METHOD FOR ASSIGNING A COMMUNICATION CHANNEL BETWEEN A LOW-NOISE BLOCK AND A SET-TOP BOX IN A DOMESTIC TELEVISION SYSTEM

Abstract:
Method for assigning a communication channel between a low-noise block circuit (8) and at least one set-top box unit (2) in a domestic television system, in which the low-noise block circuit (8) is associated with a plurality of communication channels arranged to carry programme signals at an intermediate frequency. The method is characterized in that it comprises the following operations: - associating each of the set-top box unit (2) and the low-noise block circuit (8) with a respective FSK transceiver (4, 10) for transmitting and receiving messages using FSK modulation; - exchanging a plurality of channel assignment messages between the set-top box unit (2) and the low-noise block circuit (8), by means of the respective transceivers (4, 10), in such a way that a channel identifier is automatically assigned to said set-top box unit (2) for identifying one of said plurality of communication channels for the transmission of a programme signal between said set-top box unit (2) and said low-noise block circuit (8).
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Method for assigning a communication channel between a low-noise block and a set-top box in a domestic television system

The present invention relates to a method for assigning a communication channel between a low-noise block and a set-top box in a domestic television system.

More specifically, the invention relates to a method for assigning a communication channel for a single cable reception (SCR) architecture for single or multiple dwelling units, to enable a multi-tuner or multiple set-top box (STB) unit to control peripheral devices connected to a single coaxial cable. More specifically, single dwelling units are single-family houses in which the STB units are located, while multiple units are apartment buildings in which a plurality of separate apartments is provided with STB units.

A STB unit can be a television tuner, a decoder, or an integrated receiver and decoder (IRD). In order to operate correctly, a STB unit of the decoder type must have its tuner connected via a coaxial cable to a LNB (low-noise block) circuit of a parabolic antenna. The parabolic antenna, and particularly the LNB circuit, receives a satellite signal carrying a plurality of television and/or radio programmes. This satellite signal is handled by the LNB circuit and is subsequently sent to the tuners of the various STB units connected to the antenna.

Up to the present time, SCR/DiSEqC (Digital Satellite Equipment Control) technology has been used to control STB units. This technology was introduced to simplify the installation by enabling signals for multiple tuners to be carried on a single coaxial cable running from an antenna to single STB units or DVR (digital video recorder) devices. Thus this technology enables a plurality of tuners to share a single coaxial cable.

Typically, a DVR device contains two tuners, each of which requires a corresponding coaxial cable for connection to the antenna, while dual DVR devices and/or multiple STB units may require more than two tuners each. By using the SCR/DiSEqC technology, therefore, it is possible to serve a plurality of STB units or DVR devices with a single coaxial cable, by sending signals corresponding to the desired television or radio
programmes to these units or devices.

The typical installation configuration includes a parabolic antenna having an LNB circuit to which a single coaxial cable is connected, the incoming radio frequency signal being split by means of conventional splitters into a plurality of signals which are assigned to different tuners, each tuner being tuned to a corresponding frequency sub-band. The signals corresponding to the television or radio programmes required by the various STB units or DVR devices are transmitted in each sub-band. Thus the installation of multiple cables is avoided, and savings can be made.

Low-power silicon integrated circuits are known, which are subsystems of the LNB circuits of parabolic antennae and which use the SCR/DiSEqC technology. Each integrated circuit can shift the frequency of an incoming satellite signal to a fixed intermediate frequency associated with a predetermined sub-band: this makes it possible to extract a plurality of signals, each corresponding to a television or radio programme, from the satellite signal, and to send each signal in the associated sub-band to a specified tuner. These signals are carried on the single coaxial cable running from the LNB circuit and are sent to a plurality of tuners in one or more STB units.

