United States Patent and Trademark Office

Before the Patent Trial and Appeal Board

Intel Corporation
Petitioner,
v.
Qualcomm Incorporated
Patent Owner

Case No: IPR2019-00128 and IPR2019-00129

Petitioner's Demonstrative Exhibits

***Inter Partes Review* of U.S. Patent No. 9,154,356**

February 27, 2020

Intel 1341
Intel v. Qualcomm
IPR2019-00128

Agenda

- Introduction
- Technology Background
- U.S. Patent No. 9,154,356
- Overview of Prior Art
- Disputed Issues

Introduction

Introduction: Instituted Grounds

IPR2019-00128		
Grounds	**Reference(s)**	**Challenged Claims**
Ground I	Anticipated by *Lee*	1, 7, 8, 11, 17, and 18
Ground II	Obvious over *Lee*	7 and 8
Ground III	Obvious over *Lee* in view of *Feasibility Study*	1, 7, 8, 11, 17, and 18

IPR2019-00129		
Grounds	**Reference(s)**	**Challenged Claims**
Ground I	Anticipated by *Lee*	2-6
Ground II	Obvious over *Lee* in view of *Youssef*	10
Ground III	Obvious over *Lee* in view of *Feasibility Study*	2-6
Ground IV	Obvious over *Lee* in view of *Feasibility Study* and *Youssef*	10

-00128 IPR, Paper 9 (Institution Decision) at 32; -00129 IPR, Paper 9 (Institution Decision) at 35-36

Introduction: Summary of Disputes

IPR2019-00128 (Claims 1, 7, 8, 11, 17, 18)

- If Board adopts Petitioner's construction of "carrier aggregation":
  - Claims 1, 11, 17, and 18 are anticipated by Lee (Ground I)
  - Claims 7-8 anticipated (Ground I) and/or obvious over Lee (Ground II)
- Board need not reach Ground III (obviousness of all challenged claims)

IPR2019-00129 (Claims 2-6, 10)

- If Board adopts Petitioner's construction of "carrier aggregation":
  - Claims 2-6 are anticipated (Ground I)
  - Claim 10 is obvious (Ground II)
- Board need not reach Grounds III or IV (obviousness of all challenged claims)

Introduction: Prior Adjudication

- **January 8, 2018:** Qualcomm files ITC action asserting '356 patent against Apple.
- **August 28, 2018:** ITC ALJ construes "carrier aggregation" to mean "simultaneous operation on multiple carriers"
- **November 9, 2018:** Intel files IPR petitions at issue
- **March 26, 2019:** ITC ALJ issues final initial determination finding independent claims 1 and 17 of the '356 patent invalid as anticipated by Lee

-00128 IPR, Paper 3 (Petition) at 1; -00128 IPR, Ex. 1336 (Markman CC Order) at 16-17, Appx. A at 24, 30;
-00128 IPR, Paper 8 (Updated Mandatory Notices) at 1

Introduction: Prior Adjudication

In spite of this explanation with examples, Qualcomm and Staff make an unusual argument that the construction of "carrier aggregation" should incorporate language not used to describe "carrier aggregation" in the '356 patent specification. (SMBr. at 12

-00128 IPR, Ex. 1336 (Markman CC Order) Appx. A at 24 (annotated)

A bandwidth limitation like the one proposed by Staff and Qualcomm would steer "carrier aggregation" away from how the applicant characterized the invention and toward prior art the applicant distinguished from the invention. Moreover, as mentioned

-00128 IPR, Ex. 1336 (Markman CC Order) Appx. A at 27

Technology Background

Technology Background:
Wireless System

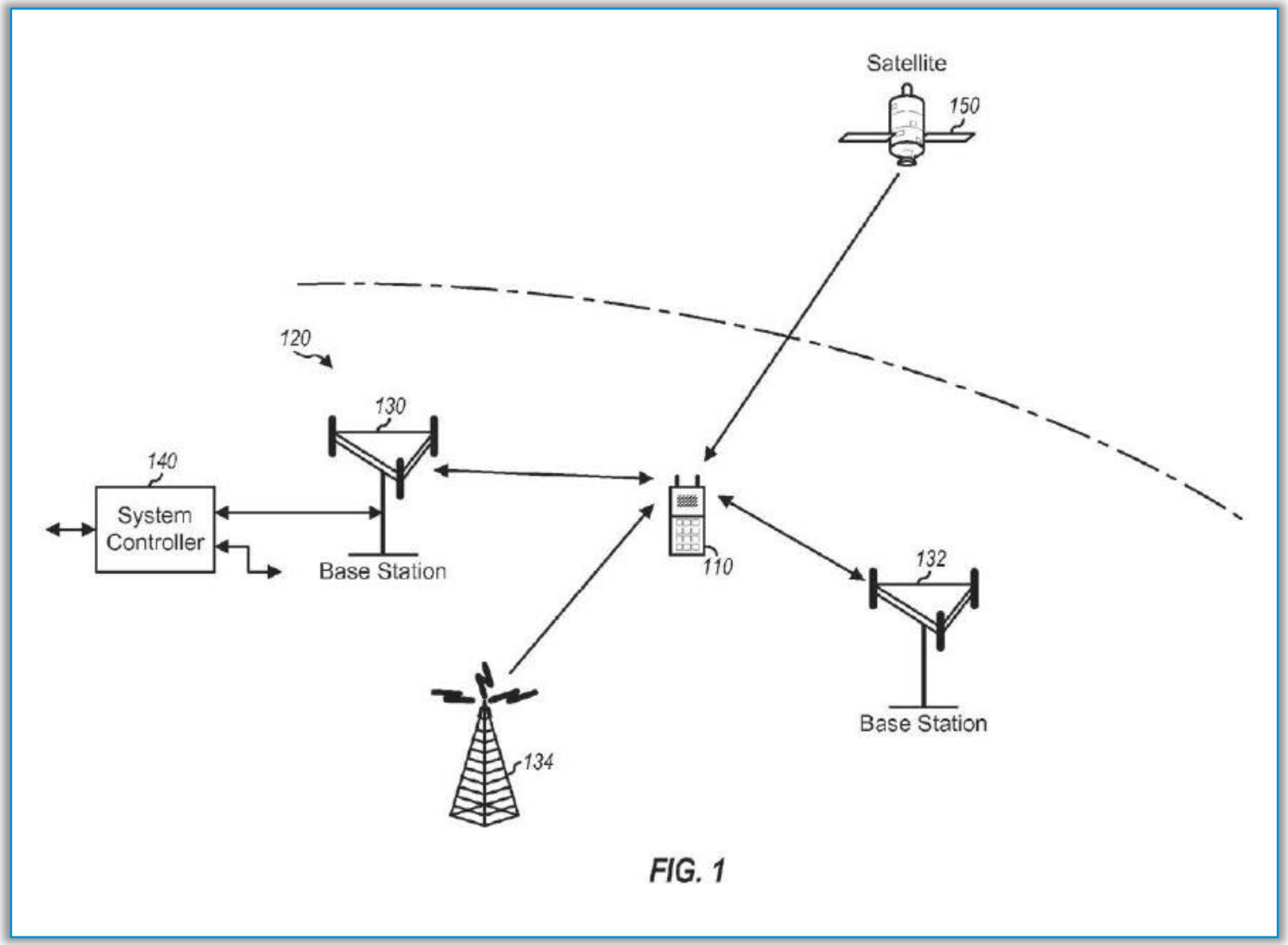
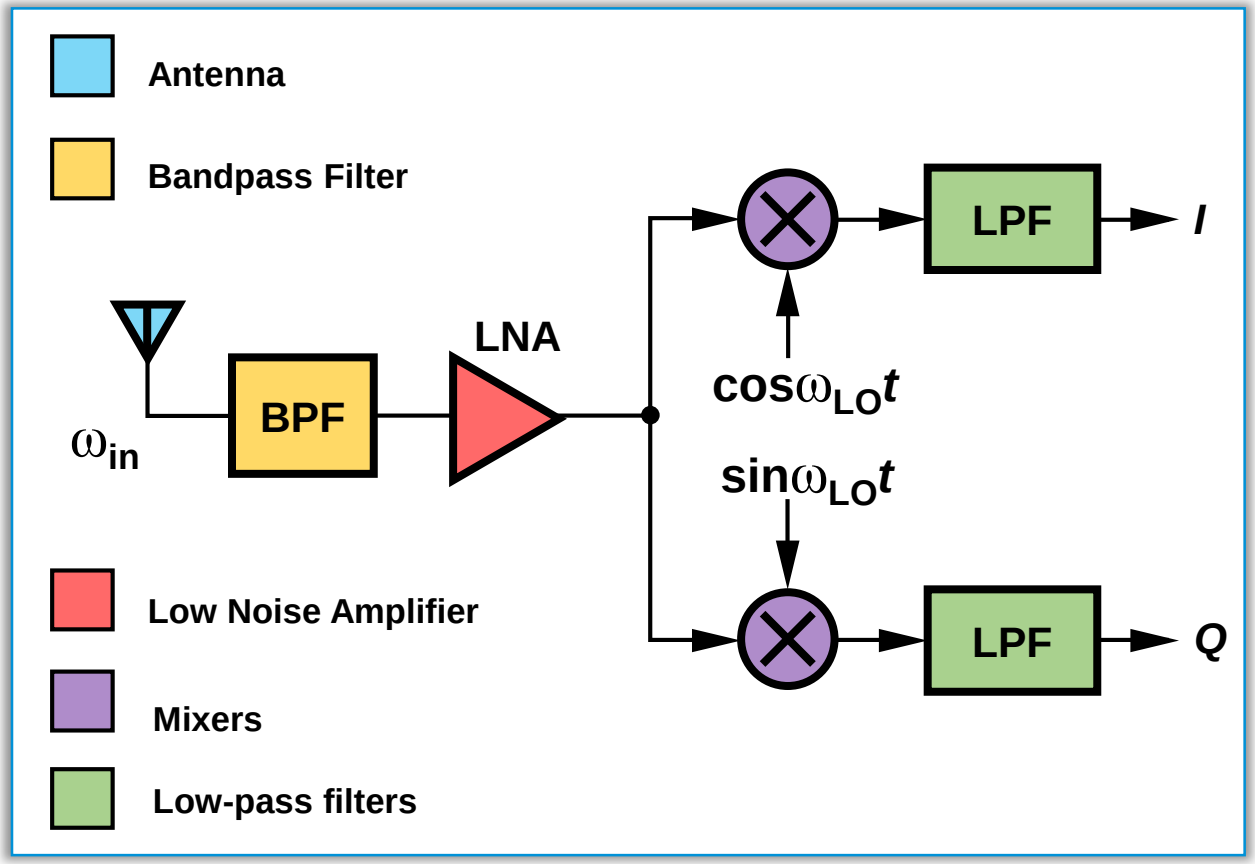


FIG. 1

-00128 IPR, Ex. 1301 ('356 Patent) Fig. 1

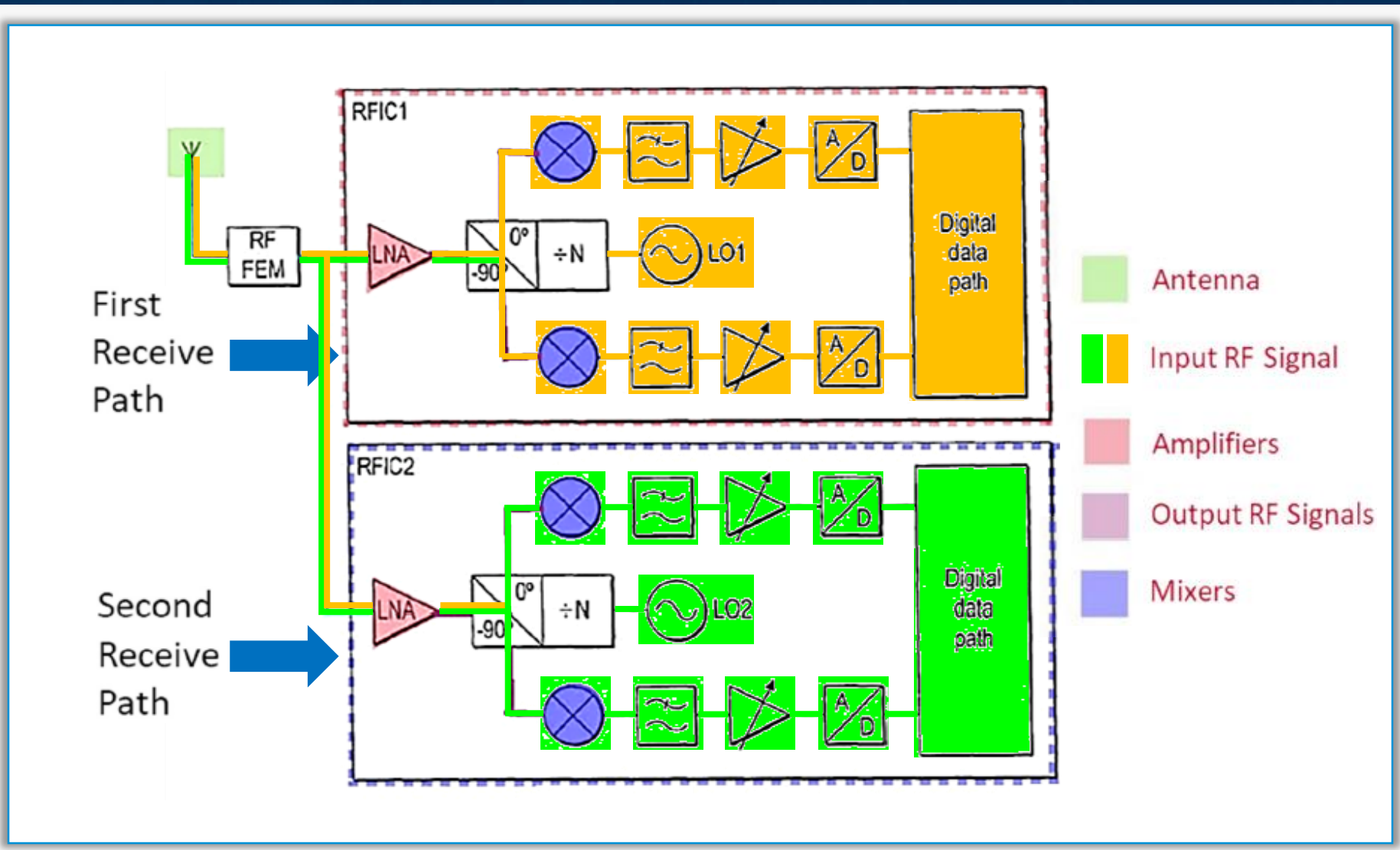
Technology Background:
Basic Receiver



- "antenna for receiving signals"
- "low noise amplifier for amplifying the signals"
- "mixers for down conversion"
- "various filters for removing undesired signals"

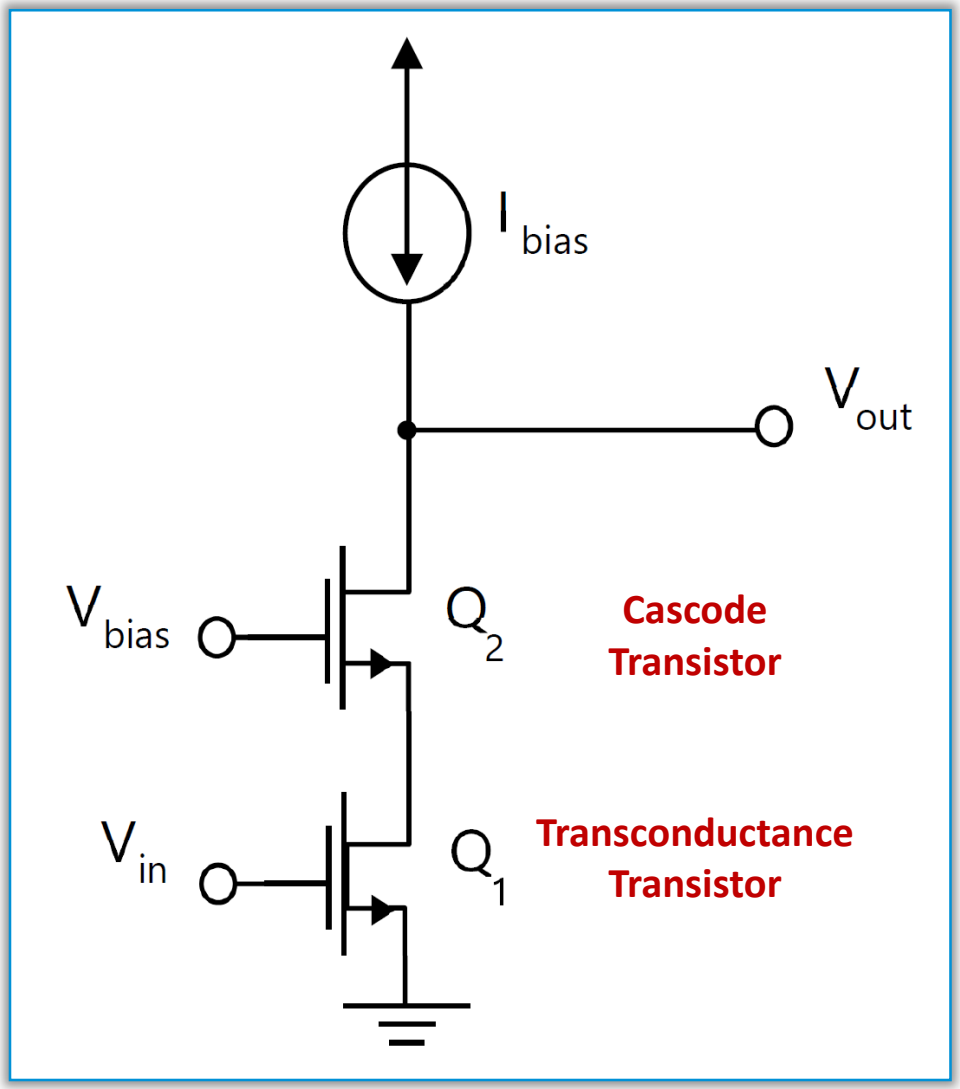
-00128 IPR, Ex. 1302 (Fay Decl.) ¶ 33

Technology Background:
Carrier Aggregation



-00128 IPR, Paper 3 (Petition) at 14, Fig. 7 (annotated); see also -00128 IPR, Ex. 1325 (Kaukovuori), Fig. 15

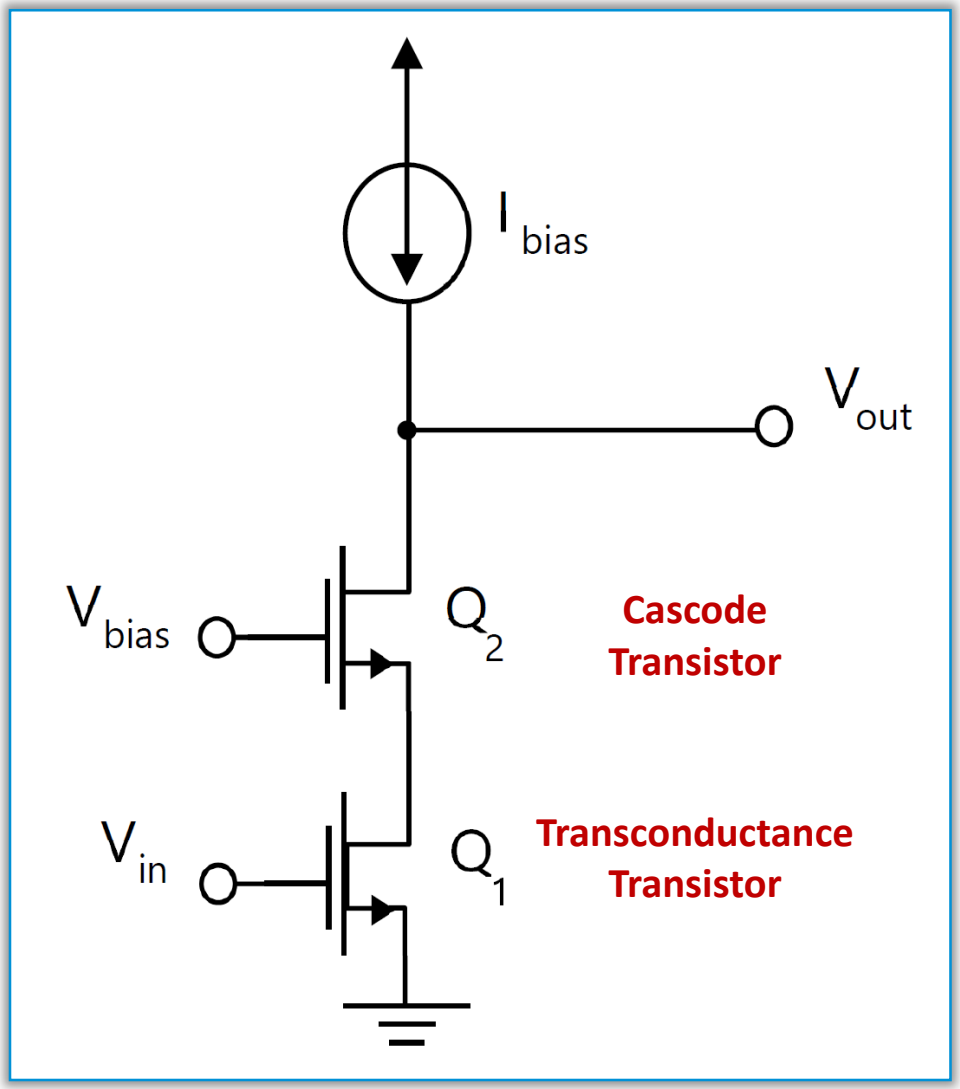
Technology Background:
Low Noise Amplifiers (LNAs)



- "A low noise amplifier ('LNA') is a well-known and widely used component of the receiver front end."
- "The purpose of the LNA is to increase the power of a received signal while introducing minimal 'noise.'"

