

CONTROL DEVICE FOR A RADIO RECEIVER

This invention relates to a control device for providing signals at a RF target reception frequency.

Many types of communication links and networks are increasingly used for both business and domestic purposes, involving both static and mobile user terminals and radio waves of various frequencies. Today's sophisticated communication systems allow constant access to information and information providers even when on the move. A known kind of radio receiver incorporates a Radio Data System (RDS) capability which causes the radio to interrupt its present operating mode, eg. mute or play back of recorded music, in order to issue a special information announcement (after which, the interrupted operating mode is resumed). However, the radio has to be specially adapted for this purpose.

An object of the present invention is to provide a control device which can automatically tune an external or auxiliary input signal to the frequency currently being received by a target receiver.

According to one aspect, the invention consists in a control device for using noise from a target receiver to tune an auxiliary signal to the frequency being received by the target receiver. The noise may be mixed with a modulated signal bearing the auxiliary signal in order to provide an output signal which contains a component at the target reception frequency.

According to another aspect, invention provides a control device for deducing at least one possible reception frequency of a target receiver, the reception frequency being the frequency to which the target receiver is tuned, and providing signals at said at least one deduced frequency.

The present invention may be used in combination with many kinds of communication system, and may automatically tune an external or auxiliary input signal to the frequency currently being received by an RF receiver within the communication system. It may

interrupt the currently selected RF signal, and allow the RF receiver to receive the incoming signal of interest by converting it to the frequency to which the RF receiver is currently tuned i.e. the target reception frequency. This provides the automatic reception of information without the need to alert the user to the fact that a signal of interest has been sent, and without the need for the user to manually alter any of the tuning states of the receiver to receive the incoming signal. At the end of the transmission of interest, the device allows the original RF signal transmission reception to resume. This is particularly useful in the case of a radio receiver in a car. In this case, the incoming signal, such as a telephone call, or information announcement, can be transmitted through the speaker system of the existing car radio.

In one embodiment, the control device operates in combination with a superheterodyne RF receiver in a communication system. The control device tunes its transmission frequency to a RF target reception frequency by extrapolation from the currently defined local oscillator frequency of the target superheterodyne RF receiver, as determined by the detection of oscillator noise propagated at the target superheterodyne receiver's antenna input. In other words, the control device uses the local oscillator frequency to extrapolate the current target RF reception frequency and then tunes the frequency of its transmission signal to the same frequency as that to which the target RF receiver is currently tuned so that the control device's transmission frequency signal can be received by the target RF receiver.

The control device may be switched between a standby mode and a function mode.

When in a standby mode, the control device may allow the free uninterrupted passage of normal signals from the antenna to the receiver. This standby mode may also include continuous or intermittent scanning of the noise on the receiver antenna input, including that from the local oscillator, using the data obtained to deduce the station frequency to which the receiver is currently tuned.

When in a function mode, the control device may detect a transmitted signal at the external or auxiliary signal input, and once detected, mute the antenna signal automatically, and replace the antenna signal with a signal generated by an internal RF modulator at the same

frequency as that to which the receiver is tuned, but avoiding transmitting any interference on the antenna. This results in the transmission of an external or auxiliary input signal using the audio-visual system of, for example, a radio or television, in the same way as if the external or auxiliary input signal - for instance a voice audio message - were coming from the currently selected radio or television station.

The external or auxiliary input signal may be generated by a number of different sources, for example, a PA microphone, an in-vehicle mobile phone, a CB-radio, an in-vehicle intercom, a pager or mobile phone messaging system, a portable computer, a home-security or a child-minding system, an internet e-mail link, or any combination of the foregoing.

In one embodiment, the oscillator frequency of the target receiver may be determined by the detection of local oscillator noise propagated at the target receiver's antenna input.

In another embodiment, the control device may alternatively or additionally detect a broader range of the noise propagated at the target receiver's antenna input and provide signals at deduced frequencies extrapolated from each noise frequency at which there is a noise signal above a predetermined level. The control device arrives at the deduced frequencies by processing each of the deduced frequencies as if it were a noise signal from the local oscillator of the target receiver. In this manner, the control device provides a spectrum of signals, at least one of which is at a frequency to which the receiver is tuned.

