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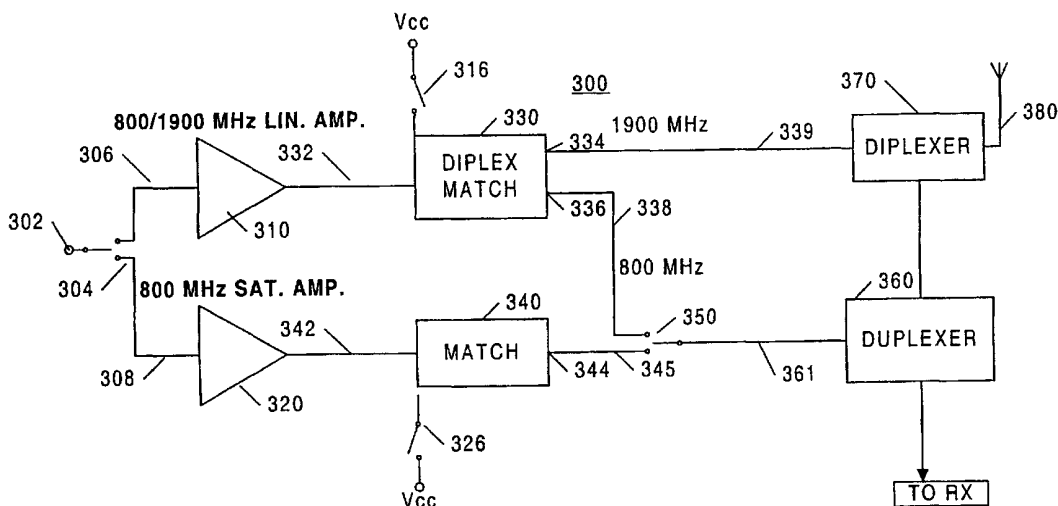
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(54) Title: A DUAL-BAND, DUAL-MODE POWER AMPLIFIER



(57) Abstract: A power amplifier circuit has a driver amplifier stage including a low band driver amplifier (412) and a high band driver amplifier (402). A final amplifier stage includes a linear mode amplifier (404) for amplifying digitally modulated signals and a saturated (nonlinear) mode amplifier (414) for amplifying frequency modulated (analog) signals. A switching network (418) interconnects the driver amplifier stage and the final amplifier stage. Depending on the desired mode of operation, an appropriate driver amplifier can be coupled to an appropriate final amplifier to most effectively and efficiently amplify analog or digital RF signals in either of a plurality of frequency bands. A diplex matching circuit (430) is coupled to the linear mode final amplifier (404) for impedance matching and for separating D-AMPS (800 MHz band) and PCS (1900 MHz band) digital signals. A power impedance matching circuit (440) is coupled to the output of the saturated mode final amplifier.



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**A Dual-Band, Dual-Mode Power Amplifier****RELATED APPLICATIONS**

5 This application is a continuation-in-part of copending  
U.S. patent application serial no. 08/888,168 filed July 3,  
1997 (Attorney Docket EUS00502) and U.S. patent application  
serial no. 08/939,870 filed September 29, 1997 (Attorney  
Docket EUS00806), each of which is assigned to the assignee of  
the present application and each of which is hereby  
10 incorporated by reference.

**BACKGROUND OF THE INVENTION**

## 1. Field of Invention

The present invention relates generally to power  
15 amplifiers and in particular to a dual-band, dual-mode power  
amplifier.

## 2. Description of Related Art

In the United States, cellular operating licenses have  
20 been awarded by the Federal Communication Commission (FCC)  
pursuant to a licensing scheme which divides the country into  
geographic service markets. Cellular licenses were originally  
granted for radio frequency (RF) blocks in the 800 MHz range.  
Most 800 MHz cellular telephone systems in the United States  
25 utilize the Advanced Mobile Phone Service (AMPS) analog air  
interface standard. A later generation air interface standard  
for the 800 MHz band, known as D-AMPS, has subsequently been  
developed and implemented. The D-AMPS standard comprises both  
digital and analog cellular communication. Thus, there are  
30 presently both analog (AMPS) and digital (D-AMPS) cellular  
telephone networks in operation at 800 MHz in the United  
States.

In response to increased demand for cellular services, a  
number of digital air interface standards were developed for  
35 providing efficient digital communication of voice, data, fax

and text messages under the umbrella of "personal communications services" or PCS.

Operational PCS systems, such as systems based on the GSM TDMA (Time Division Multiple Access) or IS-95 CDMA (Code  
5 Division Multiple Access) air interface standards, are being implemented in the United States in the 1900 MHz frequency range. Meanwhile, existing 800 MHz cellular systems are continuing to operate.

Thus, there are presently operating in the United States  
10 analog and digital cellular systems at 800 MHz and digital PCS systems at 1900 MHz. Mobile subscribers who desire to receive services from systems operating at 800 MHz and from systems operating at 1900 MHz must either use two different mobile transceivers capable of operating within the cellular or 800  
15 MHz band and the PCS or 1900 MHz band, respectively, or, preferably, use a single "dual-band" mobile transceiver which can receive and transmit RF signals in both frequency bands. Moreover, mobile subscribers who wish to communicate using both analog and digital systems must again either use two  
20 different mobile transceivers or, preferably, use a single "dual-mode" transceiver. Ideally, a mobile transceiver is capable of both dual-mode and dual-band operation to provide the user with maximum flexibility and functionality.