-00128 IPR, Ex. 1302 (Fay Decl.) ¶ 35; see also -00128 IPR, Paper 3 (Petition) at 11, Fig. 6

Technology Background:
Low Noise Amplifiers (LNAs)

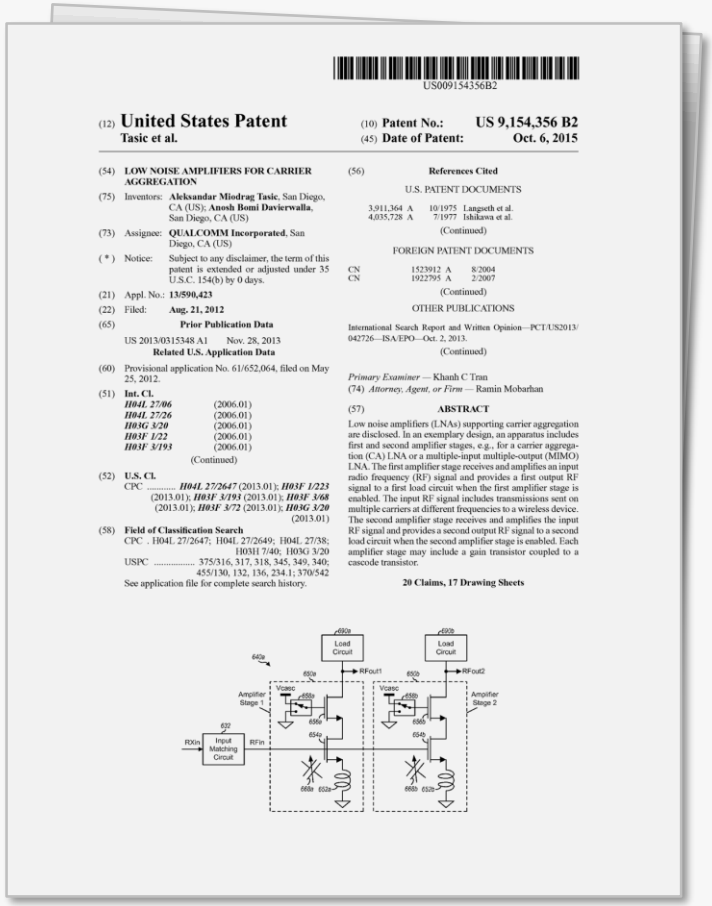


- "Cascode amplifiers include a common source 'transconductance' transistor that receives an input voltage signal (Vin) and converts it to current with an applied gain, and a common gate 'cascode' transistor that couples the current to the output signal."

-00128 IPR, Ex. 1302 (Fay Decl.) ¶ 36; see also -00128 IPR, Paper 3 (Petition) at 11, Fig. 6

U.S. Patent No. 9,154,356

U.S. Patent No. 9,154,356 ("'356 Patent")



US009154356B2

(12) **United States Patent**
Tasic et al.

(10) **Patent No.: US 9,154,356 B2**
(45) **Date of Patent: Oct. 6, 2015**

(54) **LOW NOISE AMPLIFIERS FOR CARRIER AGGREGATION**

(75) Inventors: **Aleksandar Miodrag Tasic**, San Diego, CA (US); **Anosh Bomi Davierwalla**, San Diego, CA (US)

(73) Assignee: **QUALCOMM Incorporated**, San Diego, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **13/590,423**

(22) Filed: **Aug. 21, 2012**

(65) **Prior Publication Data**

US 2013/0315348 A1 Nov. 28, 2013

Related U.S. Application Data

(60) Provisional application No. 61/652,064, filed on May 25, 2012.

(51) **Int. Cl.**

H04L 27/06	(2006.01)
H04L 27/26	(2006.01)
H03G 3/20	(2006.01)
H03F 1/22	(2006.01)
H03F 3/193	(2006.01)

(Continued)

(52) **U.S. Cl.**

CPC ***H04L 27/2647*** (2013.01); ***H03F 1/223*** (2013.01); ***H03F 3/193*** (2013.01); ***H03F 3/68*** (2013.01); ***H03F 3/72*** (2013.01); ***H03G 3/20*** (2013.01)

(58) **Field of Classification Search**

CPC . H04L 27/2647; H04L 27/2649; H04L 27/38; H03H 7/40; H03G 3/20

USPC 375/316, 317, 318, 345, 349, 340; 455/130, 132, 136, 234.1; 370/542

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,911,364	A	10/1975	Langseth et al.
4,035,728	A	7/1977	Ishikawa et al.

(Continued)

FOREIGN PATENT DOCUMENTS

CN		1523912	A 8/2004
CN		1922795	A 2/2007

(Continued)

OTHER PUBLICATIONS

International Search Report and Written Opinion—PCT/US2013/042726—ISA/EPO—Oct. 2, 2013.

(Continued)

Primary Examiner — Khanh C Tran
(74) *Attorney, Agent, or Firm* — Ramin Mobarhan

(57) **ABSTRACT**

Low noise amplifiers (LNAs) supporting carrier aggregation are disclosed. In an exemplary design, an apparatus includes first and second amplifier stages, e.g., for a carrier aggregation (CA) LNA or a multiple-input multiple-output (MIMO) LNA. The first amplifier stage receives and amplifies an input radio frequency (RF) signal and provides a first output RF signal to a first load circuit when the first amplifier stage is enabled. The input RF signal includes transmissions sent on multiple carriers at different frequencies to a wireless device. The second amplifier stage receives and amplifies the input RF signal and provides a second output RF signal to a second load circuit when the second amplifier stage is enabled. Each amplifier stage may include a gain transistor coupled to a cascode transistor.

20 Claims, 17 Drawing Sheets

(10) **Patent No.: US 9,154,356 B2**
(45) **Date of Patent: Oct. 6, 2015**

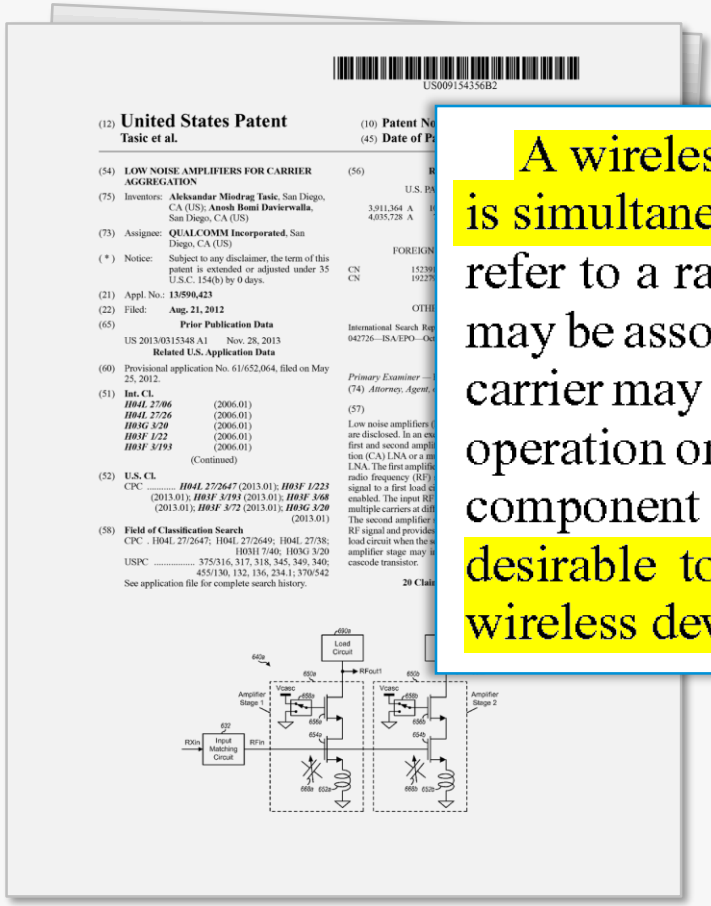
(54) **LOW NOISE AMPLIFIERS FOR CARRIER AGGREGATION**

(57) **ABSTRACT**

Low noise amplifiers (LNAs) supporting carrier aggregation are disclosed. In an exemplary design, an apparatus includes first and second amplifier stages, e.g., for a carrier aggregation (CA) LNA or a multiple-input multiple-output (MIMO) LNA. The first amplifier stage receives and amplifies an input radio frequency (RF) signal and provides a first output RF signal to a first load circuit when the first amplifier stage is enabled. The input RF signal includes transmissions sent on multiple carriers at different frequencies to a wireless device. The second amplifier stage receives and amplifies the input RF signal and provides a second output RF signal to a second load circuit when the second amplifier stage is enabled. Each amplifier stage may include a gain transistor coupled to a cascode transistor.

-00128 IPR, Ex. 1301 ('356 Patent) at Cover, Abstract

'356 Patent: Alleged Problem in the Prior Art



US009154356B2

(12) **United States Patent**
Tasic et al.

(10) Patent No
(45) Date of P

(54) **LOW NOISE AMPLIFIERS FOR CARRIER AGGREGATION**

(75) Inventors: **Aleksandar Miodrag Tasic**, San Diego, CA (US); **Anosh Bomi Davierwalla**, San Diego, CA (US)

(73) Assignee: **QUALCOMM Incorporated**, San Diego, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **13/590,423**

(22) Filed: **Aug. 21, 2012**

(65) **Prior Publication Data**

US 2013/0315348 A1 Nov. 28, 2013

Related U.S. Application Data

(60) Provisional application No. 61/652,064, filed on May 25, 2012.

(51) **Int. Cl.**
H04L 27/06 (2006.01)
H04L 27/26 (2006.01)
H03G 3/20 (2006.01)
H03F 1/22 (2006.01)
H03F 3/193 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H04L 27/2647*** (2013.01); ***H03F 1/223*** (2013.01); ***H03F 3/193*** (2013.01); ***H03F 3/68*** (2013.01); ***H03F 3/72*** (2013.01); ***H03G 3/20*** (2013.01)

(58) **Field of Classification Search**
CPC . H04L 27/2647; H04L 27/2649; H04L 27/38; H03H 7/40; H03G 3/20
USPC 375/316, 317, 318, 345, 349, 340; 455/130, 132, 136, 234.1; 370/542
See application file for complete search history.

(56)
U.S. PA
3,911,364 A
4,035,728 A
FOREIGN
CN
CN
OTH
International Search Rep
042726—ISA/EPO—Oc
Primary Examiner
(74) *Attorney, Agent,*

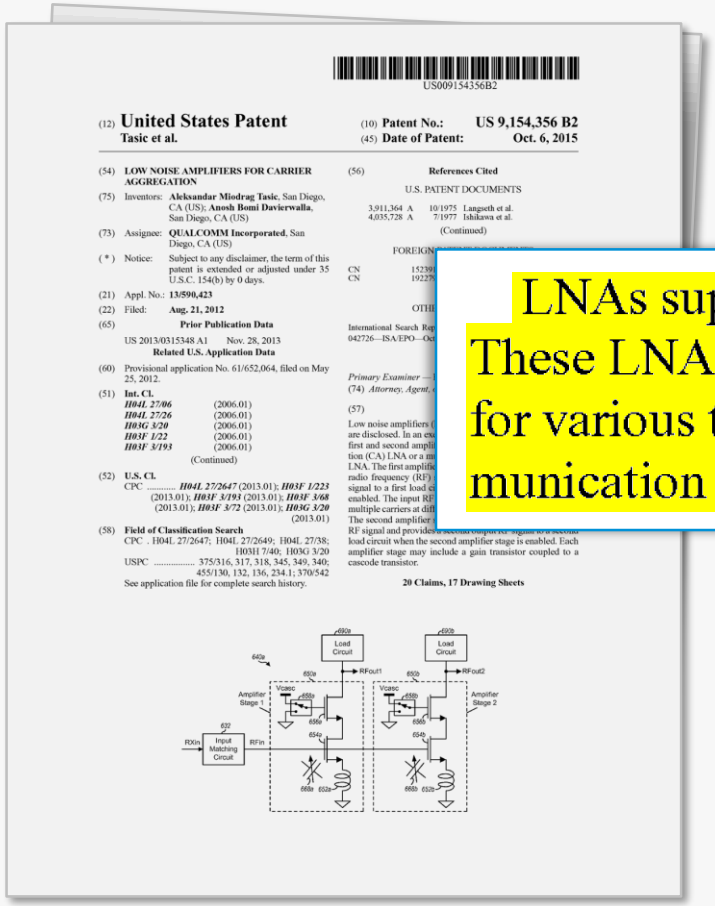
(57)
Low noise amplifiers (
are disclosed. In an ex
first and second ampli
tion (CA) LNA or a m
LNA. The first amplifi
radio frequency (RF)
signal to a first load c
enabled. The input RF
multiple carriers at dif
The second amplifier
RF signal and provides
load circuit when the
amplifier stage may i
cascade transistor.

20 Clai

A wireless device may support carrier aggregation, which is simultaneous operation on multiple carriers. A carrier may refer to a range of frequencies used for communication and may be associated with certain characteristics. For example, a carrier may be associated with system information describing operation on the carrier. A carrier may also be referred to as a component carrier (CC), a frequency channel, a cell, etc. It is desirable to efficiently support carrier aggregation by the wireless device.

-00128 IPR, Ex. 1301 ('356 Patent) at 1:32-40 (annotated)

'356 Patent: Alleged Solution



US009154356B2

(12) **United States Patent**
Tasic et al.

(10) **Patent No.: US 9,154,356 B2**
(45) **Date of Patent: Oct. 6, 2015**

(54) **LOW NOISE AMPLIFIERS FOR CARRIER AGGREGATION**

(75) Inventors: **Aleksandar Miodrag Tasic**, San Diego, CA (US); **Anosh Bomi Davierwalla**, San Diego, CA (US)

(73) Assignee: **QUALCOMM Incorporated**, San Diego, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **13/590,423**

(22) Filed: **Aug. 21, 2012**

(65) **Prior Publication Data**

US 2013/0315348 A1 Nov. 28, 2013

Related U.S. Application Data

(60) Provisional application No. 61/652,064, filed on May 25, 2012.

(51) **Int. Cl.**

H04L 27/06	(2006.01)
H04L 27/26	(2006.01)
H03G 3/20	(2006.01)
H03F 1/22	(2006.01)
H03F 3/193	(2006.01)

(Continued)

(52) **U.S. Cl.**

CPC ***H04L 27/2647*** (2013.01); ***H03F 1/223*** (2013.01); ***H03F 3/193*** (2013.01); ***H03F 3/68*** (2013.01); ***H03F 3/72*** (2013.01); ***H03G 3/20*** (2013.01)

(58) **Field of Classification Search**

CPC . H04L 27/2647; H04L 27/2649; H04L 27/38; H03H 7/40; H03G 3/20

USPC 375/316, 317, 318, 345, 349, 340; 455/130, 132, 136, 234.1; 370/542

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,911,364 A 10/1975 Langseth et al.
4,035,728 A 7/1977 Ishikawa et al.

(Continued)

FOREIGN

CN 152391
CN 192279

OTH

International Search Rep
042726—ISA/EPO—Oc

Primary Examiner —
(74) *Attorney, Agent,*

(57)

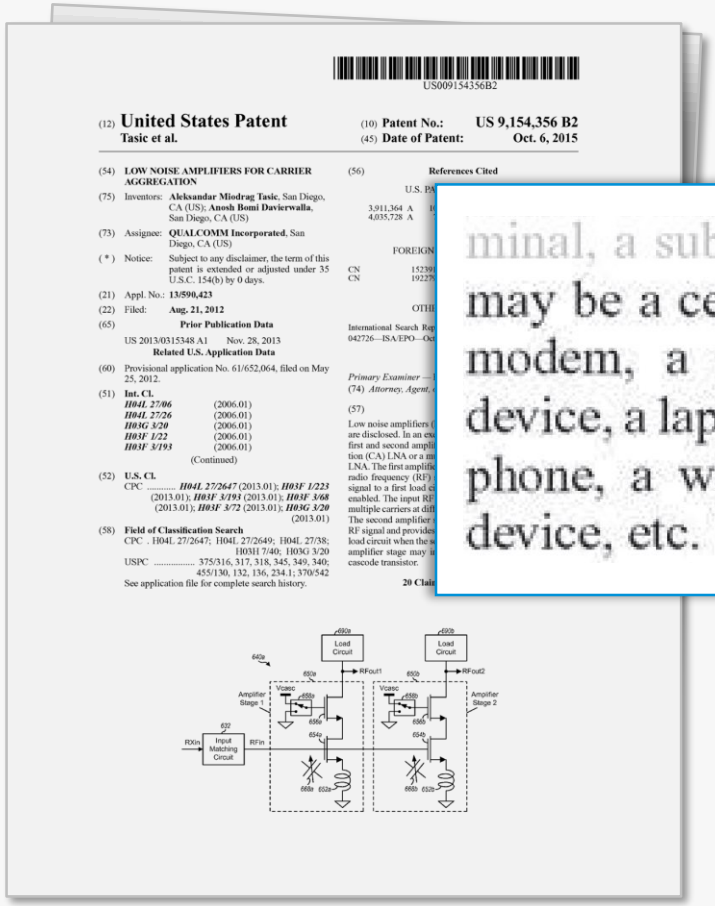
Low noise amplifiers (
are disclosed. In an ex
first and second ampli
tion (CA) LNA or a m
LNA. The first amplifi
radio frequency (RF)
signal to a first load c
enabled. The input RF
multiple carriers at dif
The second amplifier
RF signal and provides
load circuit when the second amplifier stage is enabled. Each amplifier stage may include a gain transistor coupled to a cascode transistor.

20 Claims, 17 Drawing Sheets

LNAs supporting carrier aggregation are disclosed herein. These LNAs may have better performance and may be used for various types of electronic devices such as wireless communication devices.

-00128 IPR, Ex. 1301 ('356 Patent) at 2:22-25 (annotated)

'356 Patent: Alleged Solution



US009154356B2

(12) **United States Patent**
Tasic et al.

(10) **Patent No.: US 9,154,356 B2**
(45) **Date of Patent: Oct. 6, 2015**

(54) **LOW NOISE AMPLIFIERS FOR CARRIER AGGREGATION**

(75) Inventors: **Aleksandar Miodrag Tasic**, San Diego, CA (US); **Anosh Bomi Davierwalla**, San Diego, CA (US)

(73) Assignee: **QUALCOMM Incorporated**, San Diego, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **13/590,423**

(22) Filed: **Aug. 21, 2012**

(65) **Prior Publication Data**

US 2013/0315348 A1 Nov. 28, 2013

Related U.S. Application Data

(60) Provisional application No. 61/652,064, filed on May 25, 2012.

(51) **Int. Cl.**

H04L 27/06	(2006.01)
H04L 27/26	(2006.01)
H03G 3/20	(2006.01)
H03F 1/22	(2006.01)
H03F 3/193	(2006.01)

(Continued)

(52) **U.S. Cl.**

CPC ***H04L 27/2647*** (2013.01); ***H03F 1/223*** (2013.01); ***H03F 3/193*** (2013.01); ***H03F 3/68*** (2013.01); ***H03F 3/72*** (2013.01); ***H03G 3/20*** (2013.01)

(58) **Field of Classification Search**

CPC . H04L 27/2647; H04L 27/2649; H04L 27/38; H03H 7/40; H03G 3/20

USPC 375/316, 317, 318, 345, 349, 340; 455/130, 132, 136, 234.1; 370/542

See application file for complete search history.

(56) **References Cited**

U.S. PA
3,911,364 A
4,035,728 A

FOREIGN
CN
CN

OTH
International Search Rep
042726—ISA/EPO—Oc

Primary Examiner
(74) *Attorney, Agent,*

(57)

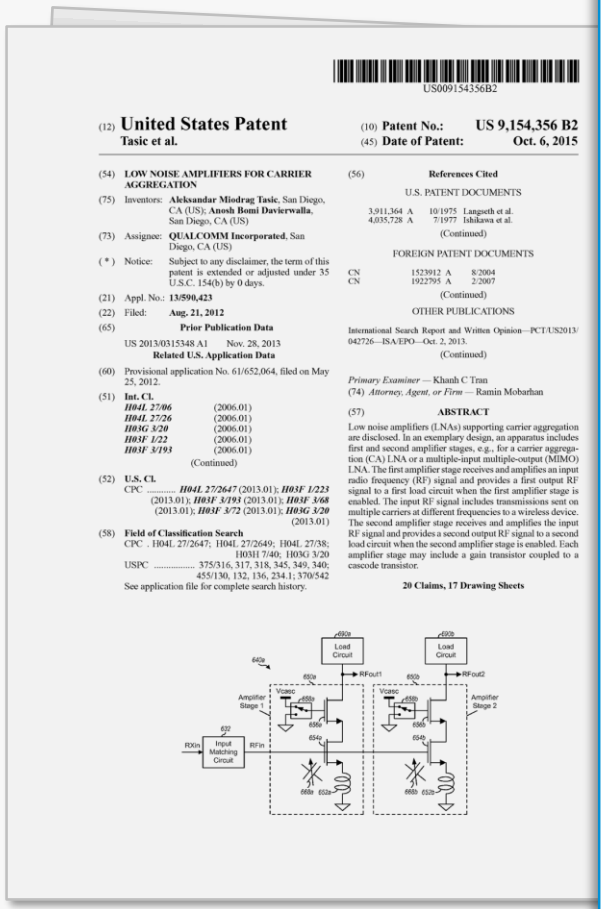
Low noise amplifiers (
are disclosed. In an ex
first and second amplif
tion (CA) LNA or a m
LNA. The first amplifie
radio frequency (RF)
signal to a first load ci
enabled. The input RF
multiple carriers at diff
The second amplifier
RF signal and provides
load circuit when the s
amplifier stage may i
cascode transistor.

20 Clai

minal, a subscriber unit, a station, etc. Wireless device **110** may be a cellular phone, a smartphone, a tablet, a wireless modem, a personal digital assistant (PDA), a handheld device, a laptop computer, a smartbook, a netbook, a cordless phone, a wireless local loop (WLL) station, a Bluetooth device, etc. Wireless device **110** may be capable of commu-

-00128 IPR, Ex. 1301 ('356 Patent) at 2:40-45

'356 Patent: Overview of Claim 1



US009154356B2

(12) **United States Patent**
Tasic et al.

(10) **Patent No.: US 9,154,356 B2**
(45) **Date of Patent: Oct. 6, 2015**

(54) **LOW NOISE AMPLIFIERS FOR CARRIER AGGREGATION**

(75) Inventors: **Aleksandar Miodrag Tasic**, San Diego, CA (US); **Anosh Bomi Davierwalla**, San Diego, CA (US)

(73) Assignee: **QUALCOMM Incorporated**, San Diego, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **13/590,423**

(22) Filed: **Aug. 21, 2012**

(65) **Prior Publication Data**

US 2013/0315348 A1 Nov. 28, 2013

Related U.S. Application Data

(60) Provisional application No. 61/652,064, filed on May 25, 2012.

(51) **Int. Cl.**
H04L 27/06 (2006.01)
H04L 27/26 (2006.01)
H03G 3/20 (2006.01)
H03F 1/22 (2006.01)
H03F 3/193 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H04L 27/2647*** (2013.01); ***H03F 1/223*** (2013.01); ***H03F 3/193*** (2013.01); ***H03F 3/68*** (2013.01); ***H03F 3/72*** (2013.01); ***H03G 3/20*** (2013.01)

(58) **Field of Classification Search**
CPC . H04L 27/2647; H04L 27/2649; H04L 27/38; H03H 7/40; H03G 3/20
USPC 375/316, 317, 318, 345, 349, 340; 455/130, 132, 136, 234.1; 370/542
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,911,364 A 10/1975 Langseth et al.
4,035,728 A 7/1977 Ishikawa et al.
(Continued)

FOREIGN PATENT DOCUMENTS

CN 1523912 A 8/2004
CN 1922795 A 2/2007
(Continued)

OTHER PUBLICATIONS

International Search Report and Written Opinion—PCT/US2013/042726—ISA/EPO—Oct. 2, 2013.
(Continued)

Primary Examiner — Khanh C Tran
(74) *Attorney, Agent, or Firm* — Ramin Mobarhan

(57) **ABSTRACT**

Low noise amplifiers (LNAs) supporting carrier aggregation are disclosed. In an exemplary design, an apparatus includes first and second amplifier stages, e.g., for a carrier aggregation (CA) LNA or a multiple-input multiple-output (MIMO) LNA. The first amplifier stage receives and amplifies an input radio frequency (RF) signal and provides a first output RF signal to a first load circuit when the first amplifier stage is enabled. The input RF signal includes transmissions sent on multiple carriers at different frequencies to a wireless device. The second amplifier stage receives and amplifies the input RF signal and provides a second output RF signal to a second load circuit when the second amplifier stage is enabled. Each amplifier stage may include a gain transistor coupled to a cascode transistor.