In a further embodiment, the control device may perform a frequency scan to determine what frequencies are being used for broadcast purposes in the locality and provide signals for the target receiver at these deduced frequencies.

Certain embodiments of the present invention will now be described, by way of example only, with reference to the accompanying figures which show:

Figure 1 is a diagram illustrating an automatic RF control device;

Figure 2 is a diagram illustrating an automatic RF control device embedded in a telephone and the use thereof with receiver equipment;

Figure 3 is a diagram illustrating an automatic RF control device adapted for incorporation into a vehicle;

Figure 4 is a diagram illustrating an automatic RF control device which is in wireless communication with an antenna line; and

Figure 5 is a diagram illustrating an automatic RF control device incorporating a mixer.

Figure 1 shows an automatic RF control device 10 according to the present invention positioned in the antenna signal path 12a, 12b between an RF antenna 14 and a radio or television superheterodyne receiver 16. The control device 10 has an auxiliary input 18 for an audio, data and/or video signal for voice, text and/or video insertions, and operates as follows:

In a stand-by mode, the device of the present invention can, using detector 20, continuously or intermittently scan the RF noise on the receiver antenna input 12b, and deduce the station frequency to which the receiver is tuned at any given time from the frequency being generated by the local oscillator (LO) circuitry of the receiver 16 which is propagated to the receiver antenna input 12b, as a non-utilised, but detectable noise signal.

When an input signal of interest is received at the device auxiliary input 18, the device is switched to an operation mode in which the existing antenna signal is automatically muted, and replaced with a signal generated by an internal RF modulator 22 at the same frequency as the channel to which the receiver 16 is currently tuned, but without transmitting undesirable or illegal interference on the antenna 14. Once the input signal stops, the device switches back to standby mode and, either immediately, or following a pre-defined pause, the original channel frequency reception continues.

An alternative embodiment of the automatic control device is better adapted to cope with systems in which local oscillator noise propagation is suppressed. The automatic control

device of this embodiment scans the RF noise on the receiver antenna input and determines the frequencies of all noise signals having at least a predetermined amplitude. The automatic control device then deduces a possible reception frequency for each noise frequency by treating each noise frequency in turn as if it were the actual local oscillator noise signal.

When an input signal of interest is received at the auxiliary input 18 of the automatic control device, it mutes the existing antenna signal and replaces it with signals generated by RF modulator 22 at the spectrum of possible reception frequencies which were deduced from the noise frequencies. It will be appreciated that at least one of the signals in the spectrum will likely be at the frequency to which the target receiver is tuned.

A further preferred embodiment of the automatic control device is shown in Figure 5. The control device 60 comprises a modulator 62 which receives the auxiliary signal and which produces a signal onto which the auxiliary signals are modulated. The automatic control device 60 further comprises a mixer 64 to which are supplied the modulated signal from modulator 62 and the noise detected from the target receiver. The mixer 64 produces, for each component of the target receiver noise, two new modulated frequencies, one of which corresponds to the sum of the two mixed frequencies, and the other corresponding to the difference between them. The system is arranged (by preselection of the carrier frequency of modulator 62) such that the signal produced by mixer 64 at the differential frequency of the mixture of the target receiver local oscillator noise frequency and the output of modulator 62 will match the actual reception frequency of the target receiver. Thus, like the previous embodiment, a spectrum of signals are produced by the control device, one of which is the auxiliary signal modulated at the reception frequency of the target receiver. The automatic control device according to this embodiment is simple to implement and avoids intelligent target signal deduction and transmission signal synthesis by simply mixing all the noise signals from the target receiver with a predefined frequency produced by modulator 62. Consider the following example:

