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GAIN CONTROL OF RECEIVER BASED ON STATE OF COVERAGE AREA

REPLACED SHEETS		SG
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☒	Claim(s) : paged 11 to paged 14	
☐	Drawing(s) : paged to paged	
☐	Abstract : paged to paged	

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Field of the Invention

This invention relates to selective call receivers operating within a selective call communication system and, in particular, to a method and apparatus for controlling gain in selective call receivers, such as pagers, operating within a selective call communication system having a coverage area associated therewith.

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Background of the Invention

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Conventionally, a selective call communication system supports operation of selective call receivers, such as pagers, within a coverage area. Typically, the selective call communication system transmits paging signals which are radio frequency (rf) carriers modulated with information. These paging signals are received by the selective call receivers and amplified by radiofrequency (rf) amplifiers for subsequent processing to derive the information.

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Unfortunately, a paging signal is typically received together with noise, including undesired signals, that are close in frequency to an rf carrier of the paging signal. Consequently, both the paging signal and the noise combine to form an input signal that may saturate the rf amplifier and cause a form of signal distortion known as intermodulation (IM) distortion. Conventionally, such IM distortion is suppressed by reducing signal amplification or gain of the rf amplifier. Typically, an automatic gain control (AGC) circuit determines a gain signal for biasing the rf amplifier with an appropriate gain based on signal strength of the input signal. Comparison of the signal strength to a threshold level that is set according to characteristics of the rf amplifier enables determination of the appropriate gain to prevent the input signal from saturating the rf amplifier.

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However, conventional AGC circuits with a threshold level are not suitable in determining the gain when the coverage area has a noise level varying substantially across time and space. For example, volume of signal traffic changing across different time periods of a day, such as daytime and nighttime, also changes the noise level. Also, environmental differences within a coverage area can result in the coverage area having regions with different noise levels. In such a coverage area, paging signals are likely to have varying signal strengths for which the threshold level is ineffective unless changed. As is known in the art, an ineffective threshold level causes problems such as errors in processing or difficulties in receiving the paging signals. Furthermore, changing the threshold level or using another selective call receiver is not an economical alternative as the different noise levels may occur inconsistently. For example, adding a transmitter to the selective call communication system can subsequently affect the IM noise level in the coverage area.

Thus, a need exists for controlling gain in rf amplifiers of selective call receivers so as to effectively suppress IM distortion of paging signals received from a coverage area having different noise levels across time and space.

Summary of the Invention

It is an object of this invention to overcome or at least alleviate at least one of the problems associated with controlling gain in rf amplifiers of selective call receivers so as to effectively suppress intermodulation (IM) distortion of paging signals received from a coverage area having different noise levels across time and space.

According to one aspect of the invention, there is provided a selective call receiver for operating within a coverage area, said coverage area having different intermodulation noise levels across time or space, said selective call receiver comprising:

a receiver for receiving paging signals, said receiver having at least one radiofrequency (rf) amplifier for amplifying said paging signals;



and

a processor for processing said paging signals in accordance with at least two settings, wherein said at least two settings are determined in response to a state associated with said coverage area.

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Preferably, said paging signals can include at least one setting signal for providing said at least two settings.

Suitably, said selective call receiver can further comprise a memory for storing a plurality of settings, wherein said processor stores or updates said memory with said at least two settings.

Alternatively, said selective call receiver can further comprise a memory for storing a plurality of settings to provide said at least two settings, each of said plurality of settings having a gain indicator for indicating a gain signal to bias said rf amplifier when amplifying said paging signals.

Preferably, said memory can further store at least two state indicators, each of said at least two state indicators being associated with said at least two settings.

Suitably, said at least two state indicators can correspond to at least two time periods within said coverage area, said state being a time provided by a clock within said selective call receiver for said processor to determine one of said at least two state indicators in accordance with said at least two time periods.

Alternatively, said at least two state indicators can correspond to at least two time periods, said state being a time provided by at least one setting signal received by said selective call receiver for said processor to determine one of said at least two state indicators in accordance with said at least two time periods.

Preferably, said at least two state indicators can correspond to at least two regions within said coverage area, said state being a region of said at least two regions, wherein said selective call receiver receives at



least one setting signal for providing said region to determine one of said at least two state indicators in accordance with said at least two regions.

Alternatively, said at least two state indicators can correspond to at
5 least two regions within said coverage area, said state being a region of said at least two regions, and further wherein one of said at least two state indicators is manually selected in accordance with said at least two regions.

10 Preferably, said state can be a time, said time being provided by said paging signals and detected by said processor to determine said at least two settings from said plurality of settings.

Alternatively, said state can be a time, said time being provided by
15 at least one setting signal of said paging signals and detected by said processor to determine said at least two settings from said plurality of settings.