A problem arises, however, in that the power amplifier  
25 used in a mobile transceiver is typically optimized for use in a particular band (i.e. PCS or AMPS) and in a particular mode (i.e. analog or digital). This problem is manifested in two ways: as an impedance matching problem and as an amplifier biasing problem.

30 For maximum efficiency, the impedance at the output of the amplifier must be matched to the impedance of a duplexer/diplexer prior to transmission. However, the impedance of the matching circuit is dependent on the frequency of operation. Thus, a conventional matching circuit

optimized for matching the impedance of an amplifier at 800 MHz will generally not optimally match the impedance of the same amplifier operating at 1900 MHz. Moreover, the impedance of the amplifier is dependent on the mode of operation. Thus, a conventional matching circuit optimized for matching the impedance of an amplifier operating at 800 MHz in the AMPS mode will not adequately match the impedance of the same amplifier operating at 800 MHz in the D-AMPS digital mode.

The biasing problem arises due to the fact that the efficiency of an amplifier is dependent on the mode or class of operation of the amplifier which is determined by the modulation technique employed. Typically, analog communication systems employ well known frequency modulation (FM) techniques to modulate analog information onto a carrier signal, while digital communication systems employ digital modulation schemes, such as  $\pi/4$  DQPSK (Differential Quadrature Phase Shift Keying) modulation. Signals transmitted using frequency modulation are most efficiently amplified by a power amplifier biased and operating in non-linear or saturated mode. Signals transmitted using  $\pi/4$  DQPSK modulation, on the other hand, are most efficiently amplified by a power amplifier biased and operating in linear mode.

One possible solution to these problems is to provide a separate amplifier chain for both high-band (1900 MHz) and low-band (800 MHz) operation, as illustrated in **Figure 1**. However, this solution is expensive, redundant and wasteful. Moreover, the problem of biasing the low-band amplifier still exists, since the low-band amplifier must amplify both digital and analog signals.

In transceivers having a single amplifier chain, one possible solution to the impedance matching problem is to provide the amplifier with separate, switched high-pass and low-pass matching networks at its output. However, the switch must be capable of handling high power, which tends to require

a large, costly switch. Moreover, the match at 800 MHz will necessarily be a blended match, causing a loss of efficiency in the analog mode.

5 Another solution to the impedance matching problem is to provide a broadband power matching circuit covering both desired frequency bands and having peaks at the transmit bands. Such a configuration would tend to waste bandwidth, however, when the desired match frequencies differ by an octave or more and the desired bandwidth in each band is  
10 relatively narrow. Fano's Limit shows that there is a physical limitation on broadband matching when a reactive element (such as the drain-source capacitance of a transistor) is present.

In transceivers having a single amplifier chain, prior art  
15 solutions to the impedance matching problem address the biasing problem by providing separate bias levels, although the impedance match remains constant. If a single amplifier is used to amplify both analog and digital signals, the amplifier must be biased to barely meet linearity requirements  
20 while retaining as much analog efficiency as possible. Such an arrangement tends to be inefficient. As radiotelephones become smaller and power consumption requirements become stricter, such inefficient operation is highly undesirable.

Therefore, there is a need in the art for a power  
25 amplifier circuit capable of efficient operation in both 800 MHz and 1900 MHz systems and in both analog and digital systems. Such a dual-band, dual mode power amplifier preferably provides an integrated, efficient solution to the problems described above.

30

#### SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide a power amplifier circuit for a radio transceiver

capable of efficiently amplifying RF signals in a linear or saturated mode of operation.

It is a further object of the present invention to provide a power amplifier circuit for efficiently amplifying RF  
5 signals in a plurality of frequency bands or ranges.

It is a further object of the present invention to provide a dual-band, dual-mode power amplifier circuit that may be selectably placed in a linear mode of operation for amplifying DQPSK modulated signals and a saturated mode of operation for  
10 amplifying frequency modulated signals.

The foregoing and other objects are accomplished in a power amplifier circuit having a driver amplifier stage including a low band driver amplifier and a high band driver amplifier. A final amplifier stage includes a linear mode  
15 amplifier for amplifying digitally modulated signals and a saturated (nonlinear) mode amplifier for amplifying frequency modulated (analog) signals. A switching network interconnects the driver amplifier stage and the final amplifier stage. Depending on the desired mode of operation, an appropriate  
20 driver amplifier can be coupled to an appropriate final amplifier to most effectively and efficiently amplify analog or digital RF signals in either of a plurality of frequency bands.

A diplex matching circuit is coupled to the linear mode  
25 final amplifier for impedance matching and for separating D-AMPS (800 MHz band) and PCS (1900 MHz band) digital signals. A power impedance matching circuit is coupled to the output of the saturated mode final amplifier.

The amplifier circuit includes means for selectably  
30 placing the amplifier circuit in a linear mode or a saturated mode, corresponding to digital and analog modes of operation of the radiotelephone, respectively. In the linear or digital mode, the linear final amplifier is biased in the on state and the saturated mode amplifier may be biased in the off state.

Similarly, in the saturated or analog mode of operation, the saturated mode final amplifier is biased in the on state and the linear amplifier may be biased in the off state.

