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(54) Processor based wireless detector

Prozessorgestützter drahtloser Detektor

Dispositif de détection sans fil basé sur un processeur

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Description

Field of the Invention:

[0001] The invention pertains to wireless detectors usable in alarm systems. More particularly, the invention pertains to such detectors which incorporate single die, multi-function, programmed processors configured for energy efficient battery powered operation.

Background of the Invention:

[0002] Wireless ambient condition detectors are known. Such detectors, most conveniently, have been battery powered so that they may easily be mounted in a variety of locations without any need for power or communications cables. Known wireless detectors, while effective, have used energy at a rate which did not provide as long a battery life as desirable.

[0003] Known detectors have used separate integrated circuits to interface with different types of sensors such as smoke sensors and heat sensors. Signal processing has in turn required other circuits.

[0004] One type of circuit which has been used in detectors which incorporate smoke sensors have been application specific integrated circuits (ASIC). ASIC can be very inexpensive and cost effective in high volume, long run products. They are, however, expensive to develop, have long production lead times, and provide little or no flexibility. In addition, conventional ASIC contribute to higher than desirable power requirements.

[0005] Known detectors have used a different ASIC for communications and low battery detection. Since the ASIC coupled to the respective smoke sensor and the communications ASIC operate autonomously, they create irregular and unpredictable current draw profiles. In known detectors, this irregular and unpredictable current draw profile impedes accurate battery voltage measurements. As a result of these unpredictable current draws, low battery trouble, voltage thresholds have had to be set higher than desirable. This also contributes to shorter battery life.

[0006] Other known prior art detectors use an ASIC to couple electrical energy from the battery to an audible alarm indicating device in the detector. This produces a need for yet another, separate, circuit which must be interconnected with the rest of the circuitry of the detector and which contributes to further current draw. Additionally, sensitivity compensation, to take into account dust and aging of a sensing chamber, has in some known systems been carried out at a system control panel. Smaller, less expensive control panels may not have the processing capability to implement this function.

[0007] One known type of detector based compensation provides a maximum incremental change which can take place in the detector during each compensation cycle. While this process does provide compensation over a period of time, the greater the extent of the required compensation, the longer is the time interval that is required to achieve a desired sensitivity.

[0008] Some known detectors which incorporate heat sensors have recognized that heat sensors can be susceptible to nuisance conditions such as electrical noise from static electricity, power surges, radio-frequency interference, as well as thermal noise both from turning the sensor on and off as well as thermal variations from the ambient environment. It has been known to use reference heat sensors to compensate for temperature changes. Such reference heat sensors not only add additional cost to the respective detector but are limited in the thermal noise which can be rejected.

[0009] US 5990797 discloses an ultraloud ambient condition detector which incorporates a sensor in combination with a control circuit.

[0010] It would be desirable therefore to provide highly energy efficient multiple sensor detectors which require fewer integrated circuits. Preferably, such detectors could be implemented in a way so as to provide on-going flexibility to designers as product needs evolve, while at the same time extending battery life and providing enhanced rejection of nuisance signals.

Summary the Invention:

[0011] The invention is defined in claim 1. A wireless single detector incorporates a single chip, or die, integrated control element. The element includes an integrally formed processor, read-write, reprogrammable read only memory or one time programmable read only memory. Different memory types can be formed on the same die. The same chip can include programmable timers, and I/O ports for both analog and digital inputs or outputs.

[0012] In one aspect, the detector includes a photoelectric smoke sensor and at least one heat sensor. Executable instructions implement a common sensing cycle for both types of sensors. Two heat sensor can be incorporated into a disclosed embodiment.

[0013] In another aspect, a battery used to power the detector provides an output voltage in a predetermined monitorable range which will support successful operation. A voltage multiplier circuit, coupled to the battery, provides a higher voltage to drive an audible output device in accordance with processor supplied modulation.

[0014] In yet another aspect, the detector conserves energy, and extends battery life, by performing sensor sampling and signal processing functions for that sample interval during a single active interval. Then, the circuitry enters a low power, inactive state until the next activate interrupt arrives.

[0015] An example combines different types of sensors, some of which have longer stabilization intervals then others. Different types of sensors can be activated simultaneously. Those with relatively short stabilization intervals can be sampled and the respective signal, or signals, processed, at least in part, during longer stabi-

lization and processing interval for other types of sensors. This overlap contributes to minimal over-all energy usage during each active interval.

[0016] Numerous other advantages and features of the present invention will become readily apparent from the following detailed description of the invention and the embodiments thereof, from the claims and from the accompanying drawings.

Brief Description of the Drawings:

[0017]

Fig. 1 is a system in accordance with the present invention;

Fig. 2 is a block diagram of an electrical unit usable in the system of Fig. 1;

Fig. 3 is a timing diagram illustrating various aspects of the operation of the unit of Fig. 2;

Fig. 4 is a timing diagram illustrating other aspects of the operation of the unit of Fig. 2;

Fig. 5 is a block diagram illustrating a method of processing signals from a smoke sensor carried by the unit of Fig. 2; and

Fig. 6 is a flow diagram illustrating processing of signals associated with one or more heat sensors carried by the electrical unit of Fig. 2.

Detailed Description of the Preferred Embodiments:

[0018] While this invention is susceptible of embodiment in many different forms, there are shown in the drawing and will be described herein in detail specific embodiments thereof with the understanding that the present disclosure is to be considered as an exemplification of the principles of the invention and is not intended to limit the invention to the specific embodiments illustrated.

[0019] Fig. 1 illustrates a monitoring system 10 in accordance with the present invention. The system 10 incorporates a system control element 12 which could incorporate one or more programmed processors and prestored executable instructions. It will be understood that the exact details of the control element 12 are not a limitation of the present invention.

[0020] The control element 12 is coupled to a wireless antenna 12a wherein the system 10 has been implemented using RF-type wireless transmissions. Other forms of wireless transmission come within the scope of the present invention.

[0021] The members of a plurality of electrical units 16 are wirelessly coupled to control element 12. The members of the plurality 16, for example electrical unit 16i, could be implemented as battery powered units having one or more ambient condition sensors for purposes of monitoring a region. The sensors could be responsive to smoke, gas, position, flow, intrusion, movement or the like all without limitation of the present invention. The electrical units 16 via respective antennas, such as antenna 16i-1 communicate status information and information pertaining to the condition being monitored to the control element 12. Various levels of processing of the signals from the respective sensor or sensors at the unit 16i can be carried out locally and the results thereof transmitted via antennae 16i-1 and 12a to control element 12.

[0022] It will also be understood that system 10 can incorporate one or more wired communication links, representatively illustrated as link 18, coupled to control element 12. Members of a plurality of electrical units 20 can be coupled to link 18 for communication with control element 12. Those of skill in the art will understand that the members of the plurality 20 could incorporate detectors of ambient conditions as well as output or control devices all without limitation of the present invention.

