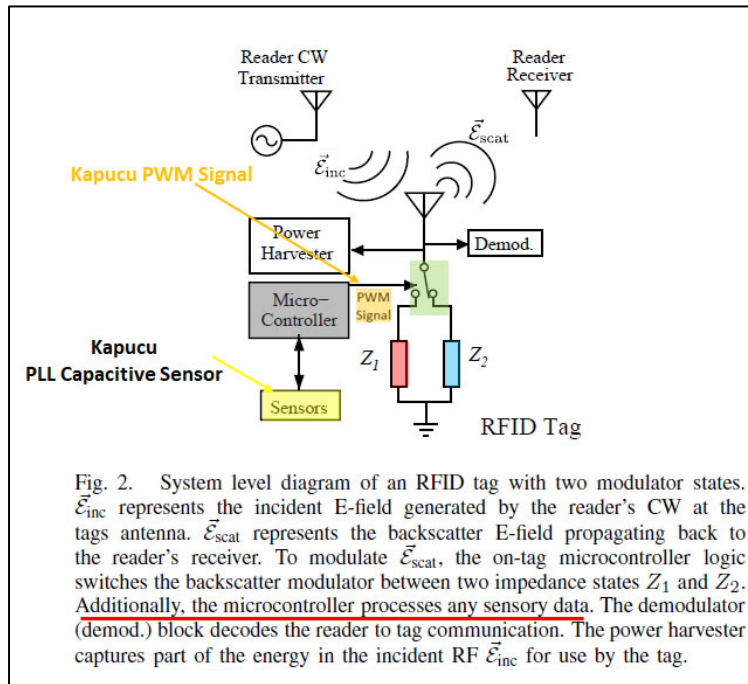


Kapucu further teaches how the PWM RFID tag operates using a model of the behavior. “The PWM signal from the waveform generator”—which models the signals received from capacitor sensors—“controls the RF switch, which changes the load seen by the cable between short circuit and the impedance Z_L .” *Id.* at 4. This concept is illustrated in the model circuit shown in Figure 4, with a binary modulation switch (green) just as in Boyer:



In the modified system, Kapucu’s capacitive sensors are used as Boyer’s “sensors” (shown in yellow in Figure 2 below), and Kapucu’s PLL interface is used along with the microcontroller (grey) to control the binary modulator switch (green)

between impedances (Z_1 and Z_2) based on the pulse train (PWM, orange) to create the PWM backscattered signals, as taught by Kapucu.



Ex-1003, ¶¶297-300.

2. Motivation to use Kapucu's PWM

A POSITA would have been motivated to modify Boyer's RFID tag having a reactive impedance (C_{mod}) as taught RFID Handbook with Kapucu's teachings of PWM of the backscatter communications—including its PLL-based capacitive sensor interface—at least for use with capacitive sensors.

First, Kapucu motivates the combination by explaining the benefits of integrating PLL sensors into RFID tags like Boyer. Kapucu explains that “integration of sensors with passive UHF RFID tags extends the application of RFID

technology” Kapucu, 1. Thus, modifying Boyer’s RFID tag would have enabled it to operate in these fields and have wider applicability, including with different types of sensors. Ex-1003, ¶¶301-302.

In addition, Kapucu explains that “phase-locked loop (PLL) based sensor interfaces can be used in RFID tags with capacitive sensors to *reduce* the power consumption of the tags.” Kapucu, 1. Boyer teaches that power was a limiting factor in RFID performance. Thus, a POSITA would have been motivated to include additional techniques that would have reduced power consumption to further improve the RFID performance. Ex-1003, ¶303.

Second, Boyer is already capable of, and configured to, work with Kapucu’s components and teachings. For example, Boyer includes “sensors,” a microcontroller to process sensor data, and a “switch” used to modulate the backscattered signal. And like Kapucu, Boyer’s RFID backscattering is achieved by varying the load impedance on the antenna. Thus, this modification would have resulted in an RFID tag that would function in the same way, although improved with Kapucu’s lower power and PLL sensors, and would therefore have constituted use of a known technique to improve similar devices in the same way and/or applying a known technique to a known device ready for improvement to yield predictable results. *KSR*, 550 U.S., 415-421; Ex-1003, ¶304.