5 The amplifier circuit may include means for selectably coupling either the first diplex matching circuit output or the low pass matching circuit output to an output line when the amplifier circuit is selectably placed in linear mode or saturated mode, respectively.

10 These and other objects of the invention, together with features and advantages thereof will become apparent from the following detailed specification when read with the accompanying drawings in which like reference numerals refer to like elements.

15

#### **BRIEF DESCRIPTION OF THE DRAWINGS**

Figure 1 is a schematic diagram of a dual amplifier chain configuration known in the art.

20 Figure 2 is a schematic diagram of a single amplifier chain with diplex power matching circuit for dual band operation.

Figure 3 is a schematic diagram of a dual band, dual mode amplifier chain.

25 Figure 4 is a schematic diagram of another embodiment of a dual band, dual mode amplifier chain.

Figure 5 is a circuit diagram of a harmonic trap for use with the embodiment of Figure 4.

30

#### **DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS**

The present invention will now be described with reference to the accompanying drawings, in which preferred embodiments of the invention are shown. However, this invention may be embodied in many different forms and should not be construed

as limited to the specific embodiments shown. Rather, the preferred embodiments are provided so that this disclosure is thorough and complete, and will fully convey the scope of the invention to those skilled in the art.

5           In this application, the terms "duplexer" and "diplexer" both refer to a three port, frequency selective splitter. A duplexer is used to enable an RF transceiver to simultaneously transmit and receive on nearly adjacent frequencies using a common antenna, whereas a diplexer separates input signals  
10 into high band or low band signals.

          Referring first to **Figure 2**, a dual-band power amplifier circuit is indicated generally by reference numeral **200**. Power amplifier circuit **200** has a diplex matching circuit **205** for matching the impedance of a multi-band power amplifier.  
15 Radio Frequency (RF) signals are input to a multi-band amplifier **220** at RF input port **210**. Amplifier **220** amplifies the RF signals and outputs the amplified RF signals to a diplex power matching circuit **205** at port **225**.

          In the embodiment shown in **Fig. 2**, the amplified RF  
20 signals may fall into one of two frequency bands. However, it will be readily apparent to one skilled in the art that the present invention could be modified for use in connection with a power amplifier capable of amplifying RF signals contained in more than two frequency bands.

25           RF signals falling in the first frequency band will be passed by filter/match circuit **230** to duplexer **235**. Likewise, RF signals falling in the second frequency band will be passed by filter/match circuit **240** to duplexer **245**.

30           Filter/match circuit **230** blocks RF signals in the second frequency band while providing a suitable impedance match for signals in the first frequency band. Likewise, filter/match circuit **240** blocks RF signals in the first frequency band while providing a suitable impedance match for signals in the second frequency band.



RF signals passed by filter/match circuit **230** are passed through duplexer **235** (if necessary) and into diplexer **260** for transmission using antenna **270**. Depending on the communication system in which the amplifier **200** is being used and whether full duplex operation at 1900 MHz is required, duplexer **235** may or may not be necessary. RF signals passed by filter/match circuit **240** are passed through duplexer **245** and into diplexer **260** for transmission using antenna **270**.

The embodiment illustrated in **Figure 2** and implementations thereof are described in greater detail in copending U.S. patent application serial no. 08/888,168 (Attorney Docket EUS00502).

Referring now to **Figure 3**, a dual-mode, dual-band amplifier circuit is indicated generally by reference numeral **300**. Amplifier circuit **300** is advantageously included in the transmitter or transceiver of a radiotelephone (not shown) for amplifying both analog and digital signals in two different frequency bands or ranges, thereby providing the radiotelephone with dual-band, dual-mode functionality.

Amplifier circuit **300** includes an RF input port **302** which is coupled to a mode select switch **304**. Depending on whether the radiotelephone is being operated in a digital or analog mode, the setting of mode select switch **304** will cause input RF signals to be transmitted down digital path **306** or analog path **308**, respectively. The position of mode select switch **304** is controlled by a mode control signal from a microprocessor (not shown) within the radiotelephone. The control signal provided by the microprocessor is used to selectively place amplifier circuit **300** in a linear mode or a saturated (nonlinear) mode of operation.

Digital path **306** includes a linear amplifier **310**, which efficiently amplifies signals which have been modulated using a linear modulation technique such as DQPSK modulation. The

output of linear amplifier **310** is coupled to a diplex matching circuit **330** which efficiently separates 1900 MHz signals from 800 MHz signals while providing an impedance match for linear amplifier **310** in both frequency ranges. The structure and  
5 function of diplex matching circuit **330** is described in greater detail below.

Diplex matching circuit **330** has a 1900 MHz output **334** and an 800 MHz output **336**. The 1900 MHz output is coupled via path **339** to a diplexer **370**, which couples the 1900 MHz output  
10 signal to an antenna **380**. Additionally, a duplexer may be provided between the 1900 MHz output **334** and diplexer **370** if full duplex operation is desired for 1900 MHz operation, for example in a CDMA or multirate TDMA system.

Analog path **308** includes a nonlinear amplifier **320** which  
15 efficiently amplifies frequency modulated signals. The output of nonlinear amplifier **320** is coupled to a matching circuit **340** which provides a 50-Ohm impedance match for nonlinear amplifier **320**. Matching circuit **340** also helps suppress harmonic content that could feed back down the 1900 MHz path  
20 **339**.

