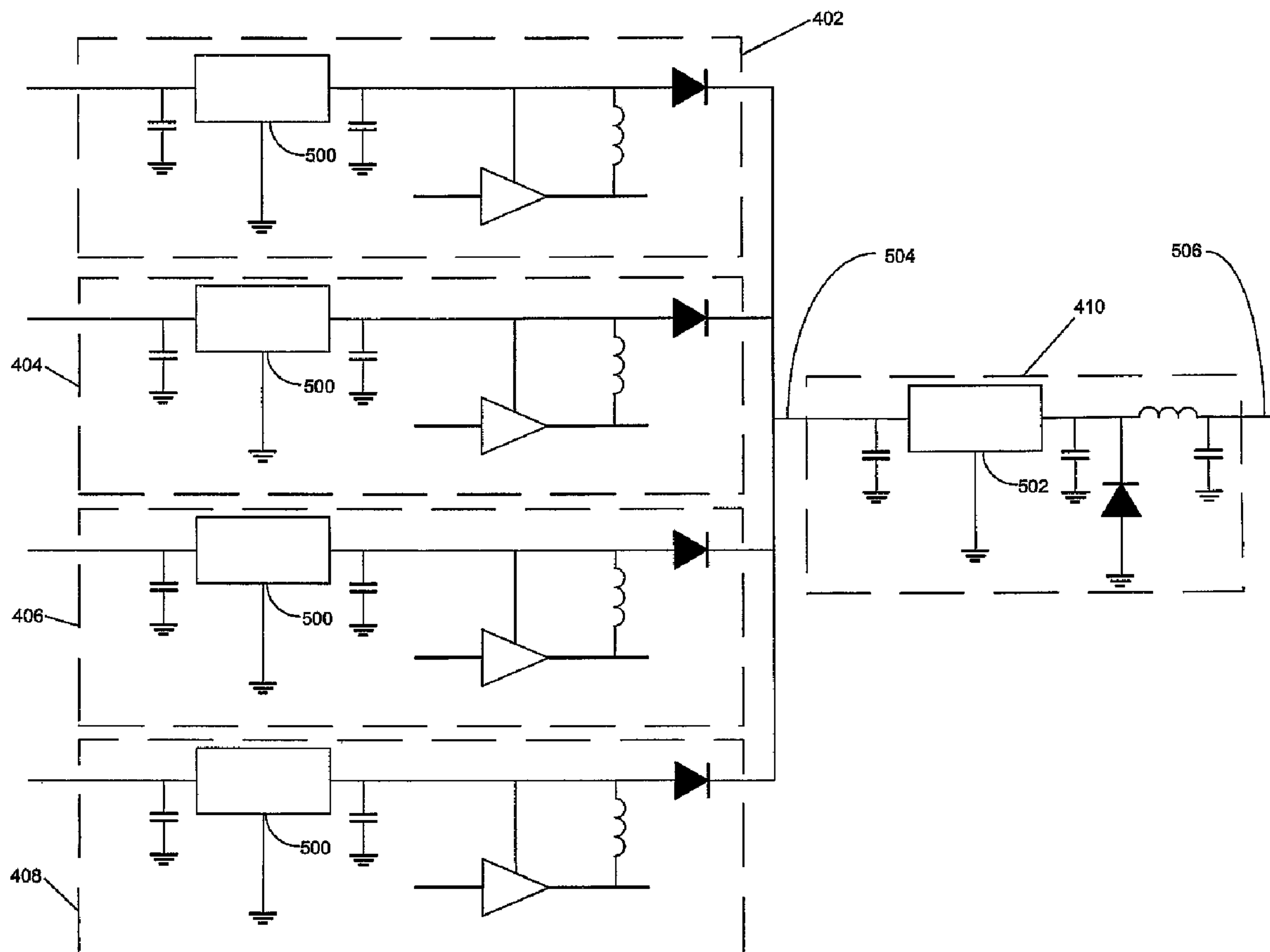




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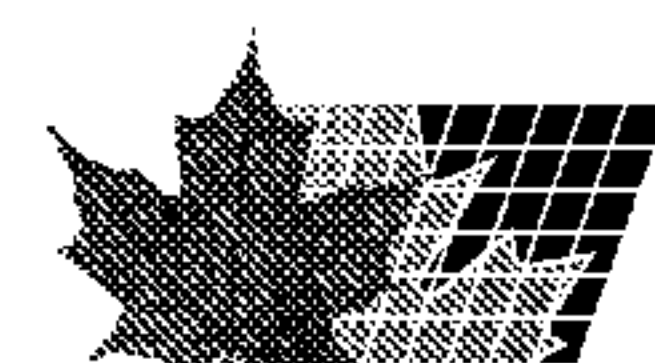
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(54) Title: DYNAMIC CURRENT SHARING IN KA/KU LNB DESIGN



(57) Abrégé/Abstract:

A method, apparatus and system providing power to Low Noise Block Amplifiers (LNBs) in a satellite signal receiving system wherein at least one receiver provides power to the LNBs. A system in accordance with the present invention comprises a first



(57) **Abrégé(suite)/Abstract(continued):**

stage of power regulation, coupled to the at least one receiver in a respective fashion, wherein the first stage of power regulation comprises linear regulation, and a second stage of power regulation, coupled between the first stage of power regulation and the LNBS, wherein the second stage of power regulation comprises a switching power regulator. Another embodiment of the present invention comprises a first stage of power regulation, coupled to the at least one receiver in a respective fashion, wherein the first stage of power regulation comprises a switching power regulator, and a second stage of power regulation, coupled between the first stage of power regulation and the LNBS, wherein the second stage of power regulation comprises a linear regulator.

