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Title: SENSOR POWER MANAGEMENT

Abstract: A sensor power management arrangement (200) includes a signal processing circuit (220) configured to receive signal from a sensor (210), to test the signal against at least one criterion, and to pass the signal for further processing in response to the signal passing the at least one criterion. In this way, only signals that are of a sufficient importance or significance will consume the maximum amount of processing energy and through processing by later processes or circuitry. Should a signal from a sensor (210) not be strong enough or meet other criteria, power will not be wasted in preparing that signal for provision to the microcontroller or microprocessor (260). Additional flexibility in the sensor power management can be realized by adjusting the criteria against which the sensor signal is compared based on a status of the sensor apparatus (200).
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SENSOR POWER MANAGEMENT

[0001] This relates generally to sensor technology, and more specifically to controlling the power consumption of sensors.

BACKGROUND

[0002] Power consumption of electronic devices is becoming an increasingly important aspect of electronic design. Reducing power consumption of various electrical devices can result in cost savings, extension of battery life for portable devices, and address ecological and conservation concerns.

[0003] In the context of sensor based systems, various power management techniques are known as applied to microcontrollers, digital signal processors, and wireless communication systems as may be employed as part of a larger sensor system. These known power management techniques, however, are not applied to the sensor node itself. Sensors, for example, are required to be either "on" or "off" such that the sensor is able to detect the physical phenomenon for which the sensor is designed. For instance, a sensor configured to detect the presence of a person needs to be on to perform that function. Further power savings may be realized should power management techniques be able to be applied to the sensor as part of the larger power management scheme for a sensor network.

SUMMARY

[0004] Pursuant to described embodiments, an apparatus includes a sensor configured to output a signal in response to detecting a phenomenon or outside stimulus. The apparatus also includes a signal processing circuit configured to receive the signal from the sensor and to test the signal against at least one criterion and to pass the signal for further processing in response to the signal passing the at least one criterion. Much of the electrical power consumed in connection with operation of a sensor is consumed as part of the operation of various circuit elements in developing or processing the sensor's signal before provision of that signal to a microcontroller or other processing device of the larger sensing apparatus. Thus, power savings can be realized by testing the sensor signal or information related to the sensor signal at various
points in its initial processing prior to provision to a microcontroller or processing device for the larger sensing apparatus. In this way, only signals that are of a sufficient importance or significance will consume the maximum amount of processing energy and ultimately be processed by the microcontroller or microprocessor. Should a signal from a sensor not be strong enough or meet other criteria, power will not be wasted in preparing that signal for provision to the microcontroller or microprocessor.

[0005] Additional flexibility in the power management of the sensor can be realized by adjusting the criteria against which the sensor signal or information related to the sensor signal may be compared based on a status of the sensor apparatus. For example, if the sensor apparatus is connected to a continuous power supply such as wall socket, the criteria for blocking signals from further processing may be lower such that more signals are fully processed. If, on the other hand, the apparatus is operating off of battery that is drained to a certain level whereby power savings is more important, the criteria against which the sensor signal or information related to the sensor signal can be adjusted such that fewer signals are fully processed, thereby saving additional power.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] FIG. 1 comprises a block diagram of an example sensing apparatus as configured in accordance with various embodiments of the invention.

[0007] FIG. 2 comprises a block diagram of an example sensing apparatus as configured in accordance with various embodiments of the invention.

[0008] FIG. 3 comprises a flow diagram of an example power management method as configured in accordance with various embodiments of the invention.

[0009] FIG. 4 comprises a flow diagram of another example power management method as configured in accordance with various embodiments of the invention.

DETAILED DESCRIPTION OF EXAMPLE EMBODIMENTS

[0010] FIG. 1 illustrates a sensor network including a sensor 110 that is configured to create a signal in response to sensing a physical phenomenon. Such sensors may include motion detectors, light detectors, sound detectors, vibration sensors, and the like. In response to sensing the physical phenomenon for which the sensor is designed to detect, the sensor 110 provides a signal to a sensor signal conditioning circuit 120. The sensor signal conditioning circuit 120 takes the initial sensor signal and processes it into a form receivable and understandable by a
microcontroller unit or digital signal processing circuit 130. The processing circuit 130 processes the signal according to its programming or design such that the signal will trigger certain actions based upon the design and operation of the overall apparatus. For instance, in a wireless setting the processing circuit 130 can control a radio 140 to transmit signals regarding the operation of the sensor 110 via an antenna 150. In this example, an energy storage and management circuit 160 is configured to operate and control power management schemes for each of the sensor signal conditioning circuit 120, the microcontroller unit or digital signal processing circuit 130, and the radio 140. The power management of the microcontroller unit or digital signal processing circuit 130 and of the radio 140 are handled via conventional and known means that require no further description herein. The control of the power management for the sensor signal conditioner circuit 120 by the energy storage management circuit 160 will be described in further detail below.