[0023] Fig. 2 illustrates more details of a representative member 16i of the plurality 16. The electrical unit 16i is carried in a housing 16i-2. The housing 16i-2 can be mounted to a selected surface.

[0024] The unit 16i includes a single die, programmed, control element 30. The element 30 includes a processor 30a, read/write memory 30b, and non-volatile memory 30c. The read/write memory 30b can be implemented using a variety of random access or quasi random access technologies as would be understood by those of skill in the art within the scope of the present invention.

[0025] The non-volatile memory 30c can be implemented with a variety of non-volatile technologies including OPT, flash memory, EEPROM or PROM storage circuitry or combinations thereof. It will be understood that executable instructions and calibration parameters can be stored in one or more types of non-volatile memory all on the same die. By use of EEPROM or other types of reprogrammable storage, parameters and/or executable instructions can be up-dated wirelessly from time to time as a result of commands and files received from the control element 12. In addition, when the unit 16i is being manufactured, executable instructions can be written therein, executed and/or modified without having to be delayed by expensive revisions to mask sets.

[0026] The control element 30 includes, integrated on the same die, interrupt and I/O ports 30d. Circuitry 30a, 30b, 30c and 30d are all interconnected on the single die resulting in a single chip element which also promotes manufacturability.

[0027] Storing the executable instructions and calibration parameters in the same type of non-volatile memory, or in different types of non-volatile memory, but all on the same die, eliminates any need for separate integrated circuitry and associated interfaces, interconnections and the like. As will be understood by those of skill in the art, and discussed in more detail subsequently, sensor control and processing as well as other local functions and communications with control element 12 are implemented, in part, via the executable constructions in the non-volatile memory 30c in combination with local hardware.

[0028] The unit 16i also includes a wireless interface

34 coupled to the I/O ports 30d and antenna 16i-1. As those of skill in the art will understand, a variety of wireless interfaces can be used in the unit 16i without departing from the spirit and scope of the present invention so long as the interfaces enable the respective units, such as the unit 16i to communicate with the control element 12 wirelessly. Preferably communication will be bidirectional although unidirectional communication from the respective electrical units 16 comes within the scope of the present invention.

[0029] The illustrated electrical unit 16i also includes a smoke chamber 36a. Chamber 3 6a is configured to permit an inflow and outflow of smoke carrying ambient atmosphere in the vicinity of the unit 16i. Mounted within or adjacent to the chamber 36a are a radiant energy source 36b, and, a radiant energy receiver 36c. The radiator 36b, which could be a laser diode or a light emitting diode, and the receiver 36c which could be a photo diode or a photo transistor. They are configured, in chamber 36a, to provide a smoke sensing function, commonly referred to as a photo electric smoke sensor, as would be understood by those of skill in the art.

[0030] Drive circuits 38a coupled to I/O port 30d and emitter 36b provide electrical energy to emitter 36b under control of instructions being executed by processor 38. Similarly, photo amp 38b coupled between I/O ports 30d and sensor 36c via an activate line 38b-1 and an amplified sensor output line 38b-2 make it possible to drive emitter 36b via instructions being executed in processor 30a, activate sensing amplifier 38b and receive an analog signal therefrom via line 38b-2. The analog signal on line 38b-2 can be converted in an analog-to- digital converter integral to I/O ports 30d. The resulting digitized value can be processed via instructions executed by processor 30a. It will be understood that the photo-amp 38b can be eliminated where the analog-to-digital converter has sufficient resolution.

[0031] Representative first and second thermal or heat sensors 40a and 40b are coupled via one or more sensor activate lines 40a-1 and 40b-1 to I/O ports 30d. It will be understood that one or more than two thermal sensors could be used without departing from the scope of the present invention. Analog output signals from sensors 40a, 40b can be coupled via one or more output lines 40a-2 and 40b-2 to I/O ports 30d. It will be understood that either a common activate line or a common feedback line or multiple activate or multiple feedback lines can be used to control or receive signals from the thermal sensors 40a, 40b without departing from the scope of the present invention.

[0032] The processor 30a can periodically and autonomously activate sensors 40a, 40b via respective lines 40a-1, 40b-1. This in turn provides analog signals, indicative of ambient adjacent thermal conditions on output lines 40a-2, 40b-2. These signals can then be digitized and processed by processor 30a.

[0033] As described in more detail subsequently, with respect to Fig. 3, the processor 30a, to minimize average energy requirements, can be activated only during intermittent spaced apart time intervals. Both smoke sensing and thermal sensing takes place during a common activation interval. Processing of the received signals from the respective sensors also takes place during the same activation interval.

[0034] The unit 16i is preferably energized by a replaceable battery B. A battery condition measuring circuit 42 is coupled to I/O ports 3 0d via an activation line 42-1 and a battery parameter feedback line, indicative of battery voltage, 42-2. The condition of the battery B can be periodically evaluated by processor 30a by activating measurement circuitry 42. The condition of the battery B can then be monitored in real- time by processor 30a with a known current profile. For monitoring purposes, the value received from measuring circuit 42, on line 42-2 can be compared to a factory programmed threshold value. If the sensed voltage of the battery B is below the preset threshold, the processor 30a can carry out a prestored low battery voltage routine.

[0035] Voltage incrementing circuit 44 is coupled to battery B and enabling line 44-1, for example a voltage multiplying circuit, can be used to generate an audible device output driving voltage on line 44-2. This driving voltage substantially exceeds the value of the voltage of the battery B. The applied high voltage on the line 44-2 can be modulated via processor 30a and output line 44-3 to drive audible output device 48. This device could be implemented as an audible sounder or piezo-electric device without limitation.

[0036] As discussed in more detail subsequently with respect to Fig. 4, processor 30a directly drives battery voltage incrementing circuit 44 to produce an output voltage on line 44-2 sufficiently high to operate the sounder. The sounder via line 44-3 can be modulated in accordance with one or more pre-stored output patterns. For example, an ANSI S 3.41 output pattern can be stored and audibly output via device 48 where the units 16 are marketed in the United States. Alternately, a Canadian Standards Association, CSA, output pattern can be stored and output for electrical units installed in Canadian markets.

[0037] When processor 30a is generating an audible output pattern, use is made of the silent intervals between tone bursts to carry on a non-tonal processing such as reading sensor values, processing sensor values, reading battery values processing battery output values and executing communication sequences. By multiplexing these operations, only the single processor 30a need be used. Using this same multiplexing approach, a low battery audible indicator can also be produced as appropriate.

[0038] The timing diagrams of Fig. 3 illustrate the energy efficient operation of the electrical unit 16i. Graph 100 illustrates one of a plurality of spaced apart active intervals for the control circuits 30. During this interval, the resources of the processor 30a can be devoted to sensor sampling and signal processing. For example and

without limitation, graph 102 illustrates a stabilization and sensing interval of photo amplifier 38b, activated via line 38b-1. As illustrated in graph 104, the emitter 36b is activated via drive circuits 38a, line 38a-1 near the end of the stabilization interval. This in turn produces radiant energy R in sample chamber 36a, a portion of which, indicative of smoke, is converted to an electrical signal output via photo amp 38b. This signal is sampled, graph 106, and converted to a digital value at the end of the emitter activate interval.

