

CATV NETWORK INTERFACE UNIT WITH BANDPLAN DETECTION ON DOWNSTREAM SIGNALS

BACKGROUND

[0001] Typically when a cable television (CATV) operator wants to change the upstream/downstream frequency plan/band, all amplifiers need to be replaced or reconfigured. The network interface unit (NIU) is a small amplifier in an end user premise. When the upstream/downstream frequency plan changes, the existing NIU is typically replaced with a new one configured for the new upstream/downstream frequency band.

SUMMARY

[0002] One embodiment is directed to network interface unit. The network interface unit comprises a network connector configured to receive signals from and send signals to a cable television (CATV) headend and a first diplexer comprising a first high pass filter configured for a first downstream radio frequency (RF) band and a first low pass filter configured for a corresponding first upstream RF band. The network interface unit further comprises a second diplexer comprising a second high pass filter configured for a second downstream RF band and a second low pass filter configured for a corresponding second upstream RF band, a cable modem port configured to output downstream RF signals to a cable modem and to receive upstream signals from the cable modem, and a coupling device configured to couple at least one of the first diplexer or the second diplexer to the cable modem port. The network interface unit further comprises a switch configured to switch between a first state and a second state, the first state coupling the network connector to the first diplexer and the second state coupling the network connector to the second diplexer and a control circuit coupled to the network connector and the switch, the control circuit configured to detect when a broadband trigger signal is present at a predetermined frequency spectrum within the first downstream RF band. When the broadband trigger signal is not detected, the detection circuit causes the switch to switch from the first state to the second state.

[0003] Another embodiment is directed to a cable television (CATV) network. The CATV network comprises a CATV headend comprising a cable modem termination system (CMTS) coupled to a wide area network and an RF combiner configured to combine downstream signals from the CMTS with downstream television program feeds. The CATV network

further comprises a plurality of network interface units communicatively coupled to the CATV headend, each of the plurality of network interface units located in a respective end user premise. The CATV headend is configured to transmit a broadband trigger signal at a predetermined frequency spectrum within a first downstream RF band while the network interface units are to utilize a first upstream RF band and the first downstream RF band. At least one of the plurality of network interface units is an enhanced network interface unit configured to monitor for the broadband trigger signal at the predetermined frequency spectrum and to switch from the first upstream RF band and the first downstream RF band to the second upstream RF band the second downstream RF band when the broadband trigger signal is not detected at the predetermined frequency spectrum.

[0004] Another embodiment is directed to a method of configuring a network interface unit. The method comprises transmitting signals from a CATV headend to one or more network interface units in a first downstream radio frequency (RF) band, transmitting a broadband trigger signal at a plurality of frequencies within the first downstream RF band, ceasing to transmit the broadband trigger signal when it is determined to switch from the first downstream RF band to the second downstream RF band, and transmitting signals in the second downstream RF band.

DRAWINGS

[0005] Understanding that the drawings depict only exemplary embodiments and are not therefore to be considered limiting in scope, the exemplary embodiments will be described with additional specificity and detail through the use of the accompanying drawings, in which:

[0006] Figure 1 is a high level block diagram of one embodiment of an exemplary enhanced network interface unit.

[0007] Figure 2 is a high level block diagram of another embodiment of an exemplary enhanced network interface unit.

[0008] Figure 3 is a high level block diagram of one embodiment of an exemplary control circuit.

[0009] Figure 4 is a high level block diagram of another embodiment of an exemplary control circuit.

[0010] Figure 5 is a block diagram of one embodiment of an exemplary CATV network utilizing enhanced network interface units.

[0011] Figure 6 is a flow chart depicting one embodiment of an exemplary method of configuring a network interface unit.

[0012] In accordance with common practice, the various described features are not drawn to scale but are drawn to emphasize specific features relevant to the exemplary embodiments.

DETAILED DESCRIPTION

[0013] In the following detailed description, reference is made to the accompanying drawings that form a part hereof, and in which is shown by way of illustration specific illustrative embodiments. However, it is to be understood that other embodiments may be utilized and that logical, mechanical, and electrical changes may be made. Furthermore, the method presented in the drawing figures and the specification is not to be construed as limiting the order in which the individual steps may be performed. The following detailed description is, therefore, not to be taken in a limiting sense.

[0014] The embodiments described below enable an enhanced network interface unit to selectively utilize one of two or more frequency bands. Furthermore, the embodiments of the exemplary enhanced network interface units described herein are configured to automatically detect when to switch from one frequency band to another without the need for end user action or the need for a technician to visit the end user premises.

[0015] Figure 1 is high level block diagram of one embodiment of an exemplary enhanced network interface unit (NIU) 100. As used herein, an enhanced network interface unit is a CATV network interface unit with selectable upstream/downstream frequency bands. Furthermore, as used herein downstream refers to a communication direction from a CATV headend toward an end user premise and upstream refers to a communication direction from the customer user premise toward the CATV headend. Thus, an upstream path refers to the components coupled together to communicate signals in the upstream direction and a downstream path refers to the components coupled together to communicate signals in the downstream direction.

[0016] In the example shown in Figure 1, the enhanced NIU 100 includes a network connector 102 for all of the selectable upstream/downstream radio frequency (RF) bands. In particular, in this embodiment, the network connector 102 is used for both a first upstream

RF band and its associated first downstream RF band as well as for a second upstream RF band and its associated second downstream RF band. For example, in this exemplary embodiment, the first downstream RF band covers an RF spectrum of approximately 87.5 MHz to approximately 1200 MHz and the first upstream RF band covers an RF spectrum of approximately 15 MHz to approximately 65 MHz. Additionally, in this example, the second downstream RF band covers an RF spectrum of approximately 250 MHz to approximately 1200 MHz and the associated upstream RF band covers an RF spectrum of approximately 15 MHz to approximately 200 MHz. However, it is to be understood that other frequency spectrums can be used for the respective upstream/downstream RF band pairs in other embodiments.

[0017] As used herein, network connectors are connectors that communicatively couple the NIU 100 to a CATV network. In particular, in this example, the network connector 102 is implemented as a coaxial RF connector, such as female F-connectors configured to mate with a corresponding male F-connector. Such connectors are known to one of skill in the art and not discussed in further detail herein. However, it is to be understood that other connector types can be used in other embodiments.

[0018] The enhanced NIU 100 also includes two diplexers 104-1 and 104-2. Each of the diplexers 104-1 and 104-2 is configured for one of the upstream/downstream RF band pairs. For example, in this exemplary embodiment, the high pass filter 108-1 in diplexer 104-1 has a cut off frequency of approximately 87.5 MHz (i.e. frequencies above 87.5 MHz are passed) and the low pass filter 110-1 has a cut off frequency of approximately 65 MHz (i.e. frequencies below 65 MHz are passed). Hence, the first diplexer 104-1 corresponds to the exemplary first upstream/downstream RF band pair used in this example. Similarly, the high pass filter 108-2 in diplexer 104-2 has a cut off frequency of approximately 250 MHz and the low pass filter 110-2 has a cut off frequency of approximately 200 MHz. Hence, the second diplexer 104-2 corresponds to the exemplary second upstream/downstream RF band pair used in this example.

