



It is known that domestic entertainment electronic devices, such as for example colour television sets, video recorders or HiFi equipment, may be operated using remote-control units, which transmit control signals to the device in question, by way of a directed wireless channel, using say infra red or ultrasonic waves. remote-control systems of this kind for use in the domestic sphere may also be used for the control of other types of equipment, such as electric stoves, baking ovens or room heaters.

With remote-control systems of this type it has also been proposed (EP-A-0 129 794 published on 2.1.1985) to equip the device with a second transmitter and the remote-control unit with a second receiver associated with this transmitter, which will activate the remote-control unit and the control system of the device only if a pre-defined standby signal of the second transmitter is received. This simplifies the handling of such a remote-control unit inasmuch as the operator is better able to check on the functional ability of the remote-control.

If several remote-control units communicate with a number of devices in a room, wrong operations or functional disturbances could take place. If two or more remote-control units are transmitting simultaneously it will not be possible for a device to decode the transmitted instructions. A wrong decoding is also possible, thus causing incorrect control of the device. There is moreover the need to provide a number of remote-control units having equal access to all devices, especially if there are a greater number of devices and persons located in the room.

The aim of the invention is to make possible a trouble-free operation of the devices in a system that comprises a number of remote-control units and devices.

This aim is accomplished by the invention described in claim 1. Advantageous further developments of the invention are described in the subordinate claims.

Associated with the various channels for bi-directional transmission between remote-control units and the devices are time intervals which repeat periodically in a time sequence. This effectively prevents disturbances between these time multiplex channels, because there can be transmission of the identification signals and of the instruction signals in one channel only in any one time interval. Thus there can be no priority remote control unit, which is advantageous, and, in a further development of the invention, there is even a protection against an unintended operation of certain functions. When for example a remote-control unit has switched a video recorder to "record" an unwanted alteration of this function by the action of another remote-control unit is not possible. It is made possible for a number of remote-control units in a room to have access to all devices, except for the function just described.

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So that a number of remote-control units and devices may communicate with each other it is also known (DE-A-2 304 874) to provide a number of bi-directional channels between the remote-control units and the devices, for transmitting identification and instruction signals, and to allocate recurrent serial multiplex time intervals to these channels. This ensures that the communication paths between the remote-control units and the devices are effective in a time series so that they do not disturb each other.

The aim of this invention is to determine the duration and the spacing of the time intervals associated with the devices in the method referred to above, without any need for having synchronized clocks in the said devices.

This aim is accomplished by the invention which is described in claim 1. Advantageous further developments of the invention are described in the subordinate claims.

It is also known (EP-A-0 075 317) to provide a bi-directional channel for transmitting data between a remote-control unit and an electrical device. Here however there is no attempt to operate a number of devices at will using a number of remote-control units.

The idea of the invention is based on the reasonable assumption that the devices in a method of this kind intended for domestic use are always connected to the mains voltage. The entire remote-control system will determine how the time multiplex system is designed depending on the number of communicating devices, using a control circuit which interrogates the devices, itself being preferably formed by a remote-control unit, or contained inside this. If there is an operational disturbance this will be detected by the control circuit and the said structure of the multiplex system will be reorganized. This reorganisation also occurs if another device is included in the number of communicating devices. The reorganisation takes place automatically and without any noticeable delay.

The invention will now be described in detail, with reference to the drawing, in which

Fig. 1 shows the interactive principle between the remote-control units and the devices,

Fig. 2 shows the structure of the signals which are transmitted by the devices and the remote-control units,

Fig. 3 depicts a diagram showing the organisation of the time multiplex system, and

Fig. 4 shows a logic flow chart for the effective mode of the transmitter inside the remote-control unit after the time multiplex system is set up.

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Fig. 1 shows three devices G1, G2, G3 which are connected to a main terminal 1 of frequency 50 Hz for supplying the power and synchronizing the time multiplex system. The devices G can be controlled by means of two remote-control units F1, F2. All the devices G and all remote-control units F contain a transmitting and a receiving part SE, whereby the bi-directional channels 2 are established between the remote-control units F and the devices G. Over these channels the device G may transmit identification signals or ready-to-send signals to a remote-control unit F, and a remote-control unit F may transmit instruction signals to a device G. This kind of communication between the devices and the remote-control units is described in detail in EP-A-129794. Because of the directivity characteristic of wireless transmission in Fig. 1 not every remote-control unit F may communicate with all devices and vice-versa. The devices G "see" each other just as little as the remote-control units F.