[0011] The energy storage and management circuit 160 is further configured to receive information from an energy harvest circuit 170. The energy harvest circuit 170 is configured to collect information regarding the power status for the overall apparatus and provide that information to the energy storage and management circuit 160, so that the energy storage and management circuit 160 can take the appropriate action with respect to the power management of the various other circuits of the device.

[0012] FIG. 2 illustrates an example apparatus 200 for implementing power management of sensor signals. In this example, a sensor 210 is configured to output an analog signal in response to detecting a physical phenomenon. As discussed above, the signal is generated in response to any of a variety of physical phenomenon depending on the design and purpose of the given sensor. Such sensors and how the sensors create analog signals in response to physical phenomenon are well known in the art and need no further description herein. The apparatus 200 further includes a signal processing circuit 220 configured to receive the analog signal and to test the analog signal against at least one criterion. The signal processing circuit 220 is further configured to pass for further processing information related to the analog signal in response to the analog signal passing the at least one criterion. For example, depending on how the individual circuit is set up, the analog signal itself may be passed along to other circuitry for further processing in response to passing the at least one criterion, or in another approach a single circuit may just continue processing the analog signal as controlled by stored software or
programming in response to the analog signal passing the at least one criterion. In yet another approach, instead of passing along the analog signal itself for further processing, a processed version of the analog signal or, more generally speaking, information regarding the analog signal may be passed for further processing in response to passing the test criterion. As indicated in FIG. 2, one or more sensors 210 may be connected to a single signal processing circuit 220. In a sensor node network, more than one sensor 210/signal processing circuit 220 is provided.

[0013] The signal processing circuit 220 can be configured to apply any of a number of tests to the analog signal or information relating to the signal before passing the signal or information regarding the signal for further processing. In one approach, the signal processing circuit 220 includes an analog signal conditioning circuit 230 configured to receive the analog signal and condition the analog signal to create a conditioned analog signal. The conditioning in this example may include any type of conditioning necessary to prepare the analog signal for further processing by the circuitry. In this example, the signal processing circuit 220 includes a test circuit 235 configured to test the conditioned analog signal against a signal criterion and to pass the conditioned analog signal for further processing. In response to the conditioned analog signal passing the signal criterion, one example test as may be applied by the test circuit 235 includes determining whether the conditioned analog signal is sufficiently strong compared to the background noise for the system to warrant further processing by the device although other tests are possible. Other example tests include determining whether the conditioned analog signal matches one or more particular time domain signatures, determining the frequency at which the conditioned analog signal crosses a zero line or other value, and detecting and counting peaks and valleys in an analog signal window to name but a few.

[0014] In another approach, the signal processing circuit 220 includes a digital filtering circuit 240 configured to receive a signal corresponding to the analog signal and to digitally filter the signal to create a digitally filtered signal. Digital filtering and conversion of analog signals into digital signals is well known in the art and needs no further description herein. In this approach, the signal processing circuit 220 includes a test circuit 245 configured to test the digitally filtered signal against a digital signal criterion and to pass the digitally filtered signal for further processing in response to the digitally filtered signal passing the digital signal criterion. One example of a test performed by the test circuit 245 relating to the digitally filtered signal is to confirm that the signal has a particular frequency or other characteristic sufficient to warrant
further processing by the device although other tests are possible. Another example test includes sample-rate up-conversion or down-conversion to fit the requirements of later microcontroller or circuit processing.