[0039] During the photo amplifier stabilization interval, graph 102, one of the thermal sensors such as 40a, can be activated for a predetermined period of time, graph 108. An analog output therefrom, line 40a-2 can be sampled and digitized at the I/O port 30d, signal 110a.

[0040] A second heat or thermal sensor, such as sensor 40b can be subsequently activated, graph 112. An analog output therefrom, line 40b-2, can be sampled and digitized at the end of the activation interval 112, waveform 110b. Subsequently, graph 114, the acquired values from the smoke sensor and the thermal sensors can be processed.

[0041] Fig. 4 illustrates a set of timing diagrams wherein a modulation signal, graph 120, is presented via line 44-3 to an audible output device or sounder. During the time interval wherein the sounder ON signal is being provided, graph 120, processor 30a via line 44-1 and voltage increasing circuit for example voltage multiplier circuit 44 can be driven thereby producing on the output line 44-2 a high enough output voltage to properly drive the sounder 48. During sounder OFF intervals, for example between internal tonal groups, such as 120a, 120b and 120c, sensor activation and signal processing, as illustrated in Fig. 3 can be carried out Additionally, low battery testing, discussed above as well as any supervisory signal generation can be carried out and implemented in any of intervals 120a, 120b or 120c.

[0042] As noted above, sensor signal processing can be carried out in the same activate cycle as the signal has been acquired, graph 114, Fig. 3. Fig. 5 is a flow diagram of processing in accordance herewith.

[0043] With respect to Fig. 5, on a periodic basis and autonomously, the processor 30a samples the photo sensor 36c, step 140. This sensor output is processed and filtered to produce an adjusted value, for example Min3 processing as described in Tice U.S. Patent No. 5,736,928, step 142. The value of Min3_smoke is updated with every photo sample.

[0044] On every thirtieth photo sample, step 144, the updated Min3_smoke value is used to calculate a running average, Avg step 146. The running average is calculated using, for example, a sample size of 256. It will be understood that other numbers of samples could be used without departing from the scope of the present invention.

[0045] Another value, Smooth, which represents the short-term increase in Min3_smoke, is computed, step 148, by averaging the last two differences between Min3_smoke and corresponding Avg. Smooth is greater than zero when Min3_smoke is increasing. Smooth declines to zero when Min3_smoke remains constant or decreases.

[0046] The most recent value of Smooth is compared with a predetermined value, step 150. When exceeded, an alarm signal is transmitted and an indication is given at the detector step 152. The above described steps not only filter out sensor noise, minimizing false alarms, they also carry out sensitivity compensation.

[0047] With respect to Fig. 6, on a periodic basis and autonomously, the processor 30a samples the reading of a heat sensor, such as sensor 40a, graph 108, step 160. A value, Avg_temp, representing the running average of the last 256 consecutive Inst_temp. including the most recent sample, is calculated, step 162, and stored in memory, step 164. Another value, Delta, representing the difference between the most recent Inst_temp and the most recent Avg_temp is calculated step 166a. A third value, Avg_delta is calculated step 166b by taking the running average of the last 12 consecutive Deltas and then stored, step 168.

[0048] The current reading is compared to 22 degrees C, step 170. If above 22 degrees C and if Avg_delta is greater than or equal to 4, step 172, then the flag ROR is set step 174.

[0049] If ROR is set, step 176i the fixed heat alarm threshold is set to a value that is higher than the most recent Inst_temp by an amount equal to 25% of the difference between the most recent Inst_temp and the predetermined fixed heat alarm threshold step 178. This makes the detector more sensitive by allowing the detector to alarm at a temperature lower than the predetermined fixed heat alarm threshold.

[0050] If Avg_delta is less than 4, then the fixed heat alarm threshold will not be reduced. The detector in this case will respond at the predetermined fixed heat alarm threshold step 180. This process is repeated for the second heat sensor 40b.

[0051] By setting the heat alarm threshold above the current Inst_temp by a percentage of the difference between the current Inst_temp and the predetermined fix heat alarm threshold, a single adjustment would not be able to cause a valid alarm condition to occur. This reduces the chance of false alarms.

[0052] Where more than one heat sensor is employed, when Avg_delta becomes greater or equal to 4 for one heat sensor, the fixed heat alarm thresholds for all heat sensors are adjusted. The adjustment to heat alarm threshold is only made if the temperature is above 22°C, i.e. room temperature, step 170. The Avg_temp, and Avg_delta values for each heat sensor are stored individually. Inst_temp is also compared to the predetermined heat alarm threshold step 180. When exceeded, an alarm signal is transmitted and an indication is given at the detector, step 182. Inst_temp is also compared to a second heat threshold. When exceeded, a trouble signal, different from an alarm signal, is transmitted and an indication is given at the detector.

[0053] It will be understood that smoke sensor output signals and thermal sensor output signals can be processed using a variety of methods without departing from the spirit and scope of the present invention. Similarly, other types of sensors can be incorporated into unit 16i without departing from the scope of the present invention.

[0054] From the foregoing, it will be observed that numerous variations and modifications may be effected without departing from the scope of the invention. It is to be understood that no limitation with respect to the specific apparatus illustrated herein is intended or should be inferred. It is, of course, intended to cover by the appended claims all such modifications as fall within the scope of the claims.

Claims

1. A detector comprising:

at least one ambient condition sensor (36a);
an audible output device (48) for producing an interrupted audio tonal pattern having predetermined on and off intervals; **characterized in that** the detector further comprises :
a control circuit (30) coupled to the sensor (36a) and to the device (48) wherein in response to the presence of a selected, sensed ambient condition the control circuit (30) drives the output device (48) in accordance with the predetermined on and off intervals and wherein during the on intervals the control circuit (30) is substantially completely dedicated to providing electrical energy for driving the output device (48) and wherein during off intervals the control circuit (30) is adapted to carry out different, non-driving functions.

2. A detector as in claim 1 which includes a wireless output circuit (34), coupled to the control circuit (30).

3. A detector as in claim 2 which includes a replaceable power source (B) coupled to a voltage increasing circuit (44).

4. A detector as in claim 3 wherein the power source (B) comprises a battery.

5. A detector as in claim 4 which includes a voltage multiplier circuit (44) coupled between the battery (B) and the output device (48).

6. A detector as in claim 1 which incorporates a second, different, sensor (40a) wherein the control circuit (30) comprises executable instructions (30c) for establishing a sampling cycle and for sampling both sensors (36a, 40a) during the sampling cycle.

7. A detector as in claim 6 wherein the executable instructions (30c) implement at least one stabilization interval prior to sampling the sensors (36a, 40a).