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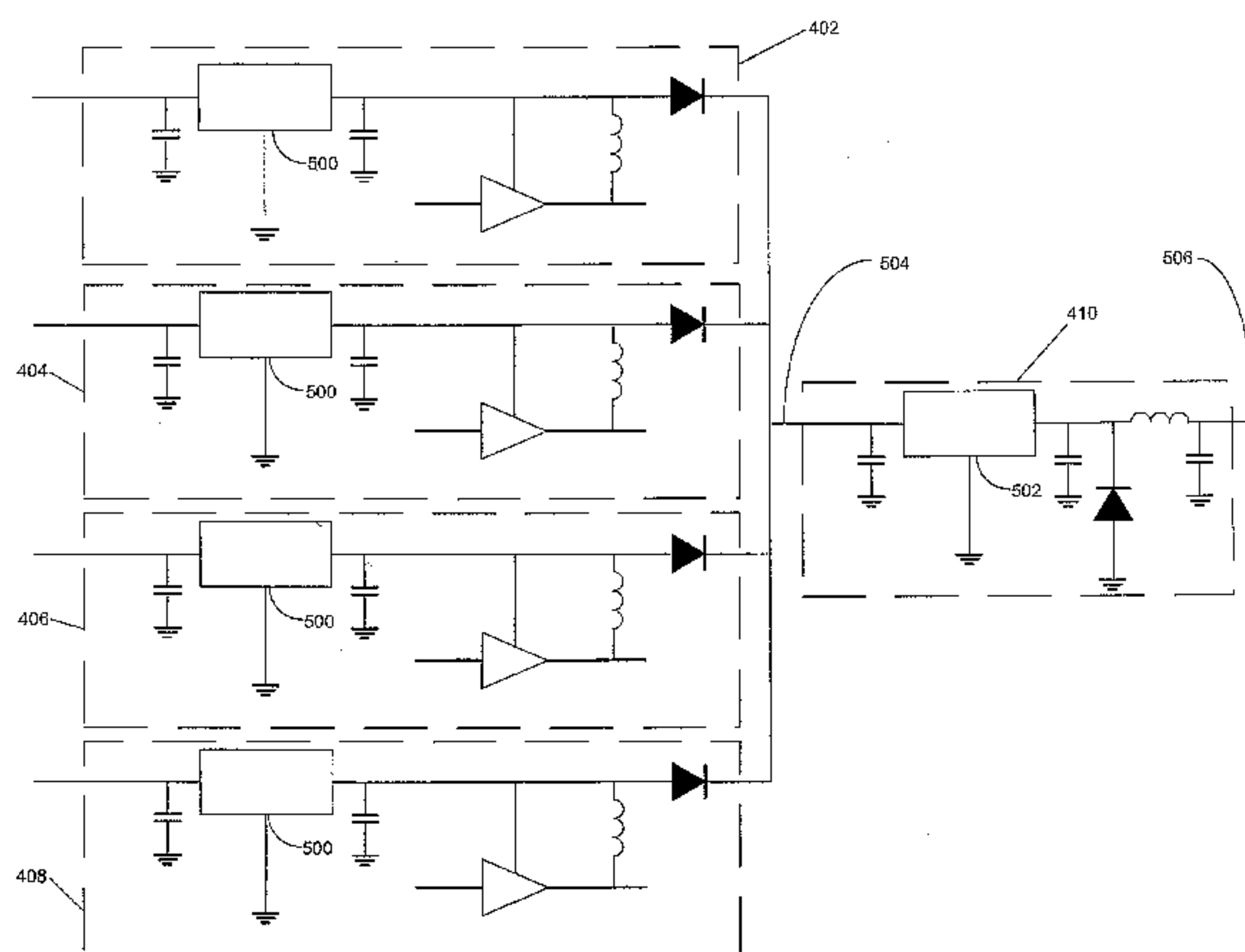
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(54) Title: DYNAMIC CURRENT SHARING IN KA/KU LNB DESIGN



(57) Abstract: A method, apparatus and system providing power to Low Noise Block Amplifiers (LNBs) in a satellite signal receiving system wherein at least one receiver provides power to the LNBs. A system in accordance with the present invention comprises a first stage of power regulation, coupled to the at least one receiver in a respective fashion, wherein the first stage of power regulation comprises linear regulation, and a second stage of power regulation, coupled between the first stage of power regulation and the LNBs, wherein the second stage of power regulation comprises a switching power regulator. Another embodiment of the present invention comprises a first stage of power regulation, coupled to the at least one receiver in a respective fashion, wherein the first stage of power regulation comprises a switching power regulator, and a second stage of power regulation, coupled between the first stage of power regulation and the LNBs, wherein the second stage of power regulation comprises a linear regulator.

DYNAMIC CURRENT SHARING IN KA/KU LNB DESIGN

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit under 35 U.S.C. § 119(e) of the following co-

5 pending and commonly-assigned U.S. provisional patent applications:

Application Serial No. 60/725,781, filed on October 12, 2005 by John L. Norin and Kesse Ho, entitled "TRIPLE STACK COMBINING APPROACH TO Ka/Ku SIGNAL DISTRIBUTION," attorneys' docket number PD-205054;

10 Application Serial No. 60/725,782, filed on October 12, 2005 by Kesse Ho and John L. Norin, entitled "SINGLE LOCAL OSCILLATOR SHARING IN MULTI-BAND KA-BAND LNBS," attorneys' docket number PD-205055;

Application Serial No. 60/726,118, filed on October 12, 2005 by John L. Norin, entitled "KA/KU ANTENNA ALIGNMENT," attorneys' docket number PD-205058;

15 Application Serial No. 60/726,149, filed on October 12, 2005 by Kesse Ho, entitled "DYNAMIC CURRENT SHARING IN KA/KU LNB DESIGN," attorneys' docket number PD-205059;

Application Serial No. 60/726,150, filed on October 12, 2005 by Kesse Ho, entitled "KA LNB UMBRELLA SHADE," attorneys' docket number PD-205060;

20 Application Serial No. 60/726,151, filed on October 12, 2005 by John L. Norin and Kesse Ho, entitled "BAND UPCONVERTER APPROACH TO KA/KU SIGNAL DISTRIBUTION," attorneys' docket number PD-205056;

Application Serial No. 60/727,143, filed on October 14, 2005 by John L. Norin and Kesse Ho, entitled "BAND UPCONVERTER APPROACH TO KA/KU SIGNAL DISTRIBUTION," attorneys' docket number PD-205064;