[0015] In yet another approach, the signal processing circuit 220 includes a microcontroller signal analysis circuit 250 configured to receive a signal corresponding to the analog signal and to analyze the signal to create an analyzed signal. In this approach, the analysis performed to create the analyzed signal may comprise a more substitutive analysis of the signal with respect to the type of signal being sensed by the sensor 210 although other analysis is possible. In this approach, a test circuit 255 is configured to test the analyzed signal against an analyzed signal criterion and to pass the analyzed signal for further processing in response to the analyzed signal passing the analyzed signal criterion. For example, the test circuit 255 in this approach may apply certain substitutive tests to the analyzed signal to make the determination of whether the signal or information related to the signal may be processing further by the sensing device although other tests are possible. Another example test includes determining whether the signal or information regarding a signal from the particular sensor 210 should be transmitted in its entirety, in part, compressed, or not at all based on information received from other sensors in communication with the apparatus 200.

[0016] In this example illustrated in FIG. 2, the signal processing circuit 220 passes the information related to the analog signal to a processing device 260 configured to receive the information and act according to its programming or configuration in response to the information. In various embodiments, the processing device 260 may be a controller, a state processing device, or a packet processing device depending on the configuration of the overall apparatus 200. The processing device 260, in this example, is in communication with a radio 270 to send and receive signals via an antenna 275. The processing device 260 is also in communication with actuators 277 to control physical devices based upon the overall design of the apparatus 200. Such applications of sensing devices or networks are known in the art and need no further description herein.

[0017] By one approach, the apparatus 200 can be configured such that the criterion against which the analog signal or information related to the analog signal is compared or tested can be variable to provide additional flexibility for the design and application of the apparatus 200. In one example for providing this flexibility, a power management unit circuit 280 is in
communication with the signal processing circuit 200. In this example, the power management unit circuit 280 is configured to adjust the at least one criterion in response to a change in electrical power supply condition for the apparatus 200. For instance, the power management unit circuit 280 can be configured to receive information relating to the electrical power supply condition for the apparatus such as from the processing device 260. The information relating to the electrical power supply condition can include, for example, one or more of the type of power source being used by the apparatus 200, the power available from the power source 200, a maximum power draw available from the power source 200, an approximate time left before the power source becomes unavailable for the apparatus 200, or the like.

In another example, the power management unit circuit 280 is configured to adjust the at least one criterion in response to a feedback signal indicating a priority of signals to be passed for further processing. The power management unit circuit 280 in the illustrated example receives the feedback signal indicating the priority of signals to be passed for further processing from the processing device 260. In this case, the feedback signal is used by the power management unit circuit 280 to directly control the criterion based on feedback signal. For instance, the feedback signal can provide a specific direction with respect to each criterion as based on a given programming or operational environment as may be programmed into the processing device 260. By one example, the processing device 260 may note that a particular signal from the sensor 210 indicates a situation of interest such that it is worth operating the sensor 210 in a high power usage mode to obtain an increased amount of signals from the sensor 210 in view of the signal of interest. In that situation, the processing device 260 will send a feedback signal to the power management unit circuit 280 to adjust the test criteria to allow more signals from the sensor 210 to be fully processed. For example, a motion sensor may operate at a low power (i.e., fewer signals being processed) mode until a large indication of motion is sensed, at which time the motion sensor may be changed to a high power (i.e., more signals being processed) mode to obtain finer details regarding the sensed movement. In another example, the processing device 260 can receive signals with information regarding the activity of other sensors, and if another sensor node registered significant activity, in response the processing device 260 can send a feedback signal to the power management unit circuit 280 to cause the power management unit circuit 280 to allow more or all signals from the sensor 210 to be fully processed in view of the other sensor activity. In still another example, the processor circuit 260
is configured to monitor the signals or information regarding the signals from the sensor 210 and
determine that a particular signal or signal pattern is merely background noise. In this case, the
particular signal or signal pattern can be dismissed to limit energy waste processing background
signals.

[0019] The power management unit circuit 280 can be configured to execute either or
both of the above processes (control based on information regarding the power supply and/or
control based on a feedback signal) depending on the application. For example, in a multi-modal
setting (including multiple sensors), the power management unit circuit 280 can be configured to
fully power down one or more of the sensors, or fully activate some or all of the sensors,
according to the information regarding the power supply and or the feedback signal depending
on the power and sensor sensitivity needs at a given time. In a sensor node network with more
than one sensor or signal processing circuit, one power management unit circuit 280 can
communicate with multiple sensors and signal processing circuits or each signal processing
circuit can have a dedicated power management unit circuit 280.