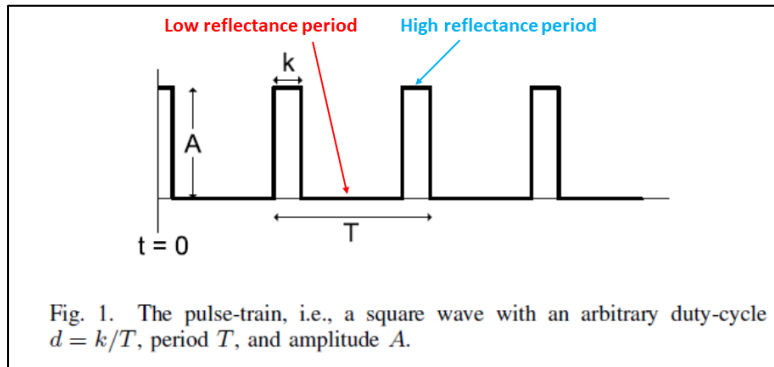
3. Claims 6 and 8 were obvious.

Limitation [6D] requires “*wherein the circuit increases a duty cycle of the low reflectance periods and decreases a duty cycle of the high reflectance periods to increase a time period of wireless power transmission.*” Claim 8 requires “*the duty cycle of the low reflectance periods to greater than 50%.*”

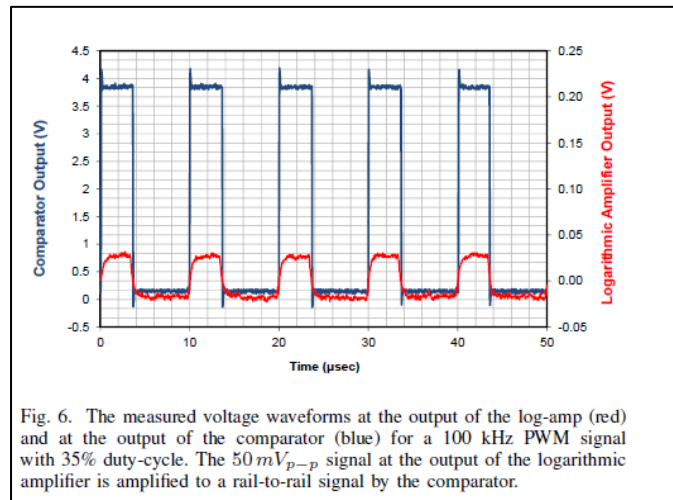
In the combined system, the duty cycle for the **high** and **low** reflectance periods are varied based on the sensor data as taught by Kapucu. Specifically, “the output of the sensor interface is a pulse train whose duty cycle is proportional to the variation in the sensor capacitance value.” *Id.* “The pulse train signal controls the backscattering switches that short the antenna terminals. This way the sensor value information is pulse-width modulated and sent to the base station (reader) by backscattering.” *Id.*¹⁸

Kapucu shows that the duty cycle of the **high reflectance period** is decreased, resulting in a duty cycle of greater than 50% for the **low reflectance period**:

¹⁸ Although Kapucu shorts the antenna, as explained above, Boyer and the general knowledge in the field (Ex-1021, 214-218) would have motivated a POSITA to use modulating impedance Z_2 (e.g., capacitor C_{mod}).



Kapucu further discloses how the PWM varies the duty cycle: “The duty-cycle of the PWM signal controlling the RF switch is swept from 20% to 80%” *Id.*, 4. Figure 6 shows an example of the “voltage waveforms recorded during the measurements for a 100 kHz PWM signal with **35% duty cycle.**” *Id.* A POSITA would have therefore understood that the duty cycle could be any value within the modeled range—*i.e.*, between 20% and 80%—and that 35% is an example.



Ex-1003, ¶¶305-308.

Moreover, to the extent Patent Owner argues that that duty cycle must be

increased “*to increase a time period of wireless power transmission*”—*i.e.*, that this limitation is more than an intended use or outcome—that is disclosed in the combined system. Boyer teaches the **low reflectance period** (matched state) harvests more power than the **high reflectance period** and hence a system in which the duty cycle of the low reflectance period is longer increases power harvesting and hence the time of “*power transmission.*” See limitation [11C.2]; Ex-1003, ¶¶309-310.

C. Claim 9 was obvious

See claim 19 above.

D. Claim 10 was obvious

See claim 20 above.

IX. GROUND 4: Claims 6-10 are obvious over Boyer in view of RFID

Handbook, Kapucu, and Waldner under 35 U.S.C. §103.

Although as shown above in Section VIII, claims 6-10 are rendered obvious over Boyer in view of RF Handbook and Kapucu, to the extent Patent Owner argues that these claims require that a separate antenna or separate length of antenna must be used to vary the “*reflection coefficient*” [11B.1]/[1D]/[6B]; 2) “*amount of reflectance*” [11B]/[1D]/[6B]; 3) “*reflectance*” [11C.1]/[1D]/[6C], and 4) “*resonant frequency*” [11C.3]/[1G]/[6C] of/by the “*main antenna,*” then those claims would

have been obvious in the combined system (Boyer in view of RFI Handbook and Kapucu, in further view of Waldner). As explained above in Section VII.A – VII.C, Z_2 is Waldner's separate length of antenna, and the analysis of these reflectance properties is the same regardless of the reactive (or complex) value of the impedance. Ex-1003, ¶313.