However, this technology has a number of drawbacks. The first disadvantage is related to the problem of collision: the SCR/DiSEqC technology implements a multiple master-single slave architecture, and therefore collisions may occur between the different DiSEqC control sequences sent by different STB units. Furthermore, the time required to transmit the 5 bytes of a DiSEqC command is about 100 ms, a rather long time interval which can easily give rise to collisions between consecutive signals. Consequently, the SCR/DiSEqC technology cannot handle more than four separate signals in a single coaxial cable, and the largest configuration is therefore limited to four tuners, which is suitable for single units only, not for multiple units.

The second problem is due to the fact that it is not always possible to send DiSEqC commands, which are direct current signals, in previously installed systems, since these systems commonly include isolating transformers or reactive loads which adversely affect
the transmission of DiSEqC signals.

Finally, the power consumption for an SCR/DiSEqC system is very high.

A known way of overcoming the aforementioned problems is to use FSK (Frequency Shift Key) modulation. This makes it possible to use a higher-frequency carrier, and therefore shorter data packets, than those used in the SCR/DiSEqC technology.

This simultaneous transmission method is described in patent application EP 1 833 250. This transmission method uses a plurality of FSK (FDMA) transmitters, each transmitter being associated with a corresponding STB unit in the 29-45 MHz band, and a plurality of FSK receivers, associated with the LNB circuit and each one specific to each STB unit. The LNB circuit receives the satellite signal from the parabolic antenna and converts it to intermediate frequency bands in the range from 950 to 2,150 MHz. Each FSK transmitter can send a request signal corresponding to a television or radio programme which is to be received, said programme being identified by respective frequency, band and polarization; this request signal is received by the associated FSK receiver which sends it to the LNB circuit for the purpose of selecting the desired programme within the satellite signal.

The method described in patent application EP 1 833 250 has a number of drawbacks. In the first place, the use of FSK modulation combined with an FDMA transmission method is complicated and expensive; furthermore, it is necessary to use external dongles for encoding the commands used to control the STB units into FSK modulation for communication with the LNB circuit, and vice versa.

This introduces a degree of complexity into the system and gives rise to additional costs due to the use of the FDMA method to avoid the collision problem. Furthermore, the installation of the STB units requires manual configuration of the frequency converter devices in the LNB circuit in order to associate each STB unit with a predetermined intermediate frequency.

An object of the present invention is therefore to propose a method for assigning a
communication channel between a LNB circuit and a STB unit which enables the LNB circuit to handle multiple units, while avoiding the aforementioned collision problems, and which obviates the need for manual installation of the STB units.

These and other objects are achieved by a method for assigning a communication channel whose features are defined in Claim 1.

Particular embodiments are the subject of the dependent claims, whose content is to be understood as integral and integrating part of the present description.

Briefly, the system according to the invention can handle more than four separate tuners, and specifically up to twelve tuners, using a single coaxial cable running from an LNB circuit of a parabolic antenna. This makes it possible to handle up to twelve separate users, each having a simple STB unit of the decoder type, or up to six users if each uses a DVR device (with two tuners), or up to four users if each uses a simple STB unit of the decoder type and a DVR device. Therefore, the system according to the invention is able to handle up to four dwelling units, in a configuration having the maximum number of tuners per dwelling unit, with a single coaxial cable.

Alternatively, it is possible to increase the number of tuners that can be handled by the system according to the invention; more specifically, it is possible to handle up to thirty-one separate tuners.

Alternatively, it is possible to have a software-configurable service channel, in other words a channel over which the STB units are automatically switched when in the standby state, to limit power consumption or to facilitate the automatic updating of software resident in the STB units. In this case, a maximum of eleven separate tuners can be handled with a single coaxial cable.

The method according to the invention allows collision problems to be avoided by using FSK (Frequency Shift Key) modulation with time division multiple access (TDMA). This makes it possible to use a higher-frequency carrier, and shorter data packets, than those
used in the SCR/DiSEqC technology.

Further features and advantages of the invention will become apparent from the following description, provided purely by way of a non-limiting example, with reference to the accompanying drawings, in which:

- Figure 1 is a block diagram of a system arranged to perform a method according to the invention;
- Figure 2 is a schematic representation of the ISO/OSI model;
- Figure 3 is a flow chart of the operations performed to assign an identification slot to an STB; and
- Figure 4 is a flow chart of the operations performed to re-use an identification slot previously assigned to a STB.

