(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
8 January 2009 (08.01.2009)

PCT

(10) International Publication Number
WO 2009/005681 A2

(51) International Patent Classification:
H03D 7/00 (2006.01)

(21) International Application Number:
PCT/US2008/007942

(22) International Filing Date: 26 June 2008 (26.06.2008)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:

61/007,907	28 June 2007 (28.06.2007)	US
11/819,619	28 June 2007 (28.06.2007)	US
12/155,370	3 June 2008 (03.06.2008)	US

(71) Applicant *(for all designated States except US)*: **LUCENT TECHNOLOGIES INC.** [US/US]; 600-700 Mountain Avenue, Murray Hill, NJ 07974-0636 (US).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **ARAKAWA, Yoshiyuki** [JP/JP]; 4-18-3, Shoshigaya, Setagaya-ku, Tokyo, 156-0072 (JP). **NOGUCHI, Shin-ichi** [JP/JP]; Yabe-machi 2648-7, Machida City, Tokyo, 194-0214 (JP). **RICHARDS, Larry, Benton** [US/JP]; 1-27-7 Nankoudai, Fukushima-shi, Fukushima-ken, 960-8143 (JP). **SIZER, Theodore** [US/US]; 385 Branch Avenue, Little Silver, NJ 07739-1102 (US).

(74) Agent: **LUCENT TECHNOLOGIES INC.**; Docket Administrator-Room 2F-192, 600-700 Mountain Avenue, Murray Hill, NJ 07974-0636 (US).

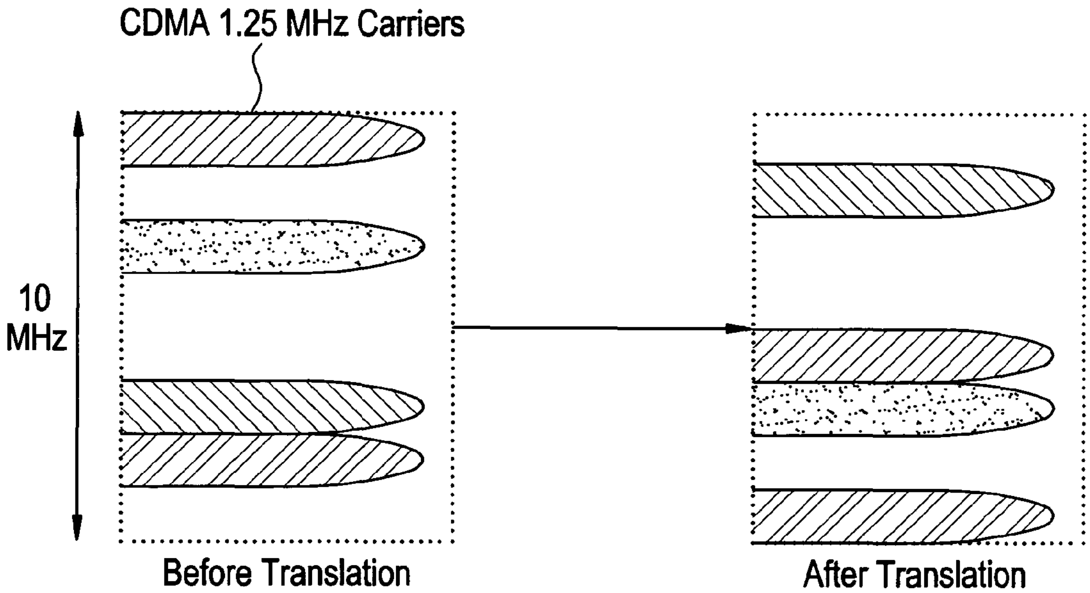
(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL,

[Continued on next page]

(54) Title: METHOD OF TRANSLATING CELLULAR CARRIERS

FIG. 1



(57) **Abstract:** A plurality of carrier signals in a wide band signal is converted (100) into a plurality of digital carrier signals. Each of the plurality of carrier signals is at a respective frequency in the wide band signal. At least one of the plurality of digital carrier signals is translated (300) to a different frequency.

WO 2009/005681 A2

NO, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— *without international search report and to be republished upon receipt of that report*

METHOD OF TRANSLATING CELLULAR CARRIERS

PRIORITY STATEMENT

This non-provisional U.S. patent application claims priority under 35 U.S.C. § 119 to U.S. provisional Patent Application No. 61/007,907 with an original filing date of June 28, 2007. U.S. provisional Patent Application No. 61/007,907 was converted on October 18, 2007 from U.S. Patent Application No. 11/819,619 filed on June 28, 2007, the entire contents of both applications of which are incorporated herein.

BACKGROUND OF THE INVENTION

In a wireless network system, for example, a code division multiple access (CDMA) network, a certain amount of spectrum is available to the system. The amount or bandwidth of the spectrum may differ depending on the standard governing the wireless network system, government regulations, etc. Also, the position of the allocated bandwidth in the spectrum may differ depending on the standard governing the wireless network system, government regulations, etc. Still further, the number of carriers supported by the allocated bandwidth may depend on the amount of allocated bandwidth, the position of the bandwidth within the spectrum, standards, etc.

For example, one 5 MHz CDMA system includes three (3) carriers, each occupying a respective 1.25 MHz of the 5 MHz bandwidth. A radio frequency signal for a carrier frequency band with a 1.25 MHz bandwidth may hold up to 64 channels (voice or data).

The assignment of carriers to frequency bands in the allocated bandwidth, the amount of allocated bandwidth and the position of the allocated bandwidth are fixed within the system. Namely, using the 5 MHz CDMA system described above as an example, two different 5 MHz CDMA systems may have different carrier frequency band allocations, and/or may have differently positioned 5 MHz bandwidths.

Because several components (e.g., receivers, etc.) of a wireless system are dependent on the allocated bandwidth, position of the allocated bandwidth within the system, the frequency band allocations, etc., these components of a wireless system may often be system specific. Namely, the components of one system are often not useable in another system. This lack of flexibility results in higher costs of design and manufacture of wireless system components.

SUMMARY OF THE INVENTION

Example embodiments of the present invention provide a method of translating cellular carriers.

In an example embodiment, a method of translating cellular carriers includes converting a plurality of carrier signals in a wide band signal into at least one individual digital carrier signal, each of the at least one individual carrier signal at a respective frequency in the wide band signal, and translating the at least one individual digital carrier signal to a different frequency.

BRIEF DESCRIPTION OF THE DRAWINGS

Example embodiments of the present invention will become more fully understood from the detailed description given herein below and the accompanying drawings, which are given by way of illustration only and thus are not limiting of the example embodiments of the present invention.

Figure 1 illustrates a before and after translation of carriers in a wide band occupying a 10-MHz total band according to an example embodiment of the present invention;

Figure 2 illustrates a block diagram of a base station adapted to be used in an example embodiment of the present invention;

Figure 3 illustrates a flow chart of a method of translating carriers according to an example embodiment of the present invention;

Figure 4 is a block diagram of a base station adapted to be used in another example embodiment of the present invention;

Figure 5 illustrates a flow chart of another method of translating carriers according to an example embodiment of the present invention;

Figure 6 is a block diagram of a base station adapted to be used in yet another example embodiment of the present invention;

Figure 7 illustrates a flow chart of yet another method of translating carriers according to an example embodiment of the present invention;

Figure 8 is a block diagram of a base station adapted to be used in still another example embodiment of the present invention;

Figure 9 illustrates carriers before and after translation according to another example embodiment of the present invention;

Figure 10 is a block diagram of a base station adapted to be used in still an example embodiment of the present invention;

Figure 11 illustrates carriers before and after translation according to an example embodiment of the present invention and

Figure 12 illustrates a flow chart of methods of translating carriers illustrated in FIGS. 8-11 according to example embodiments of the present invention.