Since separate linear and nonlinear amplifiers **310**, **320**, respectively are provided, the nonlinear amplifier may be operated as a deeply saturated Class C amplifier or as a switched mode class E amplifier. Previous solutions in which  
25 a single amplifier was used for both linear and nonlinear amplification required that the amplifier be biased (in Class AB) to barely meet linearity requirements while retaining as much nonlinear efficiency as possible. The result was a blended match that was not optimal for either linear or  
30 nonlinear amplification. The present invention overcomes this limitation while providing an amplifier circuit that can effectively and efficiently amplify signals in different frequency bands.

The output of matching circuit **340** on line **345** and the 800 MHz output of diplex matching circuit **330** on line **338** are provided to a high power switch **350**. High power switch **350** couples either the 800 MHz output of diplex match circuit **330** (corresponding to a digital 800 MHz signal) or the output of matching circuit **340** (corresponding to an analog 800 MHz signal) to duplexer **360** via output line **361**, depending on whether the cellular telephone is being operated in a digital or analog mode, respectively. As with mode select switch **304**, high power switch **350** is controlled by the mode control signal from the radiotelephone's microprocessor. Additionally, high power switch **350** provides isolation for linear amplifier **310**, thus preventing linear amplifier **310** from being loaded by nonlinear amplifier **320** and matching circuit **340**.

DC biasing for linear amplifier **310** and nonlinear amplifier **320** is provided by switching Vcc inputs **316**, **326** on or off depending on the desired mode of operation of the cellular telephone (i.e. digital or analog).

Duplexer **360** is a conventional duplexer designed to permit full duplex operation at 800 MHz. Duplexer **360** couples 800 MHz signals to diplexer **370**, which in turn couples the signals to antenna **380** for transmission.

The embodiment illustrated in **Figure 3** is particularly suited for use in a TDMA transceiver, which operates at half duplex at 1900 MHz. However, as described above, the circuit can be easily adapted for use in a CDMA or multirate TDMA transceiver by providing an additional duplexer in path **339** to permit full duplex operation at 1900 MHz.

Diplex matching circuit **330**, which is essentially the same circuit as diplex matching circuit **205** shown in **Figure 2**, is described in detail in copending U.S. application serial no. 08/888,168 (Attorney Docket EUS00502) and will not be discussed further. The embodiment illustrated in **Figure 3** and

implementations thereof are described in greater detail in copending U.S. patent application serial no. 08/939,870 (Attorney Docket EUS00806).

5 Referring now to **Figure 4**, a second dual-band dual-mode amplifier architecture is indicated generally as **400**. Amplifier **400** improves on the designs illustrated in **Figures 2 and 3** by separating the amplifier into a driver stage and a final stage, and selectively coupling the appropriate driver and final stages depending on the desired mode of operation of the amplifier **400**. Amplifier **400** includes a 1900 MHz driver amplifier **402** tuned and biased to efficiently amplify signals in the 1900 MHz frequency band and an 800 MHz driver amplifier **412** tuned and biased to efficiently amplify signals in the 800 MHz frequency band.

10 Amplifier **400** also includes a pair of final stage amplifiers **404** and **414**. Final stage amplifier **404** is biased and tuned for linear operation as a class AB amplifier to efficiently amplify digitally modulated RF signals, while final stage amplifier **414** is biased and tuned for saturated operation in an efficient mode of operation, such as a deeply saturated class C amplifier or a switched mode class E amplifier or some other highly efficient mode of operation to efficiently amplify frequency modulated analog RF signals.

15 The driver stage amplifiers **402**, **412** are connected to the final stage amplifiers **404**, **414** by means of a switching network **418** which includes switches **422**, **424** and **426**. Each of switches **422**, **424** and **426** may be a field-effect transistor (FET) switch whose design is well known to those skilled in the art. Other suitable types of switches may be substituted by those having skill in the art. The open/closed state of switches **422**, **424** and **426** is controllable by means of control lines (not shown) from an associated microprocessor or other control logic (not shown).

Switch **422** couples the output of 1900 MHz driver amplifier **402** to the input of linear final amplifier **404**. The output of 800 MHz driver amplifier **412** is coupled to node **428**. Node **428** is in turn coupled to the input of linear final amplifier **404** via switch **424** and to the input of saturated final amplifier **414** via switch **426**.

The signal output by final amplifier **404** is passed through diplex matching circuit **430** which filters and passes the signal to duplexer **460** (if necessary) or duplexer **465** (via switch **445**) depending on the frequency content of the signal.

In one embodiment, a first filter **410** is provided between the output of 1900 MHz driver amplifier **402** and switch **422**, and a second filter **420** is provided between the output of 800 MHz driver amplifier **412** and node **428**. These filters **410**, **420** filter the input signals prior to the final gain stage thereby providing receive band noise rejection and reduction of the harmonic content of the signal. In one embodiment, Filters **410**, **420** are surface acoustic wave (SAW) bandpass filters, the design of which is well known in the art.