Figure 1 shows a block diagram of a system arranged to perform the method according to the invention. The system comprises a plurality of STB units 2, each STB unit 2 comprising a FSK transceiver 4, of a known type, arranged to send and receive request signals and programme signals, respectively, via a coaxial cable 6.

The request signal comprises tuning data indicating the band, polarization and frequency of the signal corresponding to the desired television or radio programme. The coaxial cable 6 is connected to an LNB circuit 8 which comprises an FSK transceiver 10, arranged to receive a request signal sent from a STB unit 2, to select the desired programme transmitted by a satellite signal from among those received by the LNB circuit 8, and arranged to send it to one of the STB units 2. In particular, the satellite signal is received by a plurality of frequency converter devices 12 of a known type, each of which is associated with a corresponding STB unit 2, these devices being arranged to shift the satellite signal to intermediate frequency bands corresponding to channels associated with said STB units 2. When the FSK transceiver 10 receives the request signal, the programme signal corresponding to the desired programme is selected and is sent to the STB units 2, using the channels corresponding to said STB units 2.

For compatibility with STB units 2 which do not have FSK transceivers 4, an external
dongle device is provided, this device being connected to the STB unit 2 and being adapted to convert a tuning datum carried by a conventional DiSEqC signal to an FSK signal. The operation of this external dongle is equivalent to the operation of an STB unit 2 comprising a FSK transceiver 4.

The method according to the invention can be used for dynamic configuration between the LNB circuit 8 and the STB unit 2 and is similar to the DHCP protocol used to configure Internet hosts. The method according to the present invention was introduced to provide STB units 2 with configuration parameters according to the same procedure used in the DHCP for the dynamic assignment of network addresses. More specifically, the syntactic associations shown in Table 1 were created, based on RFC2131 which describes network address assignment procedures.

<table>
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<tr>
<th>DHCP</th>
<th>Method according to the invention</th>
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<tbody>
<tr>
<td>DHCP client</td>
<td>STB</td>
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<tr>
<td>DHCP server</td>
<td>LNB</td>
</tr>
<tr>
<td>STB HW address</td>
<td>STB S/N</td>
</tr>
<tr>
<td>STB IP address</td>
<td>Identification slot</td>
</tr>
<tr>
<td>IP address allocation</td>
<td>Dynamic allocation of identification slot</td>
</tr>
<tr>
<td>Subnet</td>
<td>MDU</td>
</tr>
<tr>
<td>Multiple clients</td>
<td>Multiple STBs</td>
</tr>
<tr>
<td>Single server</td>
<td>Single LNB</td>
</tr>
</tbody>
</table>

Briefly, the method according to the invention comprises a set of operations for associating an identification slot with each STB unit 2; said slot is represented by a progressive identification number associated with a predetermined communication channel, in other words a sub-band of the total frequency band supported by the coaxial cable 6, said sub-band being represented by an associated intermediate frequency.

After this association has been created, the communication between the STB units 2 and the LNB circuit 8 can be distributed in broadcast mode between the LNB circuit 8 and the
STB units 2 and in unicast mode between the STB units 2 and the LNB circuit 8; indeed, the STB units 2 are not allowed to exchange messages each other. This communication takes place in a known way.

Thus the method according to the invention enables each STB unit 2 to identify its own channel for communication with the LNB circuit 8 without any need for intervention by the user or an installer. This means that it is no longer necessary to manually configure the frequency converter devices 12 in the LNB 8 circuit in order to associate each STB unit 2 with a dedicated channel for communication with the LNB circuit 8, and consequently the configuration operation becomes faster and more reliable.

Figure 2 shows the known layout of the ISO/OSI model for implementing the method according to the invention. The ISO/OSI model is a stack of layers which serves to reduce the complexity of a communication system. More specifically, the ISO/OSI model is composed of layers, or levels, including one or more interrelated aspects of the communication between two elements of a network. The levels of interconnection are a physical layer 100, a data link layer 200, the network layer 300, the transport layer 400, the session layer 500, the presentation layer 600 and the application layer 700.