8. A detector as in claim 7 which includes a third sensor (40b), substantially identical to the second sensor (40a) and comprising executable instructions (30c) for sampling the third sensor (40b) during the sampling cycle.

9. A detector as in claim 8 wherein one sensor comprises a smoke sensor (36b, 36c) and another comprises a heat sensor (40a).

10. A detector as in claim 6 wherein the control circuit (30) comprises a programmed processor (30a) configured with an intermittent active cycle which includes the sampling cycle and wherein the control circuit (30) requires a first power level during each active cycle and a substantially reduced power level between active cycles thereby reducing average required power.

11. A detector as in claim 10 which includes executable sensitivity compensation instructions (30c) wherein different degrees of compensation are achieved in a substantially common time interval.

12. A detector as in claim 10 which includes executable sensor signal processing instructions (30c) which respond to a non-alarm indicating ambient condition from one of the sensors to adjust an alarm indicating threshold for that sensor.

13. A detector as in claim 12 wherein the one sensor is a thermal sensor (40a) and the other is a smoke sensor (36b, 36c).

14. A detector as in claim 13 which incorporates a second thermal sensor (40b).

15. A detector as in claim 1, further comprising:

a wireless interface (34) coupled to the control circuit (30); and
a multiplier circuit (44) coupled to the control circuit (30) and to the output device (48), wherein the control circuit (30) drives the multiplier circuit (44) during the spaced apart intervals, substantially to the exclusion of carrying out different control functions, and, wherein the control circuit (30) carries out the different control functions between the spaced apart intervals.

16. A detector as in claim 15 which includes a replaceable energy source (B) with an output port which is coupled to the multiplier circuit (44).

17. A detector as in claim 15 which includes a single die for at least a processor (30a) and non-volatile storage (30c) of executable instructions and parameter values.

18. A detector as in claim 17 wherein the storage (30c) comprises at least one of flash memory, PROM and EEPROM on the die.

19. A detector as in claim 15 wherein the control circuit (30) comprises executable instructions for, in part, carrying out as one different control function, processing signals received from the sensor (36a).

20. A detector as in claim 17 wherein the processor (30a) exhibits an active interval having a predetermined period and wherein executable instructions carry out sensor sampling and signal processing during the interval.

21. A detector as in claim 20 wherein executable instructions carry out a fixed time interval compensation process irrespective of degree of compensation.

Patentansprüche

1. Detektor, umfassend
mindestens einen Sensor für Umgebungsbedingungen (36a);
eine hörbare Ausgabevorrichtung (48) für die Wiedergabe eines unterbrochenen hörbaren Tonmusters mit vorbestimmten Ein- und Aus-Intervallen; **dadurch gekennzeichnet, dass** der Detektor zudem umfasst
eine Kontrollschaltung (30), die mit dem Sensor (36a) und der Vorrichtung (48) zusammengeschaltet ist, wobei als Reaktion auf das Vorliegen einer ausgewählten, erfassten Umgebungsbedingung die Kontrollschaltung (30) die Ausgabevorrichtung (48) gemäß den vorbestimmten Ein- und Aus-Intervallen ansteuert, und wobei die Kontrollschaltung (30) während der Ein-Intervalle im Wesentlichen vollständig dazu genutzt wird, elektrische Energie zur Ansteuerung der Ausgabevorrichtung (48) zu liefern, und wobei während der Aus-Intervalle die Kontrollschaltung (30) dazu ausgelegt ist, andere, nicht ansteuernde Funktionen zu erfüllen.

2. Detektor gemäß Anspruch 1, welcher eine kabellose Ausgabeschaltung (34) enthält, die mit der Kontrollschaltung (30) zusammengeschaltet ist.

3. Detektor gemäß Anspruch 2, welcher eine austauschbare Leistungsquelle (B) enthält, die mit einer Spannungserhöhungsschaltung (44) zusammengeschaltet ist.

4. Detektor gemäß Anspruch 3, wobei die Leistungsquelle (B) eine Batterie enthält.

5. Detektor gemäß Anspruch 4, welcher eine Spannungsvervielfacherschaltung (44) enthält, die zwischen die Batterie (B) und die Ausgabevorrichtung (48) geschaltet ist.

6. Detektor gemäß Anspruch 1, welcher einen zweiten, unterschiedlichen Sensor (40a) einbezieht, wobei die Kontrollschaltung (30) ausführbare Befehle (30c) umfasst zum Einrichten eines Erprobungszyklus und zum Erproben beider Sensoren (36a, 40a) während des Erprobungszyklus.

7. Detektor gemäß Anspruch 6, worin die ausführbaren Befehle (30c) mindestens ein Stabilisierungsintervall vor der Erprobung des Sensoren (36a, 40a) umsetzen.

8. Detektor gemäß Anspruch 7, welcher einen dritten Sensor (40b) enthält, der im Wesentlichen mit dem zweiten Sensor (40a) identisch ist, und wobei der Detektor ausführbare Befehle (30c) umfasst zum Erproben des dritten Sensors (40b) während des Erprobungszyklus.

9. Detektor gemäß Anspruch 8, wobei ein Sensor einen Rauchsensor (36b, 36c) umfasst und ein anderer einen Hitzesensor (40a) umfasst.

10. Detektor gemäß Anspruch 6, wobei die Kontrollschaltung (30) einen programmierten Prozessor (30a) umfasst, ausgestattet mit einem intermittierenden aktiven Zyklus, welcher den Erprobungszyklus enthält und wobei die Kontrollschaltung (30) ein erstes Leistungsniveau während jedes aktiven Zyklus benötigt und ein wesentlich reduziertes Leistungsniveau zwischen aktiven Zyklen, wodurch die durchschnittliche benötigte Leistung reduziert wird.

11. Detektor gemäß Anspruch 10, welcher ausführbare Befehle zur Sensibilitätsanpassung (30c) enthält, wobei unterschiedliche Anpassungsgrade in einem im Wesentlichen einheitlichen Zeitintervall erreicht werden.

12. Detektor gemäß Anspruch 10, welcher ausführbare Befehle enthält für die Sensorsignalverarbeitung (30c), welche auf eine nicht alarmgebende Umgebungsbedingung aus einem der Sensoren reagieren, indem sie einen alarmgebenden Schwellenwert für diesen Sensor anpassen.

13. Detektor gemäß Anspruch 12, wobei der eine Sensor ein thermischer Sensor (40a) ist und der andere ein Rauchsensor (36b, 36c) ist.

14. Detektor gemäß Anspruch 13, welcher einen zweiten thermischen Sensor (40b) einbezieht.

15. Detektor gemäß Anspruch 1, zudem umfassend
eine kabellose Schnittstelle (34), die mit der Kontrollschaltung (30) zusammengeschaltet ist; und
eine Vervielfacherschaltung (44), die mit der Kontrollschaltung (30) und mit der Ausgabevorrichtung (48) zusammengeschaltet ist, wobei die Kontrollschaltung (30) die Vervielfacherschaltung (44) während der beabstandeten Intervalle ansteuert, im Wesentlichen ohne dass unterschiedliche Kontrollfunktionen ausgeführt werden, und, wobei die Kontrollschaltung (30) unterschiedliche Kontrollfunktionen zwischen den beabstandeten Intervallen ausführt.

