

Measuring antenna signal strength with automatic gain control receiver.

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Field of the invention

The present invention relates to an arrangement for measuring an antenna signal strength comprising:

- 5 • a first amplifier section for receiving an antenna signal, for providing a first output signal and being provided with a first automatic gain control stage with a first attenuation factor controlled by a first automatic gain control signal;
- a second amplifier section for receiving a first input signal derived from said first output signal, for providing a second output signal and being provided with a second automatic
- 10 gain control stage with a second attenuation factor controlled by a second automatic gain control signal;
- automatic gain control means arranged to receive a second input signal derived from the second output signal and to generate said first and second automatic gain control signals in dependence on the second output signal;
- 15 the arrangement being arranged such that:
- for values of said antenna signal below a predetermined threshold level only said second automatic gain control stage may be active with increasing second attenuation factor with increasing values of the antenna signal;
- for values of said antenna signal above said predetermined threshold level said first
- 20 automatic gain control stage is active with increasing first attenuation factor with increasing values of the antenna signal.

Description of the prior art

25 Such an arrangement is known from US-A-4,403,346. The arrangement known from this prior art document will be illustrated with reference to figure 1 which is also presented as figure 7 in that document.

Figure 1 shows an automatic gain control (AGC) circuit for a wide band tuner as used in television systems. An antenna (not shown) receives a signal and generates an



output signal ANT INPUT applied to a first AGC stage 2. The output of the first AGC stage 2 is sent to an UHF/VHF RF circuit 40. Typically, the UHF/VHF RF circuit will comprise three parallel circuit, two for two different VHF frequency bands and one for one UHF frequency band. Instead of three different bands one band may also be applied depending on the application concerned.

The output of the RF circuit is connected to the input of an UHF/VHF selection switch 7. The selection switch comprises an U/V switch 7a and a second AGC stage 7B in series. The output of the selection switch 7 is fed to two superheterodyne sections which are not shown in figure 1. Superheterodyne sections and the way they operate are known to persons skilled in the art and need no further explanation here. The output of the second superheterodyne section is a demodulated picture signal. Moreover, the second superheterodyne section generates an AGC control voltage V_{AGC} which is an input to an AGC signal source 50.

The AGC signal source 50 comprises a differential amplifier A50 and an inverting amplifier A52. The input of the inverting amplifier A52 is connected to the inverting input of the differential amplifier A52. The non-inverting input of the differential amplifier A50 is connected to a node E50 which is connected to the AGC control voltage V_{AGC} through a resistor R50. Node E50 is also connected to the input of inverting amplifier A52 and to the anode of a diode D50. The cathode of diode D50 is connected to a slider of a trimmer resistor VR50, one side of which is connected to a power supply voltage and the other side of which is connected to ground.

The connection point between resistor R52 and the inverting amplifier A52 is called E52 and is also connected to the anode of a diode D52. The cathode of the diode D52 is connected to a slider of a trimmer resistor VR52, one side of which is connected to the power supply voltage and the other side of which is connected to ground.

When the voltage on node E50 is above a threshold voltage V_{TH1} diode D50 will conduct. Below this value diode D50 will be blocked. When the voltage on node E52 is above a threshold voltage V_{TH2} diode D52 will conduct. Below this value diode D52 will be blocked. The trimmer resistors are set such that $V_{TH1} > V_{TH2}$.

The output voltage of differential amplifier A50 is used as AGC control signal V_{AGC1} for the first AGC stage 2. The output voltage of inverting amplifier A52 is used as AGC control signal V28 for the second AGC stage 7B.

Now, the operation of the arrangement of figure 1 will be explained with reference to figures 2 and 3 which are identical to figures 8 and 9, respectively, of US-A-



4,403,346. As shown in figure 2, as long as V_{AGC} is below V_{TH2} neither diode D50 nor diode D52 is conducting. Then, V_{AGC2} (input voltage of inverting amplifier A52) shows a linear relationship with V_{AGC} . Since almost no voltage difference will be present between the differential inputs of differential amplifier A50 V_{AGC1} will be substantially equal to 0 V.

5 When V_{AGC} exceeds threshold voltage V_{TH2} diode D52 starts conducting and the input voltage V_{AGC2} of inverting amplifier A52 remains fixed at a predetermined level P2. However, from that moment onwards a current flows through resistor R52 and a voltage difference will be build up between the inputs of differential amplifier A50. Then, V_{AGC1} shows a linear relationship with V_{AGC} .

10 However, upon V_{AGC} exceeding threshold level V_{TH1} diode D50 starts conducting resulting in node E50 remaining at a fixed voltage. Therefore, for V_{AGC} values above V_{TH1} the value of V_{AGC1} remains fixed at a predetermined level P1.

Figure 3 shows the total gain of the tuner including components 2, 40, 7 in dependence on the value of control voltage V_{AGC} . The first AGC stage 2 and the second AGC stage 7B are both implemented in such a way that their respective gains are at maximum when their AGC control voltages V_{AGC1} and V_{AGC2} , respectively, equal 0 V and their gains can only decrease with increasing values of AGC control voltages V_{AGC1} and V_{AGC2} , respectively.