By providing a filtered signal to the final amplifier stage, final amplification by the linear amplifier is more effective. Placing filters between the gain stages of the amplifier allows the duplexers **460**, **465** to be implemented with one less pole, decreasing the insertion loss of the overall amplifier circuit **400** and resulting in lower dc current drain. Because of the lower insertion loss of amplifier **400**, the final amplifier stage does not need to develop as much output RF power. This has a number of desirable consequences, including a smaller die size and lower dc current consumption.

In one embodiment, a harmonic trap **455** is coupled to the input of diplex matching circuit **430**. The function of harmonic trap **455** is to reduce the harmonic content of signals output by diplex matching circuit **430** and to supply VDD to

final stage amplifier **404**. An embodiment of harmonic trap **455** is shown in Figure 5. **Figure 5** shows an embodiment of harmonic trap **455**, which includes a high-power switch **510** coupled to a pair of parallel switchable inductors **520**, **525**.

5 Inductors **520**, **525** are in turn coupled to capacitor **530**, which is coupled to the input of duplex matching circuit **430**. Inductor **520** and capacitor **530** combine to form a parallel resonant circuit that is resonant at 800 MHz, while inductor **525** and capacitor combine to form a parallel resonant circuit  
10 that is resonant at 1900 MHz. Thus, depending on the state of switch **510** (which is set according to the operating state of amplifier **400**), the harmonic trap **455** will operate to attenuate harmonic signals in the 800 MHz band or the 1900 MHz band. As with switches **422**, **424** and **426**, switch **510** is  
15 controllable by means of control lines (not shown) from an associated microprocessor or other control logic (not shown).

Since the linear final amplifier **404** is operated in a class AB mode, harmonic content of the output signal is higher than it would be using a class A amplifier. Providing a  
20 harmonic trap at the output of final amplifier **404** therefore increases the efficiency of final amplifier **404** by constraining the output energy to the desired frequencies.

Referring again to **Figure 4**, the amplifier may be operated in one of a number of selectable modes to amplify analog or  
25 digital signals in the 800 MHz frequency band or digital signals in the 1900 MHz frequency band. For the 1900 MHz mode of operation, switch **422** is closed, while switch **424** is open. Additionally, in the 1900 MHz mode of operation switch **426** may be open to provide additional isolation of the final stage  
30 amplifiers **404**, **414**. Digitally modulated input signals in the 1900 MHz frequency band are input to amplifier **400** via input terminal **405** and provided to 1900 MHz driver amplifier **402**. The signal output by 1900 MHz driver amplifier **402** is coupled

to the input of final amplifier **404** which, as noted above, is biased for operation in linear mode. Amplifier **404** efficiently amplifies the digitally modulated signal and outputs the amplified signal to diplex matching circuit **430**.

5 To amplify analog RF signals in the 800 MHz band, (800 MHz analog mode) switches **422** and **424** are open, while switch **426** is closed. Frequency modulated (i.e. analog or FM) input signals in the 800 MHz frequency band are input to amplifier **400** via input terminal **415** and provided to 800 MHz driver  
10 amplifier **412**. The signal output by 800 MHz driver amplifier **412** is coupled to the input of final amplifier **414** via closed switch **426**. Final amplifier **414** is biased for operation in saturated mode, and therefore efficiently amplifies the FM signal and outputs the amplified signal to matching circuit  
15 **440**.

To amplify digitally-modulated (e.g.  $\pi/4$  DQPSK) RF signals in the 800 MHz band, (800 MHz digital mode) switches **422** and **426** are open, while switch **424** is closed. Digitally modulated input signals in the 800 MHz frequency band are  
20 input to amplifier **400** via input terminal **415** and provided to 800 MHz driver amplifier **412**. The signal output by 800 MHz driver amplifier **412** is coupled to the input of final amplifier **404** via node **428** and switch **426**. As noted above, final amplifier **404** is biased for operation in linear mode.  
25 Amplifier **404** efficiently amplifies the digitally modulated signal and outputs the amplified signal to diplex matching circuit **430**. The operation of switch **445** is similar to that of switch **350** described in reference to **Figure 3**.

While the present invention has been described with  
30 respect to its preferred embodiment, those skilled in the art will recognize that the present invention is not limited to the specific embodiment described and illustrated herein. Different embodiments and adaptations besides those shown

herein and described as well as many variations, modifications and equivalent arrangements will now be apparent or will be reasonably suggested by the foregoing specification and drawings, without departing from the substance or scope of the invention. Accordingly, it is intended that the invention be limited only by the scope of the claims appended hereto.



What is claimed is:

1. A power amplifier circuit for amplifying RF signals, said  
5 power amplifier circuit selectively operable in a linear mode  
or a nonlinear mode and selectively operable to amplify RF  
signals in a first frequency band or a second frequency band,  
characterized by:

10 a first driver amplifier (402) for amplifying RF signals  
in a first frequency band;

first and second final amplifiers (404, 414);

a diplex matching circuit (430) coupled to said first  
final amplifier (404); and

15 a switching network (418) for selectively coupling said  
first driver amplifier (402) to said first and second final  
amplifiers (404, 414) in response to said amplifier circuit  
being placed in a linear or nonlinear mode of operation,  
respectively.

20 2. The power amplifier circuit as recited in claim 1,  
further characterized by:

a low pass matching circuit (440) coupled to an output of  
said second final amplifier; and

25 switching circuitry (445), coupled to a first output of  
said diplex matching circuit and an output of said low pass  
matching circuit (440), for selectively coupling said first  
diplex matching circuit output or said low pass matching  
circuit output to an output line when said amplifier circuit  
is selectively placed in linear mode or nonlinear mode,  
30 respectively.