The method according to the invention provides specifications for four layers: the physical layer (PHY) 100, the data link layer (DLL) 200, the network layer (NET) 300 and the application layer (APP) 700.

The physical layer 100 is concerned with the transmission of bits in a communication channel. The STB units 2 and the LNB circuit 8 use a FSK modulation, preferably in the 3 MHz to 10 MHz band, as the physical layer. The messages from a STB unit 2 to the LNB circuit 8 are sent and carried in half duplex on an uplink carrier frequency, while the messages from the LNB circuit 8 to the STB units 2 are carried on a downlink carrier frequency. Advantageously, the uplink frequency is 6.5 MHz and the downlink frequency is 4.5 MHz.

The data link layer 200 is achieved by the exchange of messages between the STB units 2
and the LNB circuit 8, based on the ETSI TS 101 964 standard and using a serial structure, with or without parity, of a known type, present in the FSK transceivers 4, 10 associated with the STB units 2 and the LNB circuit 8 respectively. The messages have a predetermined fixed length to optimize the message traffic.

The data link layer 200 of the method according to the invention is structured in such a way that each retransmission request is handled by the higher layers, while this layer executes an error check on the transmitted data.

The network layer 300 defines the mechanism by which an identification slot is assigned to each STB unit 2, enabling these slots to be re-assigned to different STB units 2 at different instants: this provides TDMA communication channel handling. The messages exchanged in the network layer contain said identification slot in such a way that each message reaches the correct STB unit 2 and the LNB circuit 8 recognizes the STB unit 2 from which a given message has been sent.

All the messages exchanged by the network layer must therefore include the same identification slot for each STB unit 2.

Figure 3 shows a flow chart of the operations executed to assign this identification slot to said STB unit 2. Advantageously, this identification slot comprises an identification number of the slot.

Each STB unit 2 is associated with a transmission identifier which may be either the serial number of the STB unit 2 (STB S/N in Table 1) or the identifier of a smart card inserted into said STB unit 2.

At this point in the description, it will be assumed that the LNB circuit 8 has a set of available identification slots, and can choose one of these to meet a new slot request from the STB unit 2. The LNB circuit 8 stores in a memory a database of allocated and released slots.
When an STB unit 2 sends a request to the LNB circuit 8, it inserts its own transmission identifier into the message; when the LNB circuit 8 answers, it inserts the same transmission identifier into the answer message. Only the STB unit 2 whose transmission identifier is the same as that present in the answer message will take into account the message from the LNB circuit 8; the other STB units 2 will disregard it.

The procedure of assigning a slot to a STB unit 2 starts at step 100 with the sending of a discovery message by a STB unit 2 which wishes to acquire an identification slot, said discovery message being sent to the LNB circuit 8 on the uplink frequency.

When it receives said discovery message, the LNB circuit 8 checks, in step 102, for the availability of a slot. If no slot is available, the LNB circuit 8 sends an error message in step 104 to notify the STB unit 2 that there are no slots available for a new installation.

If a slot is available, then in step 106 the LNB circuit 8 sends to the STB unit 2, on the downlink frequency, a message offering said slot and including the identification number of the slot.

At this point, in step 108, the STB unit 2 sends an acceptance message to the LNB circuit 8, using the uplink frequency, indicating that the STB unit 2 has accepted the slot that was offered to it.

After sending the slot offer message, the LNB circuit 8 starts a timer: if the STB unit 2 sends an acceptance message within the time interval determined by the timer, the configuration procedure continues as described below; otherwise, the slot is considered to be available again, and the assignment procedure is interrupted.

If the LNB circuit 8 receives a new discovery message from the STB unit 2, the LNB circuit 8 offers the STB unit 2 a new slot, since the STB unit 2 has refused the slot assigned to it previously.

If the LNB circuit 8 receives the acceptance message, it replies, in step 110, with an
acknowledgement message, preferably including the identification number of the slot. Advantageously, this acknowledgement message also contains a data element representing the total period of use of the slot, preferably equal to two months.