As long as V_{AGC} is below a predetermined threshold value V_{TH0} ($V_{TH0} < V_{TH2}$) both AGC stages 2, 7B show maximum gains and the total tuner gain is G_0 . When V_{AGC} exceeds threshold voltage V_{TH0} the second AGC stage 7B starts to show a linearly decreasing gain relation with increasing values of V_{AGC} until V_{AGC} reaches threshold V_{TH2} . From that moment onwards, V_{AGC2} remains fixed and the attenuation factor of the second AGC stage 7B remains fixed. Moreover, from that moment onwards, V_{AGC1} starts to show an increasing linear relation with V_{AGC} (figure 2) and the first AGC stage 2 starts to show a linearly decreasing gain relation with increasing V_{AGC} . When V_{AGC} exceeds threshold V_{TH1} also control voltage V_{AGC1} remains fixed (see figure 2). So, for values of V_{AGC} above V_{TH1} both AGC stages 2, 7B remain at a fixed attenuation level. The total tuner gain will then remain fixed at a predetermined value of G_1 .

30 Since the attenuation of the first AGC stage 2 only starts after the attenuation of the second AGC stage 7B has reached its maximum the concept of AGC shown in figures 1, 2 and 3 is also known as "delayed AGC".

As described above, the signal V_{AGC} is generated by the superheterodyne section (not shown) that outputs the demodulated picture signal. Thus, essentially, the first



and second AGC stages 2, 7B in the prior art according to figure 1 are controlled by the output of the arrangement itself. In practice, the value of threshold V_{TH0} (figure 3) is determined by a reference voltage with which the demodulated picture signal is compared. The thresholds V_{TH1} and V_{TH2} are determined by the settings of the sliders of variable resistors VR50 and VR52. These settings are made in the factory where the tuners are made and will, normally, not be accessible to buyers of the tuners.

Summary of the invention

10 The object of the present invention is to provide a tuner arrangement arranged to measure and possibly display the strength of the antenna signal supplied to the tuner arrangement.

 This object is obtained by an arrangement as defined at the outset, wherein a processor is provided arranged to calculate said antenna signal strength in accordance with the following steps:

- (a) establishing whether or not said first automatic gain control stage is active;
- (b) if said first automatic gain control stage is active, increasing said predetermined threshold level to a first new threshold level such that this first new threshold level is equal to said antenna signal strength and the first automatic gain control stage starts to become inactive, and calculating said antenna signal strength as being equal to said first new threshold level;
- (c) if said first automatic gain control stage is inactive, decreasing said predetermined threshold level to a second new threshold level such that this second new threshold level is equal to said antenna signal strength and the first automatic gain control stage starts to become active, and calculating said antenna signal strength as being equal to said second new threshold level.

 By such an arrangement the antenna signal strength can be measured which can be used to align an (outdoor) antenna connected to the arrangement to maximum signal strength reception. This is especially advantageous in those areas where outdoor antennas are used, like in developing countries.

 Such an arrangement can also be used to select a channel having the strongest signal strength of a certain transmitted program. Moreover, signal strengths of channels adjacent to an actual channel can be measured in this way. Then, V_{TH2} can be varied to



counteract intermodulation from the adjacent channels and to obtain an optimum signal-to-noise ratio based on channel frequency and signal strength of adjacent channels.

In an alternative embodiment, the present invention relates to an arrangement for measuring an antenna signal strength comprising:

- 5 • a first amplifier section for receiving an antenna signal, for providing a first output signal and being provided with a first automatic gain control stage with a first attenuation factor controlled by a first automatic gain control signal;
- a second amplifier section for receiving a first input signal derived from said first output signal, for providing a second output signal and being provided with a second automatic gain control stage with a second attenuation factor controlled by a second automatic gain control signal;
- 10 • automatic gain control means arranged to receive a second input signal derived from the second output signal and to generate said first and second automatic gain control signals in dependence on the second output signal;
- 15 the arrangement being arranged such that:
 - for values of said antenna signal below a predetermined threshold level only said second automatic gain control stage may be active with increasing second attenuation factor with increasing values of the antenna signal;
 - for values of said antenna signal above said predetermined threshold level said first automatic gain control stage is active with increasing first attenuation factor with increasing values of the antenna signal;
- 20

wherein a processor is provided arranged to calculate said antenna signal strength in accordance with the following steps:

- (a) establishing whether or not said first automatic gain control stage is active;
- 25 (b) if said first automatic gain control stage is active, increasing said predetermined threshold level to a first new threshold level such that this first new threshold level is equal to said antenna signal strength and the first automatic gain control stage starts to become inactive, and calculating said antenna signal strength as being equal to said first new threshold level; if said predetermined threshold level cannot be increased to said first new threshold level but only to a predetermined maximum level, then, calculating said antenna signal strength as being larger than said predetermined maximum level;
- 30 (c) if said first automatic gain control stage is inactive, decreasing said predetermined threshold level to a second new threshold level such that this second new threshold



level is equal to said antenna signal strength and the first automatic gain control stage starts to become active, and calculating said antenna signal strength as being equal to said second new threshold level; if said predetermined threshold level cannot be decreased to said second new threshold level but only to a predetermined minimum level, then, calculating said antenna signal strength as being smaller than
5 said predetermined minimum level.

This alternative embodiment has, essentially, the same functionality as the first mentioned embodiment, however, here it is taken into account that shifting of the
10 predetermined threshold towards the actual value of the antenna signal strength may actually not be possible, and only either an upper limit or lower limit of the actual antenna signal strength can be calculated.

Further embodiments of the inventive arrangement are claimed in dependent claims.