[0019] Coupled between the network connector 102 and the diplexers 104-1 and 104-2 is a switch 162. The switch 162 is configured to couple the network connector 102 to one of the diplexers 104-1 or 104-2 in order to select the upstream RF band and downstream RF band corresponding to the respective diplexer coupled to the network connector 102. The switch 162 can be implemented as an RF switch. Suitable switches for use in implementing the RF

switch 162 include, but are not limited to, the PE42421, the PE42721, the PE42722, and the PE42750 UltraCMOS® RF switches manufactured by Peregrine Semiconductor.

[0020] The NIU 100 also includes control circuit 170. The control circuit 170 is coupled to the network connector 102 via a directional coupler 161. The directional coupler 161 is configured to couple downstream signals received over the network connector 102 to the control circuit 170 and to reduce or prevent upstream signals from being coupled into the control circuit 170. Additionally, the control circuit 170 is coupled to the switch 162. The control circuit 170 is configured to control the switch 162 to automatically select one of the upstream and downstream RF band pairs without requiring user input or action. In particular, the switch 162 in this example is configured to switch between a first state and a second state. The first state couples the network connector 102 to the first diplexer 104-1 and the second state couples the network connector 102 to the second diplexer 104-2.

[0021] Additionally, in this example, the switch 162 initially couples the network connector 102 to the first diplexer 104-1. Hence, the first upstream/downstream RF band pair is initially selected in this embodiment. The control circuit 170 is configured to detect the presence of a downstream trigger signal at a predetermined frequency or range of frequencies. For example, in some embodiments, the downstream trigger signal is a pilot tone transmitted on a single frequency. In other embodiments, a broadband signal spread over a plurality of frequencies is used as the trigger signal. The downstream trigger signal can be a control signal intended for use by the control circuit in some embodiments. In other embodiments, the downstream trigger signal has a primary use of providing data to another device, such as an analog television signal, which the control circuit 170 is configured to use as a trigger signal based on presence of the trigger signal at the predetermined frequency range.

[0022] Additionally, as used herein, a broadband signal refers to a signal covering two or more channels in the downstream RF band. For example, two or more analog television channels of 6 MHz each can be used as a broadband signal. In some embodiments, the predetermined frequency range for a broadband trigger signal 140 MHz to 200 MHz. In other embodiments, other frequency ranges are used, such as but not limited to 88 MHz to 100 MHz. Transmitting the trigger signal as a broadband signal covering a frequency range enables resilience to noise or other interference which could cause a tone at a single frequency to go undetected. However, since the trigger signal is detected over a range of

frequencies, the control circuit 170 analyzes the composite signal level over the range of frequencies to provide more improved accuracy in detecting the trigger signal.

[0023] While the trigger signal is detected by the control circuit 170, the control circuit 170 maintains the connection between the network connector 102 and the first diplexer 104-1. Upon determining that the trigger signal is not present at the predetermined frequency or frequency range, the control circuit 170 is configured to output a command to the switch 162 to cause the switch 162 to change from the first diplexer 104-1 to the second diplexer 104-2. Hence, the second upstream/downstream RF band pair is selected when the trigger signal is not detected by the control circuit 170. In some embodiments, the control circuit 170 is configured to output the command to the switch 162 only after the trigger signal is not detected for a predetermined amount of time. The delay or predetermined amount of time is selected to reduce the probability of premature switching due to temporary errors.

[0024] Furthermore, in some embodiments, the control circuit 170 is configured to output a command to the switch 162 to cause the switch 162 to switch the connection to the network connector 102 back to the first diplexer 104-1 once presence of a trigger signal is detected again after having switched to the second diplexer 104-2. In some such embodiments, a broadband trigger signal is used to determine when to switch from the first diplexer 104-1 to the second diplexer 104-2 and a trigger pilot tone is used to determine when to switch from the second diplexer 104-2 to the first diplexer 104-1.

[0025] Also coupled to the diplexers 104-1 and 104-2 is a coupling device 112. In the embodiment of Figure 1, the coupling device is implemented as a combiner/coupler 112. The combiner/coupler 112 includes a passive combiner 114 configured to combine the output of high pass filter 108-1 with the output of high pass filter 108-2. The combiner/coupler 112 also includes a passive splitter 116 configured to split an upstream signal to be output to both the low pass filter 110-1 and 110-2. In the downstream direction, the output of the passive combiner 114 is amplified by an amplifier 118 in this example. Suitable amplifiers for amplifying the downstream RF signal are known to one of skill in the art. The amplified downstream RF signal is then split in splitter 120 in this example. The splitter 120 outputs the amplified signal to a splitter 122 and to a diplexer 124.

[0026] The splitter 122 provides a copy of the downstream RF signal to each of splitters 132 and 134 in this example. Splitter 132 splits the received downstream RF signal to provide a copy of the downstream RF signal to each of connectors 136 and 138. Similarly, the splitter

134 splits the received downstream RF signal to provide a copy of the downstream RF signal to each of connectors 140 and 142. Connectors 136, 138, 140, and 142 (also referred to herein as distributive ports) are each implemented as coaxial RF connectors similar to connector 102. The connectors 136, 138, 140, and 142 provide ports for distribution of the downstream signal to multiple devices at the end user premise. It is to be understood that the splitters 122, 132, and 134 can be implemented using passive RF splitters. Each splitter is selected/configured to keep signal loss within a predetermined maximum value, as known to one of skill in the art.

[0027] The diplexer 124 includes a high pass filter 126 and a low pass filter 128. As shown in Figure 1, a single diplexer 124 is coupled to both of diplexers 104-1 and 104-2 rather than having a separate downstream diplexer for each of diplexers 104-1 and 104-2. By enabling the use of a single diplexer 124, complexity and cost of the network interface unit is reduced as compared to using two diplexers. In some embodiments, the single diplexer 124 is enabled by configuring the diplexer 124 similarly to one of the diplexers 104-1 or 104-2. For example, in this exemplary embodiment, the high pass filter 126 has a cut off frequency of approximately 250 MHz and the low pass filter 128 has a cut off frequency of approximately 200 MHz, similar to the diplexer 104-2. In other embodiments, the diplexer 124 is configured differently than both of diplexers 104-1 and 104-2 but is able to accommodate the upstream RF band for both the first diplexer 104-1 and the second diplexer 104-2. The diplexer 124 outputs the downstream RF signal received from the splitter 120 to a connector 130 (also referred to herein as a cable modem port). The connector 130 is configured to couple the enhanced NIU 100 to a cable modem via a respective cable. In some embodiments, the connector 130 is also a coaxial RF connector similar to connector 102.