From this point onwards, the STB unit 2 can send one or more request messages to the LNB circuit 8, each message comprising tuning data indicating the band, polarization and frequency of the signal corresponding to a desired television or radio programme. The LNB circuit 8 will send the programme signals corresponding to the requested programmes to the STB unit 2.

Whenever the LNB circuit 8 receives a request message, it updates the period of use of the slot, which is returned to a predetermined initial value, for example two months; this means that the slot can again be used by the STB unit 2 for the whole of this period of use.

If, after receiving a given request message, the LNB circuit 8 receives no new request message throughout the period of use, the LNB circuit 8 cancels the assignment of the slot to the STB unit 2 and the slot is considered to be newly available.

If the LNB circuit 8 receives the acceptance message in step 108 but is unable to assign the slot to the STB unit 2, it sends a not-acknowledgement message in step 112, to notify the STB unit 2 that the installation has not been completed correctly. The STB unit 2 can therefore send a new discovery message.

Figure 4 shows a flow chart of the operations executed by an STB unit 2 after the expiry of the period of use of the slot assigned to it previously, if it wishes to attempt to re-use the slot.

The procedure of re-using a slot assigned to an STB unit 2 starts with the sending, in step 200, of an information message from an STB unit 2 which requests a preceding slot which was assigned to it previously.

In step 202, the LNB circuit 8 checks if the slot is present in the memory and if it is not
now being used by another STB unit 2.

If the slot is available, then in step 204 the LNB circuit 8 sends an acknowledgement message, preferably including the identification number of the slot. Advantageously, this acknowledgement message also contains a datum representing the total period of use of the slot, preferably equal to two months.

From this point onwards, the STB unit 2 can send one or more request messages to the LNB circuit 8, each message comprising tuning data indicating the band, polarization and frequency of the signal corresponding to a desired television or radio programme. The LNB circuit 8 will send the programme signals corresponding to the requested programmes to the STB unit 2.

Whenever the LNB circuit 8 receives a request message, it updates the period of use of the slot, which is returned to a predetermined initial value, for example two months; this means that the slot can again be used by the STB unit 2 for the whole of this period of use.

If the LNB circuit 8 finds in step 202 that the slot is not available, it sends a not-acknowledgement message to the STB unit 2, in step 206, to notify it that the configuration process was not successfully completed because the slot is not present in the memory of the LNB circuit 8 or is temporarily in use by another STB unit 2. The STB unit 2 can therefore send a new discovery message.

The application layer 700, more specifically the Electronic Program Guide (EPG), provides a user interface with different installation selection options, and receives the identification slot from the lower layers and associates them with a frequency range for transmission. The channels of the LNB circuit 8 are identified by means of progressive numbers, each of which is associated with a predetermined frequency range by using a plurality of filters, each associated with a corresponding frequency converter device 12.

In conclusion, if the differences and advantages of the present invention with respect to the SCRTDiSEqC technology are examined, it can be noted that the method according to the
invention makes it possible to handle up to four orbital locations, is preferably capable of handling up to thirty-one tuners, handles collisions by means of a TDMA system, and allows the different STB units to be installed automatically.

Clearly, the principle of the invention remaining the same, the embodiments and the details of production can be varied considerably from what has been described and illustrated purely by way of non-limiting example, without thereby departing from the scope of protection of the invention as defined in the attached claims.
CLAIMS

1. Method for assigning a communication channel between a low-noise block circuit (8) and at least one set-top box unit (2) in a domestic television system, in which said low-noise block circuit (8) is associated with a plurality of communication channels arranged to carry programme signals at an intermediate frequency, the method being characterized in that it comprises the following operations:
   - associating the set-top box unit (2) and the low-noise block circuit (8) with a respective FSK transceiver (4, 10) for transmitting and receiving messages using FSK modulation;
   - exchanging a plurality of channel assignment messages between the set-top box unit (2) and the low-noise block circuit (8), by means of the respective transceivers (4, 10), in such a way that a channel identifier is automatically assigned to said set-top box (2) for identifying one of said plurality of communication channels for the transmission of a programme signal between said set-top box unit (2) and said low-noise block circuit (8).