15 Moreover, the invention relates to methods as claimed in independent claims 8 and 9. The invention also relates to computer program products having instructions for carrying out essential steps of the invention as claimed in independent claims 10 and 12, and to computer readable mediums provided with such computer program products as claimed in claims 11 and 13.

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Brief description of the drawings

The present invention will be illustrated with reference to some drawings which are intended to illustrate the invention and not to limit its scope. The scope of the
25 present invention is only limited by the annexed claims.

Figure 1 shows a tuner arrangement according to the prior art;

Figures 2 and 3 show some diagrams to explain the operation of the prior art arrangement of figure 1;

Figure 4 shows a block diagram of the arrangement according to the invention;

30 Figure 5 shows an example of an implementation of a comparator used in the arrangement according to figure 4;

Figures 6 through 9 show diagrams for illustrating the operation of the arrangement according to figure 4.



Figure 10 is a flow diagram illustrating a method to measure the strength of the antenna signal supplied to the arrangement of figure 4;

Figure 11 shows an alternative embodiment of the invention.

5 Description of preferred embodiments

The content of figures 1, 2 and 3 has been explained above.

It is observed that the invention will be illustrated with reference to a television receiver but that the principles of the invention are equally applicable in radio
10 receivers and any other kind of wideband AGC controlled receivers.

Figure 4 shows an antenna 1 for receiving a television signal. The antenna supplies a signal X to RF amplifier 3. Actually, the RF amplifier 3 may comprise the circuits 2 (first AGC stage), 40 (UHF/VHF RF circuit) and 7A (U/V switch) of the prior art arrangement shown in figure 1. The RF amplifier 3 receives an AGC control signal $V_{RF\ AGC}$
15 from an AGC control circuit 12.

The output of RF amplifier 3 is connected to a mixer/oscillator circuit 4. The mixer/oscillator circuit may be designed in any way known to persons skilled in the art and its function is to convert a selected channel frequency to a fixed intermediate frequency (IF) by mixing the received RF signal with a locally generated oscillator frequency. The output
20 signal Y of the mixer/oscillator circuit 4 has this intermediate frequency and has an amplitude which depends on the amplitude of signal X and the gain of RF amplifier 3.

The output of the mixer/oscillator circuit 4 is connected to a SAW (Surface Acoustic Wave) filter 6. SAW filters are known to persons skilled in the art and any type of suitable SAW filter can be used. Its function is to operate as a band pass filter. Instead of a
25 SAW filter an other band pass filter may be used.

The output of SAW filter 6 is connected to an IF amplifier 8. The IF amplifier has a further input for receiving an AGC control signal $V_{IF\ AGC}$ from the AGC control circuit 12. Thus, like the arrangement of figure 1, the arrangement of figure 4 is provided with a delayed AGC. Note, however, that the second AGC stage is not provided before the
30 mixer/oscillator circuit like in figure 1 but after the mixer/oscillator circuit. Thus, in figure 4, the second AGC stage is in the IF domain. However, the concept of delayed AGC is, in principle, the same.

The output of the IF amplifier 8 is connected to a video detector 10 which generates a baseband video signal at its output. The video detector 10 has a further output



connected to the AGC control circuit. This further output provides a feedback signal from which the AGC control circuit can derive suitable values for the AGC control signals $V_{RF\ AGC}$ and $V_{IF\ AGC}$. This feedback signal will usually be related to the level of the video signal. For instance, as indicated to in figure 4, the top sync level signal $V_{sync, top}$ may be used as
5 feedback signal, as is known to persons skilled in the art.

The AGC control signal $V_{RF\ AGC}$ is also supplied to an analog-to-digital converter (ADC) 14. The output of the ADC 14 is connected to a microprocessor 16. The microprocessor 16 is connected to a non-volatile memory 20. Preferably, the microprocessor 16 is also connected to a display unit 22. Display unit 22 may be the cathode ray tube of the
10 television. The microprocessor 16 has an output connected to a digital-to-analog converter (DAC) 18. The output of the DAC 18 provides a reference signal V_{REF} to the AGC control circuit 12.

Figure 5 schematically shows one embodiment of the AGC control circuit 12. The circuit 12 comprises a comparator 24 having two inputs for receiving the signals $V_{sync, top}$ and V_{REF} , respectively. The comparator 24 has two outputs for providing the AGC signals
15 $V_{RF\ AGC}$ and $V_{IF\ AGC}$, respectively. The output providing $V_{RF\ AGC}$ is connected to a node Z which is the connection point of two resistors R1, R2. The other side of resistor R1 is connected to the power supply voltage V and the other side of resistor R2 is connected to ground. In operation a current i may flow from node Z to the comparator 24.

20 Now the operation of the circuit according to figures 4 and 5 will be explained with reference to figures 6 through 9. Figures 6 through 9 are only intended to illustrate the operation of the first AGC stage in the RF amplifier 3 and how this can be used to measure the strength of the antenna signal X at the input of RF amplifier 3. The second AGC stage in the IF amplifier 8, as controlled by AGC signal $V_{IF\ AGC}$ operates like the second AGC stage
25 7B in figure 1. I.e., as long as the strength of antenna signal X is below a predetermined threshold (corresponding to V_{TH0} in figure 3) neither the first nor the second AGC stages will be active. In other words, for very small signal values of X both AGC stages will have an attenuation value of substantially 0 dB. It is assumed that, then, the total amplification of the RF amplifier 3 and the mixer/oscillator 4 is 45 dB/ μ V. When X exceeds that predetermined
30 level the second AGC stage in the IF amplifier 8 becomes active and starts to attenuate the signal received at its input. When X exceeds a second threshold value (corresponding to V_{TH2} in figure 3) the second AGC in the IF amplifier 8 stops increasing its attenuation and keeps a fixed attenuation factor. From that moment onwards, the first AGC starts to increase its



attenuation factor. As explained above, this second threshold value is the "take-over-point". An often used value for X at this turn-over-point is $60 \text{ dB}/\mu\text{V}$.