20 Claims, 17 Drawing Sheets

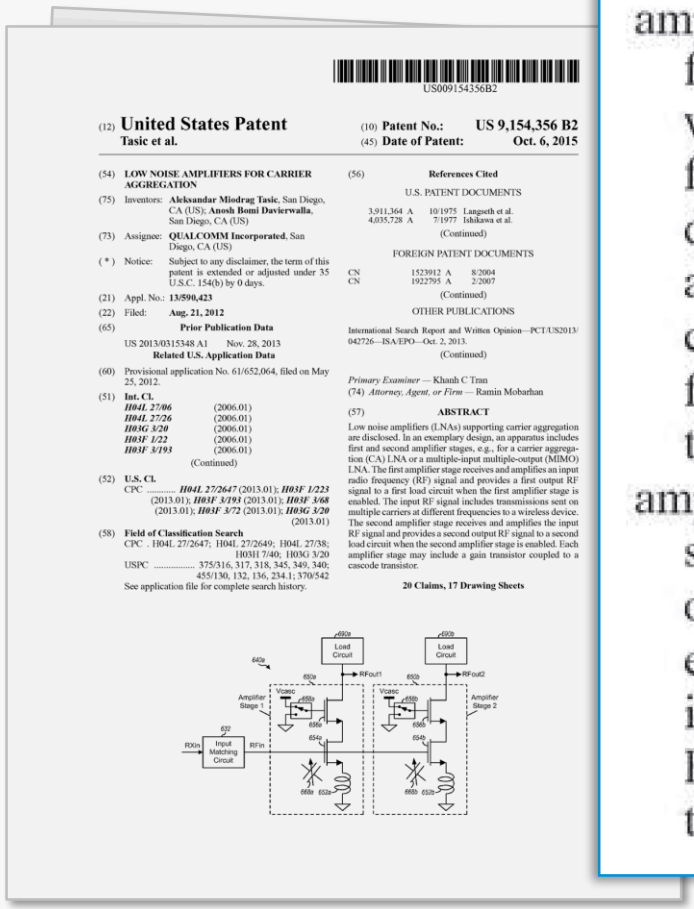
1. An apparatus comprising:

a first amplifier stage configured to be independently enabled or disabled, the first amplifier stage further configured to receive and amplify an input radio frequency (RF) signal and provide a first output RF signal to a first load circuit when the first amplifier stage is enabled, the input RF signal employing carrier aggregation comprising transmissions sent on multiple carriers at different frequencies to a wireless device, the first output RF signal including at least a first carrier of the multiple carriers; and

a second amplifier stage configured to be independently enabled or disabled, the second amplifier stage further configured to receive and amplify the input RF signal and provide a second output RF signal to a second load circuit when the second amplifier stage is enabled, the second output RF signal including at least a second carrier of the multiple carriers different than the first carrier.

-00128 IPR, Ex. 1301 ('356 Patent), Claim 1

'356 Patent: Overview of Claim 17



US009154356B2

(12) **United States Patent**
Tasic et al.

(10) **Patent No.: US 9,154,356 B2**
(45) **Date of Patent: Oct. 6, 2015**

(54) **LOW NOISE AMPLIFIERS FOR CARRIER AGGREGATION**

(75) Inventors: **Aleksandar Miodrag Tasic**, San Diego, CA (US); **Anosh Bomi Davierwalla**, San Diego, CA (US)

(73) Assignee: **QUALCOMM Incorporated**, San Diego, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **13/590,423**

(22) Filed: **Aug. 21, 2012**

(65) **Prior Publication Data**

US 2013/0315348 A1 Nov. 28, 2013

Related U.S. Application Data

(60) Provisional application No. 61/652,064, filed on May 25, 2012.

(51) **Int. Cl.**
H04L 27/06 (2006.01)
H04L 27/26 (2006.01)
H03G 3/20 (2006.01)
H03F 1/22 (2006.01)
H03F 3/193 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H04L 27/2647*** (2013.01); ***H03F 1/223*** (2013.01); ***H03F 3/193*** (2013.01); ***H03F 3/68*** (2013.01); ***H03F 3/72*** (2013.01); ***H03G 3/20*** (2013.01)

(58) **Field of Classification Search**
CPC . H04L 27/2647; H04L 27/2649; H04L 27/38; H03H 7/40; H03G 3/20
USPC 375/316, 317, 318, 345, 349, 340; 455/130, 132, 136, 234.1; 370/542
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,911,364 A 10/1975 Langseth et al.
4,035,728 A 7/1977 Ishikawa et al.
(Continued)

FOREIGN PATENT DOCUMENTS

CN 1523912 A 8/2004
CN 1922795 A 2/2007
(Continued)

OTHER PUBLICATIONS

International Search Report and Written Opinion—PCT/US2013/042726—ISA/EPO—Oct. 2, 2013.
(Continued)

Primary Examiner — Khanh C Tran
(74) *Attorney, Agent, or Firm* — Ramin Mobarhan

(57) **ABSTRACT**

Low noise amplifiers (LNAs) supporting carrier aggregation are disclosed. In an exemplary design, an apparatus includes first and second amplifier stages, e.g., for a carrier aggregation (CA) LNA or a multiple-input multiple-output (MIMO) LNA. The first amplifier stage receives and amplifies an input radio frequency (RF) signal and provides a first output RF signal to a first load circuit when the first amplifier stage is enabled. The input RF signal includes transmissions sent on multiple carriers at different frequencies to a wireless device. The second amplifier stage receives and amplifies the input RF signal and provides a second output RF signal to a second load circuit when the second amplifier stage is enabled. Each amplifier stage may include a gain transistor coupled to a cascode transistor.

20 Claims, 17 Drawing Sheets

17. A method comprising:

amplifying a first input radio frequency (RF) signal with a first amplifier stage to obtain a first output RF signal when the first amplifier stage is enabled, the first amplifier stage configured to be independently enabled or disabled, the first input RF signal employing carrier aggregation comprising transmissions sent on multiple carriers at different frequencies to a wireless device, the first output RF signal including at least a first carrier of the multiple carriers; and

amplifying the first input RF signal or a second input RF signal with a second amplifier stage to obtain a second output RF signal when the second amplifier stage is enabled, the second amplifier stage configured to be independently enabled or disabled, the second output RF signal including at least a second carrier of the multiple carriers different than the first carrier.

-00128 IPR, Ex. 1301 ('356 Patent), Claim 17

Overview of Prior Art

Overview of '356 Patent

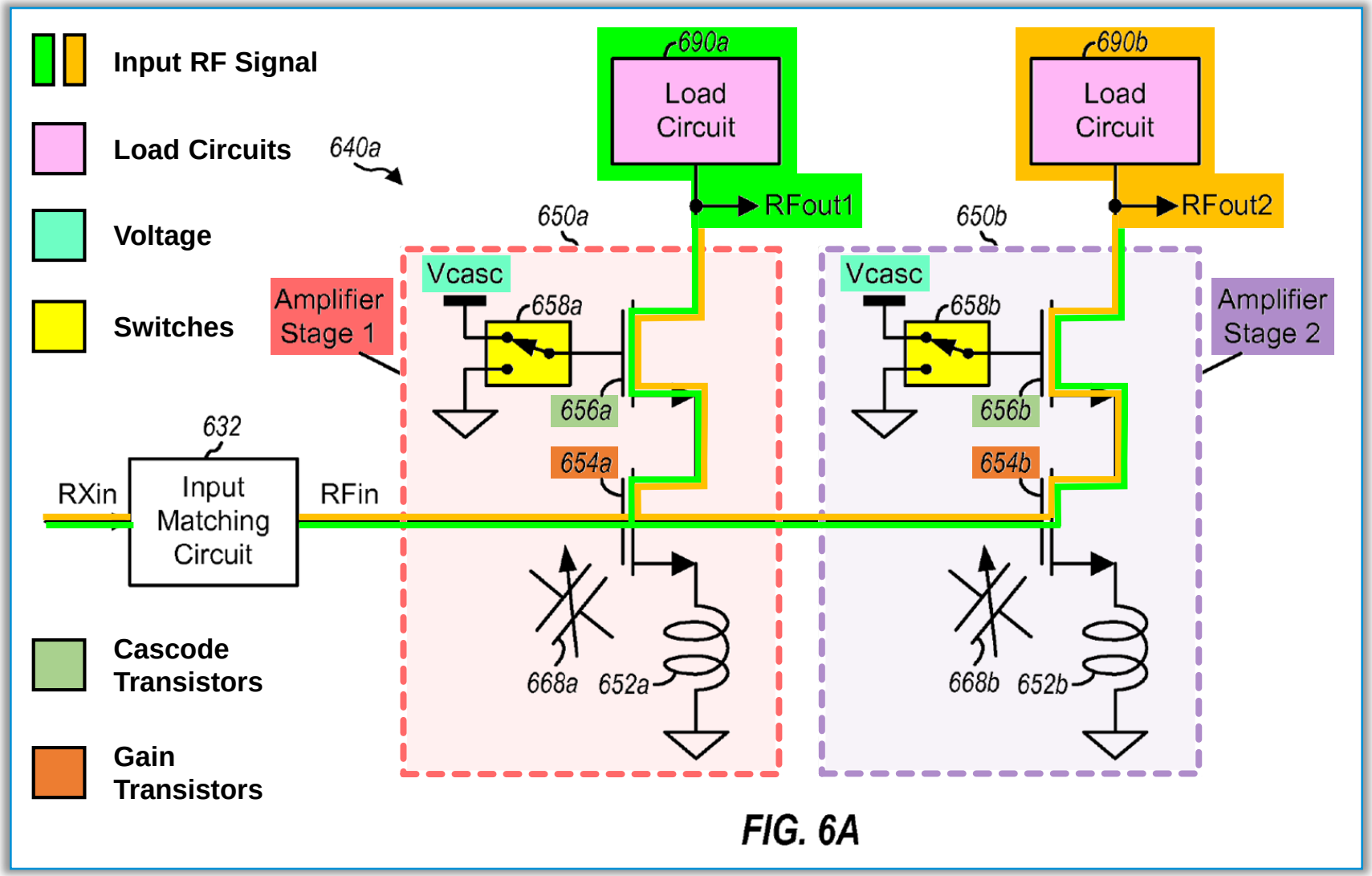


FIG. 6A

-00128 IPR, Paper 3 (Petition) at 21; -00128 IPR, Ex. 1301 ('356 Patent), Fig. 6A (annotated)

Lee

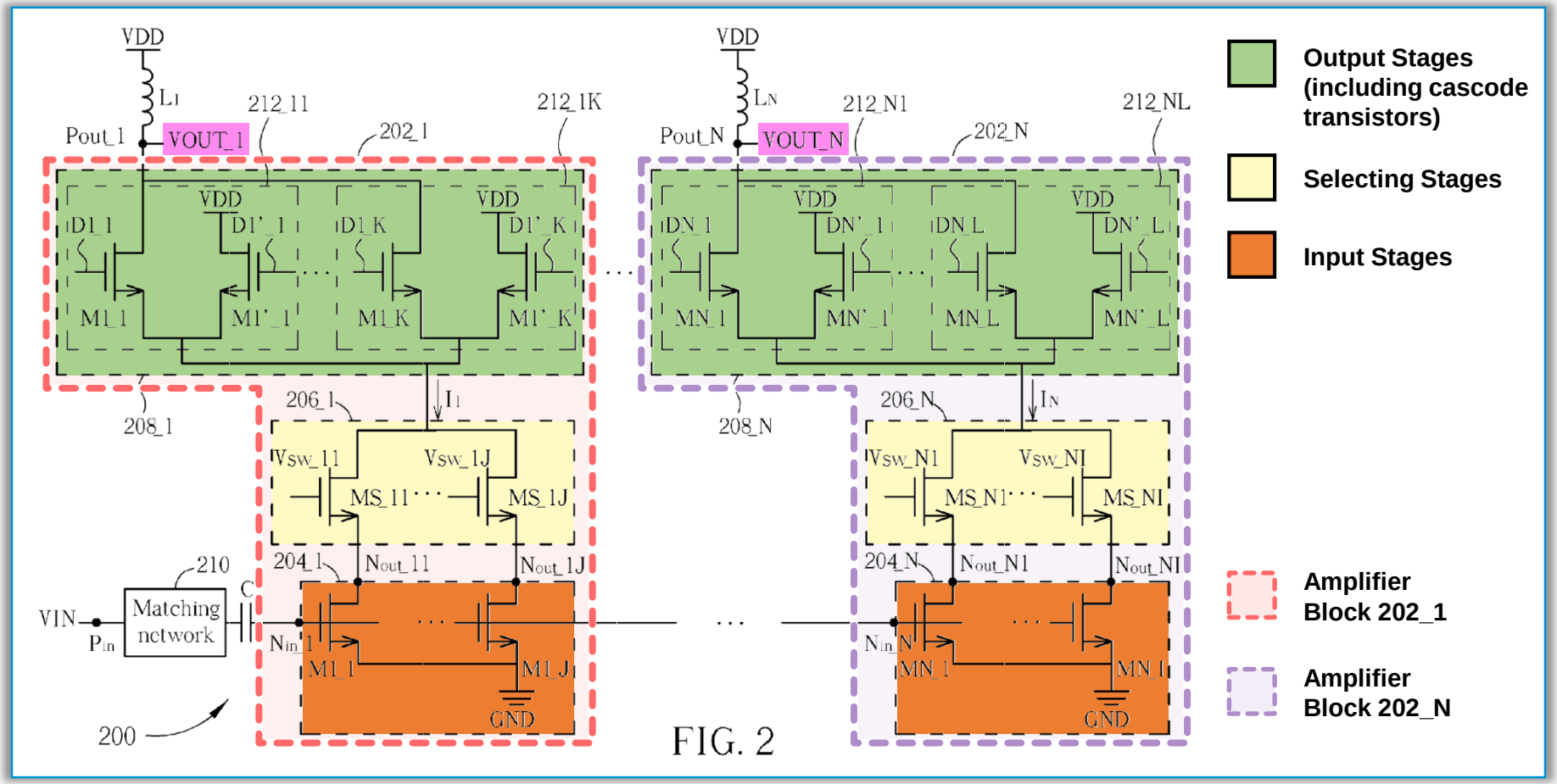


FIG. 2

-00128 IPR, Paper 3 (Petition) at 33; -00128 IPR, Ex. 1335 (Lee), Fig. 2 (annotated)

Lee v. '356 Patent

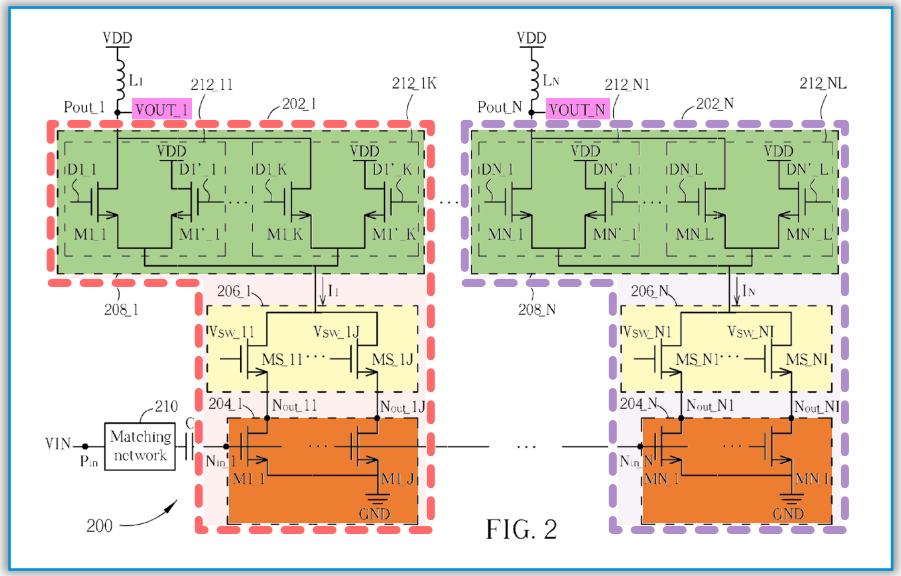


FIG. 2

-00128 IPR, Paper 3 (Petition) at 33;
-00128 IPR, Ex. 1335 (Lee), Fig. 2 (annotated)

Sept. 6, 2010

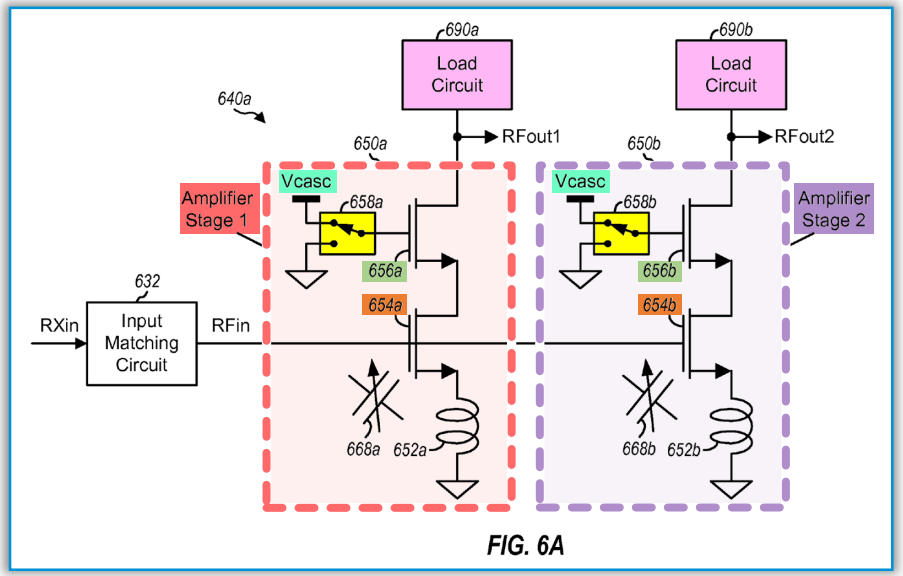


FIG. 6A

-00128 IPR, Paper 3 (Petition) at 21;
-00128 IPR, Ex. 1301 ('356 Patent), Fig. 6A (annotated)

May 25, 2012

Youssef

Digitally-Controlled RF Passive At
CMOS for Mobile TV Tu

Ahmed Youssef and James Haslett
Electrical and Computer Engineering Department
University of Calgary
Alberta, Canada

Abstract—**A novel VHF/UHF passive attenuator linearization circuit suitable for mobile TV applications has been designed and implemented in 65 nm CMOS technology. The proposed attenuator has a wide gain range of 48 dB that can be digitally programmed in 3 to 6 dB steps. At every gain setting, the input and output of the attenuator are matched to 50 Ω to facilitate its integration into mobile TV tuners.**

I. INTRODUCTION

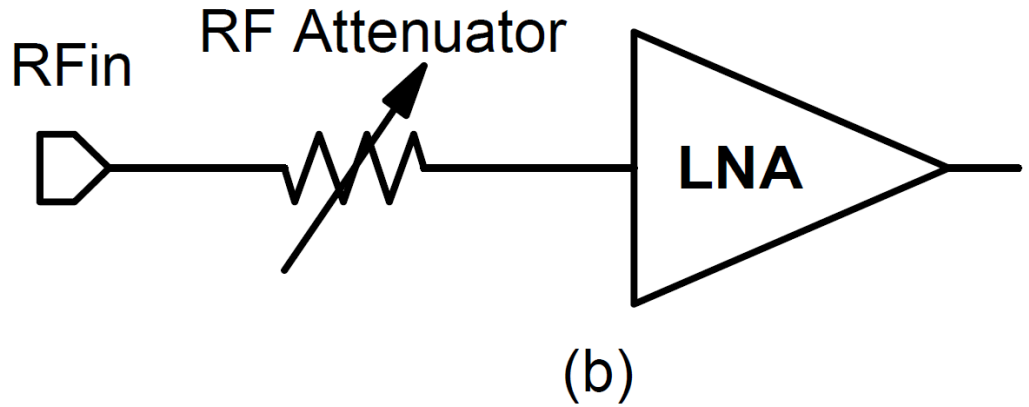
Mobile TV is one of the latest features to be added to cell phones and other hand-held devices. The low cost, low power, and small size demands of this application have pushed researchers to use nanometer CMOS technologies in designing high performance tuner chip sets. The bulky RF filters (i.e., SAW filters) usually used in traditional TV-can tuners to suppress far-away interferer blockers are thus not an option for these integrated tuners. This results in tightening the linearity requirement of the RF front-end needed for mobile TV reception, and hence demands innovative design techniques to adhere to the low power necessities for this application [1].

The RF-AGC (Automatic gain control) technique has been proposed recently in the literature as one of the low power solutions that can help mobile TV receivers achieve their stringent linearity requirements [2]-[4]. Decreasing the RF gain at large input signal levels helps the receiver pass larger signals without any degradation in the output SNR (Signal-to-Noise Ratio). Although there are many mechanisms to vary the RF gain in receivers, the efficacy of any given mechanism depends on the amount of the dynamic range that can be achieved while decreasing the RF gain.

This paper proposes an RF attenuator linearization circuit used to vary the RF gain of mobile TV receivers while maximizing their dynamic range. The paper describes a passive attenuator designed, implemented in 65 nm CMOS technology and characterized in the lab. Additionally, a 5 bit linear thermometer decoder [5] integrated in the same test chip is used to program the gain of the attenuator. The decoder sets the gain value according to the signal level received at the attenuator input. Also, an on-chip programmable matching network is used to provide a stable 50 Ω input resistance

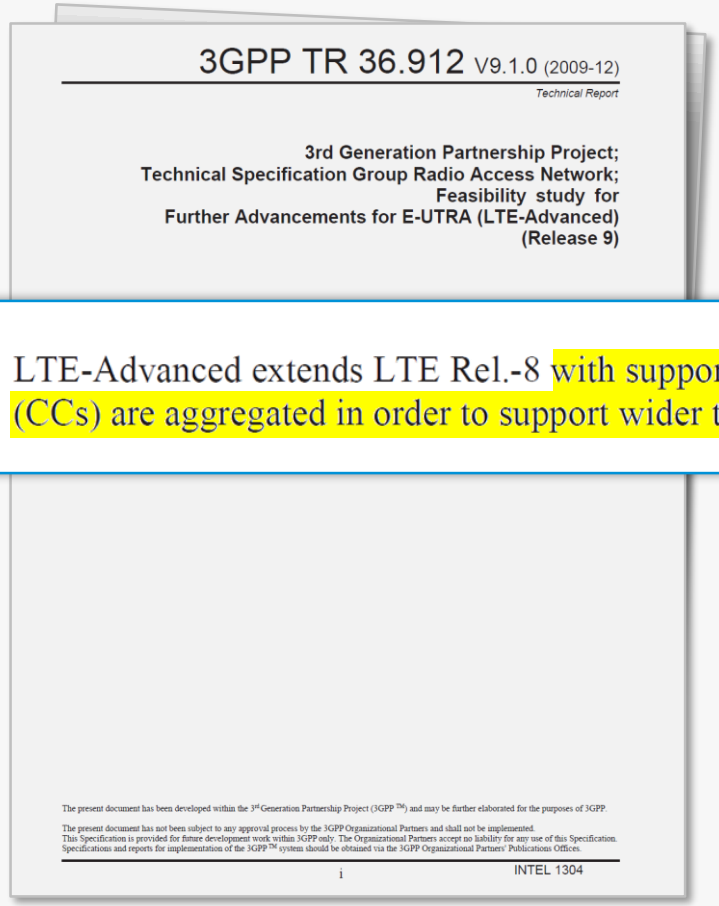
978-1-4244-5309-2/10/$26.00 ©2010 IEEE

This paper proposes an RF attenuator linearization circuit used to vary the RF gain of mobile TV receivers while maximizing their dynamic range. The paper describes a



-00129 IPR, Ex. 1409 (Youssef) at 1999, Fig. 1(b)

Feasibility Study



3GPP TR 36.912 V9.1.0 (2009-12)

Technical Report

3rd Generation Partnership Project;
Technical Specification Group Radio Access Network;
Feasibility study for
Further Advancements for E-UTRA (LTE-Advanced)
(Release 9)

The present document has been developed within the 3rd Generation Partnership Project (3GPP ™) and may be further elaborated for the purposes of 3GPP.