A radio, one of a particular genre, has an internal reception frequency of 10.7MHz. The radio is a superheterodyne receiver and has a local oscillator which produces a signal of

adjustable frequency, F_{LO} , which is mixed into incoming radio signals to mix them down to the 10.7MHz reception "window" of the radio. In this example, the control device modulates the auxiliary signal (with which it is desired to replace the existing signal received by the radio) on to a 10.7MHz carrier. The modulated signal is then mixed into the noise from the antenna line of the radio and is supplied as an input to the radio (in place of the existing reception signal). Since the antenna line noise contains noise from the radio's local oscillator at frequency F_{LO} , this new input signal contains a component whose frequency is $F_{LO} - 10.7 \text{ MHz}$, i.e. the difference between the radio's local oscillator frequency and the frequency of the auxiliary signal carrier. At the radio, this component is mixed with the radio's local oscillator signal to produce a difference frequency of $F_{LO} - (F_{LO} - 10.7 \text{ MHz}) = 10.7 \text{ MHz}$, so that the auxiliary signal is received at the radio's internal reception frequency.

Any of the above described embodiments can be supplemented by providing the automatic control device with a memory 24 containing a list of the frequencies of radio stations in the locality. The list can be used to test the likelihood of detected noise signals corresponding to the actual frequency to which the target receiver is tuned. The list may even be prioritised in accordance with known preferences of the target receiver.

The automatic control device could also be augmented by a feed-back detection process. A test signal could be emitted by the automatic control device and the noise emitted by the target receiver could be analysed by detector 20 for feed back corresponding to the test signal which would indicate that the automatic control device has correctly targeted the receiver.

In this way, the device enables the presentation of an external audio, video and/or data signal over the receiver in, for example, a radio or television, exactly as if the audio, data and/or video message was coming from the selected radio or television station. This device also has the advantage that the user can receive transmitted signals without any manual tuning or the need to manually operate any switches or use any hand-held receivers. The output from the radio or television channel currently in use is interrupted and replaced with the transmitted signal in audio, video and/or data form.

The input signal may originate as part of a PA microphone system forming part of an institutional entertainment system, or a commercial information bulletin system. This would allow messages to be delivered over an institutional PA system without the inconvenience of having to switch off an existing broadcast, and manually tune into the PA broadcasting frequency or switching between audio inputs. The existing broadcast would merely be interrupted until the PA message was completed, then the original broadcast would resume.

As shown in Figure 2, the automatic RF control device 30 may form part of a 'hands free' module in an in-vehicle mobile telephone 26. The control device 30, embedded in the telephone, receives signals on its auxiliary input (18, Figure 1) from the sound producing circuit 28 of the telephone 26. The automatic control device 30 communicates with the antenna line 32 of the in-vehicle radio 34 by way of line 36, and it is thus capable of replacing the channel presently broadcast by the radio 34 with signals from the telephone 26. Thus, the driver of the vehicle is able to safely and audibly receive incoming calls without having to stop the vehicle to operate the receiver or to turn off the radio.

When installed in a vehicle, the automatic RF control device can provide the core of an in-vehicle intercom system. The audio input from, for example, the front of a vehicle, may be output through the radio speakers in the rear of the vehicle by interruption of the radio station currently being broadcast. Likewise, an existing in-vehicle intercom system can be used to form the basis of an embodiment of the invention.

Further, in combination with text to speech processing, the automatic RF control device could be used to allow pager or e-mail messages to be audibly presented by interruption of a currently active radio or television channel.

Another use of the automatic RF control device is as a replacement to traditional car navigation systems employing graphic displays. These systems, since they represent a dangerous distraction to drivers, may well be restricted in their use or made illegal to drivers. Existing products which combine car hi-fi and 'talking' car navigation systems

exist, but are expensive since they integrate quality hi-fi systems with dedicated multi-media PCs.

However, the automatic RF control device of the present invention makes it possible to adapt any standard PC or PDA with GPS and software to provide requested navigational data for a fraction of the cost of a dedicated system. In addition, since the PC or PDA is not a dedicated system, it can also be used for navigating other vehicles and transportation means, such as boats. However, PCs or PDAs typically have sub-standard sound systems with speakers which are inadequate and provide sound that is too quiet or of too poor a quality to be heard in a vehicle over engine and road noise. The automatic RF control device not only allows the navigational information to be of improved quality by feeding the sound through the in-vehicle hi-fi speakers, but also allows the user to listen to the radio during a journey and obtain the navigational information at appropriate times without having to adjust the radio, since the system will automatically interrupt the current radio programme during delivery of the navigational information.