[0020] Those skilled in the art will recognize and appreciate that in such processor
devices such as the signal processing circuit 220 (including the circuits described therein), the
processing circuit 260, and the power management unit circuit 280 can comprise fixed-purpose
hard-wired platforms or can comprise partially or wholly programmable platforms. All of these
architectural options are well known and understood in the art and require no further description
here. Those skilled in the art will further recognize and understand that such circuits may be
comprised of a plurality of physically distinct elements as is suggested by the illustration shown
in FIG. 2. It is also possible, however, to view this illustration as comprising a logical view, in
which case one or more of these elements can be enabled and realized via a shared platform. It
will also be understood that such a shared platform may comprise a wholly or at least partially
programmable platform as are known in the art. In another design option, the test circuits 235,
245, and 255 may include one of the group consisting of low-complexity energy detectors,
max/min comparators, low-complexity filter banks, and combinations thereof.

[0021] In an additional alternative embodiment, the functionality or logic described in
FIG. 2 may be embodied in the form of code that may be executed in a distinct processor circuit.
If embodied in software, each block may represent a module, segment, or portion of code that
comprises program instructions to implement the specified logical function(s). The program
instructions may be embodied in the form of source code that comprises human-readable statements written in a programming language or machine code that comprises numerical instructions recognizable by a suitable execution system such as a processor in a computer system or other system. The machine code may be converted from the source code, etc. If embodied in hardware, each block may represent a circuit or a number of interconnected circuits to implement the specified logical function(s).

[0022] FIG. 3 illustrates an example method. The method includes receiving 310 an analog signal from a sensor configured to output the analog signal in response to detecting a physical phenomenon. The method further includes testing 320 by a signal processing circuit the analog signal against at least one criterion. Information related to the analog signal is passed 330 for further processing by other circuitry in response to the analog signal passing the at least one criterion. Optionally, the method may include modifying 340 the at least one criterion in response to a change in an electrical power supply condition for the other circuitry and/or modifying 350 the at least one criterion in response to receiving a feedback signal indicating a priority of signals to be passed for further processing as described herein.

[0023] The steps of testing 320 the signal and passing 330 the signal for further processing in response to passing the criterion during the testing 320 can be performed in any number of ways. With reference to FIG. 4, one example process for testing and passing a signal or information regarding a signal from a sensor will be described. One of skill in the art will recognize that although the flow chart of FIG. 4 shows a specific order of implementation, it is understood that the order may differ from that which is depicted depending on various factors, such as, for example, the time it takes for various circuits to complete various tasks and the like. For example, the order of two or more blocks may be scrambled relative to the order shown. Also, two or more blocks shown in succession may be executed concurrently or with partial concurrence. Moreover, certain blocks may be omitted altogether depending on the given configuration. It is understood that all such variations are within the scope of these teachings.

[0024] In the illustrated example, the method includes conditioning 410 the analog signal to create a conditioned analog signal and testing 414 the conditioned analog signal against a signal criterion. The method in this approach includes passing 418 the conditioned analog signal for further processing in response to the conditioned analog signal passing the signal criterion. In another aspect, the method includes digitally filtering 420 a signal corresponding to the analog
signal to create a digitally filtered signal and testing 424 the digitally filtered signal against a
digital signal criterion. In this case, the digitally filtered signal is passed 428 for further
processing in response to the digitally filtered signal passing the digital signal criterion. In still
another aspect, the method includes analyzing 430 a signal corresponding to the analog signal to
create an analyzed signal and testing 434 the analyzed signal against an analyzed signal criterion.
Here, the analyzed signal is passed 438 for further processing in response to the analyzed signal
passing the analyzed signal criterion. Each of these various analyses can be done in view of
various criteria such as those described above with reference to FIG. 2.