16. Detektor gemäß Anspruch 15, welcher eine Austauschbare Energiequelle (B) enthält mit einem Ausgabeport, der mit der Vervielfacherschaltung (44) zusammengeschaltet ist.

17. Detektor gemäß Anspruch 15, welcher einen einzelnen Chip enthält für mindestens einen Prozessor (30a) enthält und einen Permanentspeicher (30c) mit ausführbaren Befehlen und Parameterwerten.

18. Detektor gemäß Anspruch 17, wobei der Speicher (30c) mindestens eines aus Flash-Speicher, PROM und EEPROM auf dem Chip umfasst.

19. Detektor gemäß Anspruch 15, wobei die Kontrollschaltung (30) umfasst ausführbare Befehle, teilweise für das Ausführen, als eine unterschiedliche Kontrollfunktion, der Signalverarbeitung vom Sensor (36a).

20. Detektor gemäß Anspruch 17, wobei der Prozessor (30a) einen aktiven Intervall aufweist mit einer vorbestimmten Periode und wobei ausführbare Befehle während des Intervalls Sensorerprobung und Signalverarbeitung ausführen.

21. Detektor gemäß Anspruch 20, worin ausführbare Befehle ein Verfahren zur Fixzeitintervallanpassung ausführen, ungeachtet eines Anpassungsgrades.

Revendications

1. Détecteur comprenant :

au moins un capteur de condition ambiante (36a) ;
un dispositif de sortie audible (48) pour produire un motif acoustique interrompu ayant des intervalles actifs et inactifs prédéterminés ; **caractérisé en ce que** le détecteur comprend en outre :
un circuit de contrôle (30) couplé au capteur (36a) et au dispositif (48), dans lequel, en réponse à la présence d'une condition ambiante détectée sélectionnée, le circuit de contrôle (30) commande le dispositif de sortie (48) conformément aux intervalles actifs et inactifs prédéterminés, et dans lequel, pendant les intervalles actifs, le circuit de contrôle (30) est sensiblement complètement dédié à la fourniture d'énergie électrique pour commander le dispositif de sortie (48), et dans lequel, pendant les intervalles inactifs, le circuit de contrôle (30) est adapté pour effectuer différentes fonctions qui ne sont pas de commande.

2. Détecteur selon la revendication 1, qui comprend un circuit de sortie sans fil (34), couplé au circuit de contrôle (30).

3. Détecteur selon la revendication 2, qui comprend une source de puissance (B) remplaçable couplée à un circuit d'augmentation de tension (44).

4. Détecteur selon la revendication 3, dans lequel la source de puissance (B) comprend une batterie.

5. Détecteur selon la revendication 4, qui comprend un circuit multiplicateur de tension (44) couplé entre la batterie (B) et le dispositif de sortie (48).

6. Détecteur selon la revendication 1, qui incorpore un deuxième capteur (40a) différent, dans lequel le circuit de contrôle (30) comprend des instructions exécutables (30c) pour établir un cycle d'échantillonnage et pour échantillonner les deux capteurs (36a, 40a) pendant le cycle d'échantillonnage.

7. Détecteur selon la revendication 6, dans lequel les instructions exécutables (30c) mettent en oeuvre au moins un intervalle de stabilisation avant l'échantillonnage des capteurs (36a, 40a).

8. Détecteur selon la revendication 7, qui comprend un troisième capteur (40b), sensiblement identique au deuxième capteur (40a) et comprenant des instructions exécutables (30c) pour échantillonner le troisième capteur (40b) pendant le cycle d'échantillonnage.

9. Détecteur selon la revendication 8, dans lequel un capteur comprend un capteur de fumée (36b, 36c) et un autre comprend un capteur thermique (40a).

10. Détecteur selon la revendication 6, dans lequel le circuit de contrôle (30) comprend un processeur programmé (30a) configuré avec un cycle actif intermittent qui comprend le cycle d'échantillonnage, et dans

lequel le circuit de contrôle (30) nécessite un premier niveau de puissance pendant chaque cycle actif et un niveau de puissance sensiblement réduit entre les cycles actifs, ce qui réduit la puissance requise moyenne.

11. Détecteur selon la revendication 10, qui comprend des instructions de compensation de sensibilité exécutables (30c), dans lequel différents degrés de compensation sont atteints dans un intervalle de temps sensiblement commun.

12. Détecteur selon la revendication 10, qui comprend des instructions de traitement de signal de capteur exécutables (30c) qui réagissent à une condition ambiante d'indication de non alarme de l'un des capteurs pour ajuster un seuil d'indication d'alarme pour ce capteur.

13. Détecteur selon la revendication 12, dans lequel ledit un capteur est un capteur thermique (40a) et l'autre est un capteur de fumée (36b, 36c).

14. Détecteur selon la revendication 13, qui incorpore un deuxième capteur thermique (40b).

15. Détecteur selon la revendication 1, comprenant en outre :

une interface sans fil (34) couplée au circuit de contrôle (30) ; et
un circuit multiplicateur (44) couplé au circuit de contrôle (30) et au dispositif de sortie (48), dans lequel le circuit de contrôle (30) commande le circuit multiplicateur (44) pendant les intervalles espacés, sensiblement à l'exclusion de l'exécution de différentes fonctions de contrôle, et dans lequel le circuit de contrôle (30) exécute les différentes fonctions de contrôle entre les intervalles espacés.

16. Détecteur selon la revendication 15, qui comprend une source d'énergie (B) remplaçable avec un port de sortie qui est couplé au circuit multiplicateur (44).

17. Détecteur selon la revendication 15, qui comprend une puce unique pour au moins un processeur (30a) et une mémoire non volatile (30c) d'instructions exécutables et de valeurs de paramètres.

18. Détecteur selon la revendication 17, dans lequel la mémoire (30c) comprend au moins l'une d'une mémoire flash, d'une PROM et d'une EEPROM sur la puce.

19. Détecteur selon la revendication 15, dans lequel le circuit de contrôle (30) comprend des instructions exécutables pour, en partie, exécuter, en tant que fonction de contrôle différente, le traitement des signaux reçus du capteur (36a).

20. Détecteur selon la revendication 17, dans lequel le processeur (30a) présente un intervalle actif ayant une période prédéterminée, et dans lequel les instructions exécutables effectuent l'échantillonnage des capteurs et le traitement des signaux pendant l'intervalle.

21. Détecteur selon la revendication 20, dans lequel les instructions exécutables effectuent un processus de compensation à des intervalles de temps fixes indépendamment du degré de compensation.