X. The Board Should Not Exercise Discretion to Deny Institution

A. Fintiv Favors Institution

Patent Owner asserts the '968 patent against Petitioner TransCore. *Hand Held Products, Inc. v. TransCore, LP*, 1-23-cv-00686 (DDE).

Factor 1 (neutral): a stay is neither requested nor granted.

Factors 2-4 (against): there is no scheduling order and no trial date set. The parties have not engaged in discovery, served contentions, or claim construction. Until a pending motion is resolved, no schedule will be entered. Moreover, only claim 11 is asserted in the related litigation, whereas Petitioner challenges all claims.

Factor 5 (slightly for): Petitioner is the defendant in the related litigation.

Factor 6 (against): Petitioner presents strong grounds for invalidity.

B. The Becton, Dickinson Factors Favor Institution

None of the references relied on were previously applied, nor are they cumulative to those used during prosecution.

XI. CONCLUSION

Petitioner requests the Board institute *inter partes* review and cancel each challenged claim.

Respectfully submitted,

KING & SPALDING LLP

By: /s/ Dara M. Kurlancheek
Dara M. Kurlancheek, Reg. No. 69,815
Zachary Coots, *pro hac vice to be
submitted*

Counsel for Petitioner

XII. MANDATORY NOTICES

A. Real Parties-in-Interest Under 37 C.F.R. § 42.8(b)(1)

The real parties-in-interest are TransCore, LP and TransCore Holdings, Inc.

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

To the best of Petitioners' knowledge, the '968 patent is, or has been, involved in one district court litigation: *Hand Held Products, Inc. v. TransCore, LP*, 1-23-cv-00686 (DDE).

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

Lead Counsel	Back-up Counsel
Dara M. Kurlancheek, Reg. No. 69,815 KING & SPALDING LLP 1700 Pennsylvania Avenue NW Suite 900 Washington, D.C. 20006 (202) 626-5590 dkurlancheek@kslaw.com	Zachary Coots (<i>pro hac vice</i> to be filed) KING & SPALDING LLP 1700 Pennsylvania Avenue NW Suite 900 Washington, D.C. 20006 (202) 394-4483 zcoots@kslaw.com

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

Please address all correspondence to counsel at the addresses above.
Petitioners consent to service by email at the above email addresses.

CERTIFICATION OF WORD COUNT

The undersigned certifies pursuant to 37 C.F.R. §42.24 that the foregoing
Petition for *Inter Partes* Review, excluding any table of contents, mandatory
notices under 37 C.F.R. §42.8, certificates of service or word count, or appendix of
exhibits, contains 13,770 words according to the word-processing program used to
prepare this document (Microsoft Word).

Dated: May 31, 2024

Respectfully submitted,

By: /s/ Dara M. Kurlancheek
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1700 Pennsylvania Avenue NW
Suite 200
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(202) 626-5590

Counsel for Petitioner

CERTIFICATE OF SERVICE

Pursuant to 37 C.F.R. §§ 42.6(e) and 42.105(b), the undersigned certifies that on May 31, 2024, a complete and entire copy of this Petition for *Inter Partes* Review and Exhibits were provided overnight mail to counsel for Patent Owner by serving copies to the address below for the '968 patent:

Douglas L. Sawyer, Esq.
Mark T. Smith, Esq.
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Respectfully submitted,

By: /s/ Dara M. Kurlancheek
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Counsel for Petitioner

Appendix 1

Listing of Independent Claims

Claim 1	Limitation
[1P]	A radio-frequency identification (RFID) tag comprising:
[1A]	a main antenna that receives a radio-frequency (RF) signal from an RFID reader and wirelessly harvests power from the RF signal;
[1B]	a switch connected to a first portion of the main antenna and a separate length of antenna; and
[1C]	a circuit connected to a second portion of the main antenna, wherein the second portion of the main antenna is different than the first portion of the main antenna, the circuit being configured to:
[1D]	vary a reflection coefficient of the main antenna to transmit a reflected signal to the RFID reader, the reflected signal having high reflectance periods when an amount of reflectance by the main antenna of the RF signal is greater than a predetermined amount, and low reflectance periods when an amount of reflectance by the main antenna of the RF signal is lower than the predetermined amount;
[1E]	control the switch to intermittently connect the separate length of antenna to the main antenna;
[1F]	change a resonant frequency of the main antenna, based on the controlled switching, to generate a high reflectance period and a low reflectance period; and
[1G]	reduce a reflectance of the main antenna below a predefined amount during the high reflectance period without shorting the main antenna to enable the main antenna for continuous wireless power harvesting while transmitting the reflected signal to the RFID reader, wherein the reflectance of the main antenna during the high reflectance period is reduced based on the change in the resonant frequency of the main antenna.