DETAILED DESCRIPTION OF THE EXAMPLE EMBODIMENTS

Although example embodiments of the present invention will be described with reference to a code division multiple access (CDMA) network, a person of ordinary skill will recognize the example embodiments of the present invention may apply to other telecommunication systems, for example, WCDMA, GSM, tones in WiMax, etc.

Figures 1-12 illustrate methods of translating cellular carriers (carriers) according to example embodiments of the present invention. FIG. 1 shows a 10 MHz frequency band having four (4) carriers prior to frequency translation and after frequency translation. Each of the carriers occupies a 1.25 MHz bandwidth. Again, the carriers may be for a CDMA, WCDMA, GSM, or tones in WiMax system. Also, the embodiments will be described with respect to operation at a base station, but one skilled in the art will appreciate that the method embodiments are not limited in implementation to base stations.

Referring to FIGS. 1, 2 and 3, at a base station 1 in step 100 the entire bandwidth, including the four (4) carriers, may be converted into digital signals by an analog to digital converter (ADC) 10 included in a receiver of the base station. The receiver may be a wideband radio receiver. Although the figures show four (4) analog carriers, it is well known to a person of ordinary skill that the carriers may be a single digital wideband signal. If the carriers are a single digital wideband signal, step 100 is skipped.

In step 200, the digital carriers are further processed by a digital filter 20. A digital representation of the 10 MHz bandwidth is transformed into four (4) digital representations (signals) of the four separate 1.25 MHz carriers.

In step 300, the digital signals are then sent to a translation engine 30, for example, a frequency translator. The translation engine translates one or more of the four (4) digital signals to new frequencies. The frequency in which a particular carrier resides at an input of the receiver may be translated to a new frequency by the translation engine 30. The translation of the digital signals is accomplished in the digital domain.

In step 400, the translated digital signals are sent to a digital to analog converter (DAC) 40 to be converted into analog signals. The analog signals may be sent to a radio frequency (RF) processor 50 to be further filtered and amplified, and then the analog baseband signals are transmitted to an endpoint 60 in step 500. As an option, after the individual carriers are separated and translated, separate D/A stages may be used to create four (4) different analog signals. As another option, a digital processing may be performed on the translated carriers to create a wideband signal (width may be equal to the width at the input, e.g., 10 MHz). The wideband signal may then be sent to the DAC 40.

As disclosed above in the example embodiment of the present invention, frequency flexibility will allow smooth transition between communication frequencies, and handle the ever increasing usage and capacity requirements that may result from increased usage. In addition, a signal radio output from a base station with multiple carriers may be used to drive outputs at multiple locations with fewer carriers.

Another method of translating cellular carriers according to an example embodiment of the present invention is illustrated in FIGS. 4 and 5. A detailed description of similar steps with respect to the example embodiment illustrated in FIGS. 2 and 3 may be omitted for the sake of brevity.

Referring to FIGS. 4 and 5, carriers are converted by the ADC 10 and the converted digital signals are filtered by the digital filter 10 in steps 100 and 200, respectively. In step 250, each of the digital signals may be packetized by a packetizer 25 in known manners to create, for example, four (4) data packet streams. In step 300, the digital packet streams are sent to the translation engine 30 for translation to new frequencies. The digital packet stream may be sent through, for example, an Ethernet network. The translated digital packet streams are further sent to the DAC 40 to be converted into analog signals in steps 400. The analog signals may be sent to a radio frequency (RF) processor 50 to be further filtered and amplified, and then the analog signals are transmitted to an end point in step 500.

Another method of translating cellular carriers according to an example embodiment of the present invention is illustrated in FIGS. 6 and 7. A detailed description of similar steps with respect to the example embodiments illustrated in FIGS. 2-5 may be omitted for the sake of brevity.

Referring to FIGS. 6 and 7, carriers are converted by the ADC 10 and the converted digital signals are filtered by the digital filter 20 in steps 100 and 200, respectively. Each of the digital signals may be packetized by the packetizer 25 and each of the packets may be further concatenated by a concatenation unit 27 into a single concatenated digital packet stream in step 260. The concatenation unit 27 may be implemented by hardware or software. In step 300, the concatenated digital packet stream is sent to the translation engine 30 to be translated into a new frequency. The newly converted concatenated digital packet stream is sent to the DAC 40 to be converted into an analog signal in step 400. The analog signals may be sent to a radio frequency (RF) processor 50 to be further filtered and amplified, and then the concatenated analog signal is transmitted to an end point 60 in step 500.

Figures 8, 9 and 12 illustrate another method of translating cellular carriers according to an example embodiment of the present invention.

Referring to FIGS. 8, 9 and 12, carriers are converted by the ADC 10 and the converted digital signals are filtered by the digital filter 20 in steps 100 and 200, respectively. Each of the digital signals may be packetized by the packetized 25 in step 250. As illustrated in

FIGS. 8, 9 and 12, each digital packet stream (or, alternatively, each packet or group of packets) may be sent to separate and distinct emitter locations in step 270. A single wideband signal with one or several carriers may be fed to multiple locations, but with the same or fewer number of carriers in each single wideband signal than was received at the input of the receiver. As can be seen in the example embodiment illustrated in FIGS. 8 and 9, a single wideband signal with one carrier may be sent to location A; another single wideband signal with two carriers may be sent to location B; and yet another single wideband signal with one carrier may be sent location C.

At each distinct emitter locations, the digital packet(s) may be translated into a new frequency by, for example, a respective translation engine 30 in step 300. The newly converted digital packet(s) is sent to a respective DAC 40 to be converted into an analog signal(s). The analog signal(s) is processed by a respective RF processor 50, and transmitted to an end point 60 in steps 400 and 500, respectively.

Figures 10, 11 and 12 illustrate another method of translating cellular carriers according to an example embodiment of the present invention.

Referring to FIGS. 10, 11 and 12, carriers are converted by the DAC 10 and the converted digital signals are filtered by the digital filter 20 in steps 100 and 200, respectively. Each of the digital signals may be packetized by the packetizer 25 in step 250. In step 270, each of the digital packet streams (or, alternatively, each packet or group of packets) may be transported to separate and distinct emitter locations. As illustrated in FIGS. 10 and 11, a single wideband signal with only one carrier may be fed to one of the multiple emitter locations. At each of the separate and distinct emitter locations, a translation engine 30 translates each of the digital packets into a new frequency. Although the frequency of the four (4) carriers are different at the input of the receiver, each translation engine 30A-30D at the separate and distinct emitter locations translates each of the packet signals into the same frequency. Therefore, each of the packet signals is transmitted at the same frequency in step 500. This example embodiment may be applied to situations where access to only a single carrier's bandwidth is available, but the advantage of the cost effective use of multi-carrier radio technology is desired.

Although example embodiments of the present invention have been described with a band of frequency having four (4) cellular carriers, and the cellular carriers occupying a wideband signal of 10 MHz bandwidth, it will be appreciated that the number of cellular carriers and the bandwidth of the wideband signal may be varied without departing from the scope of the present invention.

Example embodiments of the present invention provide frequency flexibility. The frequency flexibility will allow smooth transition to government allocation of communication frequencies, and to handle the ever increasing usage and the capacity requirements that result from increased usage. The provision of this frequency flexibility may be accomplished in the digital domain by software. In addition, a signal radio output from a base station with multiple carriers may be used to drive multiple output remote radio heads with fewer carriers.

Example embodiments of the present invention will also allow wireless service providers the ability to position their carriers to better manage interference and optimally handle cellular traffic.

The example embodiments of the present invention being thus described, it will be obvious that the same may be varied in many ways. For example, while an example implementation of the present invention has been described with respect to a CDMA system, it will be appreciated that the present invention is applicable to other systems, including, for example, WCDMA, GSM, WiMax, etc. Such variations are not to be regarded as a departure from the invention, and all such modifications are intended to be included within the scope of the invention.