[0028] In the upstream direction, a signal received from the cable modem over the connector 130, is provided to the low pass filter 128 of diplexer 124. The upstream signals are passed from the diplexer 124 to the passive splitter 116 in the combiner/coupler 112 which splits the upstream signal to be provided to the diplexers 104-1 and 104-2. Hence, in this exemplary embodiment, the enhanced NIU 100 is configured to automatically select the upstream/downstream RF frequency band pair by choosing which diplexer 104 to couple to the network connector 102 based on the presence of a trigger signal from the CATV headend in the downstream RF band. Since the enhanced NIU 100 is configured to support two upstream/downstream RF frequency band pairs, a technician is not needed to re-configure or replace the NIU in order to change the RF frequency bands used. It is to be understood that

the NIU 100 can include other components not shown. For example, in some embodiments an amplifier similar to amplifier 118 can be included in the upstream path between low pass filter 128 and coupling device 112.

[0029] Figure 2 is a high level block diagram of another embodiment of an exemplary enhanced NIU 200. The enhanced NIU 200 is similar to the enhanced NIU 100 discussed above. However, in lieu of the passive combiner/coupler discussed above, the coupling device in the enhanced NIU 200 is implemented using a suitable RF switch 250, such as those mentioned above. In this embodiment, the RF switch 250 comprises two single-pull/double-throw switches 251-1 and 251-2. However, in other embodiments a single double-pull/double-throw switch can be used. The switch 250 is configured to couple one of the diplexers 104-1 or 104-2 to the cable modem port 130. In particular, the switch 250 is configured to couple one of the high pass filters 108-1 or 108-2 to the amplifier 118 an output of which is coupled to the cable modem port 130 via the splitter 120 and diplexer 124. In the upstream direction, the switch 250 is configured to couple the diplexer 124 to one of the low pass filter 110-1 or 110-2.

[0030] In the example of Figure 2, the control circuit 270 is configured to actuate both the switch 162 and the switch 250 based on the trigger signal in the downstream RF band, as discussed above. Thus, the switch 162 and switch 250 are actuated together to select the corresponding RF frequency band pair.

[0031] The use of the switch 250 in lieu of the passive coupler/combiner 112 used in enhanced NIU 100 can provide some performance benefits. For example, the switch 250 can provide better noise and/or gain performance than the combiner/coupler 112. In particular, the specific switch selected to implement switch 250 may cause less signal loss than the passive combiner/coupler 112 and the combination of the switch 250 with the amplifier 118 may have better noise performance than the combination of the passive combiner/coupler 112 with the amplifier 118.

[0032] Figure 3 is a high level block diagram of one embodiment of an exemplary control circuit 300. The control circuit 300 can be used to implement the control circuit 170 described above with respect to Figure 1. The control circuit includes a bandpass filter 380. The bandpass filter 380 is configured to allow only the predetermined frequency band of the trigger signal to pass. Coupled to an output of the bandpass filter 380 is an optional RF amplifier 382 configured to amplify the power of the trigger signal. The diode 384 and

capacitor 386 are optionally included to enable a predetermined time constant for detecting the absence of the trigger signal. For example, the predetermined time constant is in the range of $\frac{1}{2}$ to 2 seconds in some embodiments. Thus, in such embodiments, absence of the trigger signal will not trigger action by the control circuit 300 until the time corresponding to the time constant has elapsed. In this way, short interruptions in reception of the trigger signal that do not last longer than the time constant will not trigger an unintended switch from one RF band pair to another.

[0033] The control circuit 300 also includes a controller 388. The controller 388 has a ground input 390 which provides a reference for setting the predetermined frequency band to be monitored. The controller 388 also includes a signal input 392 coupled to the diode 384 and capacitor 386. When the trigger signal is not detected at the signal input 392, the controller 388 outputs a command via output 394 to a switch to change the upstream/downstream RF frequency band pair, as described above.

[0034] Figure 4 is a high level block diagram of another embodiment of an exemplary control circuit 400. The control circuit 400 operates similar to the control circuit 300 described above. However, the controller 488 also includes a second output 496 to cause a second switch for coupling the appropriate the diplexer to cable modem port, as described above with respect to Figure 2. Hence, the control circuit 400 can be used to implement the control circuit 270 described above with respect to Figure 2.

[0035] Figure 5 is a block diagram of an exemplary CATV network 500 utilizing one or more enhanced network interface units 521 such as the enhanced NIUs discussed above with respect to Figures 1-4. The network 500 includes a CATV headend 501. The CATV headend 501 includes a Cable Modem Termination System (CMTS) 503, a Public Switched Telephone Network (PSTN) gateway 505, and an RF combiner 513. The PSTN gateway 505 is coupled to the public switched telephone network 509 and the CMTS 503 is coupled to a wide area network, such as the internet 511. Downstream real time communication signals from the PSTN 509 are received at the PSTN gateway 505 and communicated to the CMTS 503. The CMTS 503 combines the signals from the PSTN gateway 505 with downstream data signals from the internet 511 and outputs the combined signals to the RF combiner 513. The RF combiner 513 combines the signals from the CMTS 503 with television (TV) program feeds. The TV program feeds can be obtained from a satellite, antenna, or terrestrial distribution system, as known to one of skill in the art.

[0036] In addition, the CATV headend 501 is configured to insert a trigger signal into the RF signal combined in the RF combiner 513. In particular, in this embodiment, the trigger signal is associated with an initial upstream/downstream RF band pair used by the CATV headend and the enhanced NIUs 521. Thus, the CATV headend 501 is configured to transmit the trigger signal until it is determined to switch to a different upstream/downstream RF band pair. In other embodiments, however, the trigger signal is used in an opposite manner. That is, the CATV headend 501 does not transmit the trigger signal until it is determined to switch from an initial upstream/downstream RF band pair to another upstream/downstream RF band pair. Hence, in such embodiments, the CATV headend 501 begins transmitting the trigger signal when it is time to switch from the initial upstream/downstream RF band pair to the other upstream/downstream RF band pair.

[0037] The combined RF signal containing the trigger signal from the RF combiner 513 is communicated over a network 515 to end user premises 517. The network 515 can be implemented using suitable physical layer cabling, such as but not limited to, fiber optic cables and copper cables. The downlink signals are distributed to the end user premises 517 using techniques known to one of skill in the art. In particular, the RF signals are communicated over a predetermined downlink frequency band.