Suitably, said state can be a time, said time being provided by a
20 clock of said selective call receiver and detected by said processor to determine said at least two settings from said plurality of settings.

Alternatively, said state can be a region, said region being manually
25 selected from at least two regions provided by said selective call receiver for said processor to determine said at least two settings from said plurality of settings.

According to another aspect of the invention, there is provided a
30 method for controlling gain of at least one selective call receiver in a selective call communication system having a coverage area associated therewith, said method comprising the steps of:

35 determining at least two settings in response to a state associated with an intermodulation noise level within said coverage area, each of said at least two settings having a gain indicator for indicating a gain signal to bias a radio frequency amplifier when amplifying paging signals received by said at least one selective call receiver;



and

adapting said at least one selective call receiver to process said paging signals in accordance with said at least two settings.

5 Preferably, said method can further comprise the step of receiving a setting signal for providing said at least two settings, wherein said step of determining includes the step of retrieving said at least two settings from said setting signal.

10 Suitably, said method can further comprise the step of storing or updating said at least two settings in a memory.

 Preferably, said method can further comprise the step of receiving a setting signal for providing said state, wherein said step of determining
15 includes the step of retrieving said at least two settings from a memory.

 Suitably, said method can further comprise the step of detecting said state, wherein said state is a time provided by a clock of said at least one receiver, and further wherein said step of determining includes the
20 step of retrieving said at least two settings from a memory.

 Alternatively, said method can further comprise the step of detecting said state, wherein said state is a time provided by said paging signals, and further wherein said step of determining includes the step of retrieving
25 said at least two settings from a memory.

 Preferably, said method can further comprise the step of detecting said state, wherein said state is a region manually selected from at least two regions provided by said at least one receiver, and further wherein said
30 step of determining includes the step of retrieving said at least two settings from a memory.



Brief Description of the Drawings

In order to describe the invention and to put it into practical effect, reference will now be made to preferred embodiments as illustrated with
5 reference to the accompanying drawings in which:

FIG. 1 shows a block diagram of a selective call receiver in accordance with a preferred embodiment of the invention;

10 FIG. 2 shows a coverage area with different regions in which the selective call receiver of FIG. 1 operates; and

FIG. 3 shows a flow chart of a method for controlling gain in the selective call receiver of FIG. 1.

15 FIG. 4 shows a flow chart of a method for controlling gain in the selective call receiver of FIG. 1 in accordance with an alternate embodiment of the invention.

20 Detailed Description of the Invention

Disclosed herein, in accordance with a preferred embodiment of the invention, is a selective call receiver for operating within a coverage area having different intermodulation (IM) noise levels across time and space.
25 FIG. 1 shows a block diagram of the selective call receiver 1 comprising a receiver 2 for receiving paging signals via an antenna 3, a memory 4 for storing a plurality of settings, a clock 7 for providing time and a processor 5 for processing the paging signals. The receiver 2 includes at least one radiofrequency (rf) amplifier 6 for amplifying the paging signals. Each of the
30 plurality of settings includes a gain indicator for indicating a gain signal to bias the rf amplifier 6 when amplifying the paging signals.

Table 1 below shows an example of the plurality of settings stored in the memory 4 of FIG. 1. Each of the plurality of settings includes a gain
35 indicator associated with a gain signal. The gain signal associated with each gain indicator is a voltage provided by the processor 5 to bias the rf

amplifier 6 accordingly when amplifying the paging signals. Although shown as a voltage, the gain signal can also be a current.

Gain Indicator	Gain Signal (V)
V _a	0.9
V _b	0.8
V _c	0.7
V _d	0.6

Table 1

- 5 In order to determine the gain signal, the selective call receiver 1 determines two settings in response to a state associated with the coverage area. The state can be either a time or a region within the coverage area. Accordingly, Tables 2 and 3 show examples of state indicators associated with the state as a time or as a region and stored in the memory of FIG. 1. Each of the state indicators is associated with two gain indicators representing the two settings from the plurality of settings and a threshold level that is based on characteristics of the rf amplifier 6. This threshold level is used by the processor 5 for comparing with signal strength of each of the paging signals in accordance with automatic gain control techniques that are well known in the art. Accordingly, for such techniques, a respective threshold level from Tables 2 or 3 serves to determine which of the two gain indicators provide a gain signal to bias the rf amplifier 6 when amplifying the paging signals.