Application Serial No. 60/728,338, filed on October 12, 2005 by John L. Norin, Kesse Ho, Mike A. Frye, and Gustave Stroes, entitled "NOVEL ALIGNMENT METHOD FOR MULTI-SATELLITE CONSUMER RECEIVE ANTENNAS," attorneys' docket number PD-205057;

5 Application Serial No. 60/754,737, filed on December 28, 2005 by John L. Norin, entitled "KA/KU ANTENNA ALIGNMENT," attorneys' docket number PD-205058R;

Application Serial No. 60/758,762, filed on January 13, 2006 by Kesse Ho, entitled "KA LNB UMBRELLA SHADE," attorneys' docket number PD-205060R; and

10 Application Serial No. 60/726,337, filed October 12, 2005, entitled "ENHANCED BACK ASSEMBLY FOR KA/KU ODU," by Michael A. Frye et al., attorneys' docket number PD-205029,

all of which applications are incorporated by reference herein.

BACKGROUND OF THE INVENTION

1. Field of the Invention.

The present invention relates generally to a satellite receiver system, and in particular,
5 to an alignment method for multi-band consumer receiver antennas.

2. Description of the Related Art.

Satellite broadcasting of communications signals has become commonplace. Satellite
distribution of commercial signals for use in television programming currently utilizes
10 multiple feedhorns on a single Outdoor Unit (ODU) which supply signals to up to eight IRDs
on separate cables from a multiswitch.

FIG. 1 illustrates a typical satellite television installation of the related art.

System 100 uses signals sent from Satellite A (SatA) 102, Satellite B (SatB) 104, and
Satellite C (SatC) 106 (with transponders 28, 30, and 32 converted to transponders 8, 10, and
15 12, respectively), that are directly broadcast to an Outdoor Unit (ODU) 108 that is typically
attached to the outside of a house 110. ODU 108 receives these signals and sends the
received signals to IRD 112, which decodes the signals and separates the signals into viewer
channels, which are then passed to television 114 for viewing by a user. There can be more
than one satellite transmitting from each orbital location.

20 Satellite uplink signals 116 are transmitted by one or more uplink facilities 118 to the
satellites 102-106 that are typically in geosynchronous orbit. Satellites 102-106 amplify and
rebroadcast the uplink signals 116, through transponders located on the satellite, as downlink
signals 120. Depending on the satellite 102-106 antenna pattern, the downlink signals 120
are directed towards geographic areas for reception by the ODU 108.

Each satellite 102-106 broadcasts downlink signals 120 in typically thirty-two (32) different sets of frequencies, often referred to as transponders, which are licensed to various users for broadcasting of programming, which can be audio, video, or data signals, or any combination. These signals have typically been located in the Ku-band Fixed Satellite Service (FSS) and Broadcast Satellite Service (BSS) bands of frequencies in the 10-13 GHz range. Future satellites will likely also broadcast in a portion of the Ka-band with frequencies of 18-21 GHz

Typically, the IRD 112 powers the ODU 108 through the cables between IRD 112 and ODU 108. However, with additional satellites being positioned for delivery of additional downlink signals 120, IRD 112 may have difficulty providing power to ODU 108 in a consistent and proper format. If the power is not delivered properly, the signals from the additional satellites will not be properly received, rendering these signals useless for data and video transmission.

It can be seen, then, that there is a need in the art for a system that can properly power up the ODU.

SUMMARY OF THE INVENTION

To minimize the limitations in the prior art, and to minimize other limitations that will become apparent upon reading and understanding the present specification, the present invention discloses a method, apparatus and system providing power to Low Noise Block Amplifiers (LNBs) in a satellite signal receiving system. wherein at least one receiver provides power to the LNBs. A system in accordance with the present invention comprises a first stage of power regulation, coupled to the at least one receiver in a respective fashion, wherein the first stage of power regulation comprises linear regulation, and a second stage of power regulation, coupled between the first stage of power regulation and the LNBs, wherein the second stage of power regulation comprises a switching power regulator.

Another embodiment of the present invention comprises a first stage of power regulation, coupled to the at least one receiver in a respective fashion, wherein the first stage of power regulation comprises a switching power regulator, and a second stage of power regulation, coupled between the first stage of power regulation and the LNBs, wherein the second stage of power regulation comprises a linear regulator.

Other features and advantages are inherent in the system and method claimed and disclosed or will become apparent to those skilled in the art from the following detailed description and its accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Referring now to the drawings in which like reference numbers represent corresponding parts throughout:

FIG. 1 illustrates a typical satellite television installation of the related art;

5 FIG. 2 illustrates a typical ODU of the present invention;

FIGS. 3 and 4 illustrate current sharing diagrams of the present invention; and

FIG. 5 illustrates a schematic diagram for an embodiment of the schema shown in
FIG. 4.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

In the following description, reference is made to the accompanying drawings which form a part hereof, and which show, by way of illustration, several embodiments of the present invention. It is understood that other embodiments may be utilized and structural changes may be made without departing from the scope of the present invention.

Overview

FIG. 2 illustrates a typical ODU of the related art.

ODU 108 typically uses reflector dish 122 and feedhorn assembly 124 to receive and direct downlink signals 120 onto feedhorn assembly 124. Reflector dish 122 and feedhorn assembly 124 are typically mounted on bracket 126 and attached to a structure for stable mounting. Feedhorn assembly 124 typically comprises one or more Low Noise Block converters 128, which are connected via wires or coaxial cables to a multiswitch, which can be located within feedhorn assembly 124, elsewhere on the ODU 108, or within house 110. LNBS typically downconvert the FSS and/or BSS-band, Ku-band, and Ka-band downlink signals 120 into frequencies that are easily transmitted by wire or cable, which are typically in the L-band of frequencies, which typically ranges from 950 MHz to 2150 MHz. This downconversion makes it possible to distribute the signals within a home using standard coaxial cables.