What is claimed is:

1. A method of translating carriers, comprising:

converting (100) at least one analog carrier signal within a wideband signal into at least one digital carrier signal, the at least one analog carrier signal at a respective frequency in the wideband signal; and

translating (300) at least one digital carrier signal to a different frequency.

2. The method of claim 1, further comprising:

filtering (200) the at least one digital carrier signal; and

wherein the translating step (300) translates the at least one filtered digital carrier signal.

3. The method of claim 1, further comprising:

digital processing (50) the at least one translated carrier signal to create a wideband signal.

4. The method of claim 1, further comprising:

converting (400) the at least one digital carrier signal back to at least one analog carrier signals.

5. The method of claim 4, wherein the at least one digital signal is converted (400) into the at least one analog carrier signal in a separate D/A stage.

6. The method of claim 4, further comprising:

amplifying and filtering (50) the at least one converted analog carriers signal; and

transmitting (500) the at least one amplified and filtered signal to an endpoint.

7. The method of claim 1, wherein the at least one carrier is a carrier in a code division multiple access (CDMA) network.

8. The method of claim 1, wherein the at least one carrier is a carrier of one of a wideband code division multiple access (WCDMA), a Global System for Mobile Communications (GSM), and tones in a Worldwide Interoperability for Microwave Access (WiMax) systems.

9. The method of claim 1, further comprising:

packetizing (250) each of the at least one digital carrier signal into at least one digital packet stream.

10. The method of claim 9, further comprising:

concatenating (260) the at least one digital packet stream.

FIG. 1

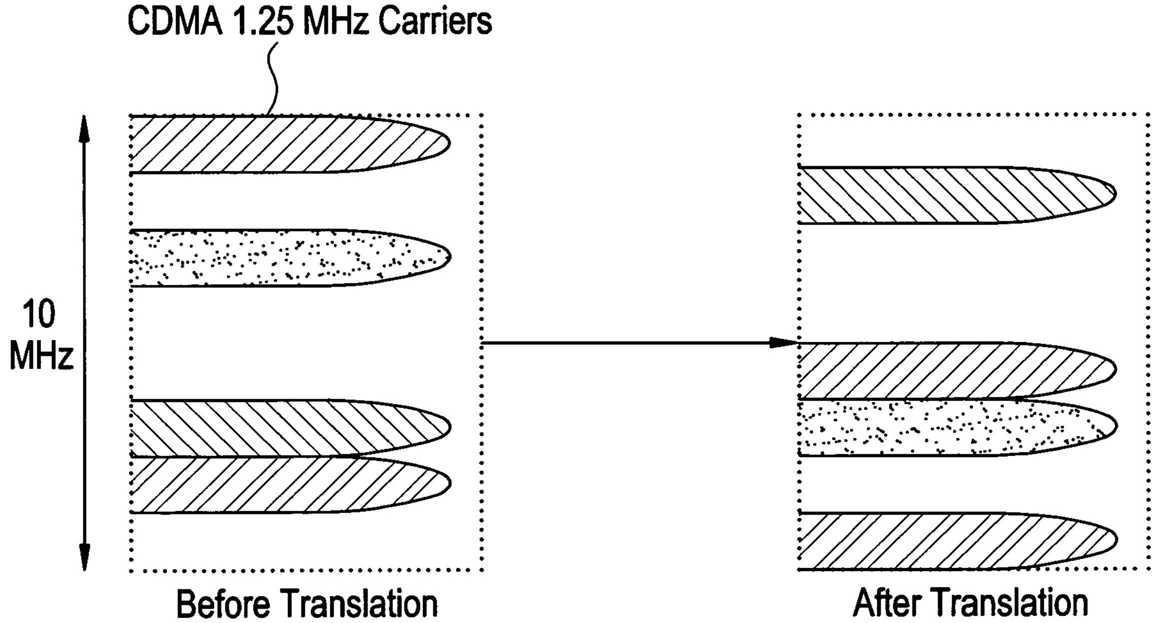

CDMA 1.25 MHz Carriers
10 MHz
Before Translation
After Translation

FIG. 2

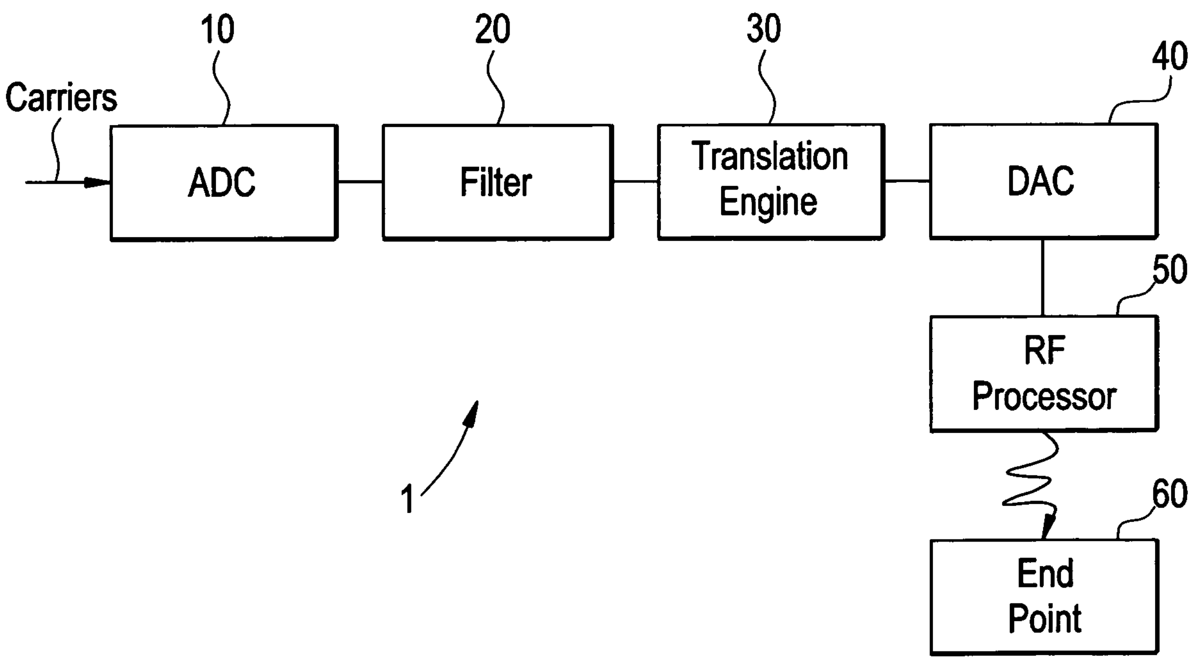

Carriers
10
ADC
20
Filter
30
Translation Engine
40
DAC
50
RF Processor
60
End Point
1