2. The RFID tag of claim 1, wherein the predetermined amount is a reflection coefficient magnitude of between 0 and 0.5.

3. The RFID tag of claim 1, wherein the predefined amount is a reflection coefficient magnitude of 0.5.

4. The RFID tag of claim 1, wherein the circuit is an application-specific integrated circuit (ASIC).

5. The RFID tag of claim 1, wherein the main antenna is a linearly polarized antenna.

Claim 6	Limitation
[1P]	A radio-frequency identification (RFID) tag comprising:
[1A]	a main antenna that receives a radio-frequency (RF) signal from an RFID reader and wirelessly harvests power from the RF signal; and
[1B]	a circuit that is configured to vary a reflection coefficient of the main antenna to transmit a reflected signal to the RFID reader, the reflected signal having a high reflectance period when an amount of reflectance by the main antenna of the RF signal is greater than a predetermined amount, and a low reflectance period when an amount of reflectance by the main antenna of the RF signal is lower than the predetermined amount,
[1C]	wherein a reflectance of the main antenna is reduced below a predefined amount during the high reflectance period without shorting the main antenna to enable the main antenna for continuous wireless power harvesting while transmitting the reflected signal to the RFID reader, wherein the reflectance of the main antenna during the high reflectance period is reduced based on a change in a resonant frequency of the main antenna,
[1D]	wherein the circuit increases a duty cycle of the low reflectance periods and decreases a duty cycle of the high reflectance periods to increase a time period of wireless power transmission.

7. The RFID tag of claim 6, wherein the predetermined amount is a reflection coefficient magnitude of between 0 and 1.

8. The RFID tag of claim 6, wherein the circuit increases the duty cycle of the low reflectance periods to greater than 50%.

9. The RFID tag of claim 6, wherein the circuit is an application-specific integrated circuit (ASIC).

10. The RFID tag of claim 6, wherein the main antenna is a linearly polarized antenna.

Claim 11	Limitation
[1P]	A radio-frequency identification (RFID) tag comprising:
[1A]	a main antenna that receives a radio-frequency (RF) signal from an RFID reader and wirelessly harvests power from the RF signal; and
[1B.1]	a circuit that is configured to vary a reflection coefficient of the main antenna to transmit a reflected signal to the RFID reader,
[1B.2]	the reflected signal having a first reflectance period and a second reflectance period when an amount of reflectance by the main antenna of the RF signal is different than during the first reflectance period,
[1C.1]	wherein a reflectance of the main antenna is reduced below a predefined amount during the first reflectance period without shorting the main antenna
[1C.2]	to enable the main antenna to continuously harvest power while transmitting the reflected signal to the RFID reader,
[1C.3]	wherein the reflectance of the main antenna is reduced based on a change in a resonant frequency of the main antenna.

12. The RFID tag of claim 11, wherein the circuit changes the resonant frequency of the main antenna to generate the first and second reflectance period.

13. The RFID tag of claim 12, wherein the circuit adds a separate length of antenna to the main antenna during the first reflectance period.

14. The RFID tag of claim 13, further comprising:

a switch that adds the separate length of antenna by connecting the separate length of antenna to the main antenna during the first reflectance period, the switch being located on a first portion of the main antenna and the circuit being located on a second portion of the main antenna, wherein the first portion of the main antenna is different than the second portion of the main antenna.

15. The RFID tag of claim 11, wherein the main antenna includes a first antenna for receiving the RF signal, and a second antenna for receiving power, and the second antenna continues to absorb a portion of the RF signal during the first reflectance period and the second reflectance period to generate a low reflectance to enable wireless power harvesting during both the first reflectance period and the second reflectance period.

16. The RFID tag of claim 11, further comprising:

a switch controlled by the circuit that connects an RF impedance to the main antenna during the first reflectance period.

17. The RFID tag of claim 11, wherein the amount of reflectance by the main antenna of the RF signal is greater than the predetermined amount during the first reflectance period, and
the amount of reflectance by the main antenna of the RF signal is lower than the predetermined amount during the second reflectance period.

18. The RFID tag of claim 11, wherein the amount of reflectance of the main antenna of the RF signal during the first reflectance period is of greater magnitude to the amount of reflectance of the main antenna of the RF signal during the second reflectance period.

19. The RFID tag of claim 11, wherein the circuit is an application-specific integrated circuit (ASIC).

20. The RFID tag of claim 11, wherein the main antenna is a linearly polarized antenna.