[0025] In one example, if each of the signal processing, testing, and passing steps as
described with reference to FIG. 4 were configured to work together in a single apparatus, the
apparatus may be described as follows. The apparatus in such an example would include, with
reference to FIG. 2, a sensor 210 configured to output an analog signal in response to detecting a
physical phenomenon and an analog signal conditioning circuit 230 configured to receive the
analog signal and to condition the analog signal to create a conditioned analog signal. The
apparatus further includes an analog test circuit 235 configured to test the conditioned analog
signal against a signal criterion and to pass the conditioned analog signal for further processing in
response to the conditioned analog signal passing the signal criterion. The next portion of
processing in this apparatus includes a digital filtering circuit 240 configured to receive the
conditioned analog signal in response to the conditioned analog signal passing the signal
criterion. In this case, the digital filtering circuit 240 is configured to digitally filter the
conditioned analog signal to create a digitally filtered signal. A digital test circuit 245 is
configured to test the digitally filtered signal against a digital signal criterion and to pass the
digitally filtered signal for further processing in response to the digitally filtered signal passing
the digital signal criterion. In a further portion of the analysis, a microcontroller signal analysis
circuit 250 is configured to receive the digitally filtered signal and to analyze the digitally
filtered signal to create an analyzed signal. Here, an analyzed signal test circuit 255 is
configured to test the analyzed signal against an analyzed signal criterion, and to pass the
analyzed signal for further processing in response to the analyzed signal passing the analyzed
signal criterion. The analog test circuit 235, the digital test circuit 245, and the analyzed signal
test circuit 255 in various approaches may comprise one or more of the group consisting of low-
complexity energy detectors, max/min comparators, low-complexity filter banks, and
combinations thereof. Using such circuitry and approaches, the test circuits can be configured
to analyze and pass the signals in any of a variety of ways that may be suitable to a given
application.

[0026] A power management unit circuit 280 is in communication with the analog test
circuit 235, the digital test circuit 245, and the analyzed signal test circuit 255. In this
configuration, the power management unit circuit 280 is configured to adjust the signal criterion,
digital signal criterion, and analyzed signal criterion in response to a change in an electrical
power supply condition for the apparatus. In one optional approach, the power management unit
circuit 280 is configured to receive a power supply signal indicating the electrical power supply
condition for the apparatus. In response to receiving a power supply signal indicating a large
electrical power supply for the apparatus, the power management unit circuit 280 is configured
to adjust the signal criterion, the digital signal criterion, and the analyzed signal criterion to allow
more signals to pass for further processing. In another approach, the power management unit
circuit 280 is configured to, in response to receiving a power supply signal indicating a restricted
electrical power supply to the apparatus, adjust the signal criterion, the digital signal criterion,
and the analyzed signal criterion to allow further signals to pass for further processing, thereby
conserving electrical power.

[0027] In a further aspect, the power management unit circuit 280 is configured to
receive a feedback signal indicating a priority of signals and in response to receiving the
feedback signal to adjust the signal criterion, the digital signal criterion, and the analyzed signal
criterion to allow certain signals to pass for further processing in accord with the feedback signal.
In this aspect, the power management unit circuit 280 can react to feedback signals from
elsewhere in the device with respect to how sensitive the sensor needs to be or the number of
sensors that need to be fully activated as described above.

[0028] So configured, systems including sensor devices can have improved power
management controls through control of the processing of signals generated by various sensors.
For instance, because sensors at their base level usually initiate in the first instance an analog
signal, if that initial analog signal does not pass a certain criterion, then further power is not
wasted by processing that signal. To further process that analog signal, for example, by turning
the analog signal into a digital signal for digital processing to thereby save energy. Additional
processing steps for signals generated by sensors can then be successive avoided depending on
the type of sensor and phenomenon being detected and tracked by a given system. Using the power management techniques described in this disclosure, not only can power savings be realized with respect to a single sensor, multi-sensor systems can also be manipulated to realize power savings using the same techniques.

[0029] Many modifications and variations of the described examples are possible. For example, the sensor and sensor signal conditioning circuit may be combined into a single housing with other circuitry located elsewhere. Those skilled in the art will appreciate that many other embodiments are possible within the scope of the claimed invention.
CLAIMS

What is claimed is:

1. An apparatus comprising:
   a sensor configured to output an analog signal in response to detecting a physical phenomenon; and
   a signal processing circuit configured to receive the analog signal and to test the analog signal against at least one criterion and to pass for further processing information related to the analog signal in response to the analog signal passing the at least one criterion.

2. The apparatus of claim 1 wherein the signal processing circuit comprises:
   an analog signal conditioning circuit configured to receive the analog signal and condition the analog signal to create a conditioned analog signal; and
   a test circuit configured to test the conditioned analog signal against a signal criterion and to pass the conditioned analog signal for further processing in response to the conditioned analog signal passing the signal criterion.