FIG. 3

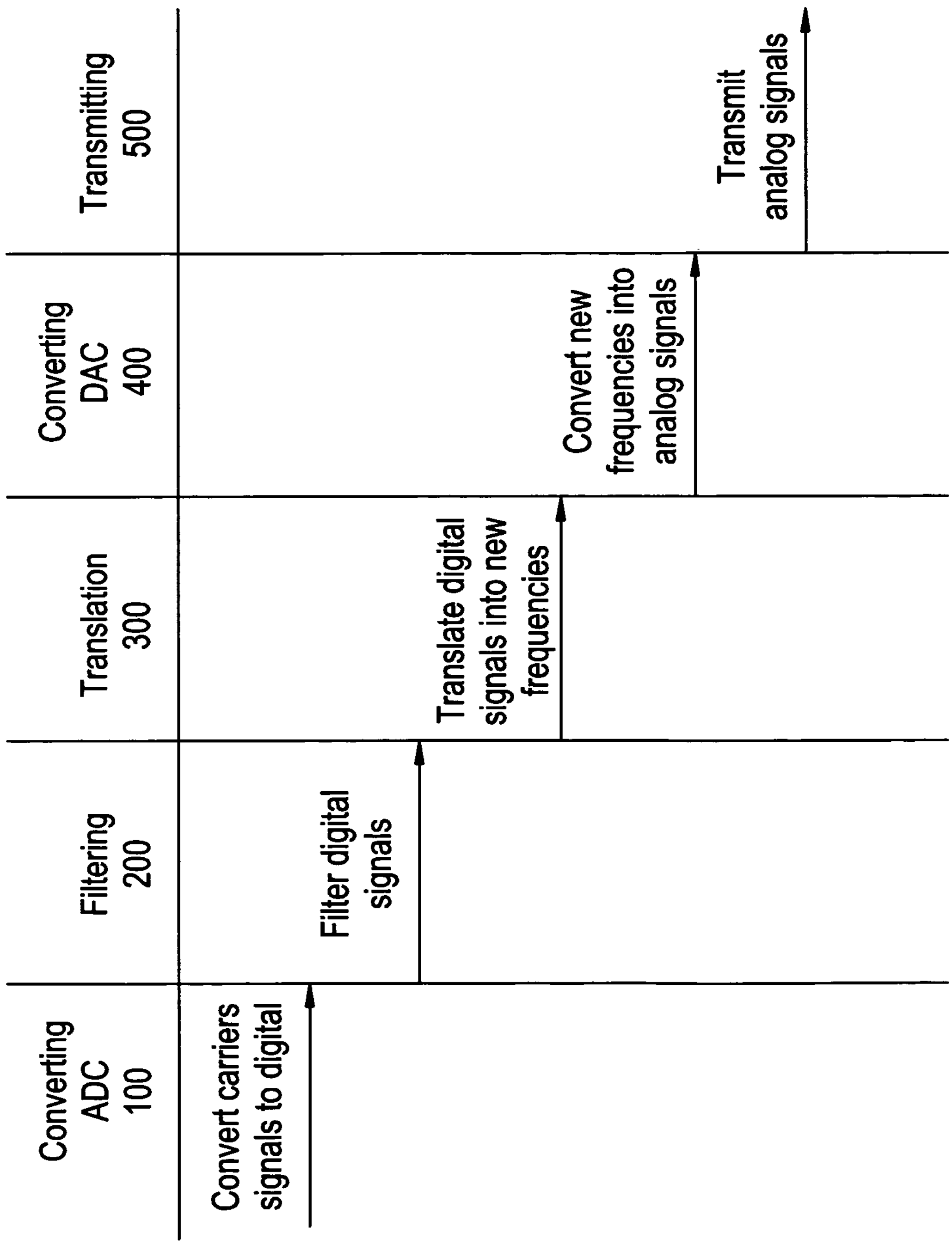

Converting ADC 100
Filtering 200
Translation 300
Converting DAC 400
Transmitting 500
Convert carriers signals to digital
Filter digital signals
Translate digital signals into new frequencies
Convert new frequencies into analog signals
Transmit analog signals

FIG. 4

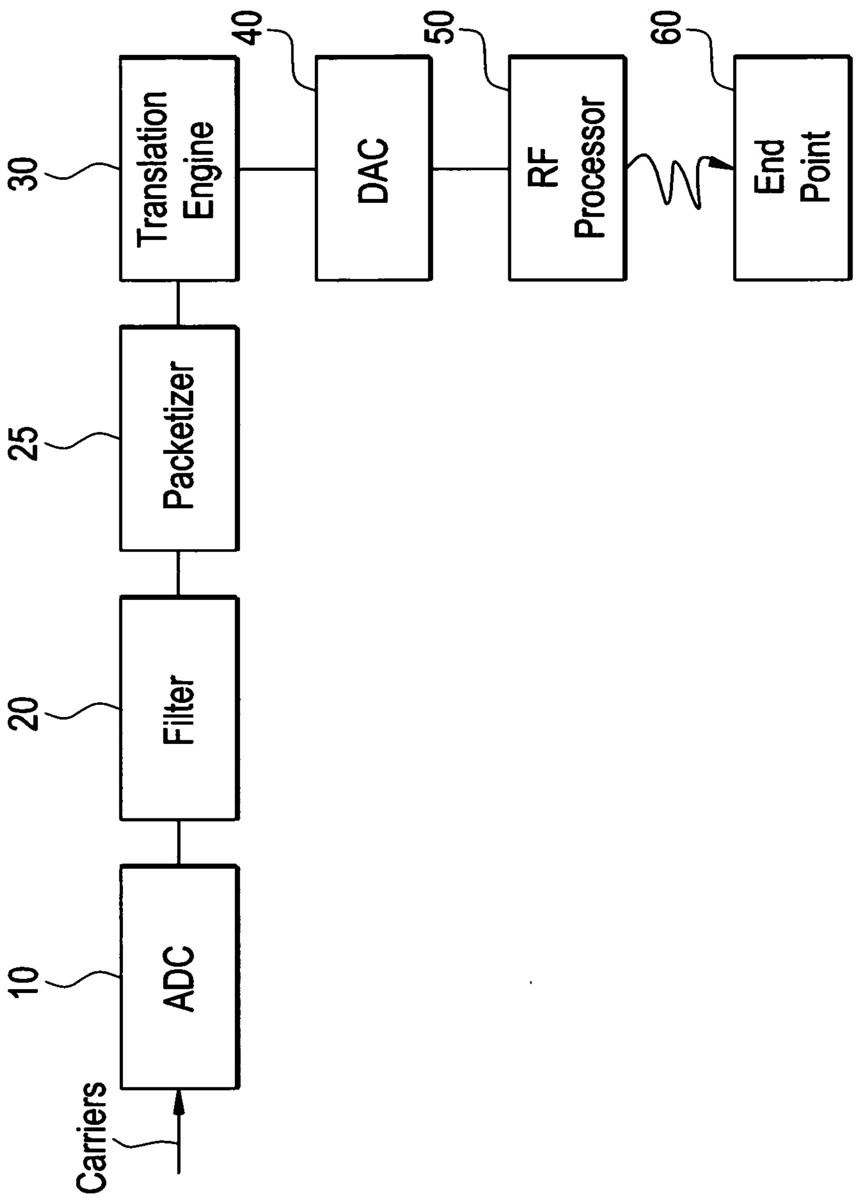

Carriers
10
ADC
20
Filter
25
Packetizer
30
Translation Engine
40
DAC
50
RF Processor
60
End Point