It is assumed that AGC control voltage $V_{\text{RF AGC}}$ is maximum as long as the first AGC stage in RF amplifier 3 is inactive and that, then, $i = 0 \text{ mA}$. Further assuming that all current from the power supply voltage V in the AGC control circuit 12, figure 5, is, then, flowing only through $R1$ and $R2$ and that $R1 = 4.7 \text{ k}\Omega$ and $R2 = 39 \text{ k}\Omega$, renders $V_{\text{RF AGC}} = 4.46 \text{ V}$ for small values of X . This is shown in figure 6 which shows $V_{\text{RF AGC}}$ as a function of X .

At the take-over-point, indicated by M in figure 6, due to changing input impedance of the RF amplifier 3 for $V_{\text{RF AGC}}$ or changing output impedance of the comparator 24, the value of $V_{\text{RF AGC}}$ falls slightly to a lower value V_N indicated by N in figure 6. V_N may, e.g., be 4.2 V . Preferably, the RF amplifier 3 is arranged that it has a maximum gain for $V_{\text{RF AGC}} > 4 \text{ V}$. The clear jump in the curve of figure 6 supports a reliable detection of the turn-over-point TOP.

After the take-over-point $V_{\text{RF AGC}}$ decreases linearly with increasing value of X until the gain reduction of RF amplifier 3 reaches its maximum value. This latter point corresponds to $X = 90 \text{ dB}/\mu\text{V}$ in figure 6. The first AGC stage in the RF amplifier 3 is arranged to show a linear increasing attenuation with decreasing values of $V_{\text{RF AGC}}$. Therefore, the IF signal strength of Y after the mixer/oscillator 4 is related to X as shown in figure 7.

For instance, when $X = 20 \text{ dB}/\mu\text{V}$ the AGC stage in RF amplifier 3 is inactive and $Y = 20 + 45 \text{ dB}/\mu\text{V} = 65 \text{ dB}/\mu\text{V}$. Until $X = 60 \text{ dB}/\mu\text{V}$ (the take-over-point), Y follows from $Y = X + 45 \text{ dB}/\mu\text{V}$. After the take-over-point, the AGC stage in the RF amplifier will function to neutralize any increase in X such that Y remains substantially the same, as shown in figure 7. A slight increase of Y with increasing X would, then, also be allowable.

At the take-over-point, the second AGC stage in the IF amplifier 8 stops further increasing its attenuation and any increase of X would, without the first AGC stage in RF amplifier 3 being active, further increase the top level of the sync signal in the video detector 10. This would result in a higher value of $V_{\text{sync, top}}$. However, comparator 24 in AGC control circuit 12 compares $V_{\text{sync, top}}$ with V_{REF} and, then, starts to drain current i from node Z to its output, in a way as shown in figure 8. By increasing i , the current through resistor $R1$ increases, resulting in a decreasing voltage at node Z and thus decreasing value of $V_{\text{RF AGC}}$, as shown in figures 8 and 6, respectively. For values of $X \geq 90 \text{ dB}/\mu\text{V}$ $V_{\text{RF AGC}}$ will be $\leq 1 \text{ V}$ and no further increasing attenuation by the first AGC stage in RF amplifier 3 will be possible.



Current i from node Z to the comparator 24 will reach its maximum value when $X = 90$ dB/ μ V. However, since the attenuation by the first AGC stage in RF amplifier 3 substantially compensates any increase in the value of X for $X \geq 60$ dB/ μ V the value of Y will remain substantially the same. So, as shown in figure 9, current i may vary substantially without
 5 substantial change in Y for $60 \text{ dB}/\mu\text{V} \leq X \leq 90 \text{ dB}/\mu\text{V}$.

Now, it will be explained how the value of $V_{\text{RF AGC}}$ may be used to measure the value of X .

The microprocessor 16, in use, generates a digital signal which is converted by DAC 18 into reference voltage V_{REF} . In the non-measuring mode of the arrangement V_{REF} is
 10 fixed and corresponds to the take-over-point of $X = 60 \text{ dB}/\mu\text{V}$, or $Y = 105 \text{ dB}/\mu\text{V}$. However, in accordance with the invention, the microprocessor is also arranged to operate in a measuring mode, the program for which is preferably stored in non-volatile memory 20 (it may also be stored in another type of memory not shown). The microprocessor controlled by that program is able to change the value of V_{REF} in m_{max} steps.

15 The arrangement is calibrated such that when Y reaches $105 \text{ dB}/\mu\text{V}$ the value of V_{REF} corresponds to a predetermined step number n_T , where $0 \leq n_T \leq m_{\text{max}}$. For instance, $n_T = 32$ and $m_{\text{max}} = 64$. The value of n_T is stored in memory 20. This calibrating is preferably done during manufacturing of the arrangement. This can, e.g., be carried out by applying a signal of $105 \text{ dB}/\mu\text{V}$ at point Y into the arrangement and disconnected antenna 1.