[0038] Each of the enhanced NIUs 521 are configured to support more than one downlink frequency band. As discussed above, an end user can selectively choose the downlink frequency band. For example, an operator may increase the downstream RF band to provide more bandwidth and/or shift the downstream RF band to accommodate an increased corresponding upstream RF band. The enhanced NIUs 521 are configured to automatically switch the upstream/downstream RF bands in response to the trigger signal, as discussed above. In conventional systems, a technician would have to replace or reconfigure the NIU to accommodate the change in upstream/downstream RF bands. However, through the use of the enhanced NIUs 521 discussed above, the switch in RF frequency bands can be made without the technician or user action. Thus, the enhanced NIUs 521 described herein can facilitate updates or changes to a network, such as transitioning from Data Over Cable Service Interface Specification (DOCSIS) 3.0 to DOCSIS 3.1, for example.

[0039] The enhanced NIUs 521 can provide downstream signals to multiple devices. For example, the enhanced NIUs 521 can provide downstream TV programming to television sets 531 and downstream data signals to a cable modem 523. The cable modem, in turn, can communicate signals to one or more end user devices 525, such as, but not limited to, an

internet protocol (IP) phone, a computer, wireless devices, etc. In addition, upstream signals from the one or more end user devices 525 are sent upstream via the cable modem 523 and the enhanced NIU 521. At the cable headend 501, the CMTS 503 and PSTN gateway 505 direct the upstream signals to the PSTN 509 or internet 511 accordingly, using techniques known to one of skill in the art.

[0040] Figure 6 is a flow chart depicting one embodiment of an exemplary method of configuring a network interface unit. At block 602, signals are transmitted from a CATV headend to one or more network interface units in a first downstream RF band. At block 604, a broadband trigger signal is transmitted from the CATV headend at a plurality of frequencies within the first downstream RF band. At block 606, the CATV headend ceases to transmit the broadband trigger signal when it is determined to switch from the first downstream RF band to the second downstream RF band. At block 608, signals are transmitted from the CATV headend to the one or more network interface units in the second downstream RF band.

[0041] Although specific embodiments have been illustrated and described herein, it will be appreciated by those of ordinary skill in the art that any arrangement, which is calculated to achieve the same purpose, may be substituted for the specific embodiments shown. Therefore, it is manifestly intended that this invention be limited only by the claims and the equivalents thereof.

EXAMPLE EMBODIMENTS

[0042] Example 1 includes a network interface unit comprising: a network connector configured to receive signals from and send signals to a cable television (CATV) headend; a first diplexer comprising a first high pass filter configured for a first downstream radio frequency (RF) band and a first low pass filter configured for a corresponding first upstream RF band; a second diplexer comprising a second high pass filter configured for a second downstream RF band and a second low pass filter configured for a corresponding second upstream RF band; a cable modem port configured to output downstream RF signals to a cable modem and to receive upstream signals from the cable modem; a coupling device configured to couple at least one of the first diplexer or the second diplexer to the cable modem port; a switch configured to switch between a first state and a second state, the first state coupling the network connector to the first diplexer and the second state coupling the network connector to the second diplexer; and a control circuit coupled to the network

connector and the switch, the control circuit configured to detect when a broadband trigger signal is present at a predetermined frequency spectrum within the first downstream RF band; wherein when the broadband trigger signal is not detected, the detection circuit causes the switch to switch from the first state to the second state.

[0043] Example 2 includes the network interface unit of Example 1, wherein the coupling device is a passive combiner configured to couple the cable modem port to the first diplexer and to the second diplexer.

[0044] Example 3 includes the network interface unit of any of the Examples 1-2, wherein the coupling device comprises at least one switch configured to selectively couple one of the first diplexer and the second diplexer to the cable modem port.

[0045] Example 4 includes the network interface unit of any of the Examples 1-3, wherein, after coupling the network connector to the second diplexer when the broadband trigger signal is not detected, the control circuit is configured to cause the switch to couple the first diplexer to the network connector when a subsequent trigger signal is detected at the predetermined frequency spectrum.

[0046] Example 5 includes the network interface unit of any of the Examples 1-4, further comprising an amplifier configured to amplify downstream signals, the coupling device configured to couple at least one of the first high pass filter and the second high pass filter to the amplifier.

[0047] Example 6 includes the network interface unit of Example 5, further comprising one or more distributive ports coupled to the amplifier and configured to output downstream RF signals received at the network interface unit from the CATV headend.

[0048] Example 7 includes the network interface unit of any of the Examples 1-6, further comprising a third diplexer comprising a third high pass filter and a third low pass filter, each having a respective cut off frequency; wherein the third diplexer is coupled between the cable modem port and the coupling device; wherein each of the first diplexer and the second diplexer are respectively coupled to the cable modem port via the third diplexer and the coupling device.

[0049] Example 8 includes the network interface unit of any of the Examples 1-7, wherein the cut off frequency for the first high pass filter is approximately 87.5 MHz, the cut off frequency for the first low pass filter is approximately 65 MHz, the cut off frequency for the

second high pass filter is approximately 250 MHz, and the cut off frequency for the second low pass filter is approximately 200 MHz.

[0050] Example 9 includes the network interface unit of any of the Examples 1-8, wherein the control circuit comprises: a bandpass filter configured to pass the predetermined frequency spectrum of the broadband trigger signal; an amplifier coupled to an output of the bandpass filter and configured to amplify the output of the bandpass filter; a diode coupled to an output of the amplifier; a capacitor coupled to the diode, wherein the diode and the capacitor set a time delay constant; and a controller configured to monitor for presence of the broadband trigger signal and to output a command to the switch to cause the switch to couple the network connector to the second diplexer when the broadband trigger signal is not detected.

[0051] Example 10 includes a cable television (CATV) network comprising: a CATV headend comprising a cable modem termination system (CMTS) coupled to a wide area network and an RF combiner configured to combine downstream signals from the CMTS with downstream television program feeds; and a plurality of network interface units communicatively coupled to the CATV headend, each of the plurality of network interface units located in a respective end user premise; wherein the CATV headend is configured to transmit a broadband trigger signal at a predetermined frequency spectrum within a first downstream RF band while the network interface units are to utilize a first upstream RF band and the first downstream RF band; wherein at least one of the plurality of network interface units is an enhanced network interface unit configured to monitor for the broadband trigger signal at the predetermined frequency spectrum and to switch from the first upstream RF band and the first downstream RF band to the second upstream RF band the second downstream RF band when the broadband trigger signal is not detected at the predetermined frequency spectrum.

[0052] Example 11 includes the CATV network of Example 10, wherein the at least one enhanced network interface unit comprises: a network connector configured to receive signals from and send signals to the CATV headend; a first diplexer comprising a first high pass filter configured for a first downstream RF band and a first low pass filter configured for a corresponding first upstream RF band; a second diplexer comprising a second high pass filter configured for a second downstream RF band and a second low pass filter configured for a corresponding second upstream RF band; a cable modem port configured to output downstream RF signals to a cable modem and to receive upstream signals from the cable

modem; a coupling device configured to couple at least one of the first diplexer or the second diplexer to the cable modem port; a switch configured to couple the network connector to one of the first diplexer and the second diplexer; and a control circuit coupled to the network connector and the switch, the control circuit configured to detect when the broadband trigger signal is present at the predetermined frequency spectrum and to cause the switch to couple the network connector to the second diplexer when the broadband trigger signal is not detected.