FIG. 5

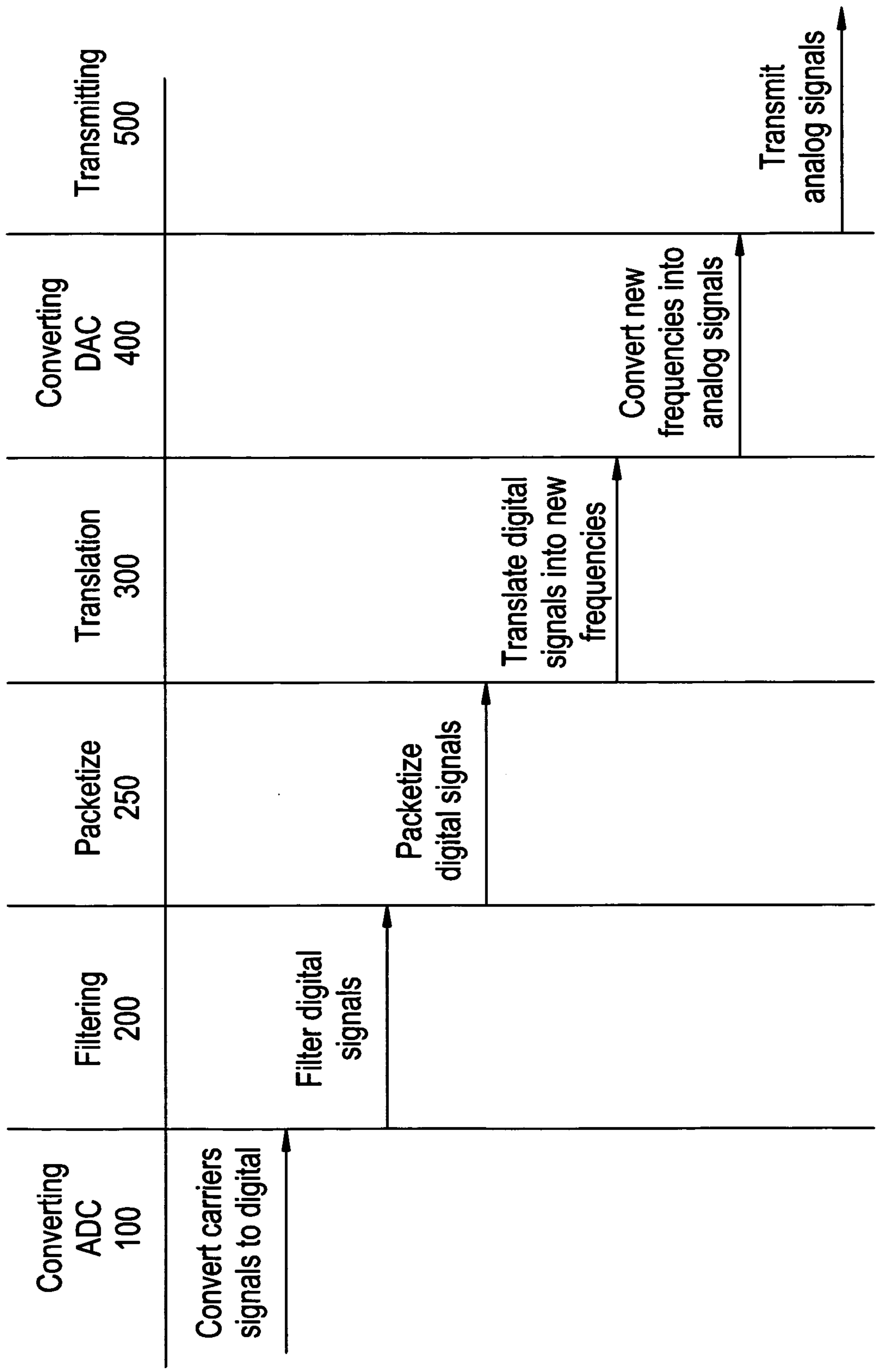

Converting ADC 100
Filtering 200
Packetize 250
Translation 300
Converting DAC 400
Transmitting 500
Convert carriers signals to digital
Filter digital signals
Packetize digital signals
Translate digital signals into new frequencies
Convert new frequencies into analog signals
Transmit analog signals

FIG. 6

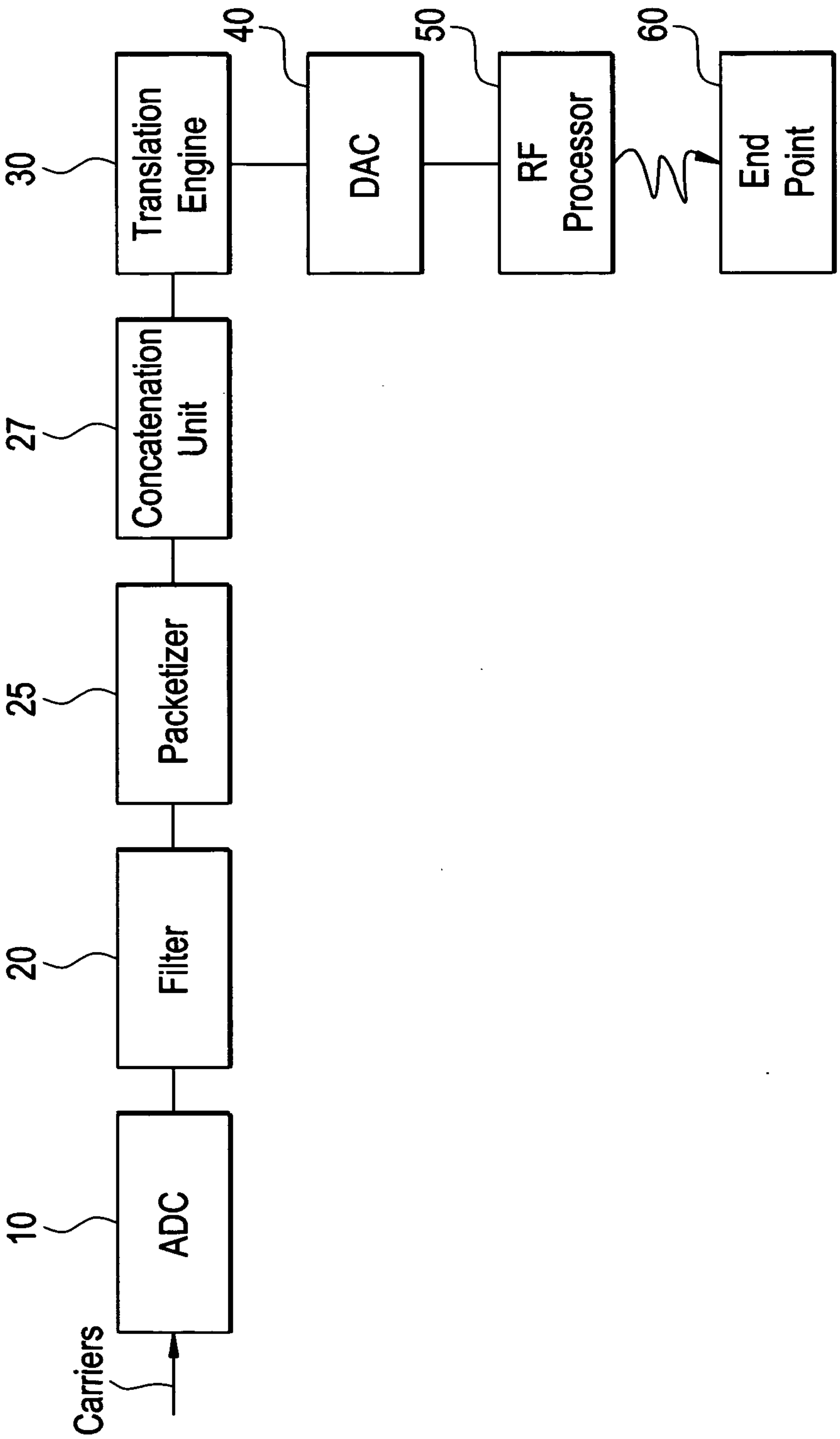

Carriers
10
ADC
20
Filter
25
Packetizer
27
Concatenation Unit
30
Translation Engine
40
DAC
50
RF Processor
60
End Point