The present document has not been subject to any approval process by the 3GPP Organizational Partners and shall not be implemented.
This Specification is provided for future development work within 3GPP only. The Organizational Partners accept no liability for any use of this Specification.
Specifications and reports for implementation of the 3GPP ™ system should be obtained via the 3GPP Organizational Partners' Publications Offices.

i

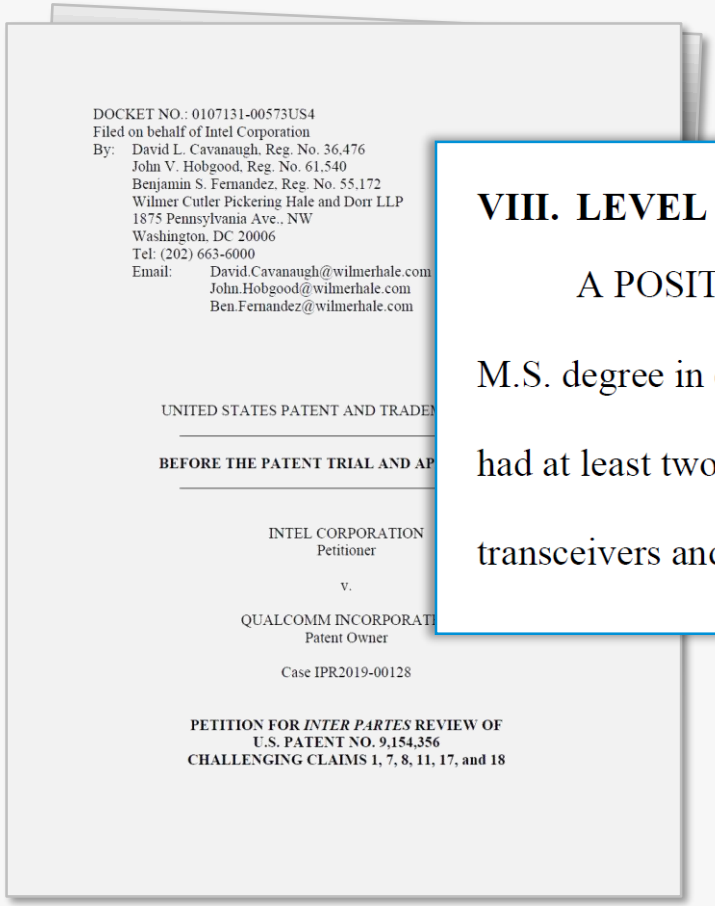
INTEL 1304

LTE-Advanced extends LTE Rel.-8 with support for *Carrier Aggregation*, where two or more *component carriers* (CCs) are aggregated in order to support wider transmission bandwidths up to 100MHz and for spectrum aggregation.

-00128 IPR, Ex. 1304 (Feasibility Study) at 8 (annotated)

Disputed Issues

Level of Ordinary Skill In The Art



DOCKET NO.: 0107131-00573US4
Filed on behalf of Intel Corporation
By: David L. Cavanaugh, Reg. No. 36,476
John V. Hobgood, Reg. No. 61,540
Benjamin S. Fernandez, Reg. No. 55,172
Wilmer Cutler Pickering Hale and Dorr LLP
1875 Pennsylvania Ave., NW
Washington, DC 20006
Tel: (202) 663-6000
Email: David.Cavanaugh@wilmerhale.com
John.Hobgood@wilmerhale.com
Ben.Fernandez@wilmerhale.com

UNITED STATES PATENT AND TRADE

BEFORE THE PATENT TRIAL AND AP

INTEL CORPORATION
Petitioner

v.

QUALCOMM INCORPORATI
Patent Owner

Case IPR2019-00128

PETITION FOR *INTER PARTES* REVIEW OF U.S. PATENT NO. 9,154,356 CHALLENGING CLAIMS 1, 7, 8, 11, 17, and 18

VIII. LEVEL OF ORDINARY SKILL IN THE ART

A POSITA at the time of the alleged invention would have had at least an M.S. degree in electrical engineering (or equivalent experience) and would have had at least two years of experience with the structure and operation of RF transceivers and related structures (or the equivalent). EX1402-Fay-Decl. ¶56.

-00128 IPR, Paper 3 (Petition) at 33

Disputed Issues

- Claim Construction of "Carrier Aggregation"
  - If Intel's proposed construction, then claims 1, 11, 17, and 18 anticipated
- Does *Lee* disclose shared and combo modes in the Figure 4 embodiment?
  - If yes, claims 7-8 anticipated
- Does *Lee* disclose cascode transistors?
  - If yes, claims 2-6 anticipated
- Was there reason to combine *Youssef* with *Lee*?
  - If yes, claim 10 obvious

Disputed Issues

Alternative Arguments

- Was there reason to combine embodiments of *Lee*?
  - IPR -00128, Claims 7-8
- Was there reason to combine *Lee* and *Feasibility Study*?
  - Both IPRs, All Challenged Claims

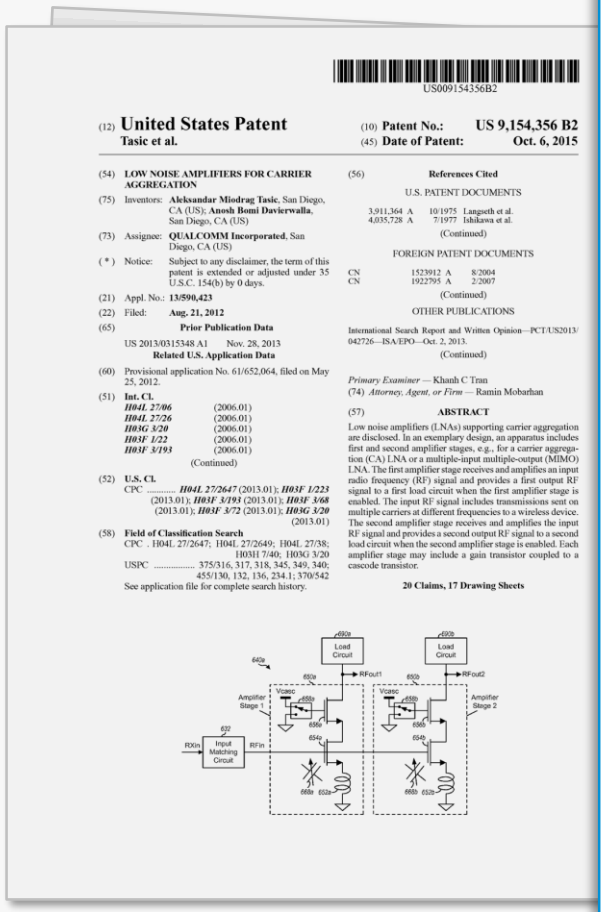
Claim Construction of "Carrier Aggregation"

Claim Construction: "Carrier Aggregation"

"carrier aggregation"	
Petitioner	**Patent Owner**
"simultaneous operation on multiple carriers"	"[1] simultaneous operation on multiple carriers [2] that are combined as a single virtual channel [3] to provide higher bandwidth"

-00128 IPR, Paper 3 (Petition) at 28-32; -00128 IPR, Paper 13 (POR) at 11-30

Claim Construction: "Carrier Aggregation"



US009154356B2

(12) **United States Patent**
Tasic et al.

(10) **Patent No.: US 9,154,356 B2**
(45) **Date of Patent: Oct. 6, 2015**

(54) **LOW NOISE AMPLIFIERS FOR CARRIER AGGREGATION**

(75) Inventors: **Aleksandar Miodrag Tasic**, San Diego, CA (US); **Anosh Bomi Davierwalla**, San Diego, CA (US)

(73) Assignee: **QUALCOMM Incorporated**, San Diego, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **13/590,423**

(22) Filed: **Aug. 21, 2012**

(65) **Prior Publication Data**

US 2013/0315348 A1 Nov. 28, 2013

Related U.S. Application Data

(60) Provisional application No. 61/652,064, filed on May 25, 2012.

(51) **Int. Cl.**

H04L 27/06	(2006.01)
H04L 27/26	(2006.01)
H03G 3/20	(2006.01)
H03F 1/22	(2006.01)
H03F 3/193	(2006.01)

(Continued)

(52) **U.S. Cl.**

CPC ***H04L 27/2647*** (2013.01); ***H03F 1/223*** (2013.01); ***H03F 3/193*** (2013.01); ***H03F 3/68*** (2013.01); ***H03F 3/72*** (2013.01); ***H03G 3/20*** (2013.01)

(58) **Field of Classification Search**

CPC . H04L 27/2647; H04L 27/2649; H04L 27/38; H03H 7/40; H03G 3/20

USPC 375/316, 317, 318, 345, 349, 340; 455/130, 132, 136, 234.1; 370/542

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,911,364 A 10/1975 Langseth et al.
4,035,728 A 7/1977 Ishikawa et al.
(Continued)

FOREIGN PATENT DOCUMENTS

CN 1523912 A 8/2004
CN 1922795 A 2/2007
(Continued)

OTHER PUBLICATIONS

International Search Report and Written Opinion—PCT/US2013/042726—ISA/EPO—Oct. 2, 2013.
(Continued)

Primary Examiner — Khanh C Tran
(74) *Attorney, Agent, or Firm* — Ramin Mobarhan

(57) **ABSTRACT**

Low noise amplifiers (LNAs) supporting carrier aggregation are disclosed. In an exemplary design, an apparatus includes first and second amplifier stages, e.g., for a carrier aggregation (CA) LNA or a multiple-input multiple-output (MIMO) LNA. The first amplifier stage receives and amplifies an input radio frequency (RF) signal and provides a first output RF signal to a first load circuit when the first amplifier stage is enabled. The input RF signal includes transmissions sent on multiple carriers at different frequencies to a wireless device. The second amplifier stage receives and amplifies the input RF signal and provides a second output RF signal to a second load circuit when the second amplifier stage is enabled. Each amplifier stage may include a gain transistor coupled to a cascode transistor.

20 Claims, 17 Drawing Sheets

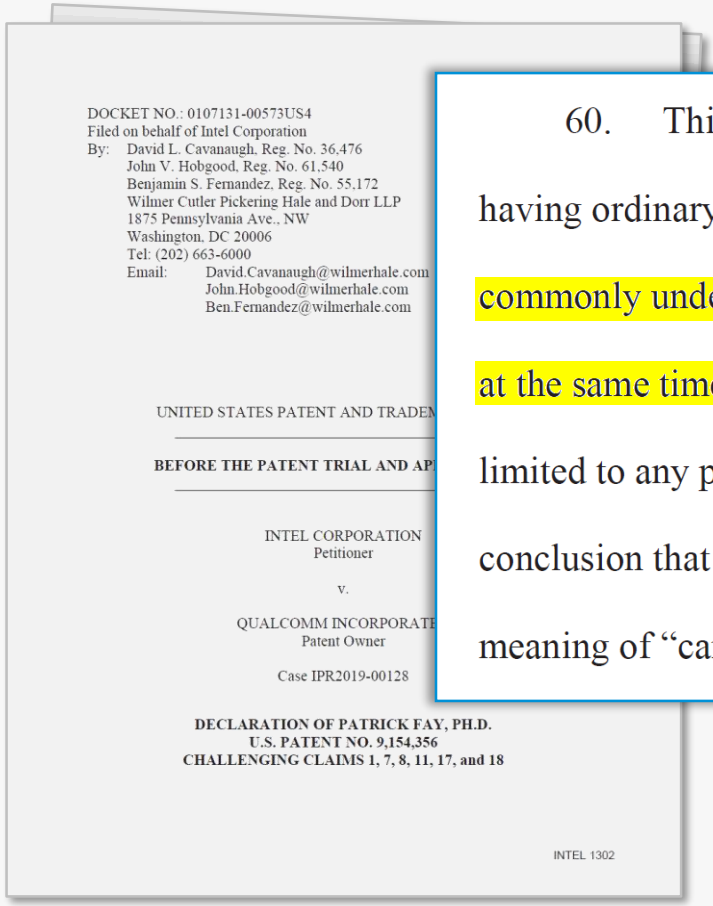
1. An apparatus comprising:

a first amplifier stage configured to be independently enabled or disabled, the first amplifier stage further configured to receive and amplify an input radio frequency (RF) signal and provide a first output RF signal to a first load circuit when the first amplifier stage is enabled, the input RF signal employing carrier aggregation comprising transmissions sent on multiple carriers at different frequencies to a wireless device, the first output RF signal including at least a first carrier of the multiple carriers; and

a second amplifier stage configured to be independently enabled or disabled, the second amplifier stage further configured to receive and amplify the input RF signal and provide a second output RF signal to a second load circuit when the second amplifier stage is enabled, the second output RF signal including at least a second carrier of the multiple carriers different than the first carrier.

-00128 IPR, Ex. 1301 ('356 Patent), Claim 1 (annotated)

Claim Construction: "Carrier Aggregation"



DOCKET NO.: 0107131-00573US4
Filed on behalf of Intel Corporation
By: David L. Cavanaugh, Reg. No. 36,476
John V. Hobgood, Reg. No. 61,540
Benjamin S. Fernandez, Reg. No. 55,172
Wilmer Cutler Pickering Hale and Dorr LLP
1875 Pennsylvania Ave., NW
Washington, DC 20006
Tel: (202) 663-6000
Email: David.Cavanaugh@wilmerhale.com
John.Hobgood@wilmerhale.com
Ben.Fernandez@wilmerhale.com

UNITED STATES PATENT AND TRADEN

BEFORE THE PATENT TRIAL AND AP

INTEL CORPORATION
Petitioner

v.

QUALCOMM INCORPORATE
Patent Owner

Case IPR2019-00128

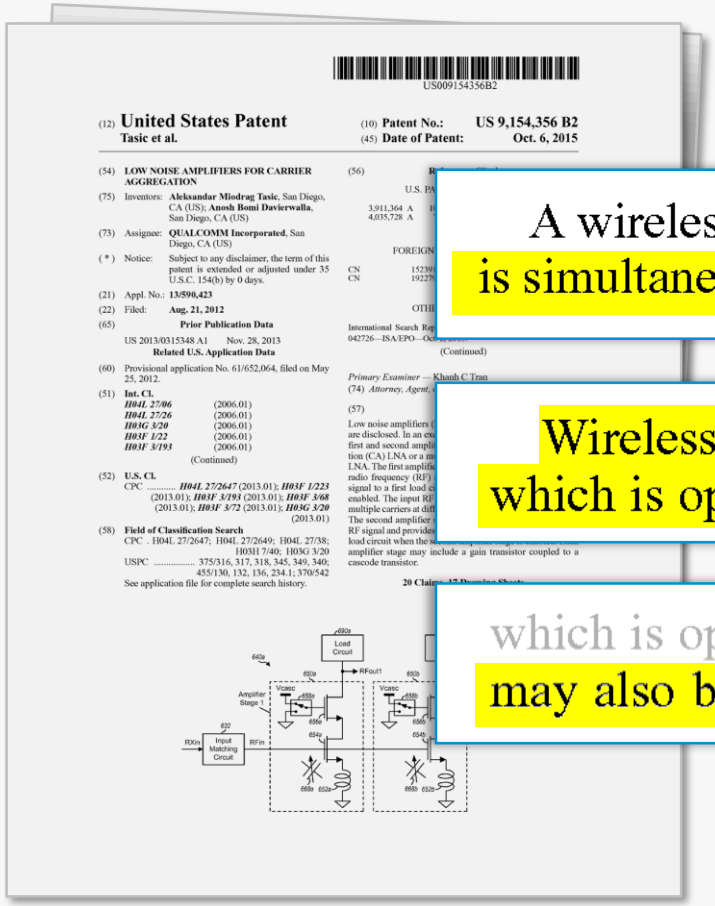
DECLARATION OF PATRICK FAY, PH.D.
U.S. PATENT NO. 9,154,356
CHALLENGING CLAIMS 1, 7, 8, 11, 17, and 18

INTEL 1302

60. This construction is consistent with the understanding of persons having ordinary skill in the art. As described above, carrier aggregation is commonly understood to mean sending data to or from a radio on multiple carriers at the same time. Carrier aggregation is known to have multiple uses and is not limited to any particular use. In light of this multi-purpose operation, it is my conclusion that "simultaneous operation on multiple carriers" captures the meaning of "carrier aggregation" to a person having ordinary skill in the art.

-00128 IPR, Ex. 1302 (Fay Decl.) at ¶ 60 (annotated)

Claim Construction: "Carrier Aggregation"



US009154356B2

(12) **United States Patent**
Tasic et al.

(10) **Patent No.: US 9,154,356 B2**
(45) **Date of Patent: Oct. 6, 2015**

(54) **LOW NOISE AMPLIFIERS FOR CARRIER AGGREGATION**

(75) Inventors: **Aleksandar Miodrag Tasic**, San Diego, CA (US); **Anosh Bomi Davierwalla**, San Diego, CA (US)

(73) Assignee: **QUALCOMM Incorporated**, San Diego, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **13/590,423**

(22) Filed: **Aug. 21, 2012**

(65) **Prior Publication Data**

US 2013/0315348 A1 Nov. 28, 2013

Related U.S. Application Data

(60) Provisional application No. 61/652,064, filed on May 25, 2012.

(51) **Int. Cl.**
H04L 27/06 (2006.01)
H04L 27/26 (2006.01)
H03G 3/20 (2006.01)
H03F 1/22 (2006.01)
H03F 3/193 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H04L 27/2647*** (2013.01); ***H03F 1/223*** (2013.01); ***H03F 3/193*** (2013.01); ***H03F 3/68*** (2013.01); ***H03F 3/72*** (2013.01); ***H03G 3/20*** (2013.01)

(58) **Field of Classification Search**
CPC . H04L 27/2647; H04L 27/2649; H04L 27/38; H03H 7/40; H03G 3/20
USPC 375/316, 317, 318, 345, 349, 340; 455/130, 132, 136, 234.1; 370/542
See application file for complete search history.

(56) [illegible]
U.S. PA
3,911,364 A
4,035,728 A
FOREIGN
CN 152399
CN 192279
OTH
International Search Rep
042726—ISA/EPO—Oc
(Continued)

Primary Examiner — Khanh C Tran
(74) *Attorney, Agent,*

(57)
Low noise amplifiers (
are disclosed. In an ex
first and second amplif
tion (CA) LNA or a m
LNA. The first amplifie
radio frequency (RF)
signal to a first load ci
enabled. The input RF
multiple carriers at diff
The second amplifier
RF signal and provides
load circuit when the
amplifier stage may include a gain transistor coupled to a cascode transistor.

20 Claim

A wireless device may support carrier aggregation, which is simultaneous operation on multiple carriers. A carrier may

Wireless device **110** may support carrier aggregation, which is operation on multiple carriers. Carrier aggregation

which is operation on multiple carriers. Carrier aggregation may also be referred to as multi-carrier operation. Wireless

-00128 IPR, Ex. 1301 ('356 Patent) at 1:32-33, 2:53-55 (annotated)

Claim Construction: "Carrier Aggregation"

- ***Phillips v. AWH Corp.,***
  415 F.3d 1303, 1315 (Fed. Cir. 2005) (en banc)
  - "[T]he specification is always highly relevant to the claim construction analysis. Usually, it is dispositive; it is the single best guide to the meaning of a disputed term." (internal quotation marks omitted)

Claim Construction: "Carrier Aggregation"

ITC Construction of "Carrier Aggregation" Under *Phillips*

> In sum, free from artificial limitations, the proper construction of "carrier aggregation" comes straight from the specification of the '356 patent: "simultaneous operation on multiple carriers."

-00128 IPR, Ex. 1336 (Markman CC Order) Appx.A at 30 (annotated)

- ***Rembrandt Wireless Techs., L.P. v. Samsung Elecs. Co.,*** 853 F.3d 1370, 1377 (Fed. Cir. 2017)
  - "the Board in IPR proceedings operates under a broader claim construction standard than the federal courts"

-00128 IPR, Paper 20 (Petitioner's Reply to POR) at 4

Claim Construction: "Carrier Aggregation"

Term	Patent Owner
"carrier aggregation"	"[1] simultaneous operation on multiple carriers **[2] that are combined as a single virtual channel** **[3] to provide higher bandwidth"**

Claim Construction: "Carrier Aggregation"

Testimony of Dr. Foty

Q. So let's go through the different parts of that claim construction. The first part is "simultaneous operation on multiple carriers." From where did you get that requirement for "carrier aggregation"?

A. That first part, the first five words, are explicitly found in the specification. That part is found.

-00128 IPR, Ex. 1340 (Foty Tr.) at 69:12-19 (annotated)

- "Single virtual channel" and "bandwidth" do not appear in the '356 patent

Claim Construction: "Carrier Aggregation"

- Patent Owner relies primarily on two sentences in the '356 specification that focus on LTE

carriers. Each carrier may cover up to 20 MHz in LTE. LTE Release 11 supports 35 bands, which are referred to as LTE/ UMTS bands and are listed in 3GPP TS 36.101. Wireless device **110** may be configured with up to 5 carriers in one or two bands in LTE Release 11.

-00128 IPR, Ex. 1301 ('356 Patent) at 2:63-67

- But the '356 patent is not limited to devices that implement LTE

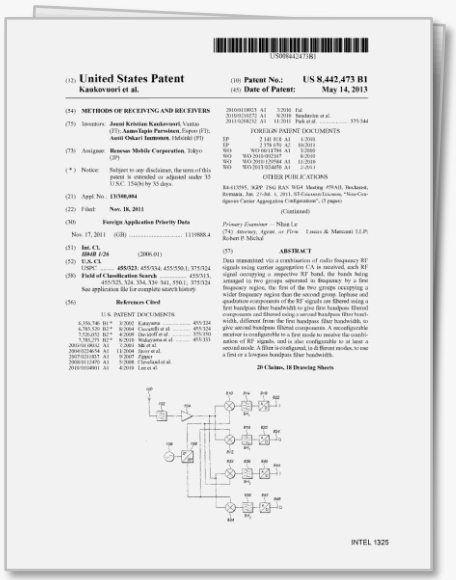
tems (GNSS), etc. Wireless device **110** may support one or more radio technologies for wireless communication such as LTE, cdma2000, WCDMA, GSM, 802.11, etc.