3. The apparatus of claim 1 wherein the signal processing circuit comprises:
   a digital filtering circuit configured to receive a signal corresponding to the analog signal and digitally filter the signal to create a digitally filtered signal; and
   a test circuit configured to test the digitally filtered signal against a digital signal criterion and to pass the digitally filtered signal for further processing in response to the digitally filtered signal passing the digital signal criterion.

4. The apparatus of claim 1 wherein the signal processing circuit comprises:
   a microcontroller signal analysis circuit configured to receive a signal corresponding to the analog signal and analyze the signal to create an analyzed signal; and
   a test circuit configured to test the analyzed signal against an analyzed signal criterion and to pass the analyzed signal for further processing in response to the analyzed signal passing the analyzed signal criterion.
5. The apparatus of claim 1 further comprising a power management unit circuit in communication with the signal processing circuit, the power management unit circuit configured to adjust the at least one criterion in response to a change in an electrical power supply condition for the apparatus.

6. The apparatus of claim 1 further comprising a power management unit circuit in communication with the signal processing circuit, the power management unit circuit configured to adjust the at least one criterion in response to a feedback signal indicating a priority of signals to be passed for further processing.

7. A method comprising:
   receiving an analog signal from a sensor configured to output the analog signal in response to detecting a physical phenomenon; and
   testing by a signal processing circuit the analog signal against a least one criterion; and passing for further processing by other circuitry information related to the analog signal in response to the analog signal passing the at least one criterion.

8. The method of claim 7 further comprising:
   conditioning the analog signal to create a conditioned analog signal;
   testing the conditioned analog signal against a signal criterion; and
   passing the conditioned analog signal for further processing in response to the conditioned analog signal passing the signal criterion.

9. The method of claim 7 further comprising:
   digitally filtering a signal corresponding to the analog signal to create a digitally filtered signal;
   testing the digitally filtered signal against a digital signal criterion; and
   passing the digitally filtered signal for further processing in response to the digitally filtered signal passing the digital signal criterion.
10. The method of claim 7 further comprising:
   analyzing a signal corresponding to the analog signal to create an analyzed signal;
   testing the analyzed signal against an analyzed signal criterion; and
   passing the analyzed signal for further processing in response to the analyzed signal
   passing the analyzed signal criterion.

11. The method of claim 7 further comprising modifying the at least one criterion in response
to a change in an electrical power supply condition for the other circuitry.

12. The method of claim 7 further comprising modifying the at least one criterion in response
to receiving a feedback signal indicating a priority of signals to be passed for further processing.

13. An apparatus comprising:
   a sensor configured to output an analog signal in response to detecting a physical
   phenomenon;
   an analog signal conditioning circuit configured to receive the analog signal and to
   condition the analog signal to create a conditioned analog signal;
   an analog test circuit configured to test the conditioned analog signal against a signal
   criterion and to pass the conditioned analog signal for further processing in response to the
   conditioned analog signal passing the signal criterion;
   a digital filtering circuit configured to receive the conditioned analog signal in response
   to the conditioned analog signal passing the signal criterion and to digitally filter the conditioned
   analog signal to create a digitally filtered signal;
   a digital test circuit configured to test the digitally filtered signal against a digital signal
   criterion and to pass the digitally filtered signal for further processing in response to the digitally
   filtered signal passing the digital signal criterion;
   a microcontroller signal analysis circuit configured to receive the digitally filtered signal
   and to analyze the digitally filtered signal to create an analyzed signal; and
   an analyzed signal test circuit configured to test the analyzed signal against an analyzed
   signal criterion and to pass the analyzed signal for further processing in response to the analyzed
   signal passing the analyzed signal criterion; and
a power management unit circuit in communication with the analog test circuit, the
digital test circuit, and the analyzed signal test circuit, the power management unit circuit
configured to adjust the signal criterion, the digital signal criterion, and the analyzed signal
criterion in response to a change in an electrical power supply condition for the apparatus.

14. The apparatus of claim 13 wherein the power management unit circuit is configured to:

receive a power supply signal indicating the electrical power supply condition for the
apparatus;

in response to receiving a power supply signal indicating a large electrical power supply
for the apparatus, adjust the signal criterion, the digital signal criterion, and the analyzed signal
criterion to allow more signals to pass for further processing; and

in response to receiving a power supply signal indicating a restricted electrical power
supply for the apparatus, adjust the signal criterion, the digital signal criterion, and the analyzed signal
criterion to allow fewer signals to pass for further processing.