FIG. 1

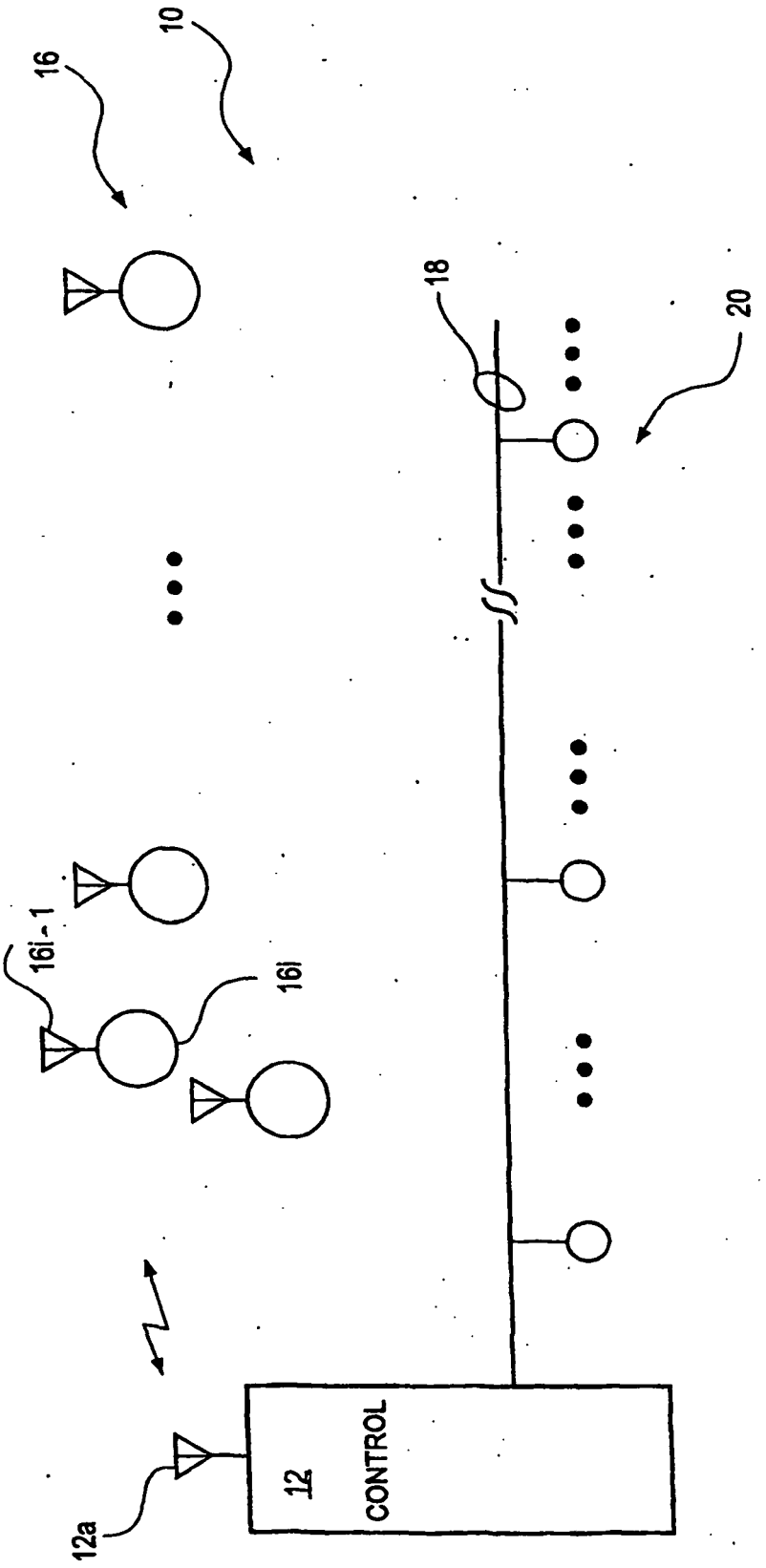


FIG. 2

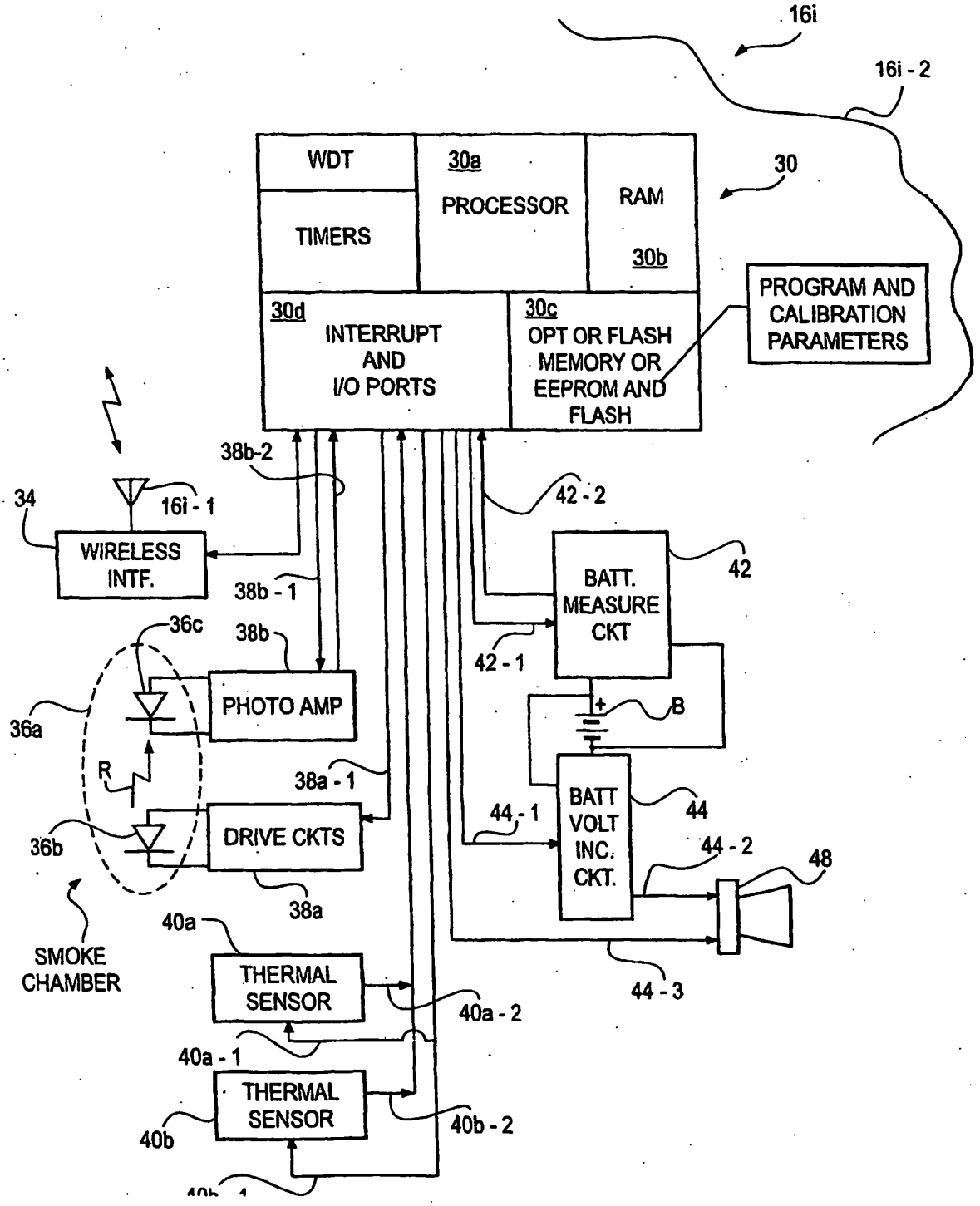

16i
16i - 2
WDT
TIMERS
30a
PROCESSOR
RAM
30b
30
30d
INTERRUPT AND I/O PORTS
30c
OPT OR FLASH MEMORY OR EEPROM AND FLASH
PROGRAM AND CALIBRATION PARAMETERS
38b-2
34
16i - 1
WIRELESS INTF.
38b - 1
42 - 2
BATT. MEASURE CKT
42
42 - 1
36c
38b
PHOTO AMP
36a
R
38a - 1
B
BATT VOLT INC. CKT.
44
44 - 1
36b
DRIVE CKTS
38a
44 - 2
48
40a
SMOKE CHAMBER
THERMAL SENSOR
44 - 3
40a - 2
40a - 1