Fig. 2a shows the structure of the identification signal, which is transmitted from a device G to a remote-control unit F. This signal comprises four serial trains I-IV, which contain the following information:

Time interval I - the identification number of the device, for example the information "I am a video recorder" or "I am device no. 6".

Time interval II - the current status of the device, for example "I am in recording mode".

Time interval IV - an error checking signal and protective signal or CRC check word (cyclic redundancy check). This signal indicates whether the total identification signal per Fig. 2a has been transmitted to the receiver in the remote-control unit F.

Fig. 2b shows the structure of an instruction signal B which is transmitted from a remote-control unit F to a device G. This instruction signal also has four serial time intervals I-IV, which contain the following information:

Time interval I having an identification for the remote-control unit, for example "I am remote-control no. 2".

Time interval II having an identification of the number of the device which is to be addressed and controlled by the remote-control unit, for example "Instruction to all devices" or "Instruction to device no. 3".

Time interval III having the actual instruction, e.g. "Stop".

Time interval IV again with a CRC error detecting and protective signal per Fig. 2a.

Fig. 3 shows the structure and the organisation of the time multiplex system for the interaction between the remote-control unit F1 and the two devices G1, G2. At instant t1 the system is activated from G1, G2. The two devices G1, G2 now send identification signals K1, K2, which may overlap in time because the synchronization is not yet established. At time instant t2 the remote-control units are activated. The entire identification signal which is received has too long a duration on account of the time overlap of the identification signals K1, K2, whereby this overlap will probably cause the CRC word to indicate an invalid identification signal. Therefore, at instant t3 the remote-control unit F1 will give an instruction to all devices G "To all devices, channel in quiescent state". Therefore from instant t4 the transmitters in the devices G will cease to transmit identification signals K. The remote-control unit F₁ then sends instruction signals B to the devices in accordance with an existing address register, that is, at t5-t6 the instruction signal B1 "To device G1: please send identification". When this signal has ended the device G1 sends at t6-t7 its identification signal K1, which has the structure as shown in Fig. 2a. The information from identification signal K1 gets stored in the remote-control unit F1. If the instruction signal B does not cause a device G of specific address to react, then there will be no storage, because there is not a device which has this address, or it is not active, or it is not within the effective range of the remote-control unit F1. Between t8-t9 the remote-control unit F1 sends a second instruction signal B2 having the content "To device 2: please send identification". From t9-t10 the device G2 sends its identification signal K2 having the structure in Fig. 2a, which is then stored in remote-control unit F1. From t11-t12 another device G3 is then queried, which, say, does not exist and thus transmits no identification signal K. Hence from t2-t13 all devices G which can communicate with the remote-control unit F1 are stored in the remote-control unit F1 with addresses as shown in Fig. 2a.

At the instant t13 the devices start to latch on to the mains frequency, i.e. the intervals for serial transmission of the signals are determined. Between t13-t14 the remote-control unit F1 sends to device G1 an instruction to synchronize itself to the mains frequency with repetition length T. A time interval is then fixed in a time position and time length for a communication between device G1 and the remote-control unit F1. At t14-t15 the device G1 then re-transmits the identification signal K1, as in Fig. 2a. This identification signal K1 is sent again and again with a repetition length of T in the time multiplex system. The value of the repetition length T is equal to the mains period length times n/k , where n = the number of devices G which communicate with the remote-control unit F, and k is the fraction of the mains period length in respect of the relevant communication between the devices G and the remote-control units F over the channels 2. If the number n of the devices is 8 and one-quarter of the mains period is required for the communication, then the repetition length for sending the identification signals K1 and K2 etc. will be 40 ms.

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Accordingly, at t_{16} - t_{17} the remote-control unit F1 will send an instruction signal to device G2 for it to synchronize itself like device G1 to the power supply, whereupon device G2 now sends from t_{17} - t_{18} the identification signal K2, which also repeats itself with an interval of T.

At t_{19} the devices G1, G2... now send out their identification signals K1, K2... which are offset in time and have spaces between them. In these spaces the instruction signals can be sent by the remote-control units F to the devices G for controlling these devices to various functions. For example, a remote-control unit F sends from t_{20} - t_{21} an instruction signal B to the device G2 with the instruction "louder", whereby the volume of the recording is increased.