20 Figure 10 illustrates the program steps carried out by microprocessor 16 for calculating the value of X .

After the start, step 100, microprocessor reads n_T from memory 20, step 102. In step 104, a parameter m is defined and made equal to n_T .

In step 106, the microprocessor checks the value of $V_{\text{RF AGC}}$ as received through ADC 14. If
 25 $V_{\text{RF AGC}} \leq V_N$ (V_N corresponds to the take-over-point), the program jumps to step 108; otherwise it jumps to step 120.

If the program jumps to step 108 this means that the first AGC stage in RF amplifier 3 is active and that $X \geq 60 \text{ dB}/\mu\text{V}$ (figure 6). In step 108, m is made 1 step smaller. In step 110, microprocessor 16 checks if the new value of $m = 0$. If the new value of $m = 0$,
 30 meaning that m cannot be further decreased, the program continues with step 118. If not, the program continues with step 112. In step 112, the microprocessor changes the value of V_{REF} such that the take-over-point N changes to a higher value of X .



In step 114, the program checks whether $V_{RF\ AGC} > V_N$. If so, this is an indication that X now equals this new take-over-point. Consequently, X may be calculated from the following equation:

$$X = [TOP + (n_T - m) \times Ss] \text{ dB}/\mu\text{V} \quad (1)$$

as shown in step 116. In the equation above, "TOP" denotes the original take-over-point which in the present example is 60 dB/ μ V, and "Ss" denotes the value of a predetermined step size parameter corresponding to one step of change in V_{REF} and, in this example, being equal to 0.75.

If, in step 114, it is established that $V_{RF\ AGC}$ is still $\leq V_N$ steps 108 through 114 are repeated as many times as needed to change the take-over-point towards the actual value of X. Steps 108 through 114 are only left at step 110 if it appears that $m = 0$. Then, the take-over-point cannot be increased anymore. This is a safety measure for large values of X. The only thing that can be calculated is:

$$X > [TOP + n_T \times Ss] \text{ dB}/\mu\text{V} \quad (2)$$

which corresponds to $X > 84 \text{ dB}/\mu\text{V}$ for $TOP = 60$, $n_T = 32$ and $Ss = 0.75$.

When, in step 106, it was established that $V_{RF\ AGC} > V_N$ this means that the first AGC stage is inactive and $X < 60 \text{ dB}/\mu\text{V}$ (take-over-point TOP). The program jumps to step 120 where m is made 1 step larger. In step 122, it is checked whether m exceeds a predetermined maximum value m_{max} . If so, the value of m cannot be increased anymore and the program jumps to step 128.

If $m < m_{max}$ the program jumps to step 124 where it makes the microprocessor change V_{REF} by one step in such a way that the take-over-point TOP is decreased by one step towards the actual value of X. As soon as the amended value of TOP reaches the actual value X the first AGC stage in RF amplifier 3 will become active which is checked in step 126. Step 126 checks this by establishing whether or not $V_{RF\ AGC}$ falls below the value of V_N .

If the answer to the test in step 126 is positive this means that the take-over-point has been decreased such that X equals the new take-over-point. Then, X can be calculated by equation (1) as presented in step 116.

If, however, the answer to the test in step 126 is negative the program continues increasing m by one step by jumping back to step 120. Steps 120 through 126 are



repeated as many times as is necessary to change the take-over-point such that it equals the actual value of X. Again there is a safety measure by checking whether or not $m = m_{\max}$ in step 122. If so, the program jumps to step 128. Then, the only thing that can be established is that:

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$$X < [\text{TOP} - (m_{\max} - n_T) \times Ss] \text{ dB}/\mu\text{V} \quad (3)$$

which equals $X < 36 \text{ dB}/\mu\text{V}$ for $\text{TOP} = 60$, $n_T = 32$ and $m_{\max} = 64$.

After steps 116, 118, and 128 the program will jump to its end, step 130.

- 10 The program illustrated above allows X to be accurately measured in an interval of 36 to 84 dB/ μ V for $\text{TOP} = 60$, $n_T = 32$ and $m_{\max} = 64$. It is to be understood that by selecting other values for these parameters other intervals can be covered as well.

- In figure 10, in steps 108, 120 it is illustrated that the microprocessor changes m one step by one step. However, in an alternative embodiment m may be changed by
 15 another step value, for instance 5, until it is detected that the first AGC stage has become active or inactive (i.e., the turn-over-point has been exceeded), respectively, and then, while changing the direction of amending m, changing m with a smaller step value, for instance 1, for fine adjustment. This increases the speed of measurement.

- The microprocessor after having calculated the value of X in the way
 20 described above preferably outputs this value of X to a user, e.g., through the television screen 22. This may be done during a predetermined time interval and may also be repeated after a predetermined other time interval.

- Above, an embodiment of an arrangement for measuring the antenna signal strength as supplied to a receiver/tuner arrangement has been described. As may be evident to
 25 persons skilled in the art, the circuit diagrams are not presented as limiting the scope of the present invention. For instance, the AGC control circuit 12 is shown as an analog circuit. However, its functionality may be implemented by digital circuits. Alternatively, it may be implemented as a distinct microprocessor unit. It may even be combined with the microprocessor unit 16 into a microprocessor 16', as shown in figure 11. Then, the
 30 microprocessor unit 16' directly receives the $V_{\text{sync, top}}$ signal through an analog-digital-converter 26. Moreover, then, the microprocessor 16' converts calculated digital automatic gain control signals into analog automatic gain control signals $V_{\text{RF AGC}}$ and $V_{\text{IF AGC}}$ through two digital-analog-converters 30, 32. Microprocessor 16' is then arranged to provide the

functionality of both the automatic gain control circuit 12 and the microprocessor 16 as explained above.