THERMAL SENSOR
40b
40b - 2

FIG. 3

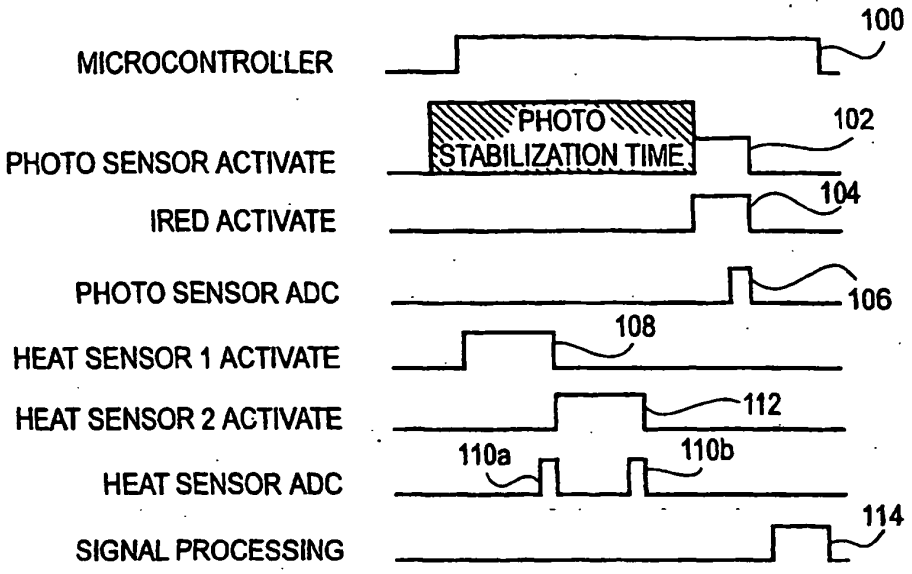

MICROCONTROLLER
100
PHOTO SENSOR ACTIVATE
PHOTO STABILIZATION TIME
102
IRED ACTIVATE
104
PHOTO SENSOR ADC
106
HEAT SENSOR 1 ACTIVATE
108
HEAT SENSOR 2 ACTIVATE
112
HEAT SENSOR ADC
110a
110b
SIGNAL PROCESSING
114

FIG. 4

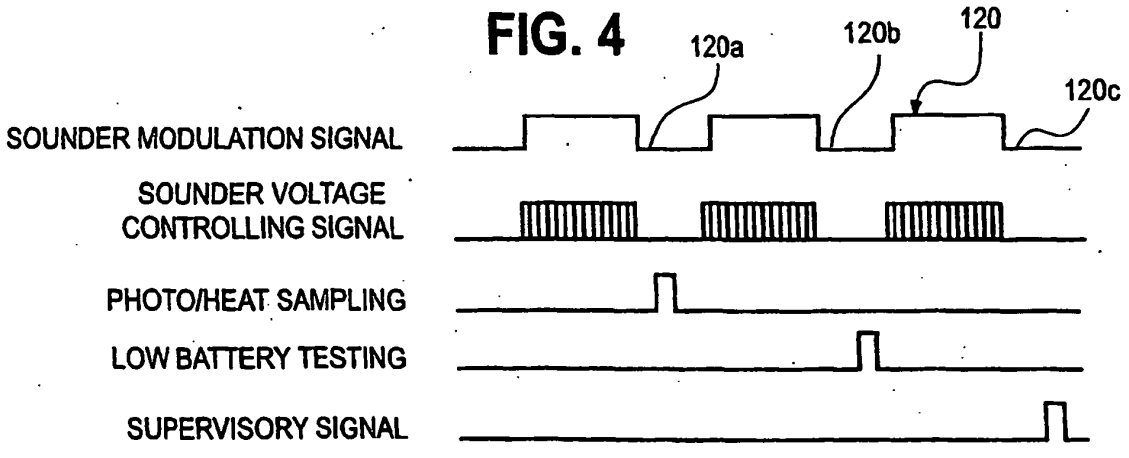

120a
120b
120
120c
SOUNDER MODULATION SIGNAL
SOUNDER VOLTAGE CONTROLLING SIGNAL
PHOTO/HEAT SAMPLING
LOW BATTERY TESTING
SUPERVISORY SIGNAL