3. The power amplifier circuit as recited in claim 1,  
further characterized by:

a second driver amplifier (412) for amplifying RF signals in a second frequency band; and

wherein said switching network (418) includes a first switch (422) coupled between said first driver amplifier (402) and said first final amplifier (404).

4. The power amplifier circuit as recited in claim 3, wherein said switching network (418) further includes a node (428) coupled to an output of said second driver amplifier (412), a second switch (424) coupled between said node (428) and an input of said first final amplifier (404) and a third switch (426) coupled between said node (428) and an input of said second final amplifier (414).

5. The power amplifier circuit as recited in claim 4, further characterized by a first filter (410) disposed between the output of said first driver amplifier (402) and said first switch (422), and a second filter (420) disposed between said second driver amplifier (412) and said node (428).

6. The power amplifier as recited in claim 3, further characterized by a harmonic trap (455) coupled to an output of said first final amplifier (404).

7. The power amplifier as recited in claim 5, wherein said first and second filters (410,420) are surface acoustic wave filters.

8. A power amplifier circuit for amplifying RF signals, said power amplifier circuit selectively operable in a linear mode or a nonlinear mode and selectively operable to amplify RF signals in a first frequency band or a second frequency band, characterized by:

a driver amplifier stage having a high band input (405) and a low band input (415);

a final amplifier stage having a linear amplifier (404) and a nonlinear amplifier (414);

5 a switching network (418) coupling said driver amplifier stage and said final amplifier stage responsive to a mode selection.

9. The power amplifier circuit as recited in claim 8,  
10 further characterized by:

a filter stage (410,420) interposed between said driver stage and said switching network.

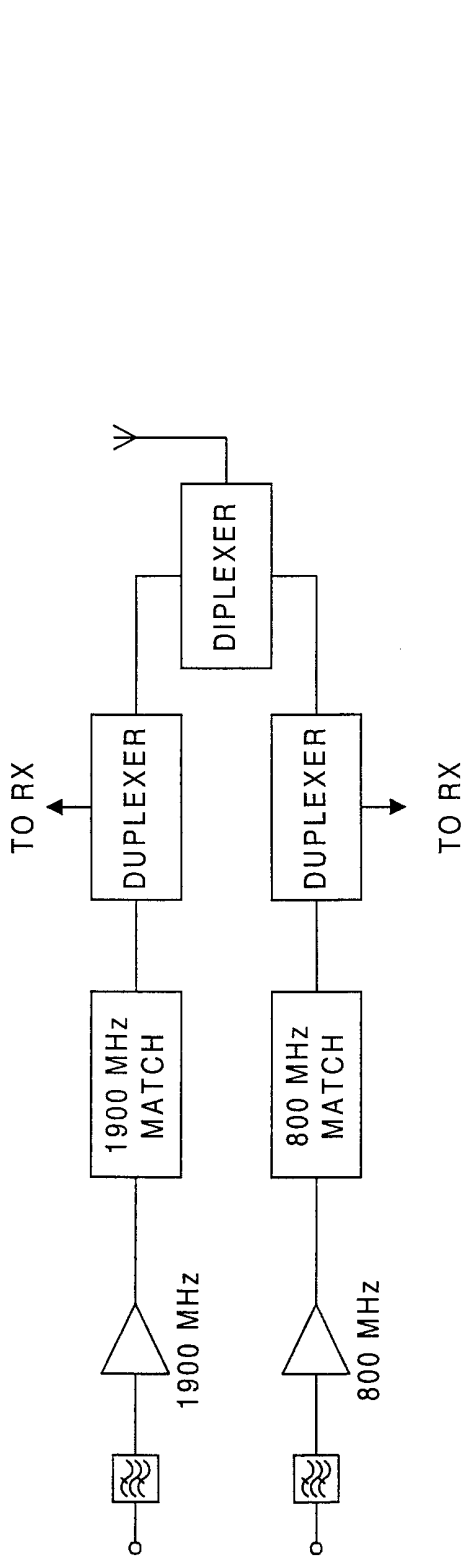


FIGURE 1 (PRIOR ART)