The time frame for the time multiplex system is calculated by a computer in the remote-control unit F1, whereby all values are available at instant t_{13} , including the total number of communicating devices G. The information for the time multiplex system is sent to all devices G and acknowledged by these. When all the devices G have latched into the frame of the time multiplex system the normal operation between the remote-control units and the devices may commence. A new incoming remote-control unit F orientates itself by monitoring the identification signals K of the devices to the situation in the room and slots into the time multiplex system. If this is not possible, or the transmission of the identification signals K is disturbed, then the said remote-control unit initiates once again the process of synchronization just described.

Fig. 4 shows the logic flow chart in respect of the described function of the transmitter in a remote-control unit F for the organisation of the system shown in Fig. 3.



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Claims

1. A time multiplex method for a remote-control system for electrical and electronic devices (G), in particular home entertainment electronic equipment, incorporating a number of bi-directional channels (2) between a number of remote-control units (F) and devices (G) for the transmission of identification and instruction signals (K,B), there being associated with these channels (2) time intervals (t13-t15; t16-t18) which are periodically repeating in the time sequence of a time-multiplex system, characterized in that the spacing and length of these intervals are determined by regular repeated counting of a fixed number of mains voltage periods.
2. A method as claimed in Claim 1, characterized in that the length of each time interval is calculated so that within its duration an identification signal (K) can be transmitted from a device (G) to a remote-control unit (F), and also an instruction signal (B) can be transmitted from a remote-control unit (F) to a device (G).
3. A method as claimed in Claim 1, characterized in that a remote-control unit (F) transmits an instruction signal (B) to a particular device (G) only during the intervals in which the remote-control unit (F) receives the identification signal (K) of the particular device (G).
4. A method as claimed in Claim 1, characterized in that each identification or instruction signal (K,B) contains an error-detecting (CRC) word which checks the correct transmission of the said signal.
5. A method as claimed in Claim 1, characterized in that the devices (G) transmit in their identification signal (K) different identifying signals (I) which can identify the device (G) and its type.
6. A method as claimed in Claim 5, characterized in that the identification signal (K) which is transmitted from a device (G) to a remote-control unit (F) contains serial information on the identity of the device (G), on its ready-to-receive state vis-a-vis the remote-control units (F) and on its current operational state, along with a closing check word (CRC).
7. A method as claimed in Claim 1, characterized in that a device (G), when it is set for a specific function, is blocked by a specific remote-control unit (F) from being operated by any other remote-control unit (F) for the duration of the function.
8. A method as claimed in Claim 1, characterized in that the remote-control units (F) transmit in their instruction signals (B) different identifying signals which recognize the remote-control unit (F) in question.



9. A method as claimed in Claim 1, characterised in that the instruction signal (B) which is sent by a remote-control unit (F) contains serial information on the identification of the remote-control unit (F), on the device (G) to which this instruction signal (B) relates, on the instruction itself, and also a closing check word (CRC).

10. A method as claimed in Claim 1, characterised in that a control circuit (F1) is provided for logging all current communicating devices (G) and for assigning the time intervals to the individual channels (2).

11. A method as claimed in Claim 10, characterised in that the control circuit (F1) fixes the absolute time positioning of the time multiplex sequence.

12. A method as claimed in Claim 10, characterised in that the information on the number of regularly-repeating periods of the mains voltage that are to be counted by the devices (G) is transmitted to all the devices (G) by the control circuit (F1).

13. A method as claimed in Claim 10, characterised in that the control circuit is formed by one of the remote-control units (F1).

14. A method as claimed in Claim 10, characterised in that if the identification signals (K) of the devices (G) are disturbed or are not correctly timed then the control circuit will cut off the transmission of all devices (G) and then send instruction signals (B) successively to the various devices (G) according to pre-defined addresses, so that the device (G) that is queried sends its identification signal (K) to the control circuit.

15. A method as claimed in Claim 14, characterised in that, after the addresses of the intercommunicating devices (G) are stored in the control unit the control unit then sends time-sequential instruction signals (B) to the devices (G) in accordance with the time multiplex, so that they synchronize themselves to the power supply, and that thereupon the devices (G) send out their identification signals (K1, K2) successively in accordance with the time multiplex.

16. A method as claimed in Claim 14 or 15, characterised in that if there is an operational disturbance in the transmission of the identification signals (K) the cyclic sequence will be automatically initiated once more.