FIG. 7

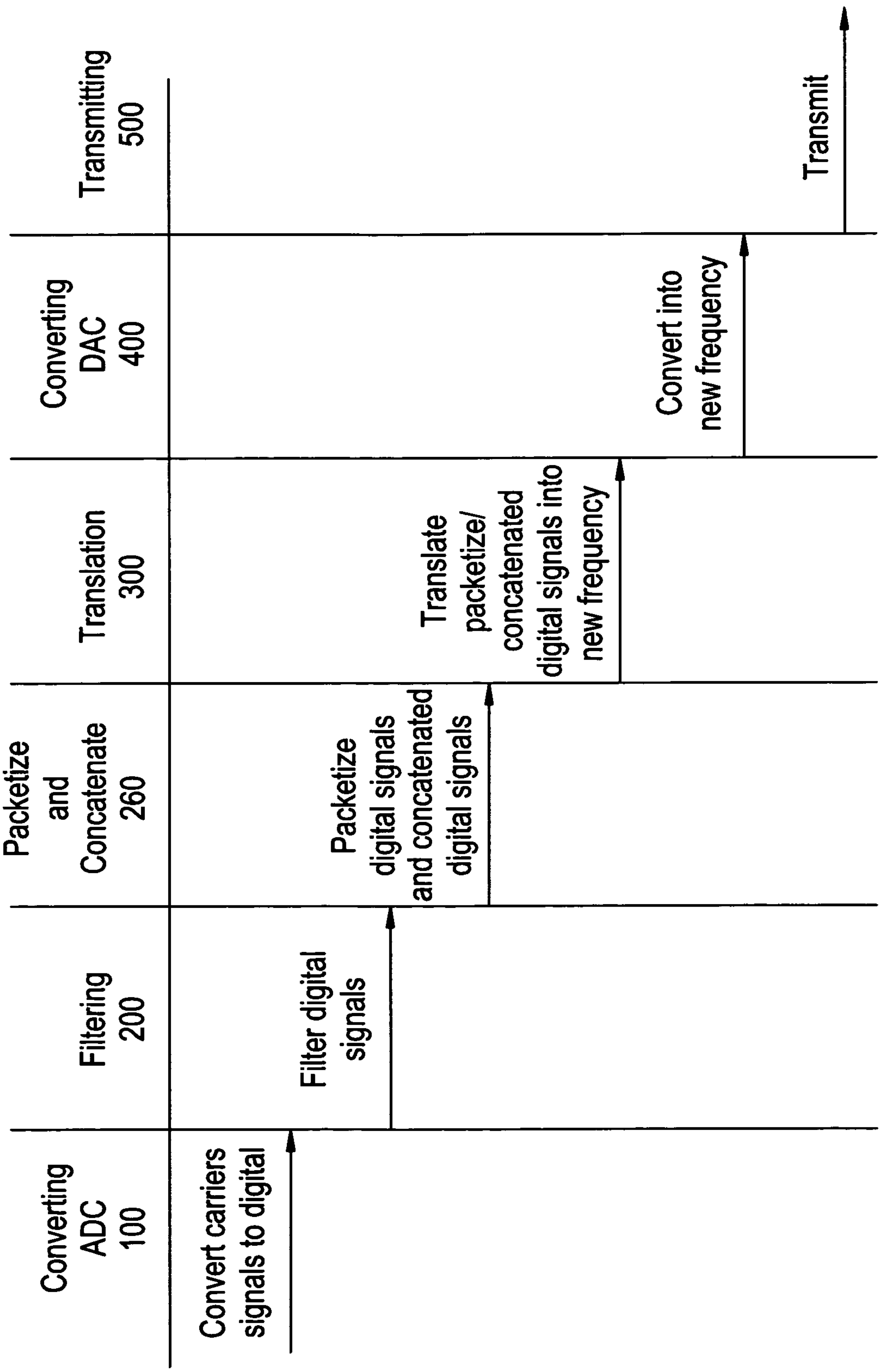
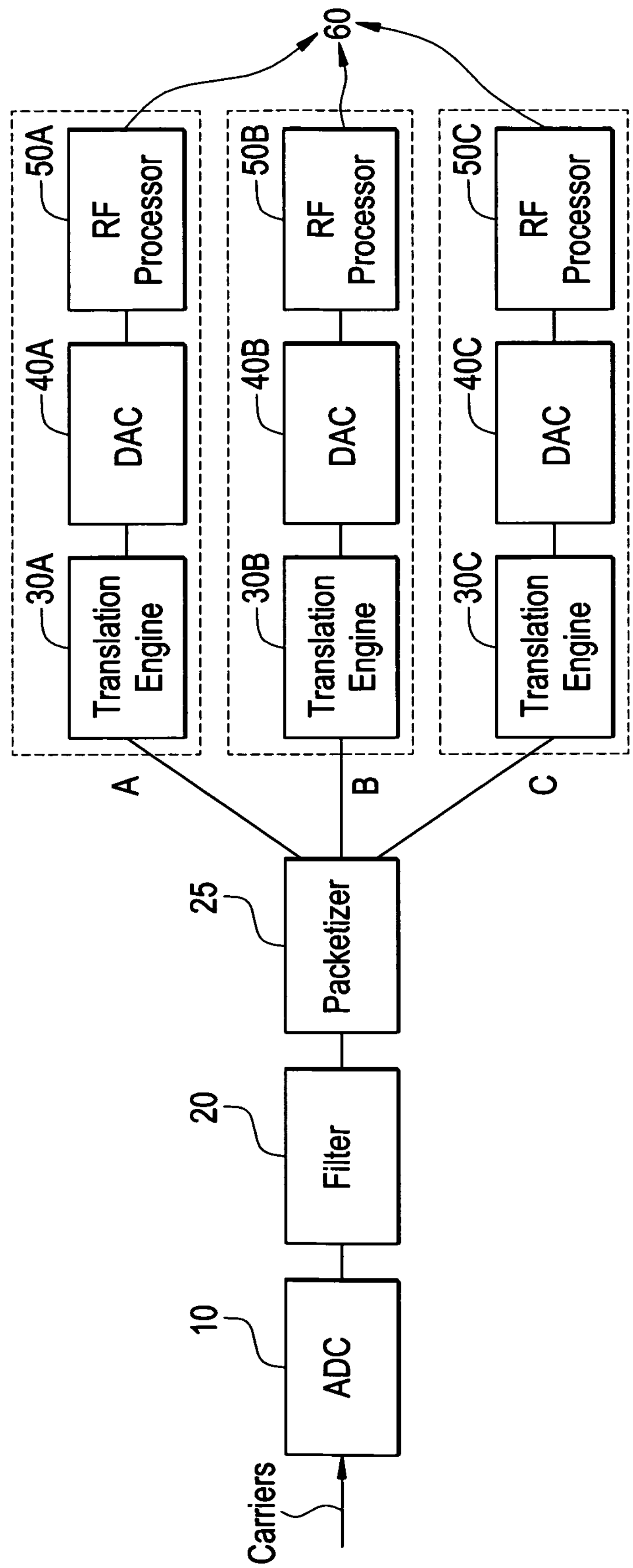

Converting
ADC
100
Filtering
200
Packetize
and
Concatenate
260
Translation
300
Converting
DAC
400
Transmitting
500
Convert carriers
signals to digital
Filter digital
signals
Packetize
digital signals
and concatenated
digital signals
Translate
packetize/
concatenated
digital signals into
new frequency
Convert into
new frequency
Transmit

FIG. 8



Carriers
10
ADC
20
Filter
25
Packetizer
A
B
C
30A
Translation Engine
40A
DAC
50A
RF Processor
30B
Translation Engine
40B
DAC
50B
RF Processor
30C
Translation Engine
40C
DAC
50C
RF Processor
60