[0053] Example 12 includes the CATV network of Example 11, wherein the coupling device is a passive combiner configured to couple the cable modem port to the first diplexer and to the second diplexer.

[0054] Example 13 includes the CATV network of any of the Examples 11-12, wherein the coupling device comprises at least one switch configured to selectively couple one of the first diplexer and the second diplexer to the cable modem port.

[0055] Example 14 includes the CATV network of any of the Examples 11-13, wherein the control circuit comprises: a bandpass filter configured to pass the predetermined frequency spectrum; an amplifier coupled to an output of the bandpass filter and configured to amplify the output of the bandpass filter; a diode coupled to an output of the amplifier; a capacitor coupled to the diode, wherein the diode and the capacitor set a time delay constant; and a controller configured to monitor for presence of the broadband trigger signal and to output a command to the switch to cause the switch to couple the network connector to the second diplexer when the broadband trigger signal is not detected.

[0056] Example 15 includes the CATV network of any of the Examples 11-14, wherein the cut off frequency for the first high pass filter is approximately 87.5 MHz, the cut off frequency for the first low pass filter is approximately 65 MHz, the cut off frequency for the second high pass filter is approximately 250 MHz, and the cut off frequency for the second low pass filter is approximately 200 MHz.

[0057] Example 16 includes a method of configuring a network interface unit, the method comprising: transmitting signals from a CATV headend to one or more network interface units in a first downstream radio frequency (RF) band; transmitting a broadband trigger signal at a plurality of frequencies within the first downstream RF band; ceasing to transmit the broadband trigger signal when it is determined to switch from the first downstream RF

band to the second downstream RF band; and transmitting signals in the second downstream RF band.

[0058] Example 17 includes the method of Example 16, wherein the first downstream RF band covers an RF spectrum of approximately 87.5 MHz to approximately 1200 MHz and the second downstream RF band covers an RF spectrum of approximately 250 MHz to approximately 1200 MHz.

CLAIMS

What is claimed is:

1. A network interface unit comprising:
 - a network connector configured to receive signals from and send signals to a cable television (CATV) headend;
 - a first diplexer comprising a first high pass filter configured for a first downstream radio frequency (RF) band and a first low pass filter configured for a corresponding first upstream RF band;
 - a second diplexer comprising a second high pass filter configured for a second downstream RF band and a second low pass filter configured for a corresponding second upstream RF band;
 - a cable modem port configured to output downstream RF signals to a cable modem and to receive upstream signals from the cable modem;
 - a coupling device configured to couple at least one of the first diplexer or the second diplexer to the cable modem port;
 - a switch configured to switch between a first state and a second state, the first state coupling the network connector to the first diplexer and the second state coupling the network connector to the second diplexer; and
 - a control circuit coupled to the network connector and the switch, the control circuit configured to detect when a broadband trigger signal is present at a predetermined frequency spectrum within the first downstream RF band;wherein when the broadband trigger signal is not detected, the detection circuit causes the switch to switch from the first state to the second state.
2. The network interface unit of claim 1, the coupling device is a passive combiner configured to couple the cable modem port to the first diplexer and to the second diplexer.
3. The network interface unit of claim 1, wherein the coupling device comprises at least one switch configured to selectively couple one of the first diplexer and the second diplexer to the cable modem port.

4. The network interface unit of claim 1, wherein, after coupling the network connector to the second diplexer when the broadband trigger signal is not detected, the control circuit is configured to cause the switch to couple the first diplexer to the network connector when a subsequent trigger signal is detected at the predetermined frequency spectrum.
5. The network interface unit of claim 1, further comprising an amplifier configured to amplify downstream signals, the coupling device configured to couple at least one of the first high pass filter and the second high pass filter to the amplifier.
6. The network interface unit of claim 5, further comprising one or more distributive ports coupled to the amplifier and configured to output downstream RF signals received at the network interface unit from the CATV headend.
7. The network interface unit of claim 1, further comprising a third diplexer comprising a third high pass filter and a third low pass filter, each having a respective cut off frequency;
wherein the third diplexer is coupled between the cable modem port and the coupling device;
wherein each of the first diplexer and the second diplexer are respectively coupled to the cable modem port via the third diplexer and the coupling device.
8. The network interface unit of claim 1, wherein the cut off frequency for the first high pass filter is approximately 87.5 MHz, the cut off frequency for the first low pass filter is approximately 65 MHz, the cut off frequency for the second high pass filter is approximately 250 MHz, and the cut off frequency for the second low pass filter is approximately 200 MHz.
9. The network interface unit of claim 1, wherein the control circuit comprises:
a bandpass filter configured to pass the predetermined frequency spectrum of the broadband trigger signal;

an amplifier coupled to an output of the bandpass filter and configured to amplify the output of the bandpass filter;

a diode coupled to an output of the amplifier;

a capacitor coupled to the diode, wherein the diode and the capacitor set a time delay constant; and

a controller configured to monitor for presence of the broadband trigger signal and to output a command to the switch to cause the switch to couple the network connector to the second diplexer when the broadband trigger signal is not detected.

10. A cable television (CATV) network comprising:

a CATV headend comprising a cable modem termination system (CMTS) coupled to a wide area network and an RF combiner configured to combine downstream signals from the CMTS with downstream television program feeds; and

a plurality of network interface units communicatively coupled to the CATV headend, each of the plurality of network interface units located in a respective end user premise;

wherein the CATV headend is configured to transmit a broadband trigger signal at a predetermined frequency spectrum within a first downstream RF band while the network interface units are to utilize a first upstream RF band and the first downstream RF band;

wherein at least one of the plurality of network interface units is an enhanced network interface unit configured to monitor for the broadband trigger signal at the predetermined frequency spectrum and to switch from the first upstream RF band and the first downstream RF band to the second upstream RF band the second downstream RF band when the broadband trigger signal is not detected at the predetermined frequency spectrum.

11. The CATV network of claim 10, wherein the at least one enhanced network interface unit comprises:

a network connector configured to receive signals from and send signals to the CATV headend;

a first diplexer comprising a first high pass filter configured for a first downstream RF band and a first low pass filter configured for a corresponding first upstream RF band;

a second diplexer comprising a second high pass filter configured for a second downstream RF band and a second low pass filter configured for a corresponding second upstream RF band;

a cable modem port configured to output downstream RF signals to a cable modem and to receive upstream signals from the cable modem;

a coupling device configured to couple at least one of the first diplexer or the second diplexer to the cable modem port;

a switch configured to couple the network connector to one of the first diplexer and the second diplexer; and

a control circuit coupled to the network connector and the switch, the control circuit configured to detect when the broadband trigger signal is present at the predetermined frequency spectrum and to cause the switch to couple the network connector to the second diplexer when the broadband trigger signal is not detected.