-00128 IPR, Ex. 1301 ('356 Patent) at 2:50-52 (annotated)

Claim Construction: "Carrier Aggregation"

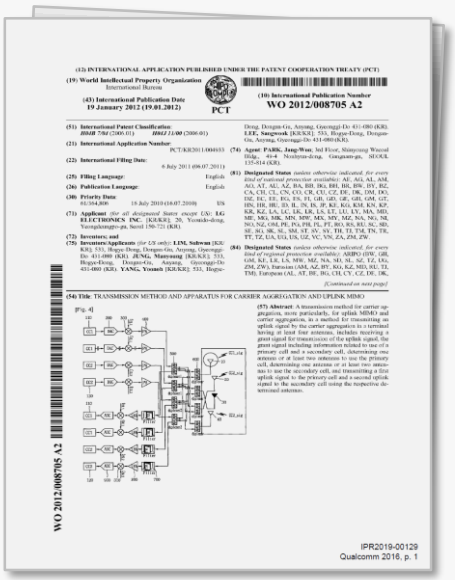
- Patent Owner relies on three specific pieces of prior art cited in the '356 prosecution history

Kaukovuori



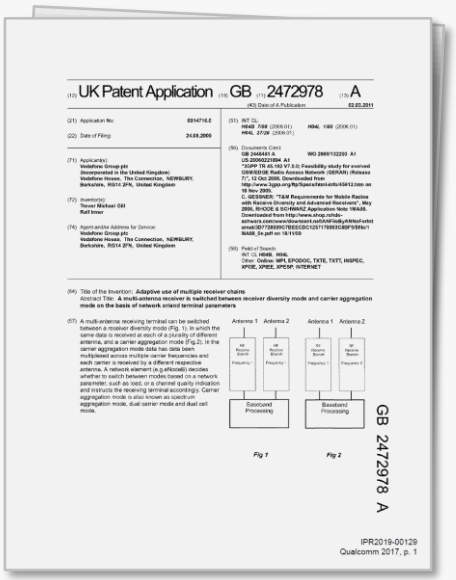
Ex. 1325

WO 2012/008705



Ex. 2016

GB 2472978



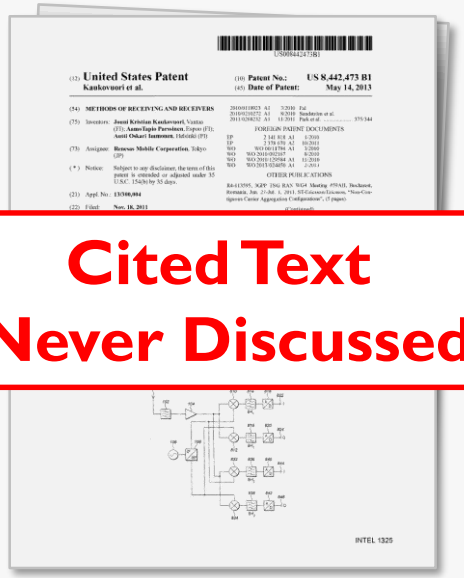
Ex. 2017

-00128 IPR, Paper 13 (POR) at 15-17

Claim Construction: "Carrier Aggregation"

- Patent Owner relies on three specific pieces of prior art cited in the '356 prosecution history

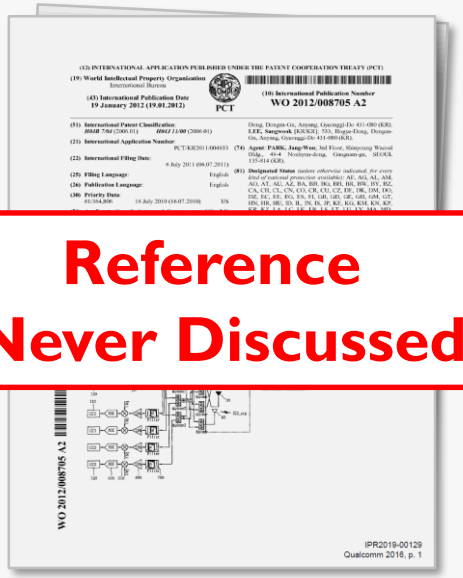
Kaukovuori



Cited Text Never Discussed

Ex. 1325

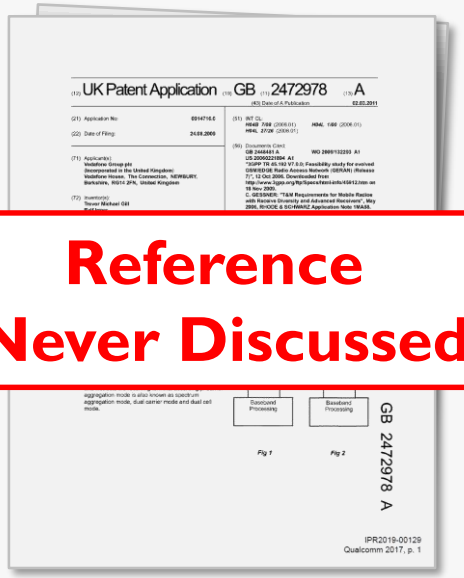
WO 2012/008705



Reference Never Discussed

Ex. 2016

GB 2472978



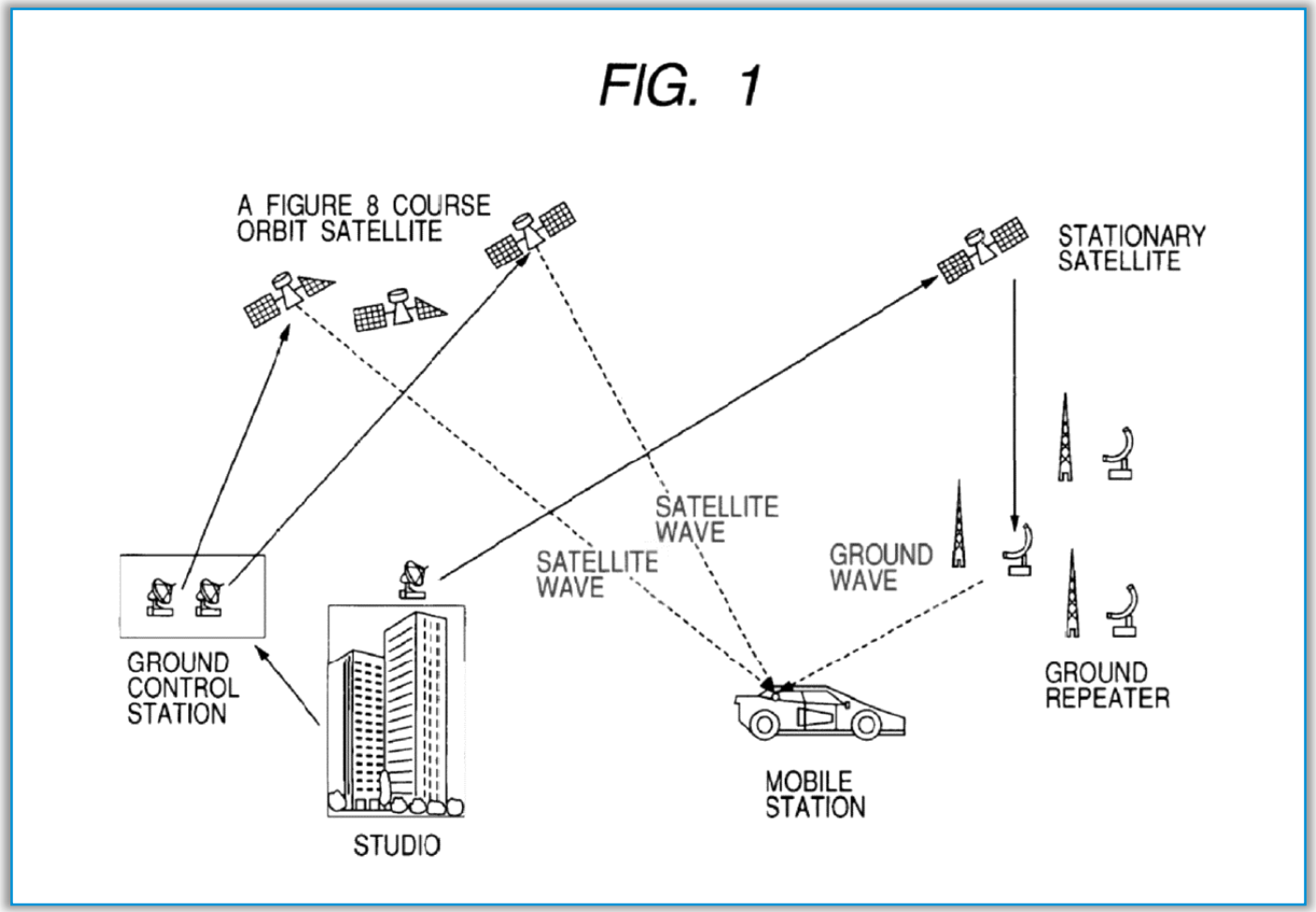
Reference Never Discussed

Ex. 2017

-00128 IPR, Paper 13 (POR) at 15-17

Claim Construction: "Carrier Aggregation"

Hirose



-00128 IPR, Paper 20 (Petitioner's Reply to POR) at 11, Fig. 1; Ex. 1314 at 2-6; Ex. 1315 at 7-10; Ex. 1324 Fig. 1

Claim Construction: "Carrier Aggregation"

Regarding amended independent claims 1 and 17, Applicant's amended independent claims 1 and 17 recite, *inter alia*, "the [] input RF signal employing ***carrier aggregation***," which is **not** disclosed in Hirose. Generally, Applicant's claimed invention recites "carrier aggregation" which results in an ***increased aggregated*** data rate. In contrast, Hirose transmits the same signals over different paths which results in ***redundant*** data at a ***common*** data rate. Specifically, the

-00128 IPR, Ex. 1315 (Patent Owner's June 6, 2014 Response) at 7 (annotated)

Applicant respectfully asserts that Hirose's "satellite wave signal and ground wave signal" do not result in "carrier aggregation" as claimed by Applicant in amended independent claims 1 and 17. As stated, Applicant's amended independent claims 1 and 17 recite, *inter alia*, "the [] input RF signal employing ***carrier aggregation***," while Hirose discloses ***redundant*** data at a ***common*** data rate. Specifically, Hirose discloses:

-00128 IPR, Ex. 1315 (Patent Owner's June 6, 2014 Response) at 8 (annotated)

Claim Construction: "Carrier Aggregation"

Petitioner's Reply

here refers to "data rate." Hirose's transmission of the "same signals over different paths" does not increase aggregated data rate because it "results in ***redundant*** data at a ***common*** data rate." Ex. 1315, 7 (bold, italics in original). Ex. 1339, ¶25. If Hirose's simultaneous signals contained non-redundant (*e.g.*, different) data, Patent Owner could not have made the argument that it did, and therefore the most natural reading of the prosecution history is that the applicant was distinguishing Hirose on the basis of its redundant transmissions. Dr. Fay's initial declaration explains this. Ex. 1302, ¶83. At a minimum, the competing interpretations of the prosecution history set forth in the Petition and in the POR demonstrate that any disclaimer was not "clear and unmistakable."[2] Ex. 1339, ¶25.

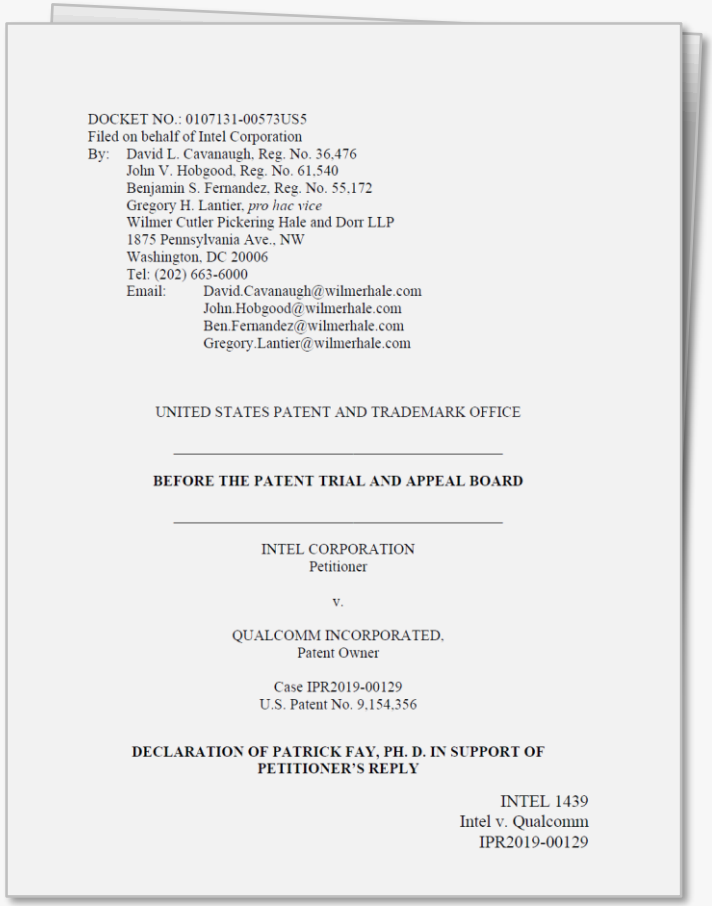
-00128 IPR, Paper 20 (Petitioner's Reply to POR) at 12 (annotated)

- ***Poly-America, L.P. v. API Indus.,***
  839 F.3d 1131, 1136 (Fed. Cir. 2016)
  - "[T]he standard for disavowal is exacting, requiring clear and unequivocal evidence that the claimed invention includes or does not include a particular feature."

-00128 IPR, Paper 20 (Petitioner's Reply to POR) at 10

Claim Construction: "Carrier Aggregation"

Petitioner's Construction Does Not Read Out "Aggregation"



DOCKET NO.: 0107131-00573US5
Filed on behalf of Intel Corporation
By: David L. Cavanaugh, Reg. No. 36,476
John V. Hobgood, Reg. No. 61,540
Benjamin S. Fernandez, Reg. No. 55,172
Gregory H. Lantier, *pro hac vice*
Wilmer Cutler Pickering Hale and Dorr LLP
1875 Pennsylvania Ave., NW
Washington, DC 20006
Tel: (202) 663-6000
Email: David.Cavanaugh@wilmerhale.com
John.Hobgood@wilmerhale.com
Ben.Fernandez@wilmerhale.com
Gregory.Lantier@wilmerhale.com

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

INTEL CORPORATION
Petitioner

v.

QUALCOMM INCORPORATED,
Patent Owner

Case IPR2019-00129
U.S. Patent No. 9,154,356

DECLARATION OF PATRICK FAY, PH. D. IN SUPPORT OF PETITIONER'S REPLY

INTEL 1439
Intel v. Qualcomm
IPR2019-00129

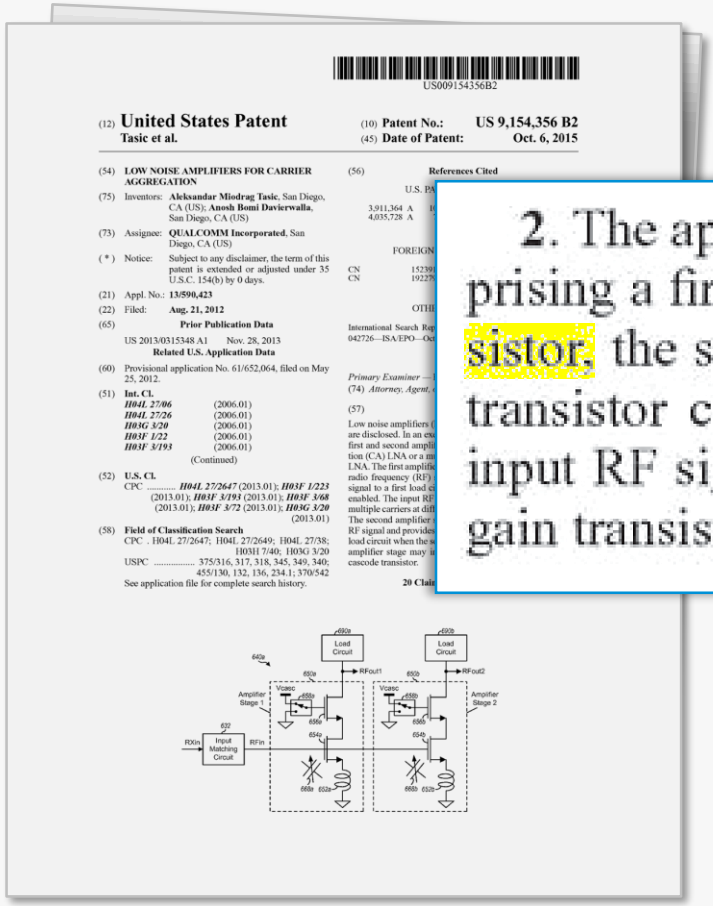
word "aggregation." POR, 28. I disagree. When the claimed "input RF signal" employs "simultaneous operation on multiple carriers," those carriers will be aggregated along the input RF signal. Pet., 49-51; Ex. 1402, ¶84 ("receiving and processing data on multiple carriers at the same time in a single input RF signal"). Thus, "carrier aggregation" in the context of the challenged claims accounts for aggregation (*i.e.*, collected together, assembled, as defined in the POR, at 29), because the multiple carriers would be present simultaneously in the input RF signal.

28. Because the '356 patent describes "carrier aggregation" as encompassing wireless devices that support "one or more radio technologies for wireless communication such as LTE, cdma2000, WCDMA, GSM, 802.11, etc.," when two or more carriers in a carrier aggregated signal are received according to "one or more" of these technologies, those carriers are all aggregated in the input RF signal (e.g. "RFin" in FIG. 6A) that enters the amplifier.

-00128 IPR, Ex. 1339 (Second Fay Decl.) at ¶¶ 27, 28 (annotated)

Anticipation by Lee of Claims 2-6

Anticipation by Lee of Claims 2-6



US009154356B2

(12) **United States Patent**
Tasic et al.

(10) **Patent No.: US 9,154,356 B2**
(45) **Date of Patent: Oct. 6, 2015**

(54) **LOW NOISE AMPLIFIERS FOR CARRIER AGGREGATION**

(75) Inventors: **Aleksandar Miodrag Tasic**, San Diego, CA (US); **Anosh Bomi Davierwalla**, San Diego, CA (US)

(73) Assignee: **QUALCOMM Incorporated**, San Diego, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **13/590,423**

(22) Filed: **Aug. 21, 2012**

(65) **Prior Publication Data**

US 2013/0315348 A1 Nov. 28, 2013

Related U.S. Application Data

(60) Provisional application No. 61/652,064, filed on May 25, 2012.

(51) **Int. Cl.**
H04L 27/06 (2006.01)
H04L 27/26 (2006.01)
H03G 3/20 (2006.01)
H03F 1/22 (2006.01)
H03F 3/193 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H04L 27/2647*** (2013.01); ***H03F 1/223*** (2013.01); ***H03F 3/193*** (2013.01); ***H03F 3/68*** (2013.01); ***H03F 3/72*** (2013.01); ***H03G 3/20*** (2013.01)

(58) **Field of Classification Search**
CPC . H04L 27/2647; H04L 27/2649; H04L 27/38; H03H 7/40; H03G 3/20
USPC 375/316, 317, 318, 345, 349, 340; 455/130, 132, 136, 234.1; 370/542
See application file for complete search history.

(56) **References Cited**

U.S. PA
3,911,364 A
4,035,728 A

FOREIGN
CN
CN

OTH

International Search Rep
042726—ISA/EPO—Oc

Primary Examiner
(74) *Attorney, Agent,*

(57)

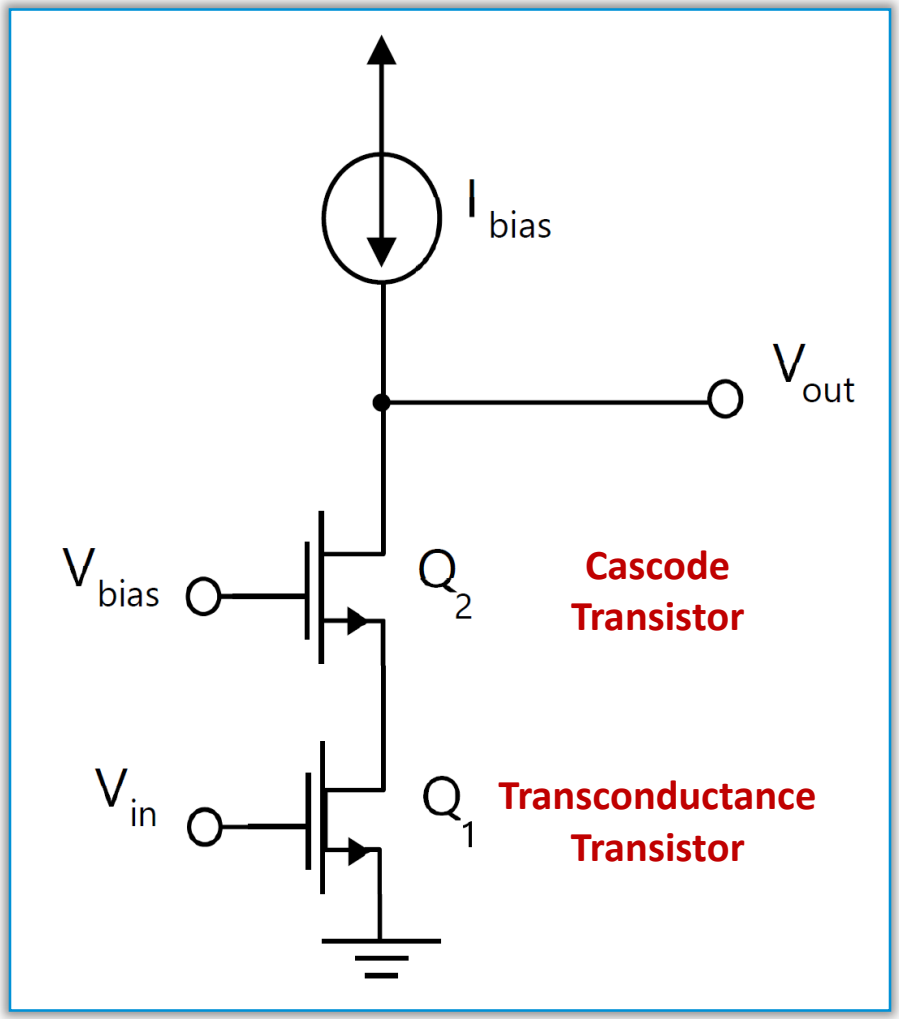
Low noise amplifiers (
are disclosed. In an ex
first and second ampli
tion (CA) LNA or a m
LNA. The first amplifi
radio frequency (RF)
signal to a first load ci
enabled. The input RF
multiple carriers at dif
The second amplifier
RF signal and provides
load circuit when the s
amplifier stage may i
cascode transistor.