The multiswitch enables system 100 to selectively switch the signals from SatA 102, SatB 104, and SatC 106, and deliver these signals via cables 124 to each of the IRDs 112A-D located within house 110. Typically, the multiswitch is a five-input, four-output (5x4) multiswitch, where two inputs to the multiswitch are from SatA 102, one input to the

multiswitch is from SatB 104, and one input to the multiswitch is a combined input from SatB 104 and SatC 106. There can be other inputs for other purposes, e.g., off-air or other antenna inputs, without departing from the scope of the present invention. The multiswitch can be other sizes, such as a 6x8 multiswitch, if desired. SatB 104 typically delivers local programming to specified geographic areas, but can also deliver other programming as desired.

To maximize the available bandwidth in the Ku-band of downlink signals 120, each broadcast frequency is further divided into polarizations. Each LNB 128 can receive both orthogonal polarizations at the same time with parallel sets of electronics, so with the use of either an integrated or external multiswitch, downlink signals 120 can be selectively filtered out from travelling through the system 100 to each IRD 112A-D.

IRDs 112A-D currently use a one-way communications system to control the multiswitch. Each IRD 112A-D has a dedicated cable 124 connected directly to the multiswitch, and each IRD independently places a voltage and signal combination on the dedicated cable to program the multiswitch. For example, IRD 112A may wish to view a signal that is provided by SatA 102. To receive that signal, IRD 112A sends a voltage/tone signal on the dedicated cable back to the multiswitch, and the multiswitch delivers the satA 102 signal to IRD 112A on dedicated cable 124. IRD 112B independently controls the output port that IRD 112B is coupled to, and thus may deliver a different voltage/tone signal to the multiswitch. The voltage/tone signal typically comprises a 13 Volts DC (VDC) or 18 VDC signal, with or without a 22kHz tone superimposed on the DC signal. 13VDC without the 22kHz tone would select one port, 13VDC with the 22kHz tone would select another port of the multiswitch, etc. There can also be a modulated tone, typically a 22 kHz tone, where the

modulation schema can select one of any number of inputs based on the modulation scheme. For simplicity and cost savings, this control system has been used with the constraint of 4 cables coming for a single feedhorn assembly 124, which therefore only requires the 4 possible state combinations of tone/no-tone and hi/low voltage.

5 To reduce the cost of the ODU 108, outputs of the LNBs 128 present in the ODU 108 can be combined, or “stacked,” depending on the ODU 108 design. The stacking of the LNB 128 outputs occurs after the LNB has received and downconverted the input signal. This allows for multiple polarizations, one from each satellite 102-106, to pass through each LNB 128. So one LNB 128 can, for example, receive the Left Hand Circular Polarization (LHCP) signals from SatC 102 and SatB 104, while another LNB receives the Right Hand Circular Polarization (RHCP) signals from SatB 104, which allows for fewer wires or cables between the feedhorn assembly 124 and the multiswitch.

 The Ka-band of downlink signals 120 will be further divided into two bands, an upper band of frequencies called the “A” band and a lower band of frequencies called the “B” band. Once satellites are deployed within system 100 to broadcast these frequencies, the various LNBs 128 in the feedhorn assembly 124 can deliver the signals from the Ku-band, the A band Ka-band, and the B band Ka-band signals for a given polarization to the multiswitch. However, current IRD 112 and system 100 designs cannot tune across this entire resulting frequency band without the use of more than 4 cables, which limits the usefulness of this frequency combining feature.

 By stacking the LNB 128 inputs as described above, each LNB 128 typically delivers 48 transponders of information to the multiswitch, but some LNBs 128 can deliver more or less in blocks of various size. The multiswitch allows each output of the multiswitch to

receive every LNB 128 signal (which is an input to the multiswitch) without filtering or modifying that information, which allows for each IRD 112 to receive more data. However, as mentioned above, current IRDs 112 cannot use the information in some of the proposed frequencies used for downlink signals 120, thus rendering useless the information transmitted in those downlink signals 120.

The problem with the additional LNBS 128 that will be required for a Ka-band system 100 is that IRD 112 will have difficulty providing power to all of the LNBS 128 simultaneously. The current drawn by the LNBS 128 is significant, and, as such, the present invention provides a method and system for providing the current to the LNBS 128 in an efficient manner.

Current Sharing Schema

FIGS. 3 and 4 illustrate current sharing diagrams of the present invention.

As system 100 has expanded to include additional satellites at different orbital slots and different frequency bands, system 100 can no longer turn off LNBS 128 that are unused. In system 100 with additional satellites transmitting at the KA-band, three LNBS 128 must be powered at the same time for any given selection code (e.g., 13 VDC selects a Ka-band low LNB 128, a Ku-band LNB 128, and a Ka-band high LNB 128). Some selections will power four LNBS 128 at the same time.

In a typical dual LNB 128 system, whichever IRD 112 has a higher voltage present at the input to the LNB 128 provides all of the current to power LNB 128. In a typical triple LNB 128 system, linear regulators are used to provide some current sharing, however, regardless of input power, each regulator dissipates some power as heat because the LNB 128

only takes what is needed.

System 300 illustrates IRDs 112A-D coupled to DC-DC converters 302-308, which are each then coupled to DC-DC linear regulator 310. Each of the DC-DC converters 302-308 acts as a switching regulator, which switches on and off rather than require a constant current draw, therefore providing more efficient delivery of power to LNBs 128.

System 400 illustrates IRDs 112A-D coupled to DC-DC linear regulators 402-408, which are each then coupled to DC-DC converter 410. DC-DC converter 410 acts as a switching regulator, which switches on and off rather than require a constant current draw, therefore providing more efficient delivery of power to LNBs 128.

FIG. 5 illustrates a schematic diagram for an embodiment of the schema shown in FIG. 4.

Linear Regulators 402-408, and DC-DC regulator 410 are shown, along with regulators 500 and DC-DC switching regulator 502. Regulators 400 are linear regulators, typically 7808 or 7809 regulators, while DC-DC switching regulator 502 is typically a 750 kHz regulator. The second stage of regulation provided by regulator 410 (or, as shown in FIG. 3, regulator 310), balances the current supplied by each of IRDs 112A-D, to allow for all LNBs 128 present in system 100 to be powered in a proper manner.