12. The CATV network of claim 11, wherein the coupling device is a passive combiner configured to couple the cable modem port to the first diplexer and to the second diplexer.

13. The CATV network of claim 11, wherein the coupling device comprises at least one switch configured to selectively couple one of the first diplexer and the second diplexer to the cable modem port.

14. The CATV network of claim 11, wherein the control circuit comprises:

a bandpass filter configured to pass the predetermined frequency spectrum;

an amplifier coupled to an output of the bandpass filter and configured to amplify the output of the bandpass filter;

a diode coupled to an output of the amplifier;

a capacitor coupled to the diode, wherein the diode and the capacitor set a time delay constant; and

a controller configured to monitor for presence of the broadband trigger signal and to output a command to the switch to cause the switch to couple the network connector to the second diplexer when the broadband trigger signal is not detected.

15. The CATV network of claim 11, wherein the cut off frequency for the first high pass filter is approximately 87.5 MHz, the cut off frequency for the first low pass filter is approximately 65 MHz, the cut off frequency for the second high pass filter is approximately 250 MHz, and the cut off frequency for the second low pass filter is approximately 200 MHz.

16. A method of configuring a network interface unit, the method comprising:

transmitting signals from a CATV headend to one or more network interface units in a first downstream radio frequency (RF) band;

transmitting a broadband trigger signal at a plurality of frequencies within the first downstream RF band;

ceasing to transmit the broadband trigger signal when it is determined to switch from the first downstream RF band to the second downstream RF band; and

transmitting signals in the second downstream RF band.

17. The method of claim 16, wherein the first downstream RF band covers an RF spectrum of approximately 87.5 MHz to approximately 1200 MHz and the second downstream RF band covers an RF spectrum of approximately 250 MHz to approximately 1200 MHz.