20 Clai

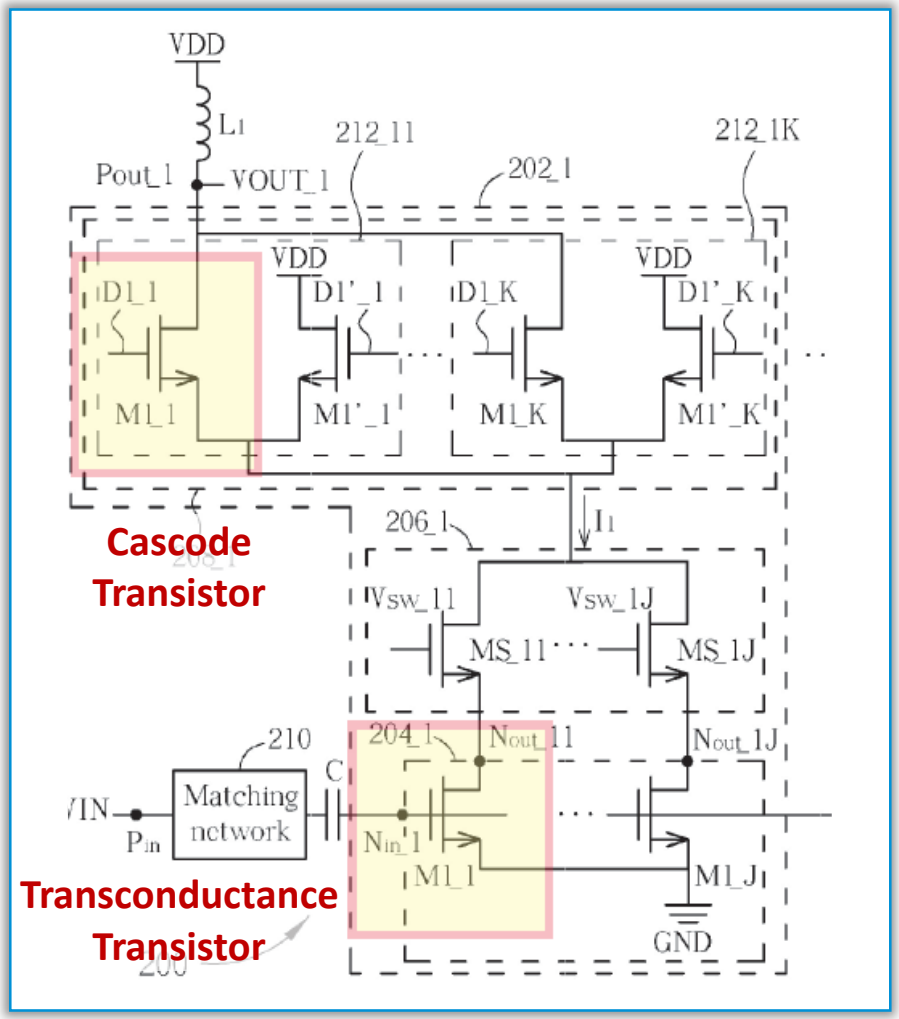
> **2**. The apparatus of claim **1**, the first amplifier stage comprising a first gain transistor coupled to a first cascode transistor, the second amplifier stage comprising a second gain transistor coupled to a second cascode transistor, and the input RF signal being provided to both the first and second gain transistors.

-00129 IPR, Ex. 1401 ('356 Patent), Claim 2 (annotated)

Anticipation by Lee of Claims 2-6



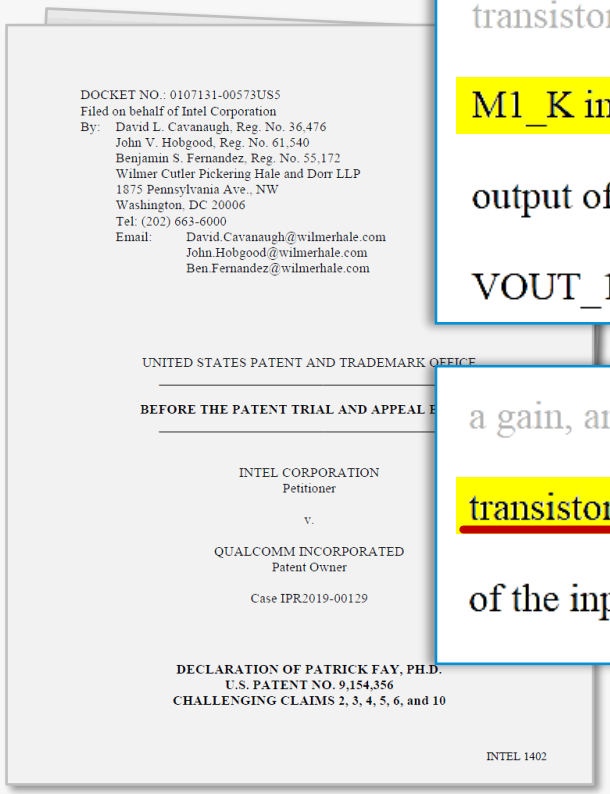
-00129 IPR, Paper 3 (Petition) at 12, Fig. 6



-00129 IPR, Ex. 1435 (Lee), Fig. 2 (annotated)

Anticipation by Lee of Claims 2-6

- Dr. Fay testified that Lee discloses the claimed cascode transistors


DOCKET NO.: 0107131-00573US5
Filed on behalf of Intel Corporation
By: David L. Cavanaugh, Reg. No. 36,476
John V. Hobgood, Reg. No. 61,540
Benjamin S. Fernandez, Reg. No. 55,172
Wilmer Cutler Pickering Hale and Dorr LLP
1875 Pennsylvania Ave., NW
Washington, DC 20006
Tel: (202) 663-6000
Email: David.Cavanaugh@wilmerhale.com
John.Hobgood@wilmerhale.com
Ben.Fernandez@wilmerhale.com

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL B

INTEL CORPORATION
Petitioner

v.

QUALCOMM INCORPORATED
Patent Owner

Case IPR2019-00129

DECLARATION OF PATRICK FAY, PH.D.
U.S. PATENT NO. 9,154,356
CHALLENGING CLAIMS 2, 3, 4, 5, 6, and 10

INTEL 1402

transistor element pairs 212_11-212_1K." *Id.* Thus, the transistors M1_1 and M1_K in the output stage 208_1 are cascode transistors because they couple the output of the input stage gain transistors M1_1 and M1_J to the amplifier output VOUT_1.

a gain, and the output stage 208_N transistors MN_1 and MN_L are cascode transistors because they couple the output of the gain transistors MN_1 and MN_I of the input stage 204_N to the amplifier output signal VOUT_N.

-00129 IPR, Ex. 1402 (Fay Decl.) at ¶¶ 97, 99 (annotated)

Anticipation by Lee of Claims 2-6

- The Board found Petitioner's evidence, including Dr. Fay's testimony, sufficient to show the claimed cascode transistors

Id. (citing Ex. 1435 ¶ 28). Petitioner contends that "transistors M1_1 and M1_K in the output stage 208_1 are cascode transistors because they couple the output of the input stage gain transistors M1_1 and M1_J to the amplifier output VOUT_1." Petitioner relies on the declaration testimony of Dr. Fay. *Id.* (citing Ex. 1402 ¶ 97).

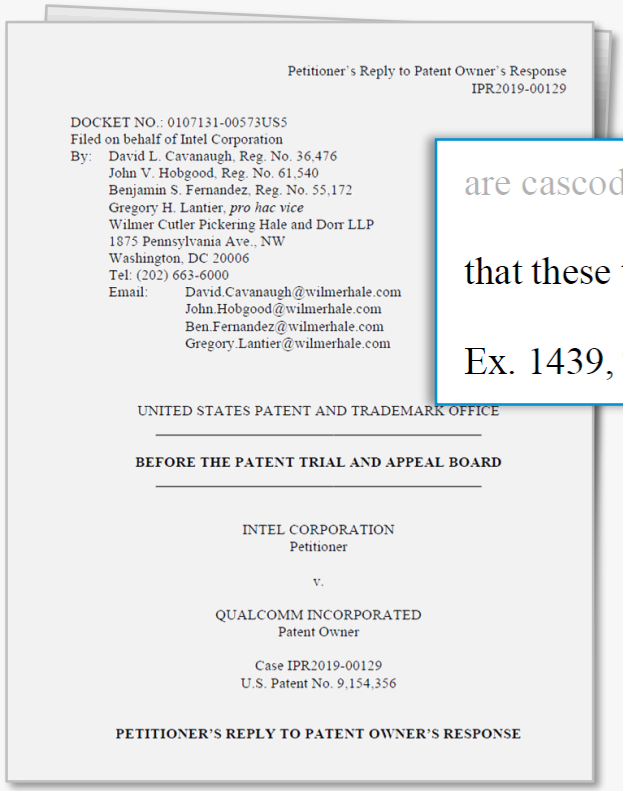
Based on the record before us, we are persuaded that Petitioner has shown sufficiently for purposes of this Decision that Lee discloses the recited "first amplifier stage."

(citing Ex. 1435 ¶¶ 26, 28). Petitioner contends that "[t]he input stage 204_N transistors are gain transistors because they receive and amplify an input RF signal according to a gain, and the output stage 208_N transistors MN_1 and MN_L are cascode transistors because they couple the output of the gain transistors MN_1 and MN_I of the input stage 204_N to the amplifier output signal VOUT_N." *Id.* Petitioner relies on the declaration testimony of Dr. Fay. *Id.* (citing Ex. 1402 ¶ 99). Based on the record before us, we are persuaded that Petitioner has shown sufficiently for purposes of this Decision that Lee discloses the recited "second amplifier stage."

-00129 IPR, Paper 9 (Institution Decision) at 28-29 (annotated)

Anticipation by Lee of Claims 2-6

- Despite Board's initial finding that Petitioner's evidence was sufficient to show the claimed cascode transistors, Patent Owner did not submit evidence that Lee ***does not*** disclose cascode transistors



Petitioner's Reply to Patent Owner's Response
IPR2019-00129

DOCKET NO.: 0107131-00573US5
Filed on behalf of Intel Corporation
By: David L. Cavanaugh, Reg. No. 36,476
John V. Hobgood, Reg. No. 61,540
Benjamin S. Fernandez, Reg. No. 55,172
Gregory H. Lantier, *pro hac vice*
Wilmer Cutler Pickering Hale and Dorr LLP
1875 Pennsylvania Ave., NW
Washington, DC 20006
Tel: (202) 663-6000
Email: David.Cavanaugh@wilmerhale.com
John.Hobgood@wilmerhale.com
Ben.Fernandez@wilmerhale.com
Gregory.Lantier@wilmerhale.com

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

INTEL CORPORATION
Petitioner

v.

QUALCOMM INCORPORATED
Patent Owner

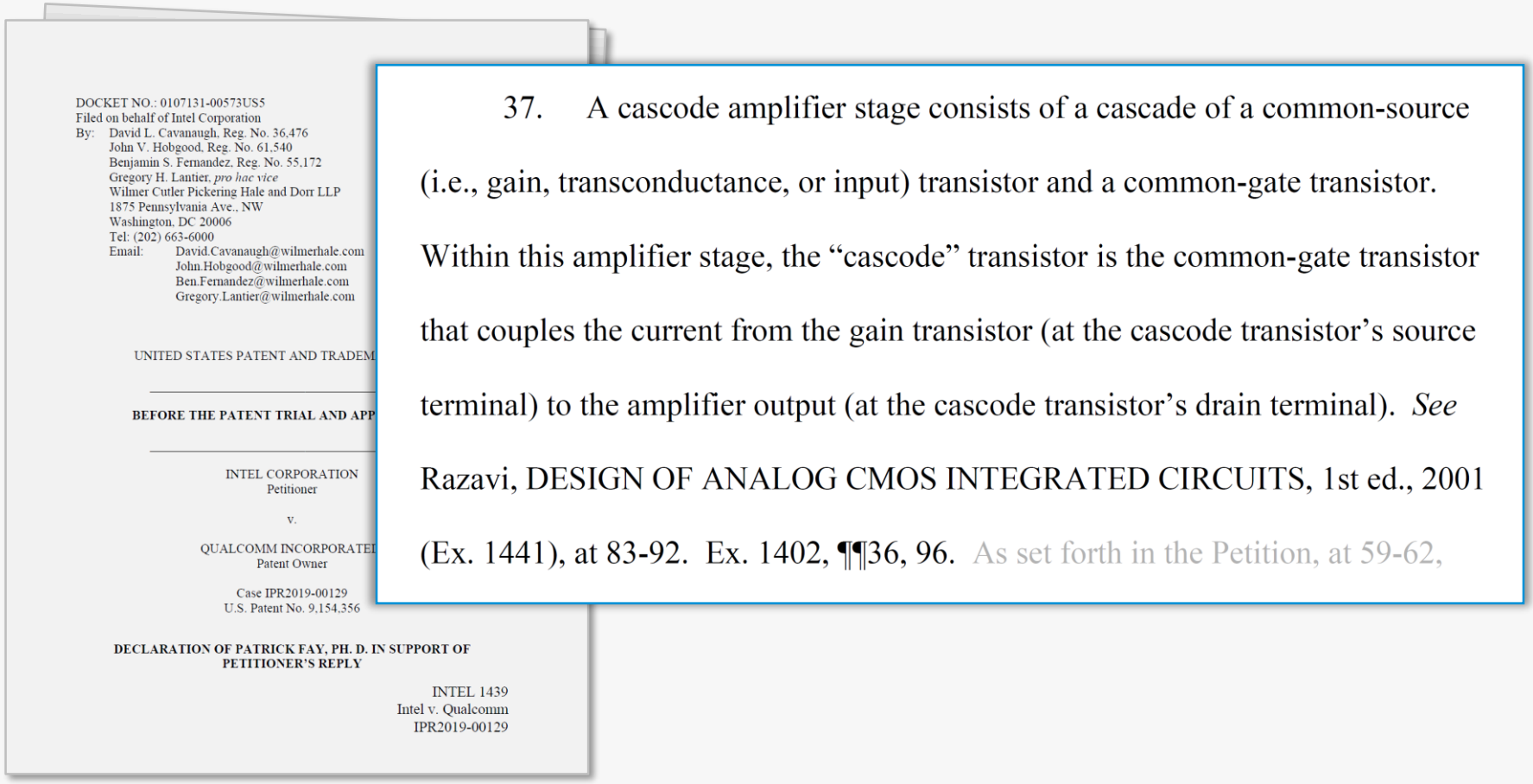
Case IPR2019-00129
U.S. Patent No. 9,154,356

PETITIONER'S REPLY TO PATENT OWNER'S RESPONSE

are cascode. *Id.*, 39-42. Notably, however, Patent Owner and its expert never state that these transistors are *not* cascode transistors. POR, 37-42; Ex. 2024, ¶¶153-161. Ex. 1439, ¶39.

-00129 IPR, Paper 20 (Petitioner's Reply to POR) at 7

Anticipation by Lee of Claims 2-6



DOCKET NO.: 0107131-00573US5
Filed on behalf of Intel Corporation
By: David L. Cavanaugh, Reg. No. 36,476
John V. Hobgood, Reg. No. 61,540
Benjamin S. Fernandez, Reg. No. 55,172
Gregory H. Lantier, *pro hac vice*
Wilmer Cutler Pickering Hale and Dorr LLP
1875 Pennsylvania Ave., NW
Washington, DC 20006
Tel: (202) 663-6000
Email: David.Cavanaugh@wilmerhale.com
John.Hobgood@wilmerhale.com
Ben.Fernandez@wilmerhale.com
Gregory.Lantier@wilmerhale.com

UNITED STATES PATENT AND TRADEM

BEFORE THE PATENT TRIAL AND APP

INTEL CORPORATION
Petitioner

v.

QUALCOMM INCORPORATED
Patent Owner

Case IPR2019-00129
U.S. Patent No. 9,154,356

DECLARATION OF PATRICK FAY, PH. D. IN SUPPORT OF PETITIONER'S REPLY

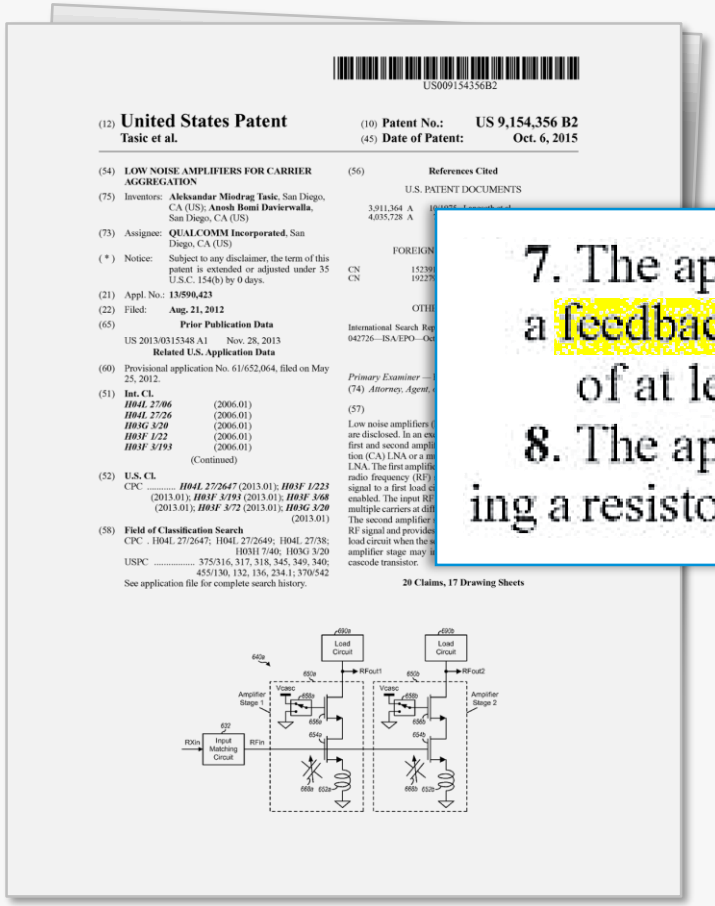
INTEL 1439
Intel v. Qualcomm
IPR2019-00129

37. A cascode amplifier stage consists of a cascade of a common-source (i.e., gain, transconductance, or input) transistor and a common-gate transistor. Within this amplifier stage, the "cascode" transistor is the common-gate transistor that couples the current from the gain transistor (at the cascode transistor's source terminal) to the amplifier output (at the cascode transistor's drain terminal). *See* Razavi, DESIGN OF ANALOG CMOS INTEGRATED CIRCUITS, 1st ed., 2001 (Ex. 1441), at 83-92. Ex. 1402, ¶¶36, 96. As set forth in the Petition, at 59-62,

-00129 IPR, Ex. 1439 (Second Fay Decl.) at ¶ 37; see also -00129 IPR, Ex. 1439 (Second Fay Decl.) at ¶¶ 41, 42

Anticipation by Lee of Claims 7-8

Anticipation by Lee of Claims 7-8



US009154356B2

(12) **United States Patent**
Tasic et al.

(10) **Patent No.: US 9,154,356 B2**
(45) **Date of Patent: Oct. 6, 2015**

(54) **LOW NOISE AMPLIFIERS FOR CARRIER AGGREGATION**

(75) Inventors: **Aleksandar Miodrag Tasic**, San Diego, CA (US); **Anosh Bomi Davierwalla**, San Diego, CA (US)

(73) Assignee: **QUALCOMM Incorporated**, San Diego, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **13/590,423**

(22) Filed: **Aug. 21, 2012**

(65) **Prior Publication Data**

US 2013/0315348 A1 Nov. 28, 2013

Related U.S. Application Data

(60) Provisional application No. 61/652,064, filed on May 25, 2012.

(51) **Int. Cl.**

H04L 27/06	(2006.01)
H04L 27/26	(2006.01)
H03G 3/20	(2006.01)
H03F 1/22	(2006.01)
H03F 3/193	(2006.01)

(Continued)

(52) **U.S. Cl.**

CPC ***H04L 27/2647*** (2013.01); ***H03F 1/223*** (2013.01); ***H03F 3/193*** (2013.01); ***H03F 3/68*** (2013.01); ***H03F 3/72*** (2013.01); ***H03G 3/20*** (2013.01)

(58) **Field of Classification Search**

CPC . H04L 27/2647; H04L 27/2649; H04L 27/38; H03H 7/40; H03G 3/20

USPC 375/316, 317, 318, 345, 349, 340; 455/130, 132, 136, 234.1; 370/542

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,911,364 A
4,035,728 A

FOREIGN

CN
CN

OTH

International Search Rep
042726—ISA/EPO—Oc

Primary Examiner
(74) *Attorney, Agent,*

(57)

Low noise amplifiers (
are disclosed. In an ex
first and second amplif
tion (CA) LNA or a m
LNA. The first amplifie
radio frequency (RF)
signal to a first load c
enabled. The input RF
multiple carriers at dif
The second amplifier
RF signal and provides
load circuit when the w
amplifier stage may i
cascode transistor.

20 Claims, 17 Drawing Sheets

7. The apparatus of claim 1, further comprising:
a feedback circuit coupled between an output and an input of at least one of the first and second amplifier stages.
8. The apparatus of claim 7, the feedback circuit comprising a resistor, or a capacitor, or both a resistor and a capacitor.