FIG. 9

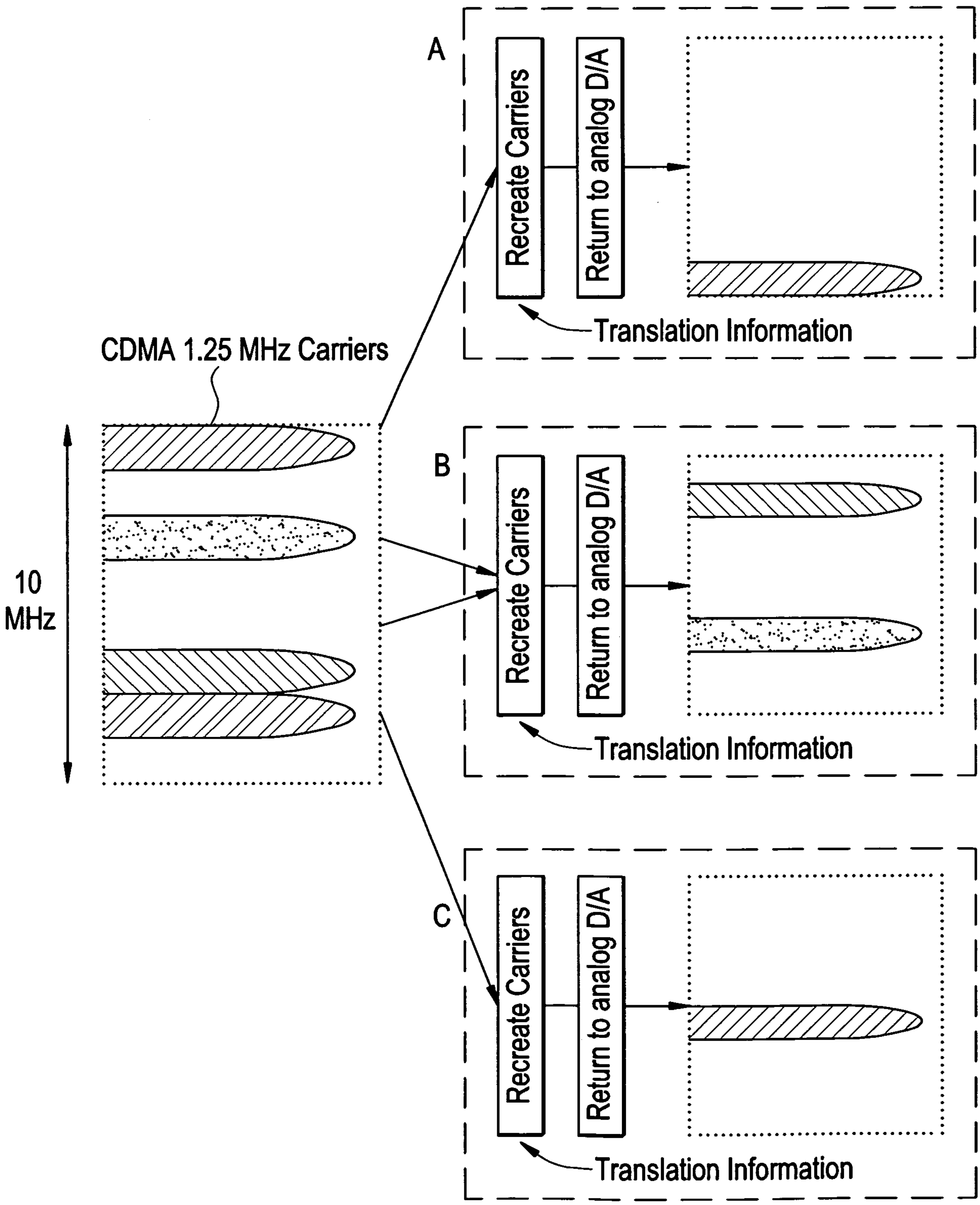

CDMA 1.25 MHz Carriers
10 MHz
A
Recreate Carriers
Return to analog D/A
Translation Information
B
Recreate Carriers
Return to analog D/A
Translation Information
C
Recreate Carriers
Return to analog D/A
Translation Information

FIG. 10

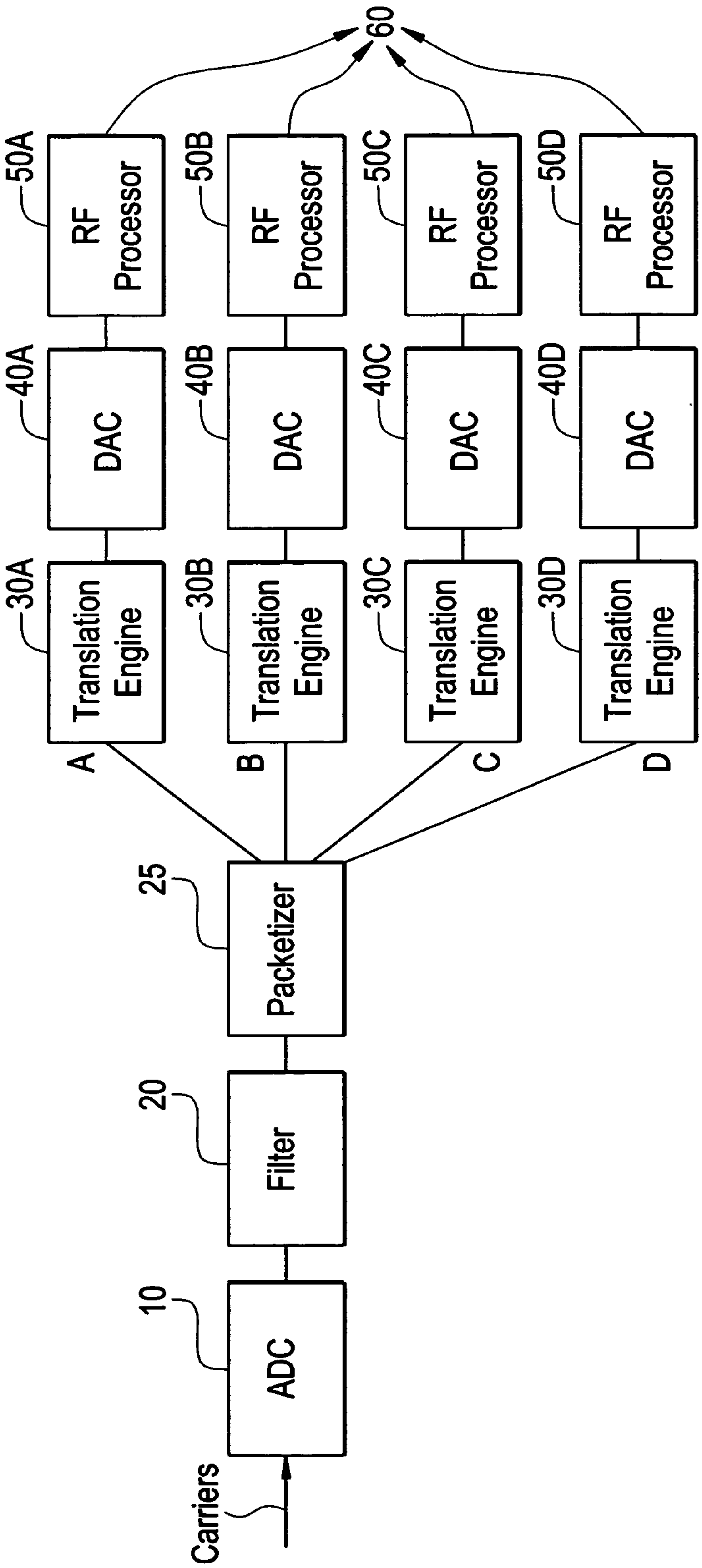
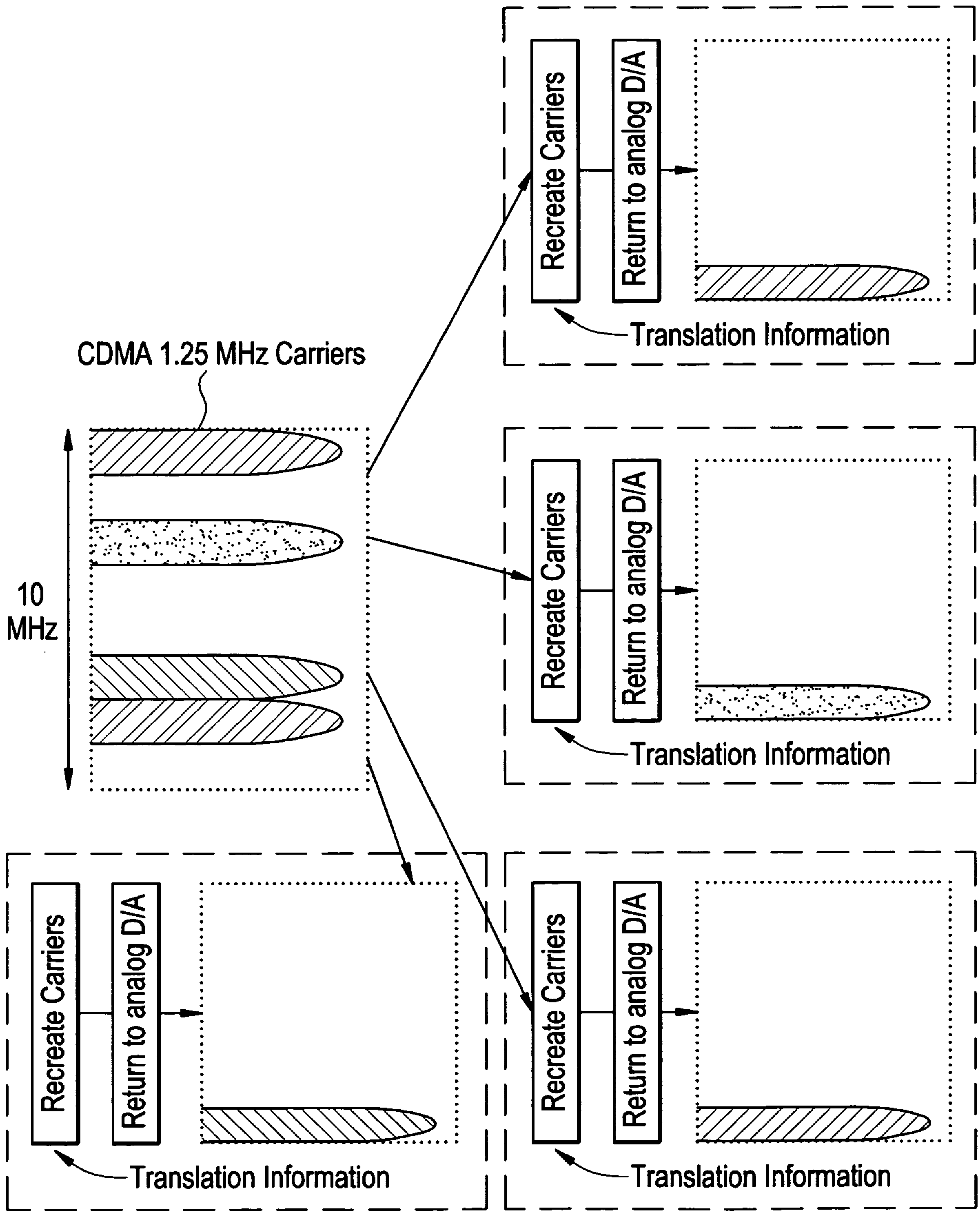