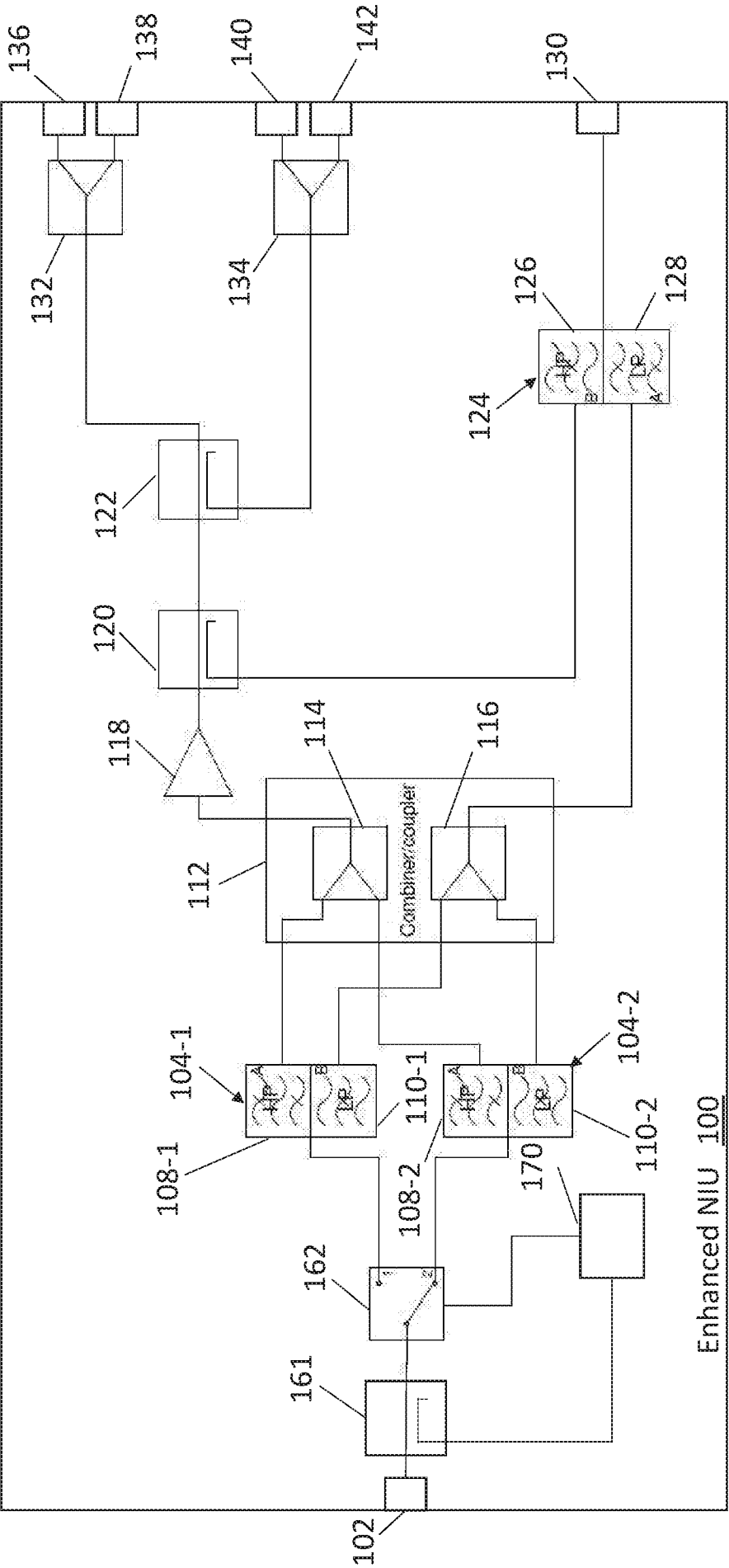


Figure 1

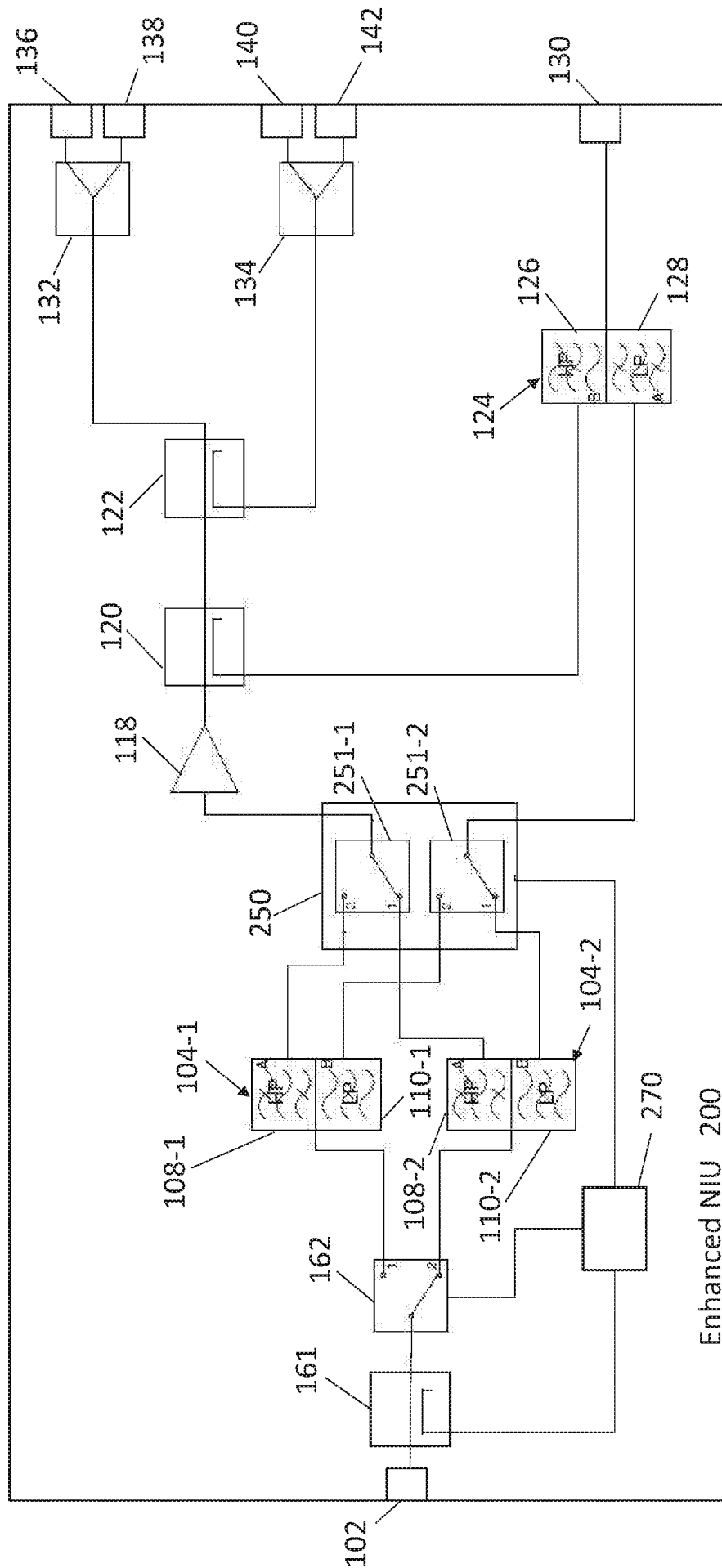


Figure 2

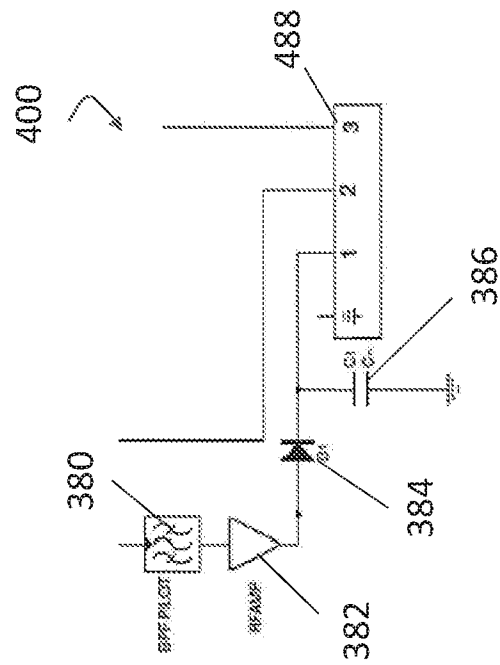


Figure 4

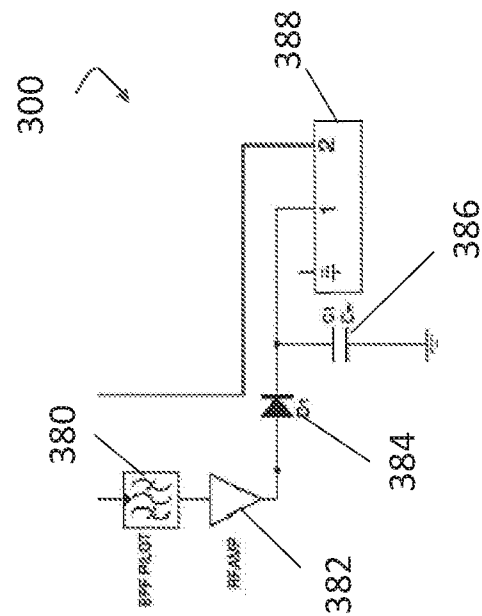


Figure 3

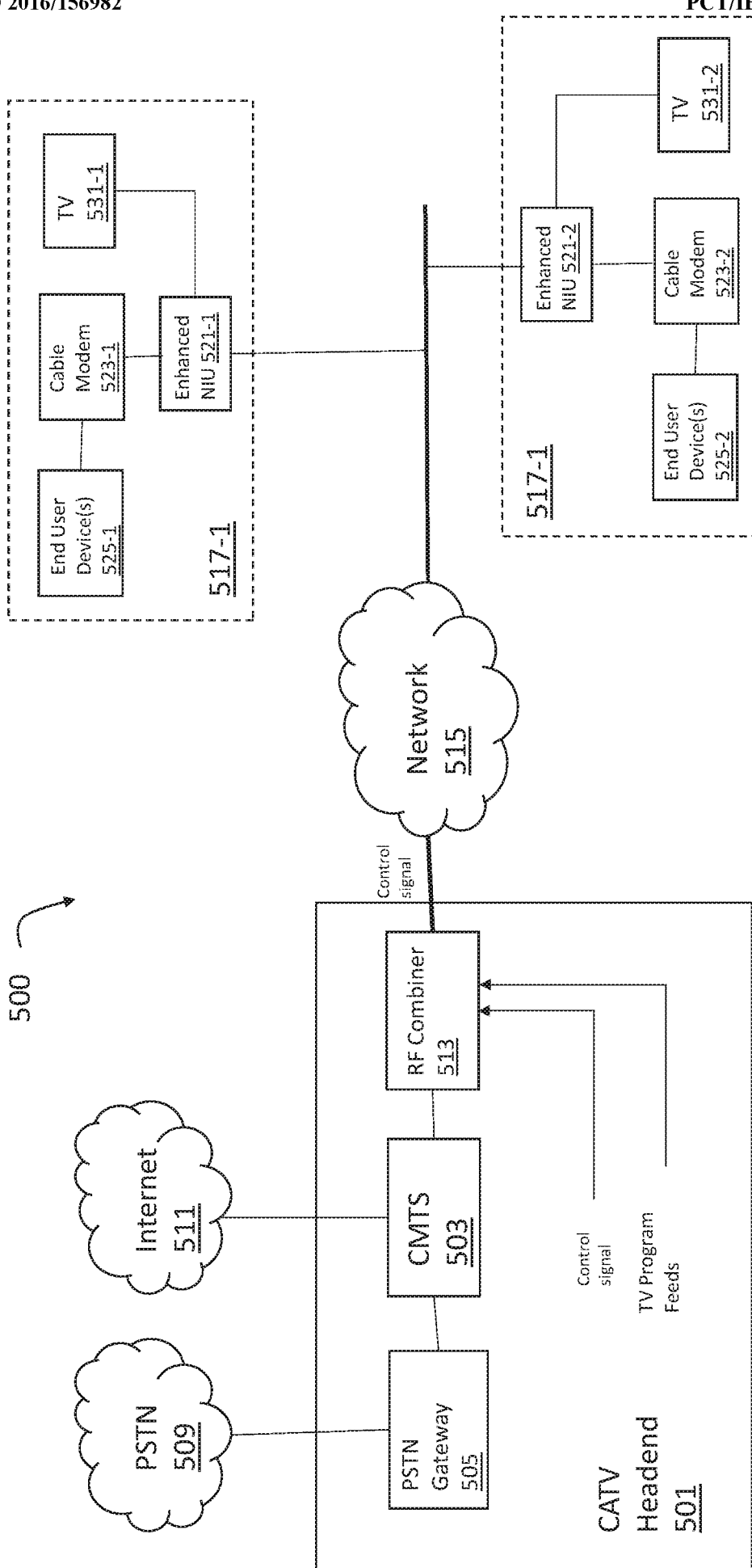


Figure 5

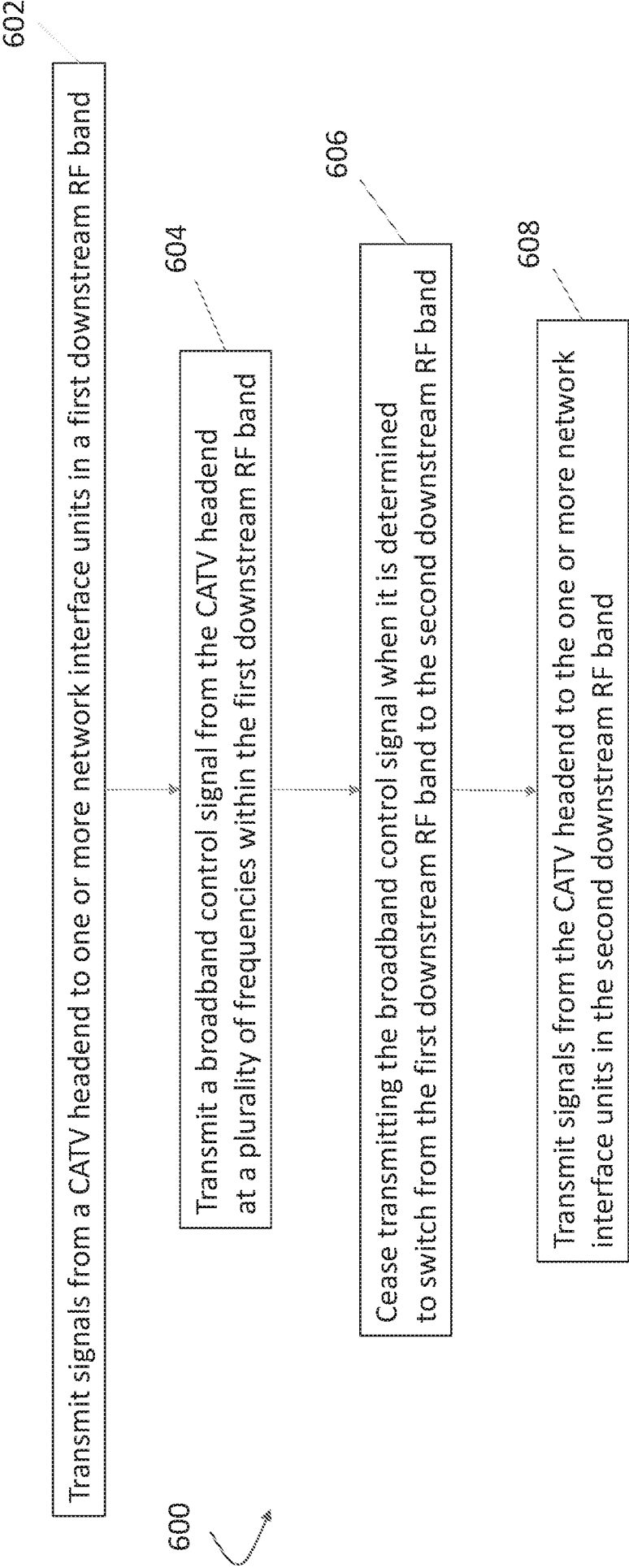


Figure 6

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2016/000510

A. CLASSIFICATION OF SUBJECT MATTER		
INV.	H04N7/10 H04B1/00	H04L12/28 H04N21/426 H04N21/61 H03H7/46
ADD.		
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) H04N H04L H03H H04B		
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 practicable, search terms used) EPO-Internal, WPI Data		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2010/251320 A1 (SHAFER STEVEN K [US] ET AL) 30 September 2010 (2010-09-30) paragraphs [0018] - [0022], [0039] - [0049], [0059] - [0062]; figure 6 -----	1-17
L	WO 2016/083356 A1 (TYCO ELECTRONICS RAYCHEM BVBA [BE]) 2 June 2016 (2016-06-02) the whole document -----	1-17
A	RICE DANIEL J: "DOCSIS 3.1 TM technology and hybrid fiber coax for multi-Gbps broadband", 2015 OPTICAL FIBER COMMUNICATIONS CONFERENCE AND EXHIBITION (OFC), OSA, 22 March 2015 (2015-03-22), pages 1-4, XP032784705, the whole document ----- -/-	1-17
☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
* Special categories of cited documents : "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 1 July 2016		Date of mailing of the international search report 11/07/2016
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016		Authorized officer Bertrand, Frédéric

INTERNATIONAL SEARCH REPORT

International application No

PCT/IB2016/000510

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2011/255452 A1 (BROOKS PAUL D [US]) 20 October 2011 (2011-10-20) paragraphs [0038] - [0046], [0054] - [0055], [0067] - [0068] -----	1-17
A	CN 203 563 085 U (SICHUAN JIUZHOU ELECTRONIC TECHNOLOGY CO LTD) 23 April 2014 (2014-04-23) the whole document -----	1-17

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/IB2016/000510

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2010251320 A1	30-09-2010	US 2010251320 A1	30-09-2010
		WO 2010117489 A1	14-10-2010

WO 2016083356 A1	02-06-2016	NONE	

US 2011255452 A1	20-10-2011	NONE	

CN 203563085 U	23-04-2014	NONE	