State Indicator	Gain Indicators	Threshold Level	State Indicator	Gain Indicators	Threshold Level
Time Period A	V _a & V _b	T ₁	Region A	V _a & V _c	T ₃
Time Period B	V _b & V _d	T ₂	Region B	V _b & V _c	T ₅
Time Period C	V _a & V _c	T ₃	Region C	V _a & V _d	T ₆
Time Period D	V _c & V _d	T ₄	Region D	V _a & V _b	T ₁

Table 2

Table 3

In Table 2, the state indicators correspond to time periods during which the coverage area has the different IM noise levels. The IM noise



levels are heuristically determined for the coverage area over time to obtain data for compiling Table 2. In Table 3, the state indicators correspond to regions within the coverage area which have the different IM noise levels. The IM noise levels are heuristically determined for the regions within the coverage area to obtain data for compiling Table 3. FIG. 2 shows a coverage area 10 having, for example, four regions 11,12,13,14. Within each region, transmitters transmit paging signals. One transmitter 15 is shown in region 11 when transmitting a paging signal 16. Although Tables 2 and 3 refer to time periods and regions separately, such tables can be compiled according to specific requirements for a selective call communication system. For example, Table 3 can also be provided with data for varying IM levels over time for each of the regions.

When the state is a time, the processor 5 detects the time with the clock 7. Alternatively, the time can be provided by a setting signal or included within the paging signals received by the receiver 2 for detection by the processor 5. Based on the time, the processor 5 then determines the two settings from one of the time periods in Table 2. Hence, if Time Period A is from 0800 hours to 1200 hours, then when the time is within these hours, gain indicators V_a and V_b corresponding to gain signals of 0.9 Volts and 0.8 Volts are selected for biasing the rf amplifier 6 in accordance with automatic gain control techniques that are well known in the art. Accordingly, for such techniques, threshold T_1 is used for comparing to signal strengths of paging signals to select either 0.9 or 0.8 Volts for biasing the rf amplifier 6.

When the state is a region, the processor 5 detects the region provided by a setting signal. Alternatively, the region can be manually selected by a user of the selective call receiver 1 in accordance with Table 3. Based on the region, the processor 5 then determines the two settings from one of the regions in Table 3. Hence, if the user is in Region B, then selecting according to Table 3 provides gain indicators V_b and V_c . From Table 1, gain signals of 0.8 Volts and 0.7 Volts corresponding to the gain indicators V_b and V_c are selected for biasing the rf amplifier 6 in accordance with automatic gain control techniques that are well known in the art. Accordingly, for such techniques, threshold T_5 is used for

comparing to signal strengths of paging signals to select either 0.8 or 0.7 Volts for biasing the rf amplifier 6.

5 In determining the two settings based on the state associated with the different IM noise levels, the invention advantageously enables effective processing of the paging signals to avoid errors in processing or difficulties in receiving the paging signals due to an ineffective threshold level. As such, the invention will appropriately bias the rf amplifier 6 to effectively suppress IM distortion when receiving paging signals from the
10 coverage area.

FIG. 3 a flow chart of a method 20 for controlling gain in the selective call receiver 1 of FIG. 1. Upon starting at step 21, the processor 5 detects the state associated with the IM noise level at step 22. The state
15 can be either time or region as shown in the examples of Table 2 and 3. In response to detection of the state, the processor 5 determines at step 23, from either Table 2 or 3, the two settings and the threshold level for biasing the rf amplifier 6 accordingly when amplifying paging signals. At step 24, the two settings are retrieved from the memory 4. Finally, at step 25, the
20 processor 5 adapts the selective call receiver 1 to process the paging signals received subsequently in accordance with the two settings and using automatic gain control techniques that are well known in the art.

FIG. 4 shows a flow chart of a method 30 for controlling gain in the selective call receiver 1 of FIG. 1 in accordance with an alternate
25 embodiment of the invention. Upon starting at step 31, the selective call receiver 1 receives a paging signal at step 32. The processor 5 checks whether the paging signal is a setting signal at step 33. For a paging signal that is not a setting signal, the method 30 proceeds to step 34 for normal processing. For a setting signal, the method 30 proceeds to step 35 to
30 determine the two settings and the threshold level for biasing the rf amplifier 6 accordingly when amplifying paging signals. Next, at step 36, the processor 5 checks whether the setting signal provides the two settings and the threshold level or the state. When the state is provided by the setting signal, the processor 5 proceeds to step 37 to retrieve the two
35 settings and the threshold level from the memory 4 in accordance with Table 1 and Tables 2 or 3. Alternatively, when the two settings and the

threshold level are provided by the setting signal, the processor 5 proceeds to step 38 to retrieve the two settings and the threshold level from the setting signal and, subsequently, to step 39 to either store or update the memory 4. Following either step 37 or step 39, the processor 5 adapts the selective call receiver 1 to process paging signals received subsequently in accordance with the two settings.

Advantageously, the invention enables the gain signal to be provided for biasing the rf amplifier 6 in response to the state of the coverage area and, therefore, adapts the selective call receiver 1 to operate to different IM noise levels accordingly. In the methods 20,30, the invention determines the two settings from the memory 4 or from the setting signal. With the two settings, an appropriate gain for the rf amplifier 6 can be determined using an appropriate threshold level to effectively suppress IM distortion of paging signals received from the coverage area having the different IM noise levels across time and space.