FIG. 5

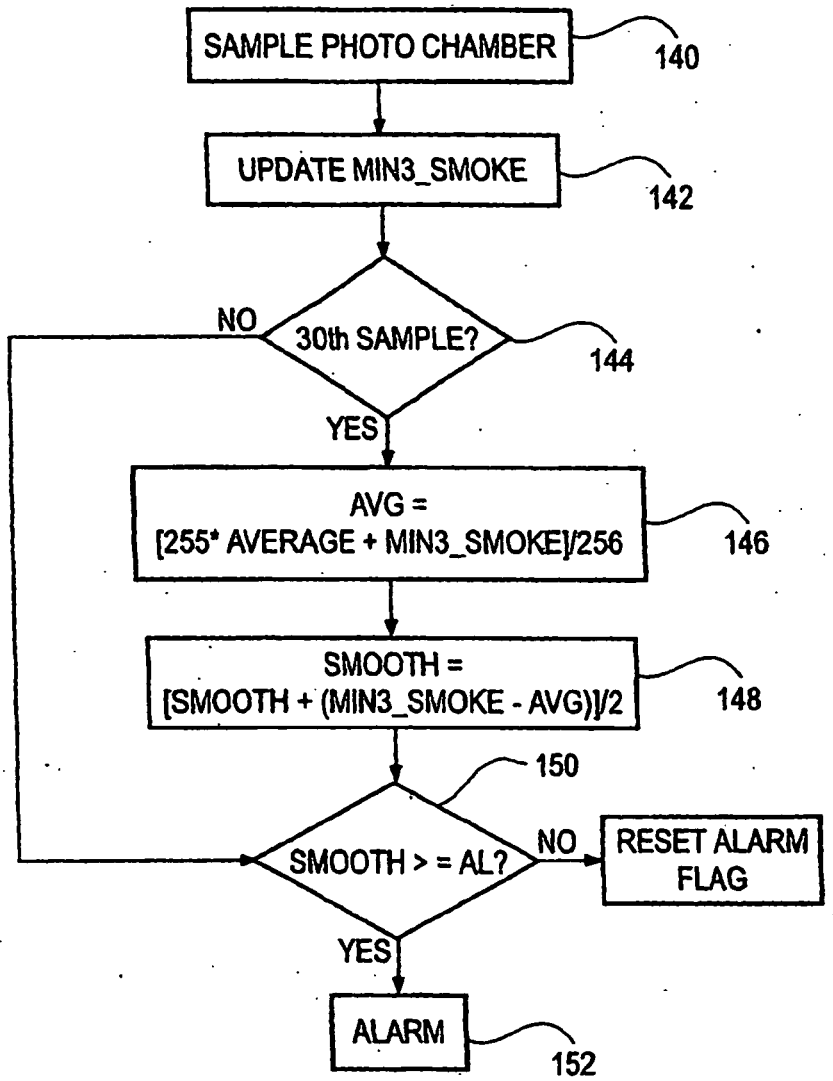
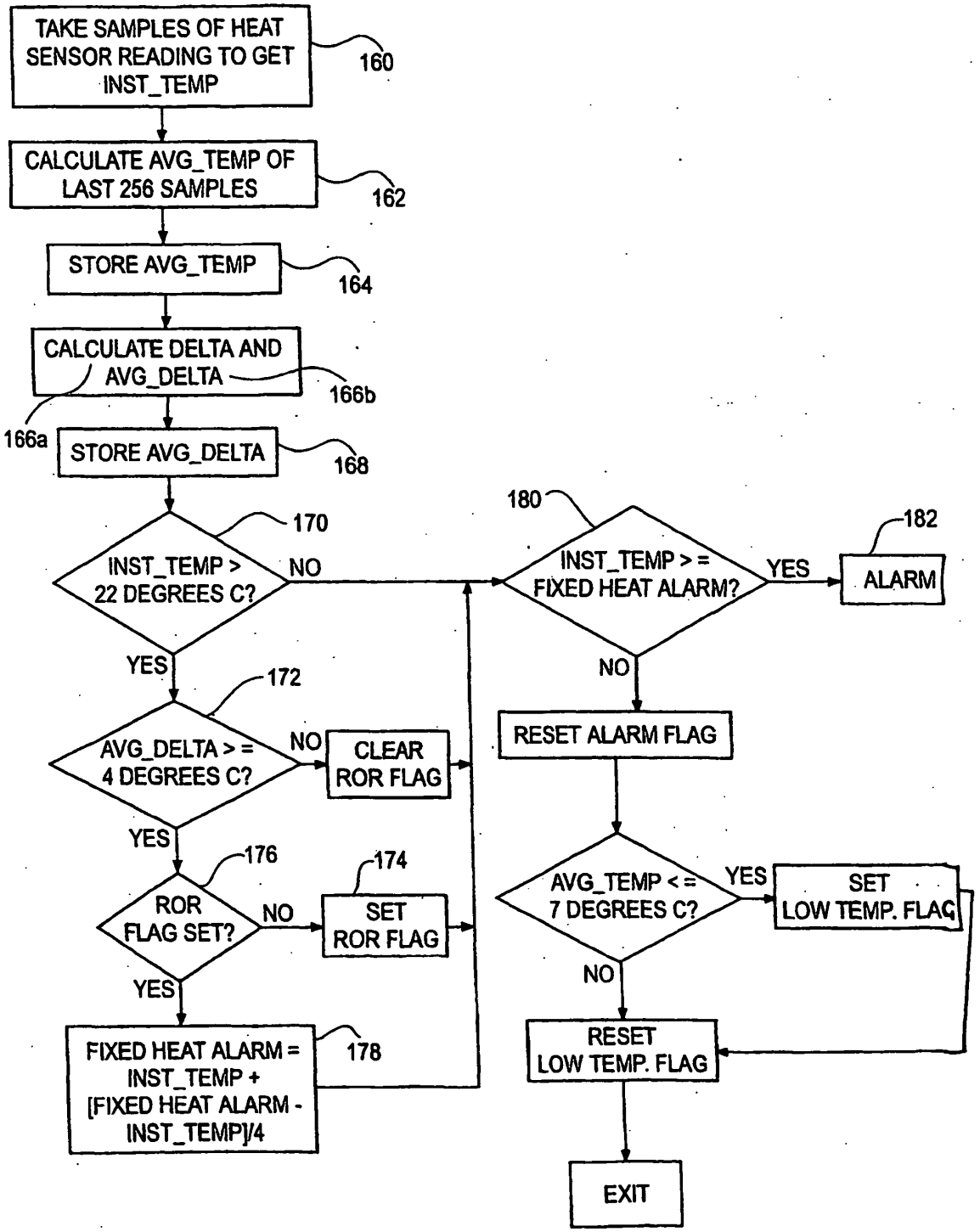

SAMPLE PHOTO CHAMBER
140
UPDATE MIN3_SMOKE
142
NO
30th SAMPLE?
144
YES
AVG =
[255* AVERAGE + MIN3_SMOKE]/256
146
SMOOTH =
[SMOOTH + (MIN3_SMOKE - AVG)]/2
148
150
SMOOTH > = AL?
NO
RESET ALARM FLAG
YES
ALARM
152

FIG. 6


TAKE SAMPLES OF HEAT SENSOR READING TO GET INST_TEMP
160
CALCULATE AVG_TEMP OF LAST 256 SAMPLES
162
STORE AVG_TEMP
164
CALCULATE DELTA AND AVG_DELTA
166b
166a
STORE AVG_DELTA
168
170
INST_TEMP > 22 DEGREES C?
NO
YES
172
AVG_DELTA > = 4 DEGREES C?
NO
CLEAR ROR FLAG
YES
176
ROR FLAG SET?
NO
174
SET ROR FLAG
YES
FIXED HEAT ALARM = INST_TEMP + [FIXED HEAT ALARM - INST_TEMP]/4
178
180
INST_TEMP > = FIXED HEAT ALARM?
YES
182
ALARM
NO
RESET ALARM FLAG
AVG_TEMP < = 7 DEGREES C?
YES
SET LOW TEMP. FLAG
NO
RESET LOW TEMP. FLAG
EXIT

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 5990797 A **[0009]**
- US 5736928 A **[0043]**