Carriers
ADC
10
Filter
20
Packetizer
25
A
B
C
D
Translation Engine
30A
30B
30C
30D
DAC
40A
40B
40C
40D
RF Processor
50A
50B
50C
50D
60

FIG. 11


CDMA 1.25 MHz Carriers
10 MHz
Recreate Carriers
Return to analog D/A
Translation Information
Recreate Carriers
Return to analog D/A
Translation Information
Recreate Carriers
Return to analog D/A
Translation Information
Recreate Carriers
Return to analog D/A
Translation Information

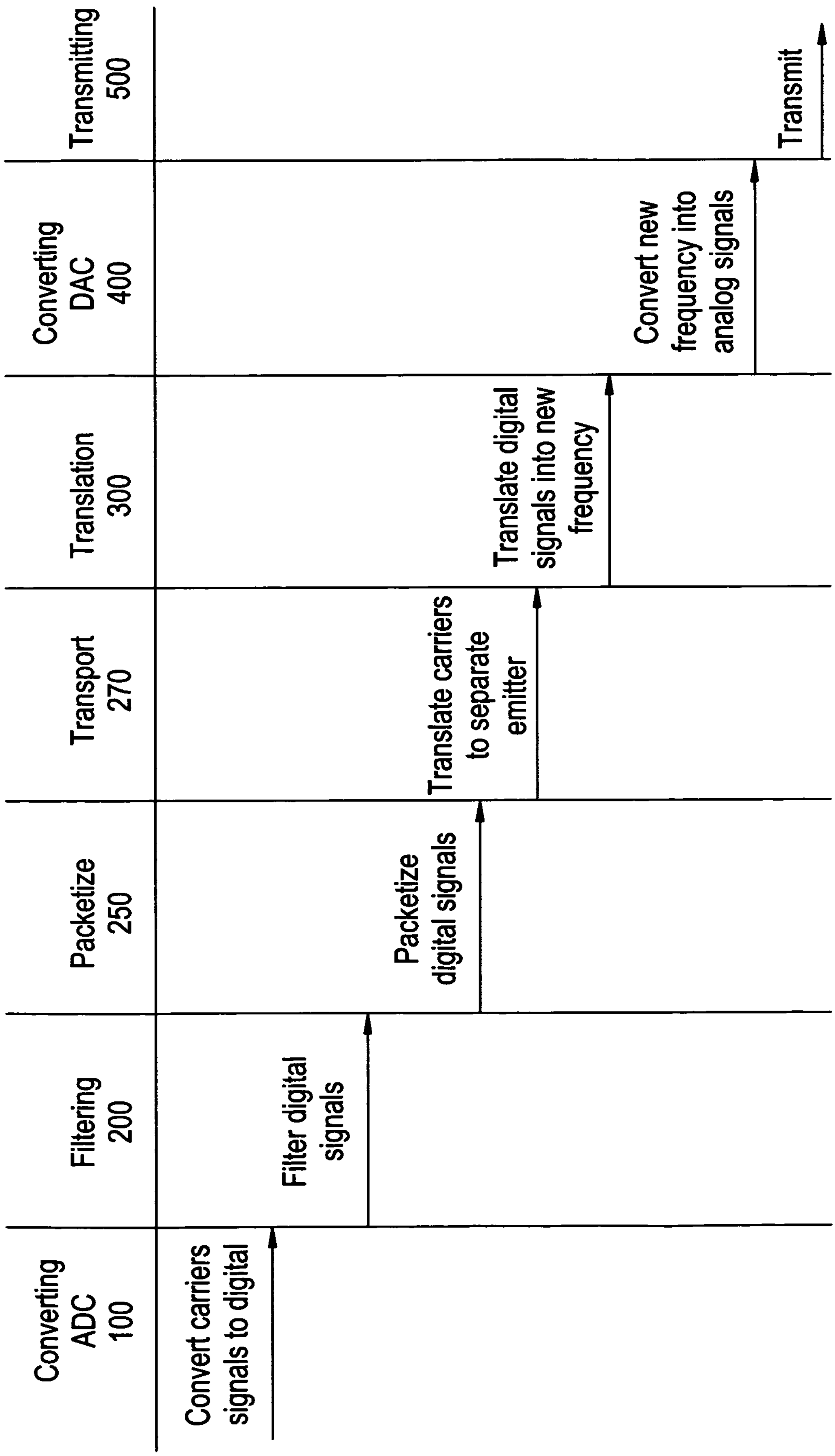

Converting ADC 100
Filtering 200
Packetize 250
Transport 270
Translation 300
Converting DAC 400
Transmitting 500
Convert carriers signals to digital
Filter digital signals
Packetize digital signals
Translate carriers to separate emitter
Translate digital signals into new frequency
Convert new frequency into analog signals
Transmit

FIG. 12