The interaction between regulator 410 with regulators 402-408 allows for a more dynamic sharing of the current requirements for LNBs 128, without overtaxing any one of the IRDs 112A-D in a given system 100.

Diodes shown in FIG. 5 are typically schottky diodes, but can be p-n diodes if desired. Further, the voltage present at point 504 is typically 8.1 volts, and the voltage present at point 506 is typically 5.1 volts, but these values can vary without departing from the scope of the

present invention.

Conclusion

In summary, the present invention comprises a method, apparatus and system
5 providing power to Low Noise Block Amplifiers (LNBs) in a satellite signal receiving
system. wherein at least one receiver provides power to the LNBs. A system in accordance
with the present invention comprises a first stage of power regulation, coupled to the at least
one receiver in a respective fashion, wherein the first stage of power regulation comprises
linear regulation, and a second stage of power regulation, coupled between the first stage of
10 power regulation and the LNBs, wherein the second stage of power regulation comprises a
switching power regulator.

Another embodiment of the present invention comprises a first stage of power
regulation, coupled to the at least one receiver in a respective fashion, wherein the first stage
of power regulation comprises a switching power regulator, and a second stage of power
15 regulation, coupled between the first stage of power regulation and the LNBs, wherein the
second stage of power regulation comprises a linear regulator.

It is intended that the scope of the invention be limited not by this detailed description,
but rather by the claims appended hereto and the equivalents thereof. The above
specification, examples and data provide a complete description of the manufacture and use
20 of the composition of the invention. Since many embodiments of the invention can be made
without departing from the spirit and scope of the invention, the invention resides in the
claims hereinafter appended and the equivalents thereof.

WHAT IS CLAIMED IS:

1. A system for providing power to Low Noise Block Amplifiers (LNBs) in a satellite signal receiving system, wherein at least one receiver provides power to the LNBs, comprising:

5 a first stage of power regulation, coupled to the at least one receiver in a respective fashion, wherein the first stage of power regulation comprises linear regulation; and
a second stage of power regulation, coupled between the first stage of power regulation and the LNBs, wherein the second stage of power regulation comprises a switching power regulator.

10 2. The system of claim 1, wherein a plurality of receivers provide power to the LNBs.

15 3. The system of claim 2, wherein the first stage of power regulation and the second stage of power regulation allow the plurality of receivers to share power requirements of the LNBs.

20 4. The system of claim 3, wherein the switching power regulator is a DC-DC converter.

5. The system of claim 4, wherein the second stage of power regulation provides current balancing to the plurality of receivers.

6. A system for providing power to Low Noise Block Amplifiers (LNBs) in a satellite signal receiving system, wherein at least one receiver provides power to the LNBs, comprising:

5 a first stage of power regulation, coupled to the at least one receiver in a respective fashion, wherein the first stage of power regulation comprises a switching power regulator; and

10 a second stage of power regulation, coupled between the first stage of power regulation and the LNBs, wherein the second stage of power regulation comprises a linear regulator.

7. The system of claim 6, wherein a plurality of receivers provide power to the LNBs.

15 8. The system of claim 7, wherein the first stage of power regulation and the second stage of power regulation allow the plurality of receivers to share power requirements of the LNBs.

9. The system of claim 8, wherein the switching power regulator is a DC-DC converter.

20 10. The system of claim 9, wherein the second stage of power regulation provides current balancing to the plurality of receivers.

11. A system for delivering satellite signals to a receiver, comprising:

a plurality of satellites, wherein at least a first satellite in the plurality of satellites broadcasts a first set of satellite signals broadcast in a first frequency band, and at least a second satellite in the plurality of satellites broadcasts a second set of satellite signals in a second frequency band;

an antenna, the antenna receiving the first set of satellite signals and the second set of satellite signals, the antenna comprising Low Noise Block Amplifiers (LNBS);

at least one receiver, coupled to the LNBS, for receiving the first set of satellite signals and second set of satellite signals, wherein at least one receiver provides power to the LNBS, and

a first stage of power regulation, coupled between the at least one receiver and the LNBS, wherein the first stage of power regulation comprises a switching power regulator; and

a second stage of power regulation, coupled between the first stage of power regulation and the LNBS, wherein the second stage of power regulation comprises a linear regulator.