2. Method according to Claim 1, further comprising the operation of associating said set-top box unit (2) with a transmission identifier, said messages exchanged between the low-noise block circuit (8) and the set-top box unit (2) containing said transmission identifier.

3. Method according to Claim 1 or 2, in which the operation of exchanging a plurality of messages comprises the operations of:
   - sending (100) from the set-top box unit (2) to the low-noise block circuit (8) a first message representing a request for the acquisition of a channel identifier;
   - sending (106) from the low-noise block circuit (8) to the set-top box unit (2) a second message representing an offer of a channel identifier;
   - sending (108) from the set-top box unit (2) to the low-noise block circuit (8) a third message representing the acceptance of said channel identifier;
   - sending (110) from the low-noise block circuit (8) to the set-top box unit (2) a fourth message of confirmation representing the correct completion of the association operation.

4. Method according to Claim 3, further comprising, after the operation of sending
(106) a second message, the operation of specifying a time interval and determining whether the third message has been sent within this time interval.

5. Method according to Claim 3 or 4, in which said fourth confirmation message contains a datum representing the total period of use of the channel identifier by said set-top box unit (2).

6. Method for communication between a low-noise block circuit (8) and at least one set-top box unit (2) in a domestic television system, in which said low-noise block circuit (8) is associated with a plurality of communication channels arranged to carry programme signals at an intermediate frequency, the method being characterized in that it comprises the following operations:
   - associating each of the set-top box unit (2) and the low-noise block circuit (8) with a respective FSK transceiver (4, 10) for transmitting and receiving messages using FSK modulation;
   - exchanging a plurality of channel assignment messages between the set-top box unit (2) and the low-noise block circuit (8), by means of the respective transceivers (4, 10), in such a way that a channel identifier is automatically assigned to said set-top box (2) for identifying one of said plurality of communication channels for the transmission of a programme signal between said set-top box unit (2) and said low-noise block circuit (8);
   - sending from the set-top box unit (2) to the low-noise block circuit (8) at least one request message representing a desired television or radio programme;
   - sending from the low-noise block circuit (8) to the set-top box unit (2) at least one programme signal corresponding to said desired programme.
FIG.2
SEND DISCOVERY MESSAGE  

CHECK AVAILABILITY OF SLOT  

SEND ERROR MESSAGE  

SEND OFFER MESSAGE  

SEND NOT-ACKNOWLEDGEMENT MESSAGE  

SEND ACCEPTANCE MESSAGE  

SEND ACKNOWLEDGEMENT MESSAGE  

FIG. 3
SEND INFORMATION MESSAGE

CHECK FOR PRESENCE AND AVAILABILITY OF SLOT

SEND ACKNOWLEDGMENT MESSAGE

SEND NOT-ACKNOWLEDGMENT MESSAGE

FIG. 4
**A. CLASSIFICATION OF SUBJECT MATTER**

*INV.: H04N7/10*

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

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

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

EPO-Internal

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

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<td>EP 1 418 760 A (FRACARRO RADIOINDUSTRIE [IT]) 12 May 2004 (2004-05-12) paragraphs [0023] - [0027]; figure 1</td>
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<td>WO 98/24229 A (GUESTNET CORP LTD [GB]; GUESTNET EUROPE LTD [NO]; CUCKOV ANDREJ [GB]; P) 4 June 1998 (1998-06-04) page 7, line 25 - page 8, line 16; figure 1</td>
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**Date of the actual completion of the international search**

17 December 2009

**Date of mailing of the international search report**

07/01/2010

**Name and mailing address of the ISA/Authority officer**

Marzal-Abarca, X

GUESTNET LTD

0023; 1-6

Further documents are listed in the continuation of Box C

See patent family annex
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Form PCT/ISA/210 (continuation of second sheet) (April 2005)
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