-00128 IPR, Ex. 1301 ('356 Patent), Claims 7-8 (annotated)

Anticipation by Lee of Claims 7-8

- Lee figure 4 discloses all elements of claims 7-8, including a "feedback circuit"

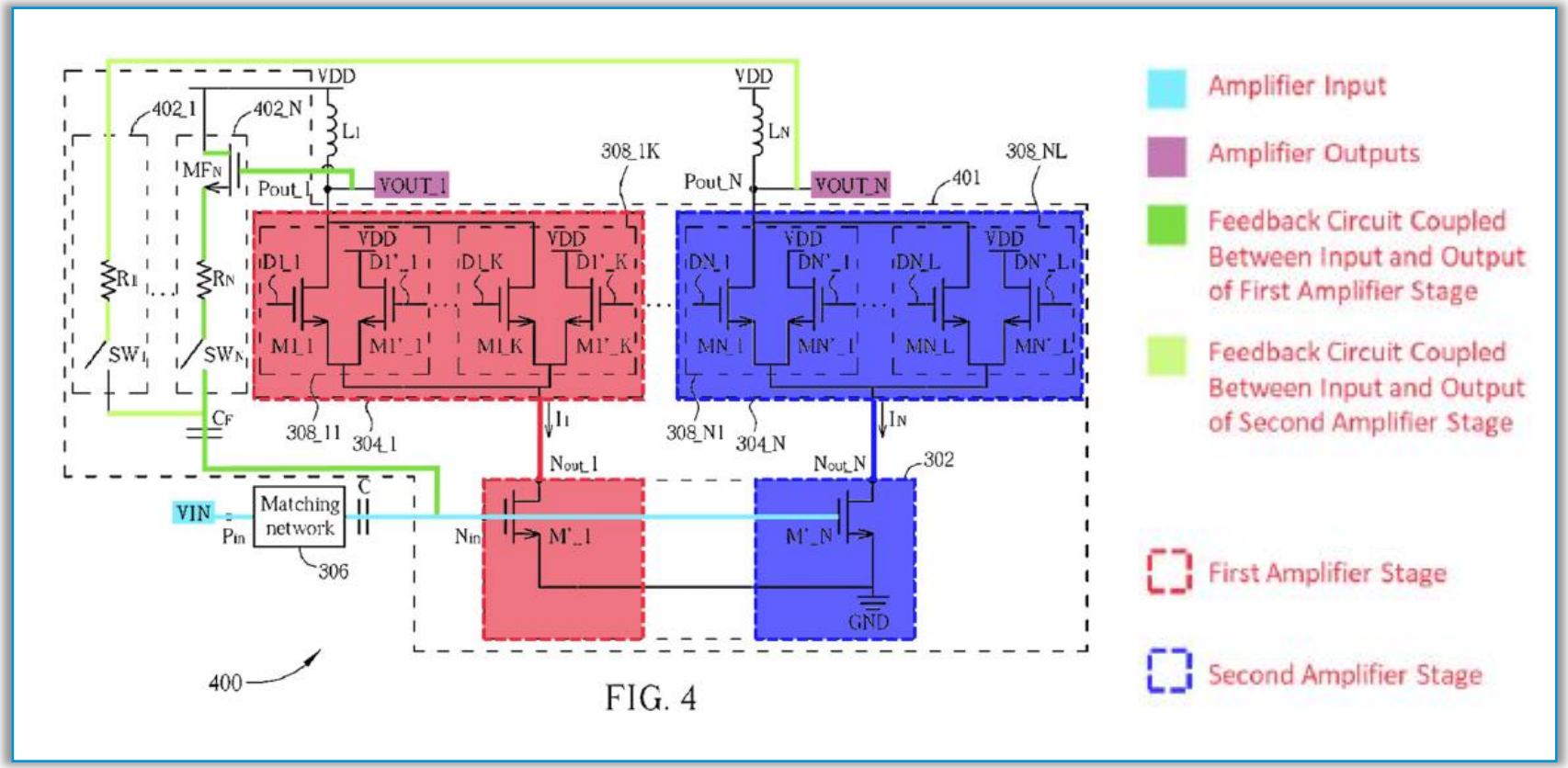
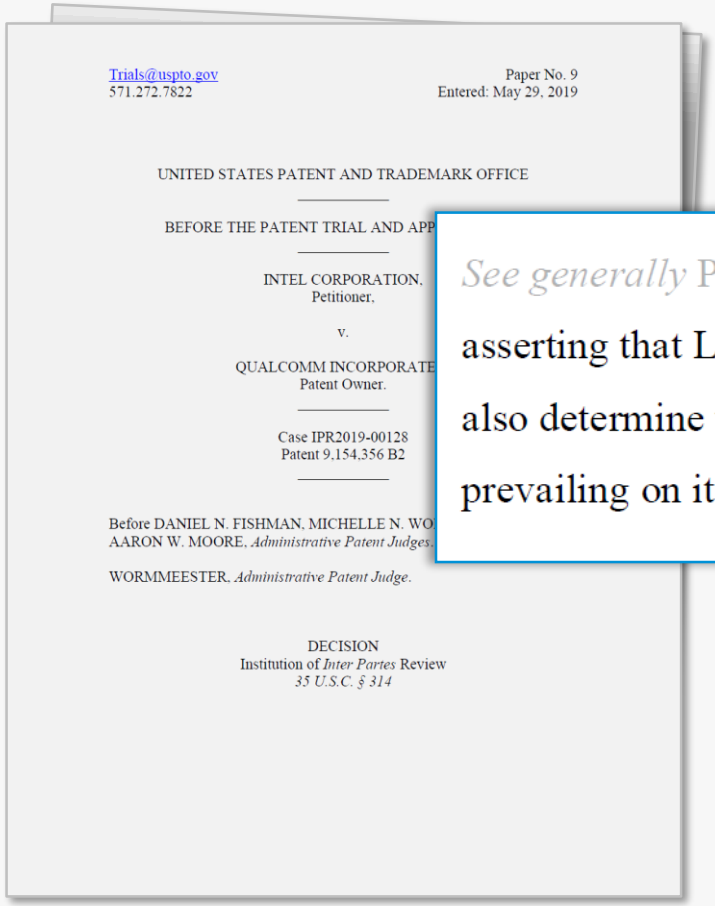


FIG. 4

-00128 IPR, Paper 3 (Petition) at 57; -00128 IPR, Ex. 1335 (Lee), Fig. 4 (annotated)

Anticipation by Lee of Claims 7-8



Trials@uspto.gov
571.272.7822

Paper No. 9
Entered: May 29, 2019

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APP

INTEL CORPORATION,
Petitioner,

v.

QUALCOMM INCORPORATE
Patent Owner.

Case IPR2019-00128
Patent 9,154,356 B2

Before DANIEL N. FISHMAN, MICHELLE N. WO
AARON W. MOORE, *Administrative Patent Judges*.

WORMMEESTER, *Administrative Patent Judge*.

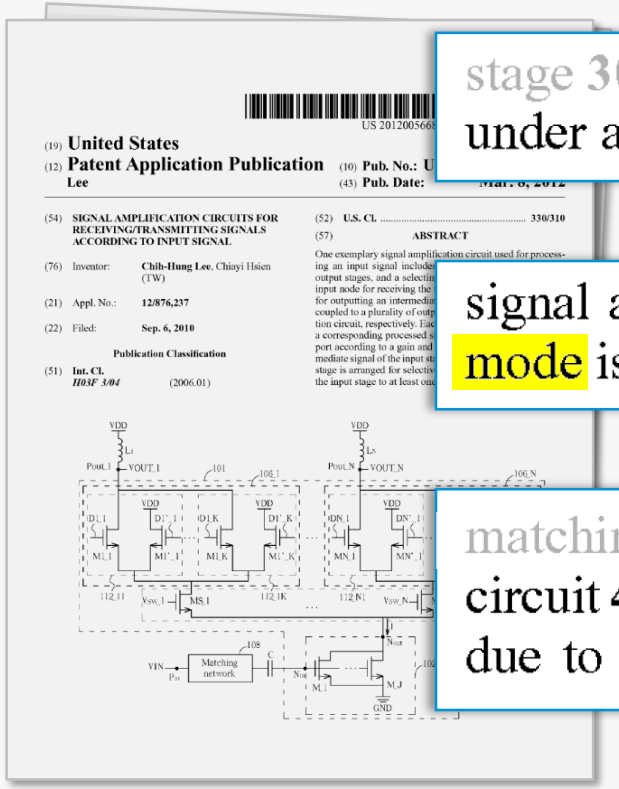
DECISION
Institution of *Inter Partes* Review
35 U.S.C. § 314

See generally Prelim. Resp. Having reviewed Petitioner's arguments asserting that Lee anticipates claims 7, 8, 11, 17, and 18 (*see* Pet. 56–68), we also determine that Petitioner has demonstrated a reasonable likelihood of prevailing on its assertion as to these dependent claims.

-00128 IPR, Paper 9 (Institution Decision) at 27

Anticipation by Lee of Claims 7-8

- The embodiment of Lee Figure 4 operates in both a "shared mode" and a "combo mode"



US 20120056[illegible]

(19) **United States**

(12) **Patent Application Publication**

(10) **Pub. No.:** U[illegible]

(43) **Pub. Date:** [illegible]

Lee

(54) **SIGNAL AMPLIFICATION CIRCUITS FOR RECEIVING/TRANSMITTING SIGNALS ACCORDING TO INPUT SIGNAL**

(76) Inventor: **Chih-Hung Lee**, Chiayi Hsien (TW)

(21) Appl. No.: **12/876,237**

(22) Filed: **Sep. 6, 2010**

Publication Classification

(51) **Int. Cl.** *H03F 3/04* (2006.01)

(52) **U.S. Cl.** **330/310**

(57) **ABSTRACT**

One exemplary signal amplification circuit used for processing an input signal includes[illegible] output stages, and a selectin[illegible] input node for receiving the[illegible] for outputting an intermedia[illegible] coupled to a plurality of outp[illegible] tion circuit, respectively. Eac[illegible] a corresponding processed s[illegible] port according to a gain and[illegible] mediate signal of the input st[illegible] stage is arranged for selectiv[illegible] the input stage to at least one[illegible]

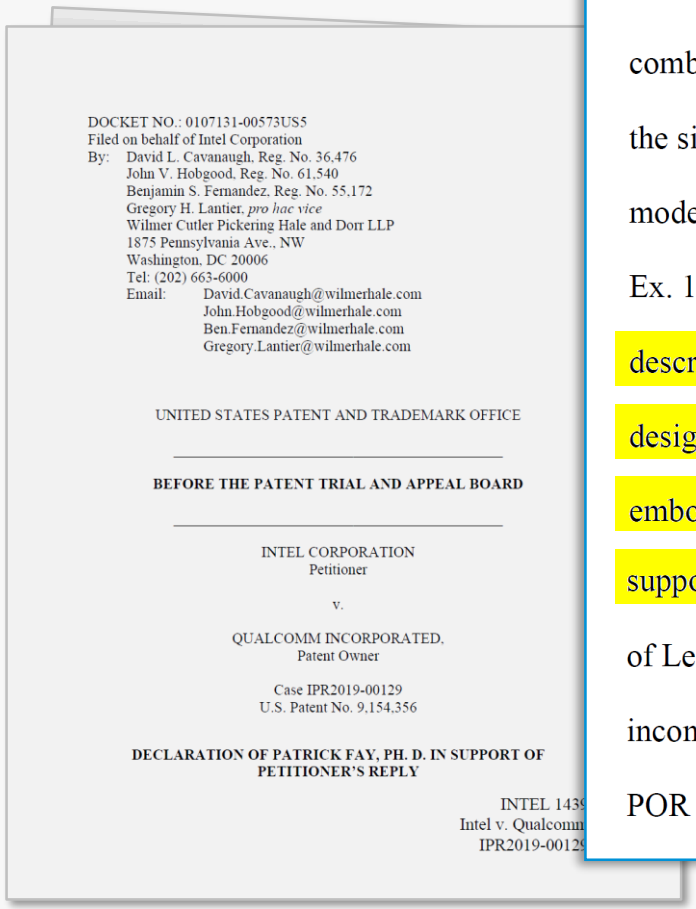
stage 304_1 of the signal amplification circuit **400** operating under a shared mode is enabled. Additionally, regarding the

signal amplification circuit **400** operating under the shared mode is enabled.

matching. In an alternative design, the signal amplification circuit **400** shown in FIG. **4** may operate under a combo mode due to the implemented feedback elements **402_1-402_N**.

-00128 IPR, Ex. 1335 (Lee) at [0038], [0041] (annotated)

Anticipation by Lee of Claims 7-8



DOCKET NO.: 0107131-00573US5
Filed on behalf of Intel Corporation
By: David L. Cavanaugh, Reg. No. 36,476
John V. Hobgood, Reg. No. 61,540
Benjamin S. Fernandez, Reg. No. 55,172
Gregory H. Lantier, *pro hac vice*
Wilmer Cutler Pickering Hale and Dorr LLP
1875 Pennsylvania Ave., NW
Washington, DC 20006
Tel: (202) 663-6000
Email: David.Cavanaugh@wilmerhale.com
John.Hobgood@wilmerhale.com
Ben.Fernandez@wilmerhale.com
Gregory.Lantier@wilmerhale.com

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

INTEL CORPORATION
Petitioner

v.

QUALCOMM INCORPORATED,
Patent Owner

Case IPR2019-00129
U.S. Patent No. 9,154,356

DECLARATION OF PATRICK FAY, PH. D. IN SUPPORT OF PETITIONER'S REPLY

INTEL 143
Intel v. Qualcomm
IPR2019-0012

38. A POSITA would understand that the circuit 400 of Lee operates in combo mode, in addition to shared mode. Ex. 1335, ¶41 ("In an alternative design, the signal amplification circuit 400 shown in FIG. 4 may operate under a combo mode"), ¶38 (describing exemplary operation "under the shared mode"), ¶¶42, 33; Ex. 1302, ¶92. A POSITA would understand that operation in the shared mode described in paragraph [0038] and elsewhere in Lee would apply in "the alternative design" of Lee paragraph [0041], and that the Petition does not "mix[] different embodiments" for its anticipation grounds; the shared and combo modes are supported by the same Fig. 4 embodiment. Nothing in paragraphs [0036] or [0037] of Lee (which from context is directed to circuits 100, 300, and Fig. 3) is inconsistent with Petitioner's anticipation grounds for claims 7 and 8, and thus the POR does not rebut Petitioner's showing of anticipation.

-00128 IPR, Ex. 1339 (Second Fay Decl.) at ¶ 38 (annotated)

Motivation to Combine Embodiments of Lee

Motivation to Combine Embodiments of Lee

- Motivation to incorporate the feedback circuit of Lee Figure 4 into the signal amplification circuit of Lee Figure 2 is directly supported by Lee's specification

-00128 IPR, Paper 3 (Petition) at 70-71

[0039] With the feedback elements implemented in the signal amplification circuit **400**, the input matching performance can be improved greatly. For example, a wider input frequency range can be covered by the signal amplification circuit **400**. In a case where the matching network **306** is

-00128 IPR, Ex. 1335 (Lee) at [0039] (annotated)

Motivation to Combine Embodiments of Lee

Institution Decision

> "feedback circuit" in both claims 7 and 8. We also are persuaded that Petitioner's proffered reasoning for modifying the signal amplification circuit of Figure 2 of Lee to include the feedback elements of Figure 4 of Lee, namely, to improve input matching performance, is sufficient to support the legal conclusion of obviousness. *See In re Kahn*, 441 F.3d 977, 988

-00128 IPR, Paper 9 (Institution Decision) at 29

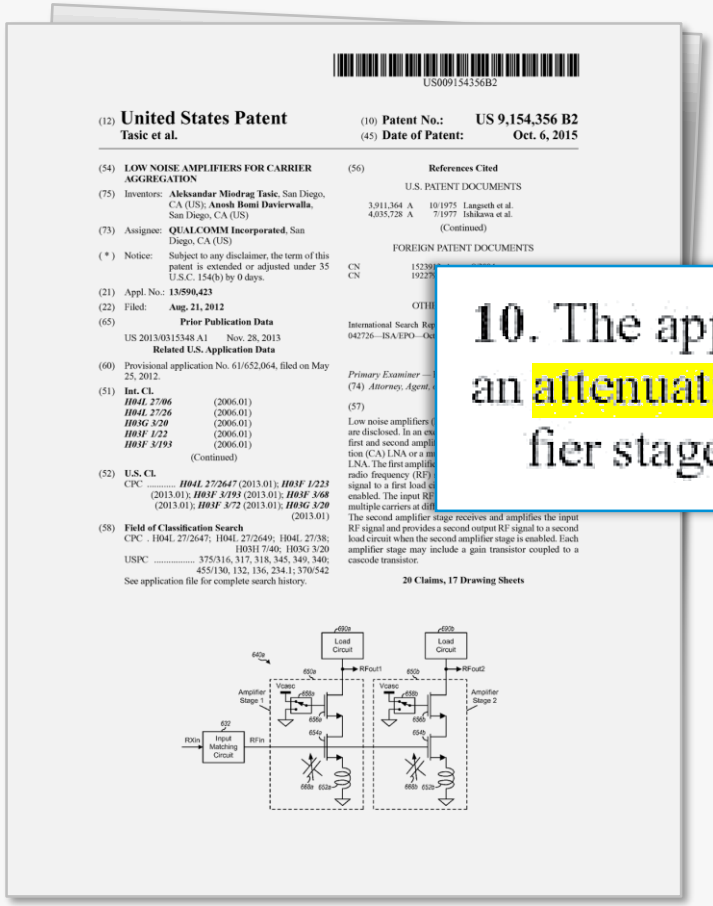
- Neither Patent Owner nor Dr. Foty states that a skilled artisan would ***not*** be motivated to incorporate the feedback circuit of Lee figure 4 into the signal amplification circuit of Lee figure 2

-00128 IPR, Paper 20 (Petitioner's Reply to POR) at 21

Motivation to Combine Lee and Youssef

Motivation to Combine Lee and Youssef

Claim 10



US009154356B2

(12) **United States Patent**
Tasic et al.

(10) **Patent No.: US 9,154,356 B2**
(45) **Date of Patent: Oct. 6, 2015**

(54) **LOW NOISE AMPLIFIERS FOR CARRIER AGGREGATION**

(75) Inventors: **Aleksandar Miodrag Tasic**, San Diego, CA (US); **Anosh Bomi Davierwalla**, San Diego, CA (US)

(73) Assignee: **QUALCOMM Incorporated**, San Diego, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **13/590,423**

(22) Filed: **Aug. 21, 2012**

(65) **Prior Publication Data**

US 2013/0315348 A1 Nov. 28, 2013

Related U.S. Application Data

(60) Provisional application No. 61/652,064, filed on May 25, 2012.

(51) **Int. Cl.**
H04L 27/06 (2006.01)
H04L 27/26 (2006.01)
H03G 3/20 (2006.01)
H03F 1/22 (2006.01)
H03F 3/193 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H04L 27/2647*** (2013.01); ***H03F 1/223*** (2013.01); ***H03F 3/193*** (2013.01); ***H03F 3/68*** (2013.01); ***H03F 3/72*** (2013.01); ***H03G 3/20*** (2013.01)

(58) **Field of Classification Search**
CPC . H04L 27/2647; H04L 27/2649; H04L 27/38; H03H 7/40; H03G 3/20
USPC 375/316, 317, 318, 345, 349, 340; 455/130, 132, 136, 234.1; 370/542
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,911,364 A 10/1975 Langseth et al.
4,035,728 A 7/1977 Ishikawa et al.
(Continued)

FOREIGN PATENT DOCUMENTS

CN
CN

OTH

International Search Rep
042726—ISA/EPO—Oct

Primary Examiner
(74) *Attorney, Agent*

(57)

Low noise amplifiers (
are disclosed. In an ex
first and second amplif
tion (CA) LNA or a m
LNA. The first amplifie
radio frequency (RF)
signal to a first load ci
enabled. The input RF
multiple carriers at diff
The second amplifier stage receives and amplifies the input RF signal and provides a second output RF signal to a second load circuit when the second amplifier stage is enabled. Each amplifier stage may include a gain transistor coupled to a cascode transistor.

20 Claims, 17 Drawing Sheets

10. The apparatus of claim **1**, further comprising: an attenuation circuit coupled to the first and second amplifier stages and configured to receive the input RF signal.

-00129 IPR, Ex. 1401 ('356 Patent), Claim 10 (annotated)

Motivation to Combine Lee and Youssef

Digitally-Controlled RF Passive At
CMOS for Mobile TV Tu

Ahmed Youssef and James Haslett
Electrical and Computer Engineering Department
University of Calgary
Alberta, Canada

Abstract—**A novel VHF/UHF passive attenuator linearization circuit suitable for mobile TV applications has been designed and implemented in 65 nm CMOS technology. The proposed attenuator has a wide gain range of 48 dB that can be digitally programmed in 3 to 6 dB steps. At every gain setting, the input and output of the attenuator are matched to 50 Ω to facilitate its integration into mobile TV tuners.**

I. INTRODUCTION

Mobile TV is one of the latest features to be added to cell phones and other hand-held devices. The low cost, low power, and small size demands of this application have pushed researchers to use nanometer CMOS technologies in designing high performance tuner chip sets. The bulky RF filters (i.e., SAW filters) usually used in traditional TV-can tuners to suppress far-away interferer blockers are thus not an option for these integrated tuners. This results in tightening the linearity requirement of the RF front-end needed for mobile TV reception, and hence demands innovative design techniques to adhere to the low power necessities for this application [1].

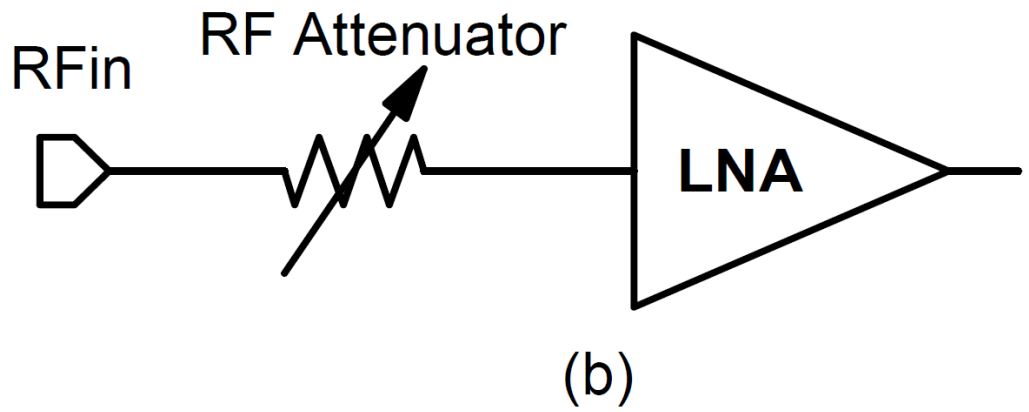
The RF-AGC (Automatic gain control) technique has been proposed recently in the literature as one of the low power solutions that can help mobile TV receivers achieve their stringent linearity requirements [2]-[4]. Decreasing the RF gain at large input signal levels helps the receiver pass larger signals without any degradation in the output SNR (Signal-to-Noise Ratio). Although there are many mechanisms to vary the RF gain in receivers, the efficacy of any given mechanism depends on the amount of the dynamic range that can be achieved while decreasing the RF gain.