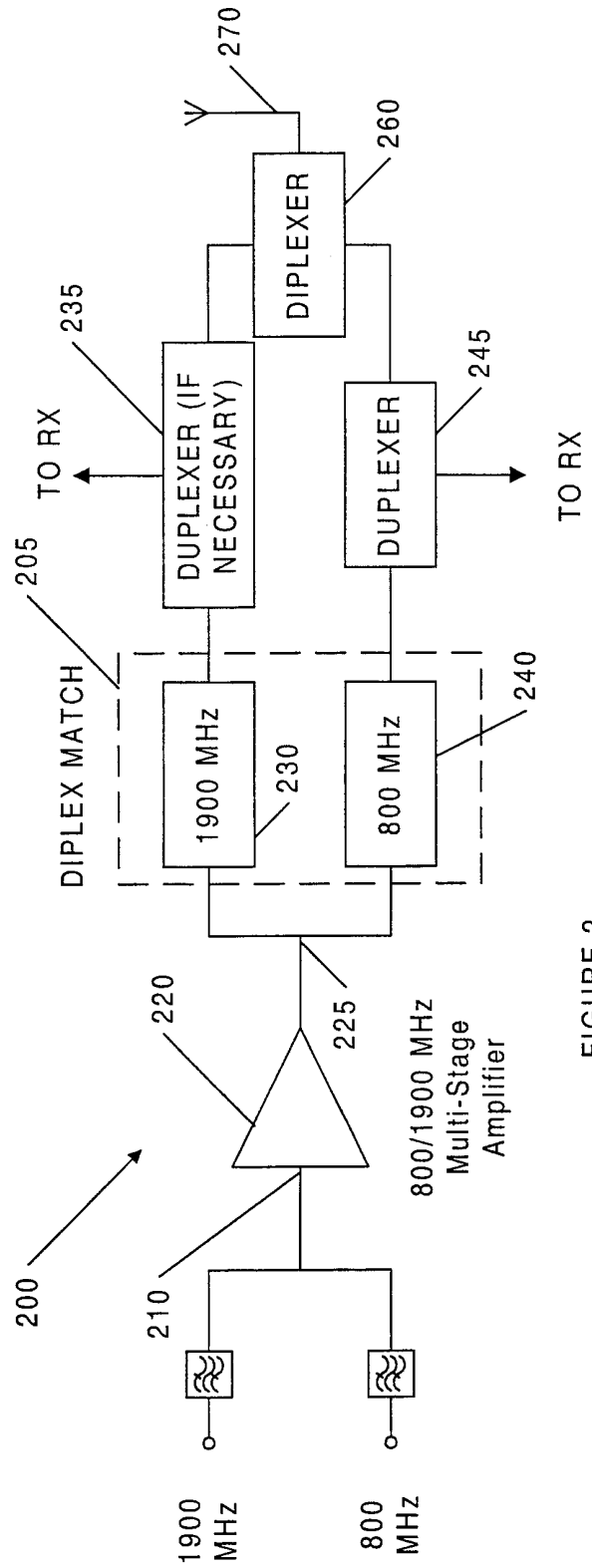


FIGURE 2

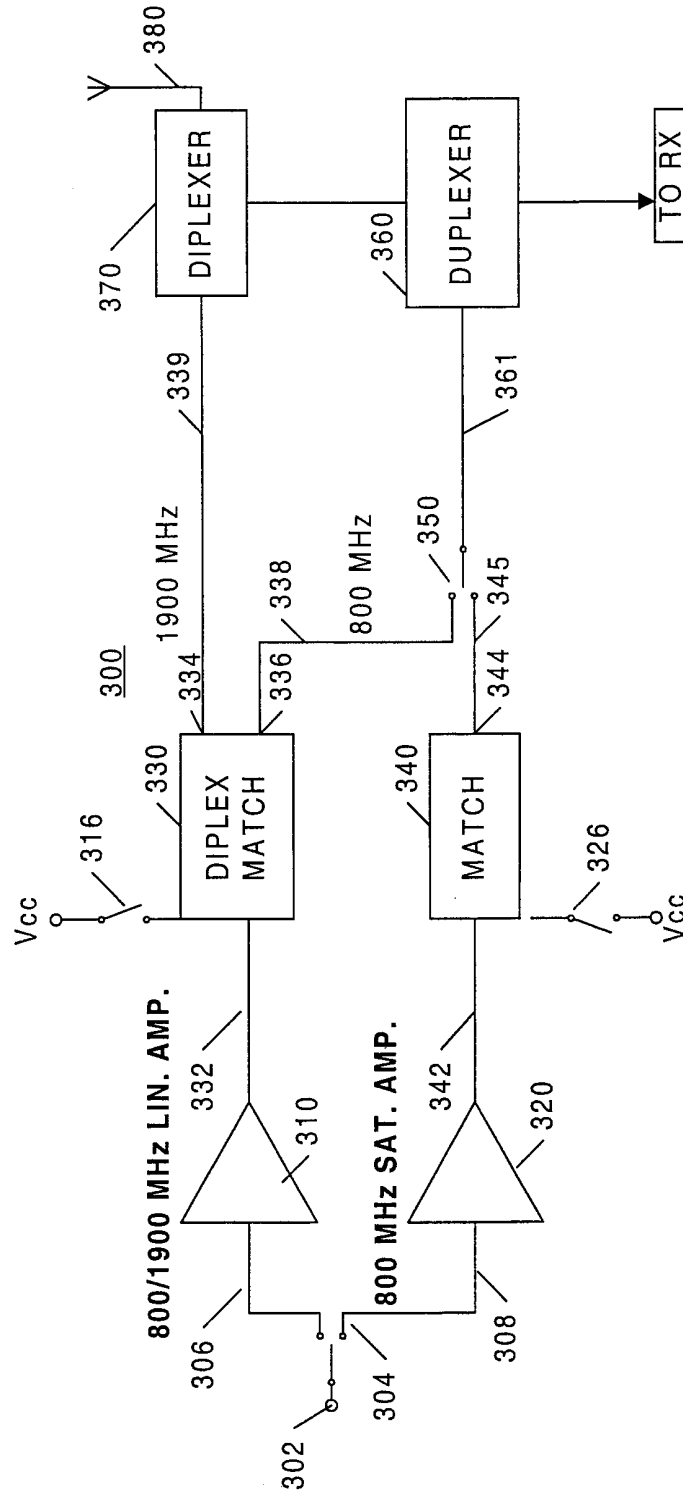


FIGURE 3

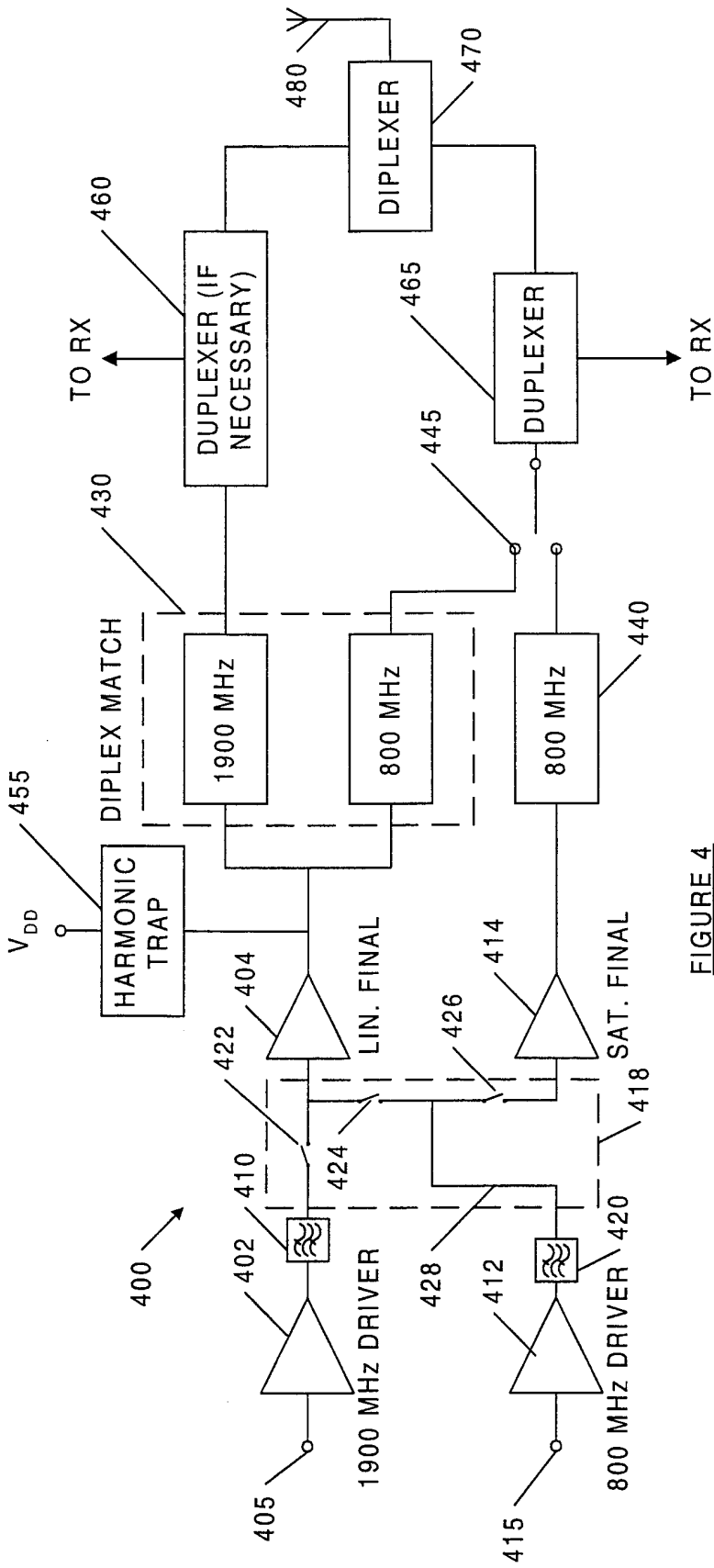


FIGURE 4

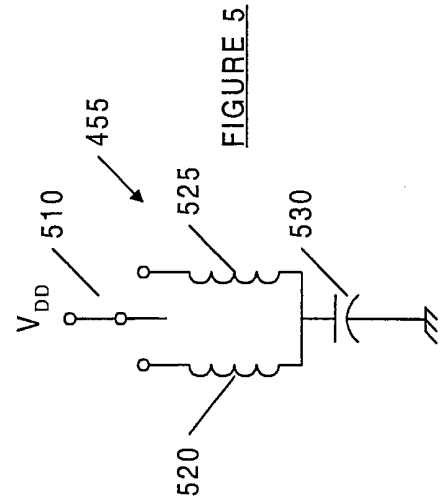


FIGURE 5

# INTERNATIONAL SEARCH REPORT

International Application No

PCT/IB 99/01255

**A. CLASSIFICATION OF SUBJECT MATTER**

IPC 7 H03H7/38 H03H7/46 H03F3/72

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 H03H H03F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 438 684 A (OSMANI RASHID M ET AL) 1 August 1995 (1995-08-01)	8
A	abstract; figures 3,4,7	1-7,9
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A	the whole document	
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Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

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Date of the actual completion of the international search

13 March 2000

Date of mailing of the international search report

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INTERNATIONAL SEARCH REPORT

International Application No

PCT/IB 99/01255

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