FM RDS-TMC (Radio Data System - Traffic Message Channel) is well known and enables broadcasters to insert traffic-related messages for motorists into ordinary radio programmes, using a sub-carrier which is only detected by compatible car radios. However, this system requires the motorist to be equipped with a compatible car radio capable of receiving these inserted traffic-related messages. The automatic RF control device can be used in combination with any existing radio anywhere in the world to provide the same programme interruption and message delivery system. In addition, this device is simpler and therefore also cheaper than existing RDS-compatible radios. Figure 3 illustrates the provision of the automatic control device 40 in the antenna line built into a vehicle. The antenna line 42 leading from the automatic control device 40 may be connected to a radio 44 installed in the fascia 46 of a vehicle at production, or later.

Home-security or child-minding systems could be augmented by the automatic RF control device of the present invention, which would allow any detected audio signal to be displayed remotely as a video, teletext or voice output to alert an operator to potential problems.

Internet e-mail links could use the automatic RF control device of the present invention to display e-mail messages - or even internet pages - on a TV set as video, teletext or voice.

In the case of video and/or teletext presentation the device would have to incorporate video and/or teletext modulator and synthesiser circuitry. It will be appreciated that the automatic control device need not be incorporated in the apparatus providing the auxiliary signals (for example, as shown in Figure 2). The automatic control device and the apparatus providing the auxiliary signals for the control device could be arranged to communicate wirelessly to transfer the auxiliary signals to the automatic control device. The wireless communication could be effected using a low cost, short range, low power, relatively high frequency link such as the "Bluetooth" system.

A further application of the automatic RF control device of the present invention would involve placing the device near the antenna path, rather than in the antenna path, of the target superheterodyne receiver. This would allow remote detection of the local oscillator noise signal, thereby allowing the transmission of a signal, at a frequency to which the target receiver is currently tuned, from a remote transmitter. Figure 4 illustrates a control device 50 similar to that described with reference to Figure 1 but inductively coupled 52 to the antenna line 54.

This system could be used, for example, at night in built-up areas where loud siren noise may be undesirable, by police in cars. The police car could drive alongside a target vehicle and transmit an audio signal, interrupting their radio reception, and request them to stop their car. Alternatively, this system could be used by emergency services to request motorists, who may not have heard the approaching emergency vehicle if they had their car radio playing at a high volume, to move aside to let them through. Another use may be in car parks, where motorists about to park their vehicles could be transmitted a message, for example, warning them of the consequences of unauthorised parking, or reminding them to buy a parking voucher. Talking traffic and road signs of all kinds could employ the system, as well as road-side advertising transmitters.

Finally, any of the above-mentioned applications for the automatic RF control device of the present invention could be used in combination.

It will be appreciated that modifications can be made within the scope of the invention

**Claims**

1. A control device for using noise from a target receiver to tune an auxiliary signal to the frequency being received by the target receiver.
2. A control device according to claim 1, wherein the frequency or frequencies present in the noise are used to tune the auxiliary signal.
3. A control device according to claim 1 or 2, wherein the noise is mixed with a signal which is modulated with the auxiliary signal to produce a mixed signal.
4. A control device according to claim 3, wherein the frequencies of the modulated and noise signals are such that the mixed signal contains a component at the target receiver frequency.
5. A control device according to claim 3 or 4, wherein the frequency difference between the modulated signal and a component of the noise signal arising from an oscillator in the receiver is equal to the target receiver frequency.
6. A control device according to claim 1 or 2, wherein at least one possible reception frequency of a target receiver is deduced, the reception frequency being the frequency to which the target receiver is tuned, and the auxiliary signal is provided at said at least one deduced frequency.
7. A control device according to claim 6, wherein noise propagated by the target receiver is monitored to deduce said at least one deduced frequency.
8. A control device according to claim 7, wherein noise at the local oscillator frequency of the target receiver is detected to determine a deduced frequency.