Moreover, it is envisaged that in future systems also other circuit blocks may be implemented in digital form, e.g., in one microprocessor only. Then, the AGC signals $V_{RF\ AGC}$ and $V_{IF\ AGC}$ may also be digital signals.

In a further alternative embodiment, the current i towards the comparator 24 may be measured instead of automatic gain control signal $V_{RF\ AGC}$, and supplied to the microprocessor 16. As is evident from figure 8, also the value of current i is an indication whether or not the first automatic gain control stage in RF amplifier 3 is active and can be used to detect when the new turn-over-point has reached the actual value of antenna signal X .

As is evident to persons skilled in the art the microprocessor 16, 16' will be controlled by a computer program provided with suitable instructions. Such a program may be loaded into, e.g., the non-volatile memory 20 from a computer readable medium like a diskette or a CDROM, or may be downloaded through, e.g., the Internet. To that end, the microprocessor 16, 16' will be connected to suitable interface means not shown.

In short, the present invention is related to arrangements and methods for measuring an antenna signal strength (X), the arrangement having:

- a first amplifier section (3) for receiving an antenna signal and having a first automatic gain control stage;
- a second amplifier section (8) having a second automatic gain control stage;
- automatic gain control means (12; 16') for generating automatic gain control signals ($V_{RF\ AGC}$, $V_{IF\ AGC}$) for the first and second amplifier sections in accordance with a delayed automatic gain control scheme with a take-over-point; to measure the antenna signal strength, the take-over-point is automatically shifted towards the actual antenna signal strength.

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CLAIMS:

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1. An arrangement for measuring an antenna signal strength (X) comprising:
 - a first amplifier section (3) for receiving an antenna signal, for providing a first output signal and being provided with a first automatic gain control stage with a first attenuation factor controlled by a first automatic gain control signal ($V_{RF\ AGC}$);
 - 5 • a second amplifier section (8) for receiving a first input signal derived from said first output signal, for providing a second output signal and being provided with a second automatic gain control stage with a second attenuation factor controlled by a second automatic gain control signal ($V_{IF\ AGC}$);
 - automatic gain control means (12; 16') arranged to receive a second input signal ($V_{sync, top}$)
10 derived from the second output signal and to generate said first and second automatic gain control signals ($V_{RF\ AGC}$, $V_{IF\ AGC}$) in dependence on the second output signal ($V_{sync, top}$);the arrangement being arranged such that:
 - for values of said antenna signal below a predetermined threshold level (TOP) only said
15 second automatic gain control stage may be active with increasing second attenuation factor with increasing values of the antenna signal;
 - for values of said antenna signal above said predetermined threshold level (TOP) said first automatic gain control stage is active with increasing first attenuation factor with increasing values of the antenna signal;
- 20 wherein a processor (16; 16') is provided arranged to calculate said antenna signal strength (X) in accordance with the following steps:
 - establishing whether or not said first automatic gain control stage is active;
 - if said first automatic gain control stage is active, increasing said predetermined threshold level (TOP) to a first new threshold level such that this first new threshold level is equal
25 to said antenna signal strength (X) and the first automatic gain control stage starts to become inactive, and calculating said antenna signal strength as being equal to said first new threshold level;
 - if said first automatic gain control stage is inactive, decreasing said predetermined threshold level (TOP) to a second new threshold level such that this second new threshold



level is equal to said antenna signal strength (X) and the first automatic gain control stage starts to become active, and calculating said antenna signal strength as being equal to said second new threshold level.

- 5 2. An arrangement for measuring an antenna signal strength (X) comprising:
- a first amplifier section (3) for receiving an antenna signal, for providing a first output signal and being provided with a first automatic gain control stage with a first attenuation factor controlled by a first automatic gain control signal ($V_{RF\ AGC}$);
 - a second amplifier section (8) for receiving a first input signal derived from said first
10 output signal, for providing a second output signal and being provided with a second automatic gain control stage with a second attenuation factor controlled by a second automatic gain control signal ($V_{IF\ AGC}$);
 - automatic gain control means (12; 16') arranged to receive a second input signal ($V_{sync, top}$)
15 derived from the second output signal and to generate said first and second automatic gain control signals ($V_{RF\ AGC}$, $V_{IF\ AGC}$) in dependence on the second output signal ($V_{sync, top}$);

the arrangement being arranged such that:

- for values of said antenna signal below a predetermined threshold level (TOP) only said
20 second automatic gain control stage may be active with increasing second attenuation factor with increasing values of the antenna signal;
- for values of said antenna signal above said predetermined threshold level (TOP) said first automatic gain control stage is active with increasing first attenuation factor with increasing values of the antenna signal;

wherein a processor (16; 16') is provided arranged to calculate said antenna signal strength
25 (X) in accordance with the following steps:

- (a) establishing whether or not said first automatic gain control stage is active;
- (b) if said first automatic gain control stage is active, increasing said predetermined threshold level (TOP) to a first new threshold level such that this first new threshold level is equal to said antenna signal strength (X) and the first automatic gain control stage starts to become inactive, and calculating said antenna signal strength as being
30 equal to said first new threshold level; if said predetermined threshold level cannot be increased to said first new threshold level but only to a predetermined maximum level, then, calculating said antenna signal strength as being larger than said predetermined maximum level;





- (c) if said first automatic gain control stage is inactive, decreasing said predetermined threshold level (TOP) to a second new threshold level such that this second new threshold level is equal to said antenna signal strength (X) and the first automatic gain control stage starts to become active, and calculating said antenna signal strength as being equal to said second new threshold level; if said predetermined threshold level cannot be decreased to said second new threshold level but only to a predetermined minimum level, then, calculating said antenna signal strength as being smaller than said predetermined minimum level.
- 5
- 10 3. Arrangement according to claims 1 or 2, wherein said processor (16) is a microprocessor having an input connected to an analog-digital-converter (14), an output connected to a digital-analog-converter (18) and is further connected to a memory (20), the analog-digital-converter (14) being connected to said automatic gain control means (12) for receiving said first automatic gain control signal ($V_{RF\ AGC}$), said digital-analog-converter (18)
- 15 supplying a reference signal (V_{REF}) to said automatic gain control means (12), and said memory storing a value (n_T) relating to said predetermined threshold (TOP).
4. Arrangement according to claim 3, wherein said automatic gain control means (12) comprises a comparator (24) arranged to receive and compare said reference signal
- 20 (V_{REF}) and said second output signal ($V_{sync, top}$).
5. Arrangement according to any of the preceding claims, wherein said processor (16; 16') is connected to a display to display said antenna signal strength (X) as calculated.
- 25 6. Arrangement according to any of the preceding claims, wherein said arrangement comprises a television tuner (3, 4) arranged to receive said antenna signal and to convert said television signal into an intermediate frequency signal (Y), a video detector (10) arranged to detect a video signal from said intermediate frequency signal, said second amplifier section (8) with said second automatic gain control stage being provided between
- 30 said tuner (3, 4) and said video detector (10).
7. Arrangement according to any of the preceding claims, wherein said automatic gain control means and said processor are integrated in one further processor (16').





8. Method for measuring an antenna signal strength (X) supplied to an arrangement, the arrangement comprising:

- a first amplifier section (3) for receiving an antenna signal, for providing a first output signal and being provided with a first automatic gain control stage with a first attenuation factor controlled by a first automatic gain control signal ($V_{RF\ AGC}$);
- a second amplifier section (8) for receiving a first input signal derived from said first output signal, for providing a second output signal and being provided with a second automatic gain control stage with a second attenuation factor controlled by a second automatic gain control signal ($V_{IF\ AGC}$);
- automatic gain control means (12; 16') arranged to receive a second input signal ($V_{sync, top}$) derived from the second output signal and to generate said first and second automatic gain control signals ($V_{RF\ AGC}$, $V_{IF\ AGC}$) in dependence on the second output signal ($V_{sync, top}$);

the method including the following steps:

- for values of said antenna signal below a predetermined threshold level (TOP), activating only said second automatic gain control stage with increasing second attenuation factor with increasing values of the antenna signal;
- for values of said antenna signal above said predetermined threshold level (TOP), activating said first automatic gain control stage with increasing first attenuation factor with increasing values of the antenna signal;

wherein said method is also arranged to calculate said antenna signal strength (X) in accordance with the following steps:

- (a) establishing whether or not said first automatic gain control stage is active;
- (b) if said first automatic gain control stage is active, increasing said predetermined threshold level (TOP) to a first new threshold level such that this first new threshold level is equal to said antenna signal strength (X) and the first automatic gain control stage starts to become inactive, and calculating said antenna signal strength as being equal to said first new threshold level;
- (c) if said first automatic gain control stage is inactive, decreasing said predetermined threshold level (TOP) to a second new threshold level such that this second new threshold level is equal to said antenna signal strength (X) and the first automatic gain control stage starts to become active, and calculating said antenna signal strength as being equal to said second new threshold level.

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9. A method for measuring an antenna signal strength (X) supplied to an arrangement, the arrangement comprising:

- a first amplifier section (3) for receiving an antenna signal, for providing a first output signal and being provided with a first automatic gain control stage with a first attenuation factor controlled by a first automatic gain control signal ($V_{RF\ AGC}$);
- a second amplifier section (8) for receiving a first input signal derived from said first output signal, for providing a second output signal and being provided with a second automatic gain control stage with a second attenuation factor controlled by a second automatic gain control signal ($V_{IF\ AGC}$);
- automatic gain control means (12; 16') arranged to receive a second input signal ($V_{sync, top}$) derived from the second output signal and to generate said first and second automatic gain control signals ($V_{RF\ AGC}$, $V_{IF\ AGC}$) in dependence on the second output signal ($V_{sync, top}$);

the method including the following steps:

- for values of said antenna signal below a predetermined threshold level (TOP), activating only said second automatic gain control stage with increasing second attenuation factor with increasing values of the antenna signal;
- for values of said antenna signal above said predetermined threshold level (TOP), activating said first automatic gain control stage with increasing first attenuation factor with increasing values of the antenna signal;

wherein a processor (16; 16') is provided arranged to calculate said antenna signal strength (X) in accordance with the following steps:

- (a) establishing whether or not said first automatic gain control stage is active;
- (b) if said first automatic gain control stage is active, increasing said predetermined threshold level (TOP) to a first new threshold level such that this first new threshold level is equal to said antenna signal strength (X) and the first automatic gain control stage starts to become inactive, and calculating said antenna signal strength as being equal to said first new threshold level; if said predetermined threshold level cannot be increased to said first new threshold level but only to a predetermined maximum level, then, calculating said antenna signal strength as being larger than said predetermined maximum level;
- (c) if said first automatic gain control stage is inactive, decreasing said predetermined threshold level (TOP) to a second new threshold level such that this second new threshold level is equal to said antenna signal strength (X) and the first automatic





gain control stage starts to become active, and calculating said antenna signal strength as being equal to said second new threshold level; if said predetermined threshold level cannot be decreased to said second new threshold level but only to a predetermined minimum level, then, calculating said antenna signal strength as
5 being smaller than said predetermined minimum level.

10. A computer program product for measuring an antenna signal strength (X) supplied to an arrangement, the arrangement comprising:

- 10 • a first amplifier section (3) for receiving an antenna signal, for providing a first output signal and being provided with a first automatic gain control stage with a first attenuation factor controlled by a first automatic gain control signal ($V_{RF\ AGC}$);
- a second amplifier section (8) for receiving a first input signal derived from said first output signal, for providing a second output signal and being provided with a second automatic gain control stage with a second attenuation factor controlled by a second
15 automatic gain control signal ($V_{IF\ AGC}$);
- automatic gain control means (12; 16') arranged to receive a second input signal ($V_{sync, top}$) derived from the second output signal and to generate said first and second automatic gain control signals ($V_{RF\ AGC}$, $V_{IF\ AGC}$) in dependence on the second output signal ($V_{sync, top}$);

20 the arrangement being arranged such that:

- for values of said antenna signal below a predetermined threshold level (TOP) only said second automatic gain control stage may be active with increasing second attenuation factor with increasing values of the antenna signal;
- for values of said antenna signal above said predetermined threshold level (TOP) said
25 first automatic gain control stage is active with increasing first attenuation factor with increasing values of the antenna signal;

wherein said arrangement comprises a processor (16; 16') arranged for carrying out a method to calculate said antenna signal strength (X) after having read said computer program product in accordance with the following steps:

- 30 (a) establishing whether or not said first automatic gain control stage is active;
- (b) if said first automatic gain control stage is active, increasing said predetermined threshold level (TOP) to a first new threshold level such that this first new threshold level is equal to said antenna signal strength (X) and the first automatic gain control

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stage starts to become inactive, and calculating said antenna signal strength as being equal to said first new threshold level;

- 5 (c) if said first automatic gain control stage is inactive, decreasing said predetermined threshold level (TOP) to a second new threshold level such that this second new threshold level is equal to said antenna signal strength (X) and the first automatic gain control stage starts to become active, and calculating said antenna signal strength as being equal to said second new threshold level.

10 11. A computer readable medium provided with a computer program product as claimed in claim 10.

12. A computer program product for measuring an antenna signal strength (X) supplied to an arrangement, the arrangement comprising:

- 15 • a first amplifier section (3) for receiving an antenna signal, for providing a first output signal and being provided with a first automatic gain control stage with a first attenuation factor controlled by a first automatic gain control signal ($V_{RF\ AGC}$);
- 20 • a second amplifier section (8) for receiving a first input signal derived from said first output signal, for providing a second output signal and being provided with a second automatic gain control stage with a second attenuation factor controlled by a second automatic gain control signal ($V_{IF\ AGC}$);
- automatic gain control means (12; 16') arranged to receive a second input signal ($V_{sync, top}$) derived from the second output signal and to generate said first and second automatic gain control signals ($V_{RF\ AGC}$, $V_{IF\ AGC}$) in dependence on the second output signal ($V_{sync, top}$);

25 the arrangement being arranged such that:

- for values of said antenna signal below a predetermined threshold level (TOP) only said second automatic gain control stage may be active with increasing second attenuation factor with increasing values of the antenna signal;
- 30 • for values of said antenna signal above said predetermined threshold level (TOP) said first automatic gain control stage is active with increasing first attenuation factor with increasing values of the antenna signal;

wherein said arrangement comprises a processor (16 16') arranged for carrying out a method to calculate said antenna signal strength (X) after having read said computer program product in accordance with the following steps:

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- (a) establishing whether or not said first automatic gain control stage is active;
- (b) if said first automatic gain control stage is active, increasing said predetermined threshold level (TOP) to a first new threshold level such that this first new threshold level is equal to said antenna signal strength (X) and the first automatic gain control stage starts to become inactive, and calculating said antenna signal strength as being equal to said first new threshold level; if said predetermined threshold level cannot be increased to said first new threshold level but only to a predetermined maximum level, then, calculating said antenna signal strength as being larger than said predetermined maximum level;
- 5
- (c) if said first automatic gain control stage is inactive, decreasing said predetermined threshold level (TOP) to a second new threshold level such that this second new threshold level is equal to said antenna signal strength (X) and the first automatic gain control stage starts to become active, and calculating said antenna signal strength as being equal to said second new threshold level; if said predetermined threshold level cannot be decreased to said second new threshold level but only to a predetermined minimum level, then, calculating said antenna signal strength as being smaller than said predetermined minimum level.
- 10
- 15
13. A computer readable medium provided with a computer program product as claimed in claim 12.
- 20

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