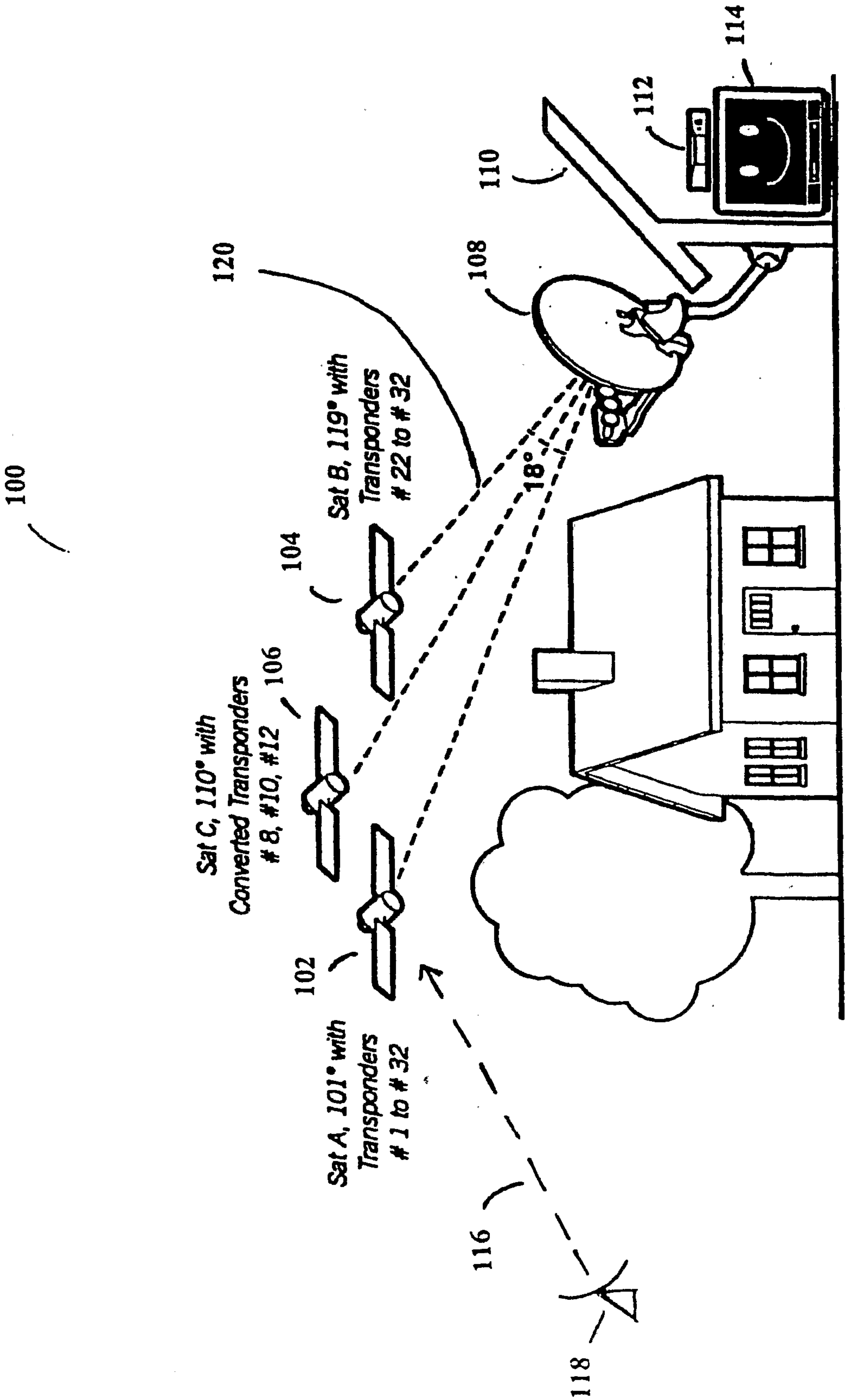
12. The system of claim 11, wherein a plurality of receivers provide power to the LNBS.

13. The system of claim 12, wherein the first stage of power regulation and the second stage of power regulation allow the plurality of receivers to share power requirements of the LNBS.

14. The system of claim 13, wherein the switching power regulator is a DC-DC converter.

15. The system of claim 14, wherein the second stage of power regulation provides current balancing to the plurality of receivers.