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9. A control device according to any one of claims 6 to 8, wherein the deduced frequencies are deduced with reference to a stored list of station frequencies in the locality.
10. A control device according to claim 9, wherein the list of station frequencies is prioritised.
11. A control device according to any one of claims 1 to 10, wherein a test signal may be sent as the auxiliary signal and the noise monitored for feedback corresponding to the signal sent.
12. A control device for deducing at least one possible reception frequency of a target receiver, the reception frequency being the frequency to which the target receiver is tuned, and providing signals at said at least one deduced frequency.
13. A control device according to claim 12, wherein the said at least one possible reception frequency is deduced by scanning for broadcast signals in the locality.
14. A control device according to any preceding claim, wherein normal signals at the reception frequency may be suppressed or removed at the target receiver so that the auxiliary signal provided by the control device can be applied to the target receiver.
15. A control device according to any preceding claim, wherein the control device is arranged to receive auxiliary signals for provision to the target receiver and the control device can enter an active mode when auxiliary signals are present and a standby mode when auxiliary signals are not present.
16. A control device according to claim 15 when dependent on claim 6, wherein the control device deduces said at least one possible reception frequency in the standby mode.

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17. A control device according to any preceding claim, wherein the auxiliary signal is an RDS or DAB/TPEG signal.
18. A control device substantially as described with reference to any one of the accompanying Figures.
19. A system comprising an antenna, an antenna line for connecting the antenna to a receiver, and a control device according to any one of claims 1 to 18 in communication with the antenna line.
20. A vehicle including a system according to claim 19.
21. A telephone, navigation system, intercom system, public announcement system, item of street furniture, computer, or e-mail system including a control device according to any one of claims 1 to 18.
22. A method of providing signals for a target receiver, the method comprising the step of using noise from the target receiver to tune an auxiliary signal to the frequency being received by the target receiver.
23. A method according to claim 22, comprising using the frequency or frequencies present in the noise to tune the auxiliary signal.
24. A method according to claim 22 or 23, comprising mixing the noise with a signal which is modulated with the auxiliary signal to produce a mixed signal.
25. A method according to claim 24, wherein the frequencies of the modulated and noise signals are such that the mixed signal contains a component at the target receiver frequency.

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26. A method according to claim 24 or 25, wherein the frequency difference between the modulated signal and a component of the noise signal arising from an oscillator in the receiver is equal to the target receiver frequency.
27. A method according to claim 22 or 23, the method comprising deducing at least one possible reception frequency of the target receiver, the reception frequency being the frequency to which the target receiver is tuned, and providing the auxiliary signal at said at least one deduced frequency.
28. A method according to claim 27, wherein noise propagated by the target receiver is monitored to deduce said at least one deduced frequency.
29. A method according to claim 28, wherein noise at the local oscillator frequency of the target receiver is detected to determine a deduced frequency.
30. A method according to any one of claims 27 to 29, wherein the deduced frequencies are deduced with reference to a stored list of station frequencies in the locality.
31. A method according to claim 30, wherein the list of station frequencies is prioritised.
32. A method according to any one of claims 22 to 31, wherein a test signal is sent as the auxiliary signal and the noise is monitored for feedback corresponding to the signal sent.
33. A method for providing signals to a target receiver, comprising deducing at least one possible reception frequency of a target receiver, the reception frequency being the frequency to which the target receiver is tuned, and providing signals at said at least one deduced frequency.
34. A method according to claim 33, wherein the said at least one possible reception frequency is deduced by scanning for broadcast signals in the locality.

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35. A method according to any one of claims 22 to 34, wherein normal signals at the reception frequency are suppressed or removed at the target receiver so that signals provided by the control device can be applied to the target receiver.
36. A method according to any one of claims 22 to 35, wherein an active mode is entered when auxiliary signals are present for provision to the target receiver and a standby mode is entered when auxiliary signals are not present.
37. A method according to claim 36 when dependent on claim 27, wherein said at least one possible reception frequency of the target receiver is deduced in the standby mode.
38. A method according to any one of claims 22 to 37, wherein the auxiliary signal is an RDS or DAB/TPEG signal.
39. A method of providing signals for a target receiver substantially described with reference to any one of accompanying Figures.

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