Claims

1. A selective call receiver for operating within a coverage area,
said coverage area having different intermodulation noise levels across
5 time or space, said selective call receiver comprising:

a receiver for receiving paging signals, said receiver having at least
one radiofrequency (rf) amplifier for amplifying said paging signals;
and

10 a processor for processing said paging signals in accordance with
at least two settings, wherein said at least two settings are determined
in response to a state associated with said coverage area.

2. The selective call receiver of Claim 1, wherein said paging
15 signals include at least one setting signal for providing said at least two
settings.

3. The selective call receiver of Claim 2, wherein said selective call
receiver further comprises a memory for storing a plurality of settings, and
20 further wherein said processor stores or updates said memory with said at
least two settings.

4. The selective call receiver of Claim 1, wherein said selective call
receiver further comprises a memory for storing a plurality of settings to
25 provide said at least two settings, each of said plurality of settings having a
gain indicator for indicating a gain signal to bias said rf amplifier when
amplifying said paging signals.

5. The selective call receiver of Claim 4, wherein said memory
30 further stores at least two state indicators, each of said at least two state
indicators being associated with said at least two settings.

6. The selective call receiver of Claim 5, wherein said at least two
state indicators correspond to at least two time periods within said
35 coverage area, said state being a time provided by a clock within said
selective call receiver for said processor to determine one of said at least
two state indicators in accordance with said at least two time periods.





7. The selective call receiver of Claim 5, wherein said at least two state indicators correspond to at least two time periods, said state being a time provided by at least one setting signal received by said selective call receiver for said processor to determine one of said at least two state indicators in accordance with said at least two time periods.

8. The selective call receiver of Claim 5, wherein said at least two state indicators correspond to at least two regions within said coverage area, said state being a region of said at least two regions, and further wherein said selective call receiver receives at least one setting signal for providing said region to determine one of said at least two state indicators in accordance with said at least two regions.

9. The selective call receiver of Claim 5, wherein said at least two state indicators correspond to at least two regions within said coverage area, said state being a region of said at least two regions, and further wherein one of said at least two state indicators is manually selected in accordance with said at least two regions.

10. The selective call receiver of Claim 4, wherein said state is a time, said time being provided by said paging signals and detected by said processor to determine said at least two settings from said plurality of settings.

11. The selective call receiver of Claim 4, wherein said state is a time, said time being provided by at least one setting signal of said paging signals and detected by said processor to determine said at least two settings from said plurality of settings.

12. The selective call receiver of Claim 4, wherein said state is a time, said time being provided by a clock of said selective call receiver and detected by said processor to determine said at least two settings from said plurality of settings.





13. The selective call receiver of Claim 4, wherein said state is a region, said region being manually selected from at least two regions provided by said selective call receiver for said processor to determine said at least two settings from said plurality of settings.

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14. A method for controlling gain of at least one selective call receiver in a selective call communication system having a coverage area associated therewith, said method comprising the steps of:

10 determining at least two settings in response to a state associated with an intermodulation noise level within said coverage area, each of said at least two settings having a gain indicator for indicating a gain signal to bias a radio frequency amplifier when amplifying paging signals received by said at least one selective
15 call receiver;
and
adapting said at least one selective call receiver to process said paging signals in accordance with said at least two settings.

20 15. The method of Claim 14 and further comprising the step of: receiving a setting signal for providing said at least two settings, wherein said step of determining includes the step of retrieving said at least two settings from said setting signal.

25 16. The method of Claim 15 and further comprising the step of: storing or updating said at least two settings in a memory.

30 17. The method of Claim 14 and further comprising the step of: receiving a setting signal for providing said state, wherein said step of determining includes the step of retrieving said at least two settings from a memory.

35 18. The method of Claim 14 and further comprising the step of: detecting said state, wherein said state is a time provided by a clock of said at least one receiver, and further wherein said step of determining includes the step of retrieving said at least two settings from a memory.





19. The method of Claim 14 and further comprising the step of:
detecting said state, wherein said state is a time provided by said paging
signals, and further wherein said step of determining includes the step of
retrieving said at least two settings from a memory.

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20. The method of Claim 14 and further comprising the step of:
detecting said state, wherein said state is a region manually selected from
at least two regions provided by said at least one receiver, and further
wherein said step of determining includes the step of retrieving said at
least two settings from a memory.

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21. A selective call receiver comprising a receiver and a processor
substantially as described herein with reference to and as illustrated by
the accompanying drawings.

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22. A method for controlling gain of at least one selective call
receiver substantially as described herein with reference to and as
illustrated by the accompanying drawings.