FIG. 1



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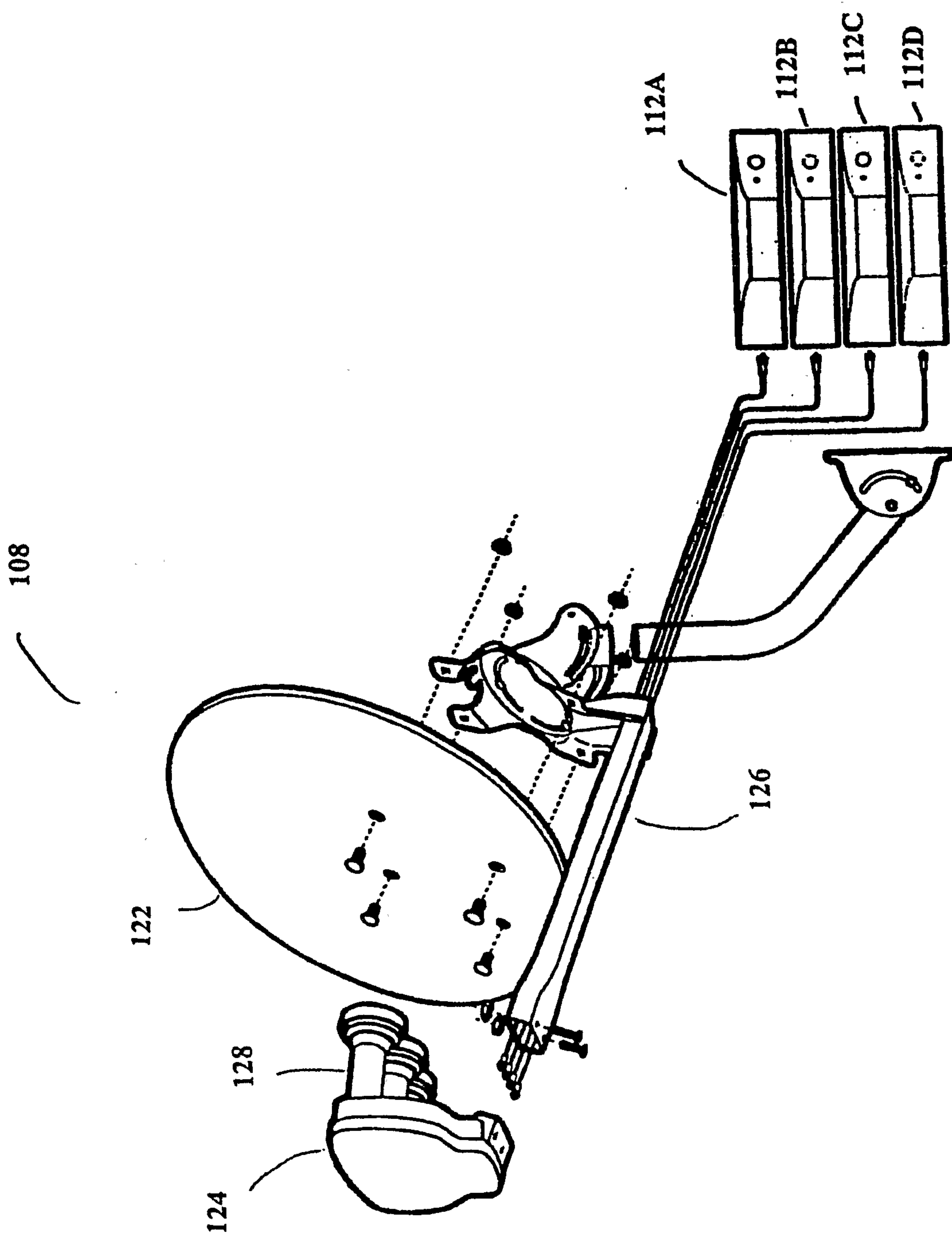
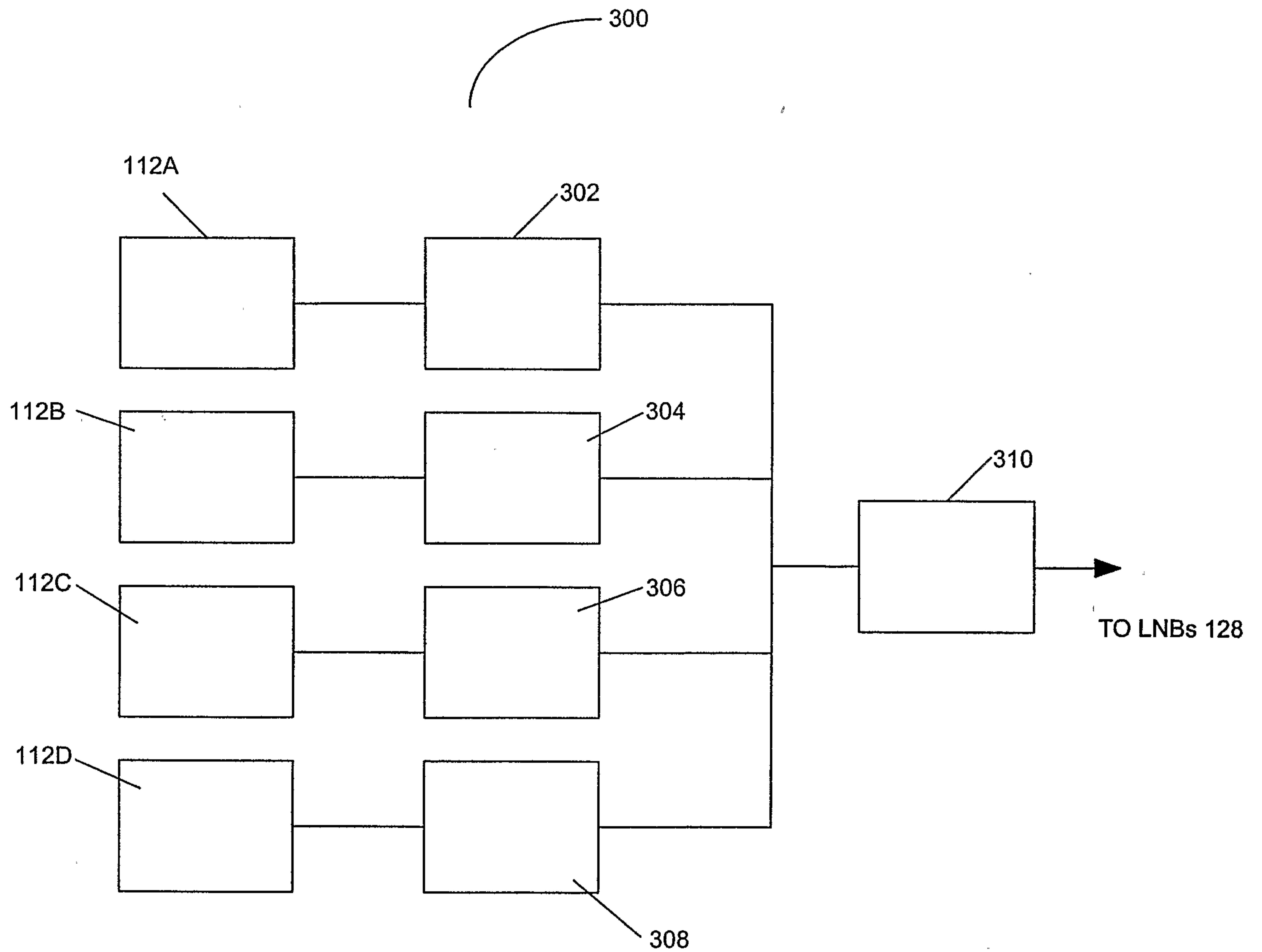
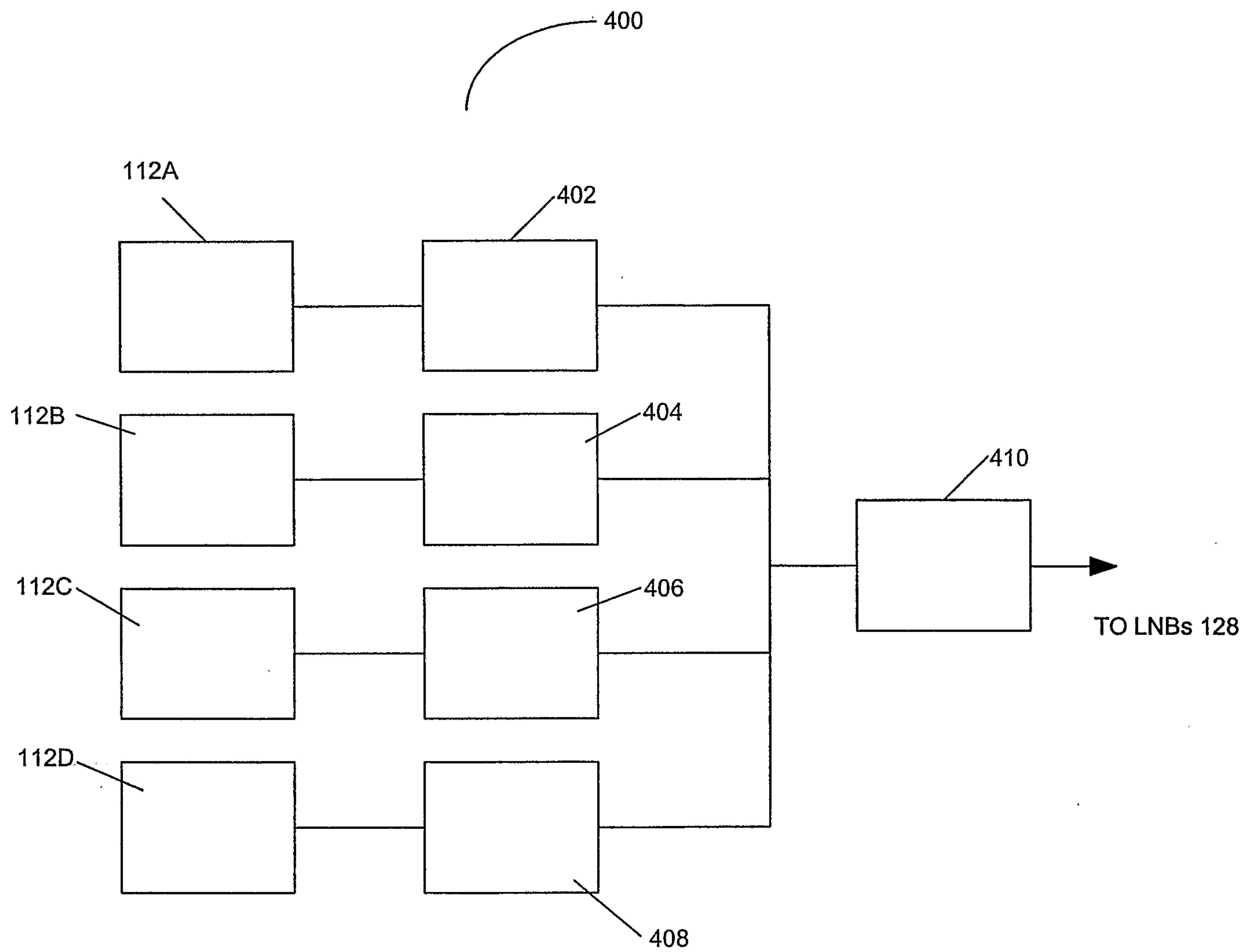