This paper proposes an RF attenuator linearization circuit used to vary the RF gain of mobile TV receivers while maximizing their dynamic range. The paper describes a passive attenuator designed, implemented in 65 nm CMOS technology and characterized in the lab. Additionally, a 5 bit linear thermometer decoder [5] integrated in the same test chip is used to program the gain of the attenuator. The decoder sets the gain value according to the signal level received at the attenuator input. Also, an on-chip programmable matching network is used to provide a stable 50 Ω input resistance

978-1-4244-5309-2/10/$26.00 ©2010 IEEE 1999

INTEL 1409

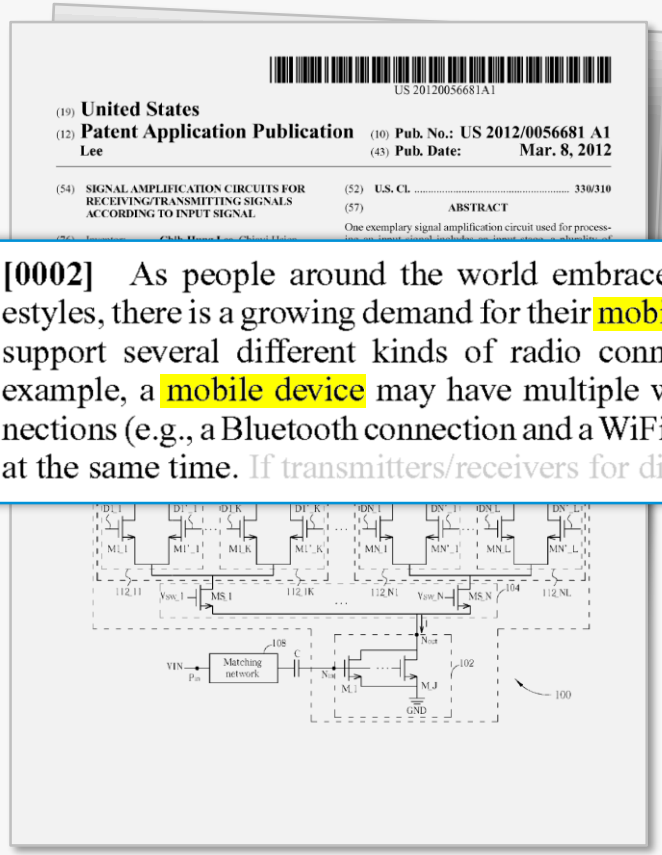
This paper proposes an RF attenuator linearization circuit used to vary the RF gain of mobile TV receivers while maximizing their dynamic range. The paper describes a



-00129 IPR, Ex. 1409 (Youssef) at 1999, Fig. 1(b)

Motivation to Combine Lee and Youssef

Lee



US 20120056681A1

(19) **United States**

(12) **Patent Application Publication**

Lee

(10) **Pub. No.: US 2012/0056681 A1**

(43) **Pub. Date: Mar. 8, 2012**

(54) **SIGNAL AMPLIFICATION CIRCUITS FOR RECEIVING/TRANSMITTING SIGNALS ACCORDING TO INPUT SIGNAL**

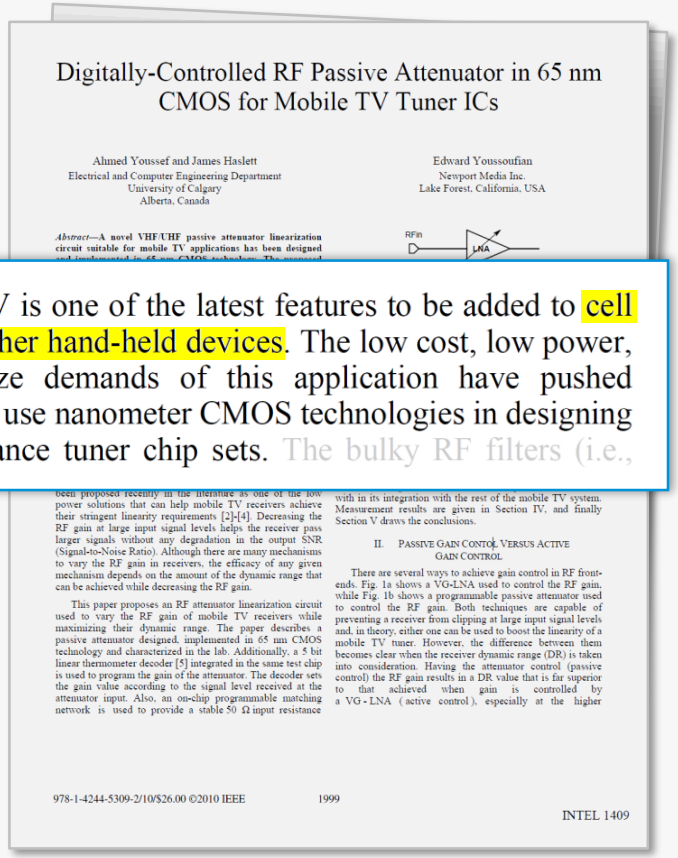
(52) **U.S. Cl.** **330/310**

(57) **ABSTRACT**

One exemplary signal amplification circuit used for process-

[0002] As people around the world embrace mobile lifestyles, there is a growing demand for their mobile devices to support several different kinds of radio connections. For example, a mobile device may have multiple wireless connections (e.g., a Bluetooth connection and a WiFi connection) at the same time. If transmitters/receivers for different radio

Youssef



Digitally-Controlled RF Passive Attenuator in 65 nm CMOS for Mobile TV Tuner ICs

Ahmed Youssef and James Haslett
Electrical and Computer Engineering Department
University of Calgary
Alberta, Canada

Edward Youssoufian
Newport Media Inc.
Lake Forest, California, USA

Abstract—A novel VHF/UHF passive attenuator linearization circuit suitable for mobile TV applications has been designed

Mobile TV is one of the latest features to be added to cell phones and other hand-held devices. The low cost, low power, and small size demands of this application have pushed researchers to use nanometer CMOS technologies in designing high performance tuner chip sets. The bulky RF filters (i.e.,

been proposed recently in the literature as one of the low power solutions that can help mobile TV receivers achieve their stringent linearity requirements [2]-[4]. Decreasing the RF gain at large input signal levels helps the receiver pass larger signals without any degradation in the output SNR (Signal-to-Noise Ratio). Although there are many mechanisms to vary the RF gain in receivers, the efficacy of any given mechanism depends on the amount of the dynamic range that can be achieved while decreasing the RF gain.

This paper proposes an RF attenuator linearization circuit used to vary the RF gain of mobile TV receivers while maximizing their dynamic range. The paper describes a passive attenuator designed, implemented in 65 nm CMOS technology and characterized in the lab. Additionally, a 5 bit linear thermometer decoder [5] integrated in the same test chip is used to program the gain of the attenuator. The decoder sets the gain value according to the signal level received at the attenuator input. Also, an on-chip programmable matching network is used to provide a stable 50 Ω input resistance

with in its integration with the rest of the mobile TV system. Measurement results are given in Section IV, and finally Section V draws the conclusions.

II. Passive Gain Control Versus Active Gain Control

There are several ways to achieve gain control in RF front-ends. Fig. 1a shows a VG-LNA used to control the RF gain, while Fig. 1b shows a programmable passive attenuator used to control the RF gain. Both techniques are capable of preventing a receiver from clipping at large input signal levels and, in theory, either one can be used to boost the linearity of a mobile TV tuner. However, the difference between them becomes clear when the receiver dynamic range (DR) is taken into consideration. Having the attenuator control (passive control) the RF gain results in a DR value that is far superior to that achieved when gain is controlled by a VG-LNA (active control), especially at the higher

978-1-4244-5309-2/10/$26.00 ©2010 IEEE

INTEL 1409

-00129 IPR, Ex. 1435 (Lee) at [0002] (annotated); -00129 IPR, Ex. 1409 (Youssef) at 1999 (annotated)

Motivation to Combine Lee and Youssef

Fay Declaration

DOCKET NO.: 0107131-00573US5
Filed on behalf of Intel Corporation
By: David L. Cavanaugh, Reg. No. 36,476
John V. Hobgood, Reg. No. 61,540
Benjamin S. Fernandez, Reg. No. 55,172
Wilmer Cutler Pickering Hale and Dorr LLP
1875 Pennsylvania Ave., NW

125. A person of ordinary skill in the art would have been motivated to couple the first and second amplifier stages of the LNA of Lee to the attenuation circuit of Youssef to prevent signal clipping and suppress interfering signals.

126. Moreover, a person of ordinary skill in the art would have been motivated to couple the attenuation circuit of Youssef to the first and second amplifier stages of Lee to improve dynamic range and linearity. *See* EX1409-

Case IPR2019-00129

DECLARATION OF PATRICK FAY, PH.D.
U.S. PATENT NO. 9,154,356
CHALLENGING CLAIMS 2, 3, 4, 5, 6, and 10

INTEL 1402

Youssef

ends. Fig. 1a shows a VG-LNA used to control the RF gain, while Fig. 1b shows a programmable passive attenuator used to control the RF gain. Both techniques are capable of preventing a receiver from clipping at large input signal levels and, in theory, either one can be used to boost the linearity of a mobile TV tuner. However, the difference between them

University of Calgary
Alberta, Canada

Lake Forest, California, USA

TV applications presents several challenges. Such an attenuator has to achieve certain characteristics so that it can protect the RF performance of a mobile TV receiver in the presence of interferer blockers as high as 0 dBm. Typically, it

suppress far-away interferer blockers are thus not an option for these integrated tuners. This results in tightening the linearity

to the mobile TV antenna for the entire gain range.

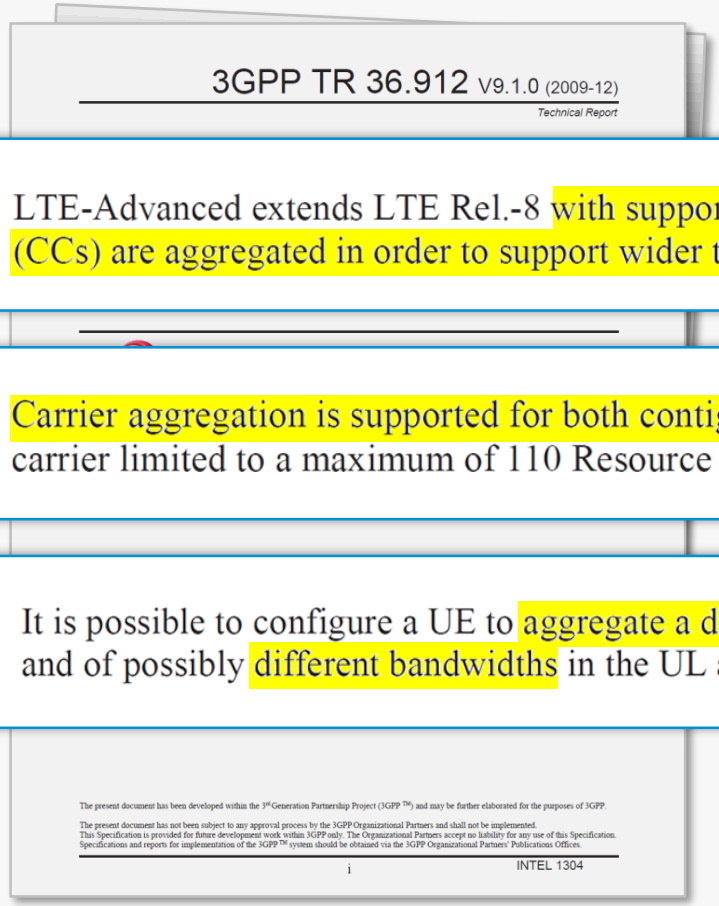
This paper is organized as follows. Section II discusses the

to control the RF gain. Both techniques are capable of preventing a receiver from clipping at large input signal levels and, in theory, either one can be used to boost the linearity of a mobile TV tuner. However, the difference between them becomes clear when the receiver dynamic range (DR) is taken into consideration. Having the attenuator control (passive control) the RF gain results in a DR value that is far superior to that achieved when gain is controlled by a VG-LNA (active control), especially at the higher attenuation (lower gain) settings.

-00129 IPR, Ex. 1402 (Fay Decl.) at ¶¶ 125, 126 (annotated); Ex. 1439 (Second Fay Decl.) at ¶¶ 44, 45 (annotated);
-00129 IPR, Ex. 1409 (Youssef) at 1999-2000 (annotated)

Motivation to Combine Lee and Feasibility Study

Motivation to Combine Lee and Feasibility Study



3GPP TR 36.912 V9.1.0 (2009-12)
Technical Report

LTE-Advanced extends LTE Rel.-8 with support for *Carrier Aggregation*, where two or more *component carriers* (CCs) are aggregated in order to support wider transmission bandwidths up to 100MHz and for spectrum aggregation.

Carrier aggregation is supported for both contiguous and non-contiguous component carriers with each component carrier limited to a maximum of 110 Resource Blocks in the frequency domain using the LTE Rel-8 numerology

It is possible to configure a UE to aggregate a different number of component carriers originating from the same eNB and of possibly different bandwidths in the UL and the DL. In typical TDD deployments, the number of component

The present document has been developed within the 3rd Generation Partnership Project (3GPP ™) and may be further elaborated for the purposes of 3GPP.

The present document has not been subject to any approval process by the 3GPP Organizational Partners and shall not be implemented.
This Specification is provided for future development work within 3GPP only. The Organizational Partners accept no liability for any use of this Specification.
Specifications and reports for implementation of the 3GPP™ system should be obtained via the 3GPP Organizational Partners' Publications Offices.

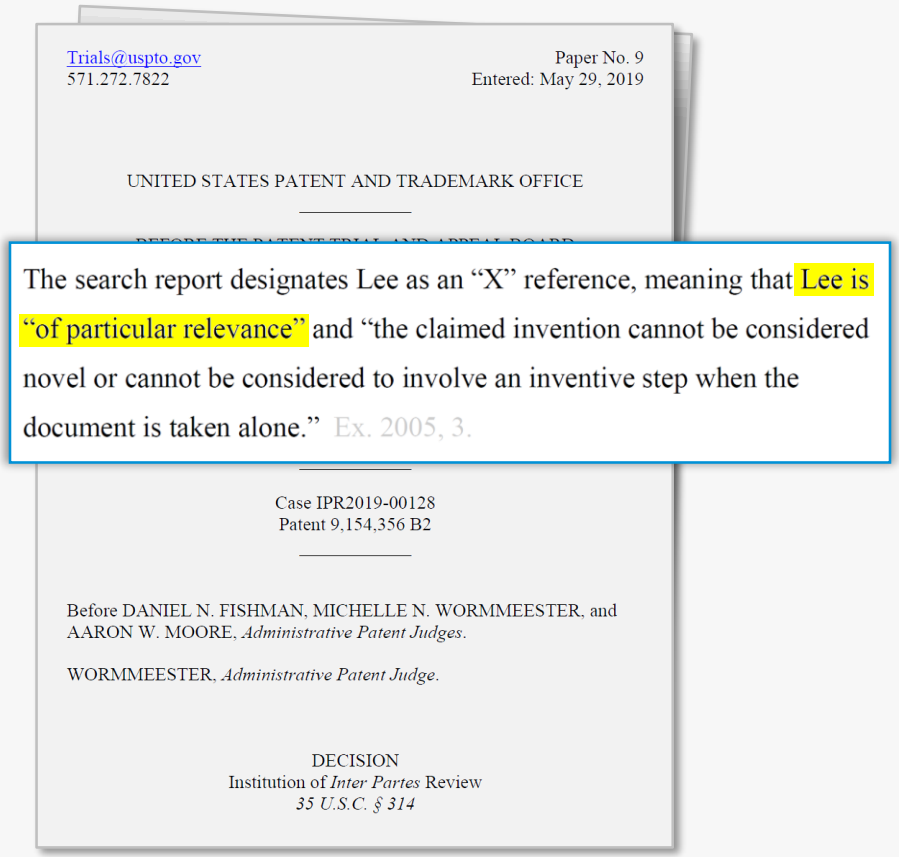
i

INTEL 1304

-00128 IPR, Ex. 1304 (Feasibility Study) at 8-9 (annotated)

Motivation to Combine Lee and Feasibility Study

Lee and Feasibility Study Are Analogous Art



Trials@uspto.gov
571.272.7822

Paper No. 9
Entered: May 29, 2019

UNITED STATES PATENT AND TRADEMARK OFFICE

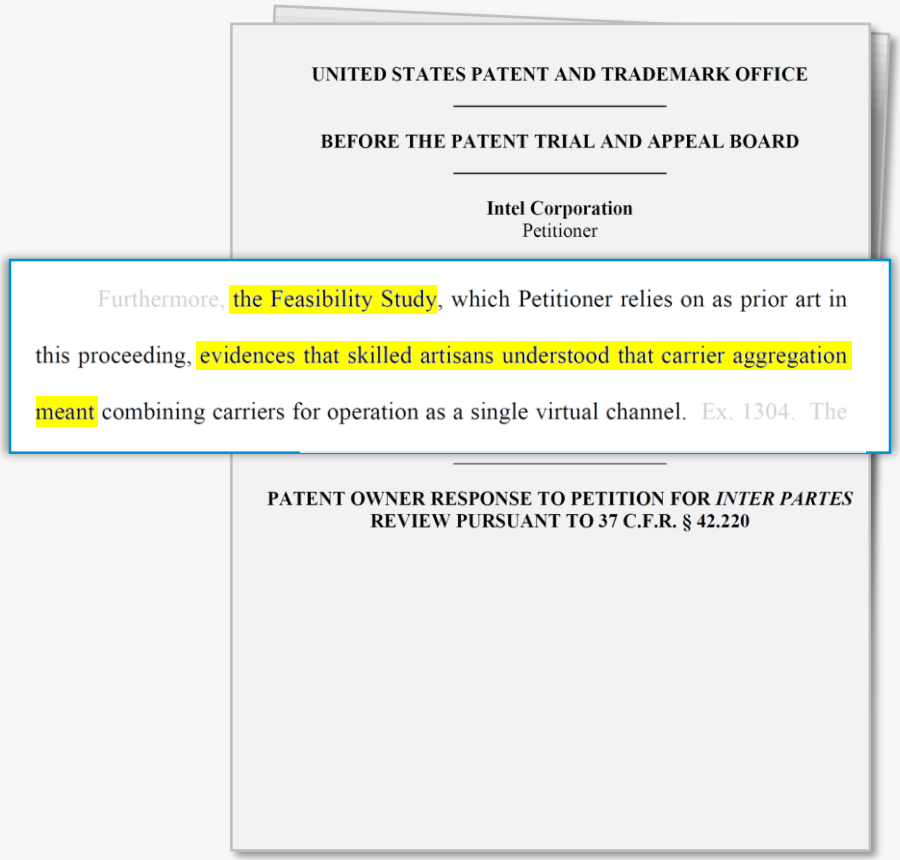
The search report designates Lee as an "X" reference, meaning that Lee is "of particular relevance" and "the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone." Ex. 2005, 3.

Case IPR2019-00128
Patent 9,154,356 B2

Before DANIEL N. FISHMAN, MICHELLE N. WORMMEESTER, and AARON W. MOORE, *Administrative Patent Judges*.

WORMMEESTER, *Administrative Patent Judge*.

DECISION
Institution of *Inter Partes* Review
35 U.S.C. § 314



UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Intel Corporation
Petitioner

Furthermore, the Feasibility Study, which Petitioner relies on as prior art in this proceeding, evidences that skilled artisans understood that carrier aggregation meant combining carriers for operation as a single virtual channel. Ex. 1304. The

PATENT OWNER RESPONSE TO PETITION FOR *INTER PARTES* REVIEW PURSUANT TO 37 C.F.R. § 42.220

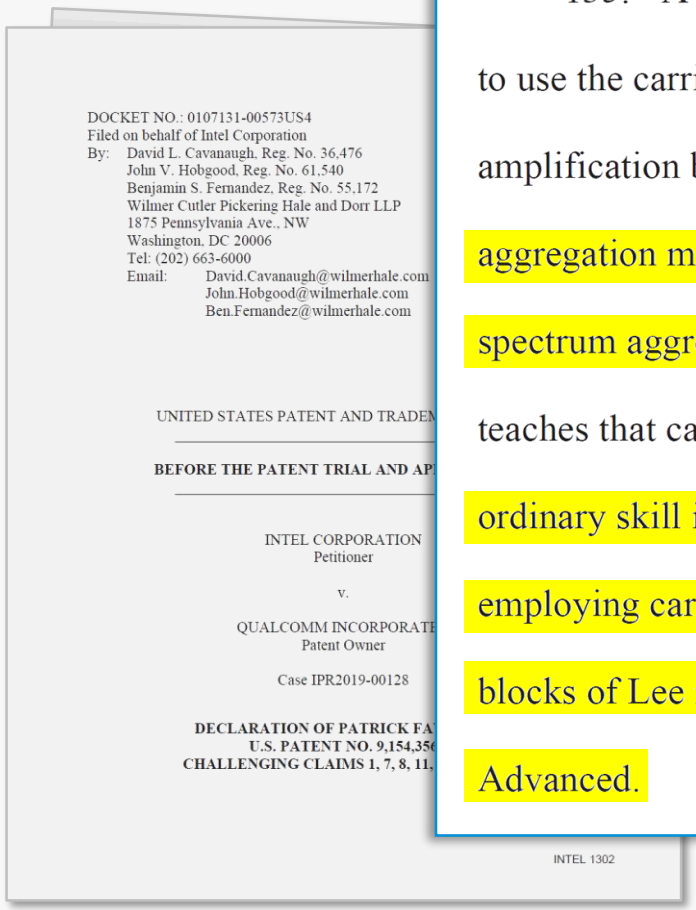
-00128 IPR, Paper 9 (Institution Decision) at 15 (annotated); -00128 IPR, Paper 13 (POR) at 19 (annotated)

Motivation to Combine Lee and Feasibility Study

- "A person having ordinary skill in the art would have found it obvious to turn to the amplification circuit of Lee in order to process the carrier-aggregated input RF signal of the Feasibility Study and would have been motivated to combine those references."
  - "The Feasibility Study recognizes that wireless mobile devices can be configured to operate with input RF signals employing carrier aggregation."
  - "The Feasibility Study further suggests that an ideal receiver for noncontiguous intra-band and inter-band carrier aggregation would have multiple RF front-ends."
  - "The Feasibility Study characterizes an 'RF front end' as having its own gain control (amplifier), mixer, and analog-to-digital conversion."
  - "Lee teaches multiple amplifier blocks providing output to different receivers."
  - "Lee thus teaches the exact type of receiver that the Feasibility Study recognizes would work with signals employing carrier aggregation."

-00128 IPR, Ex. 1302 (Fay Decl.) at ¶ 134

Motivation to Combine Lee and Feasibility Study



DOCKET NO.: 0107131-00573US4
Filed on behalf of Intel Corporation
By: David L. Cavanaugh, Reg. No. 36,476
John V. Hobgood, Reg. No. 61,540
Benjamin S. Fernandez, Reg. No. 55,172
Wilmer Cutler Pickering Hale and Dorr LLP
1875 Pennsylvania Ave., NW
Washington, DC 20006
Tel: (202) 663-6000
Email: David.Cavanaugh@wilmerhale.com
John.Hobgood@wilmerhale.com
Ben.Fernandez@wilmerhale.com

UNITED STATES PATENT AND TRADEN

BEFORE THE PATENT TRIAL AND AP

INTEL CORPORATION
Petitioner

v.

QUALCOMM INCORPORATE
Patent Owner

Case IPR2019-00128

DECLARATION OF PATRICK FA
U.S. PATENT NO. 9,154,35
CHALLENGING CLAIMS 1, 7, 8, 11,

INTEL 1302

135. A person having ordinary skill in the art would have been motivated to use the carrier-aggregated input RF signal of the Feasibility Study with the amplification blocks of Lee. The Feasibility Study teaches that carrier aggregation may provide benefits, such as wider transmission bandwidths and spectrum aggregation. *See* EX1304-Study at 8. The Feasibility Study further teaches that carrier aggregation is supported by LTE-Advanced. *Id*. A person of ordinary skill in the art would have been motivated to use the input RF signal employing carrier aggregation of the Feasibility Study with the amplification blocks of Lee in order to achieve these benefits and unlock the features of LTE-Advanced.

-00128 IPR, Ex. 1302 (Fay Decl.) at ¶ 135 (annotated)