FIG. 2

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**FIG. 3**

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**FIG. 4**

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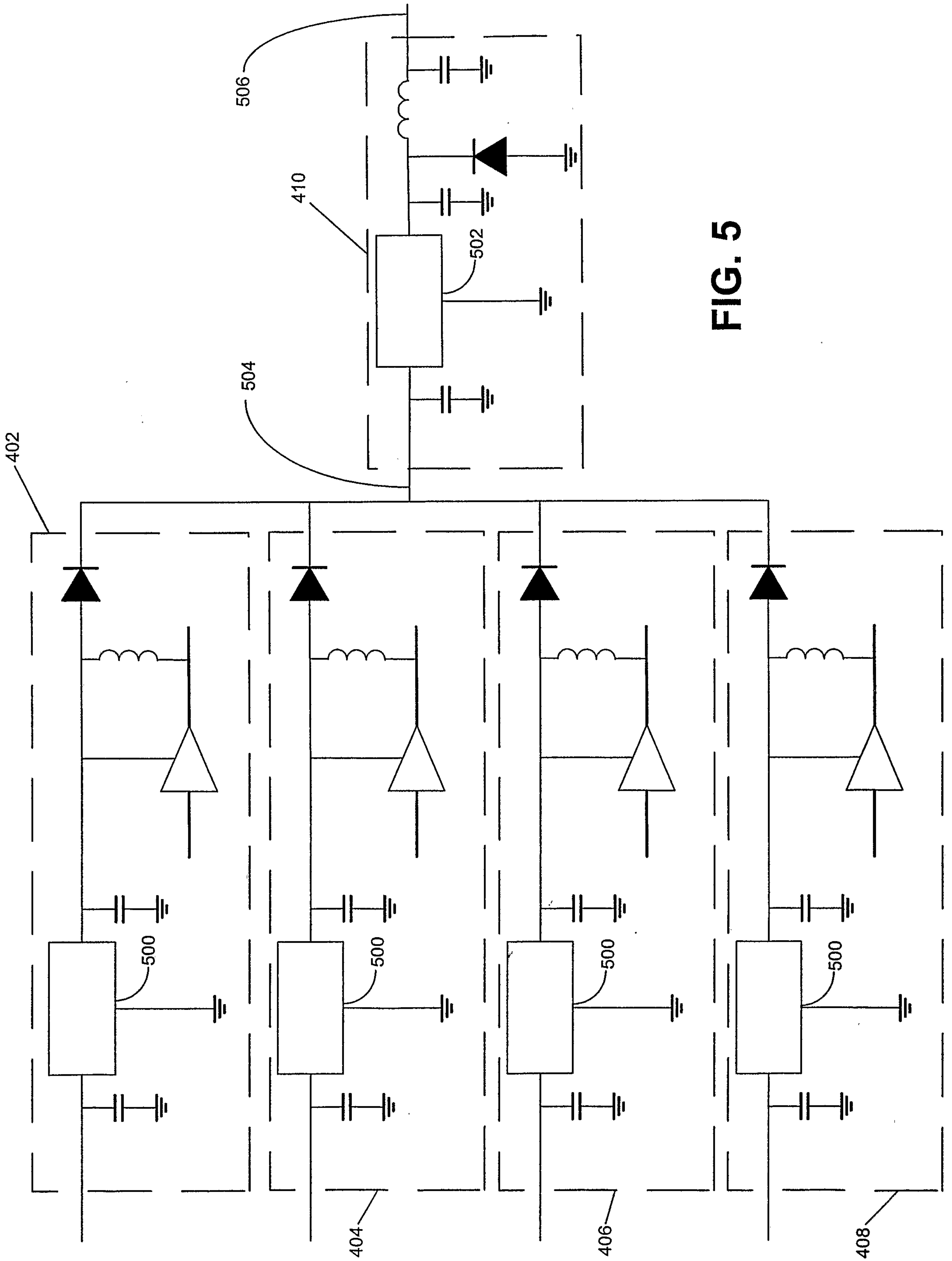


FIG. 5