15. The apparatus of claim 13 wherein the power management unit circuit is configured to:

receive a feedback signal indicating a priority of signals; and

in response to receiving the feedback signal, adjust the signal criterion, the digital signal
criterion, and the analyzed signal criterion to allow certain signals to pass for further processing
in accord with the feedback signal.

16. The apparatus of claim 13 wherein the analog test circuit, the digital test circuit, and the
analyzed signal test circuit comprise one of the group consisting of: low-complexity energy
detectors, max/min comparators, low-complexity filter banks, and combinations thereof.
FIG. 3

310  RECEIVE SIGNAL FROM SENSOR

320  TEST THE SIGNAL

330  PASS THE SIGNAL FOR FURTHER PROCESSING IN RESPONSE TO PASSING THE CRITERION

340  MODIFY THE CRITERION IN RESPONSE TO CHANGE IN ELECTRICAL POWER SUPPLY

350  MODIFY THE CRITERION IN RESPONSE TO CHANGE IN PRIORITY OF SIGNALS TO BE PASSED

FIG. 4

310  RECEIVE SIGNAL FROM SENSOR

410  CONDITION THE ANALOG SIGNAL

414  TEST THE CONDITIONED ANALOG SIGNAL

418  PASS THE CONDITIONED ANALOG SIGNAL FOR FURTHER PROCESSING IN RESPONSE TO PASSING THE SIGNAL CRITERION

420  DIGITALLY FILTER THE SIGNAL

424  TEST THE DIGITALLY FILTERED SIGNAL

428  PASS THE DIGITALLY FILTERED SIGNAL FOR FURTHER PROCESSING IN RESPONSE TO PASSING THE DIGITAL SIGNAL CRITERION

430  ANALYZE THE SIGNAL

434  TEST THE ANALYZED SIGNAL

438  PASS THE ANALYZED SIGNAL FOR FURTHER PROCESSING IN RESPONSE TO PASSING THE ANALYZED SIGNAL CRITERION
**PATENT COOPERATION TREATY**

**PCT**

**INTERNATIONAL SEARCH REPORT**

(PCT Article 18 and Rules 43 and 44)

<table>
<thead>
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<th>Applicant's or agent's file reference</th>
<th>FOR FURTHER ACTION</th>
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**Applicant**

TEXAS INSTRUMENTS INCORPORATED

This International search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 3 sheets.

- It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**
   a. With regard to the **language**, the international search was carried out on the basis of:
      - [X] the international application in the language in which it was filed
      - [ ] a translation of the international application into [language], which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b))
   b. [ ] This international search report has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43.6fc(a)).
   c. [ ] With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, see Box No. I.

2. [ ] **Certain claims were found unsearchable** (See Box No. II)

3. [ ] **Unity of invention is lacking** (See Box No. III)

4. With regard to the title,
   - [X] the text is approved as submitted by the applicant.
   - [ ] the text has been established by this Authority to read as follows:

5. With regard to the **abstract**, 
   - [X] the text is approved as submitted by the applicant.
   - [ ] the text has been established, according to Rule 38.2, by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. With regard to the drawings,
   a. the figure of the **drawings** to be published with the abstract is Figure No. 2 as suggested by the applicant.
   b. [ ] as selected by this Authority, because the applicant failed to suggest a figure.
   - [X] as selected by this Authority, because this figure better characterizes the invention.
   - [ ] none of the figure is to be published with the abstract.

Form PCT/ISA/210 (first sheet) (July 2009)
A. CLASSIFICATION OF SUBJECT MATTER

G05F 1/565(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
G05F 1/565; G05B 13/02; H04B 7/00; H01Q 11/12; G01V 1/28; H04B 1/04; H03F 1/32; H04B 1/40

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS/KIPO internal & Keywords: sensor, detector, power management, criterion, threshold, AID converter, analysis

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<td>A</td>
<td>US 2010-0145622 A1 (JAMAL HAQUE et al.) 10 June 2010 See paragraphs [0002]-[0003], [0015]-[0017], [0022]-[0030], claims 1,11 and figures 1-3.</td>
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<td>US 7904185 B2 (SRI W. SRI-JAYANTHA et al.) 08 March 2011 See column 1, line 4 - column 2, line 63, claims 1-7,31-33 and figures 1-5.</td>
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<td>EP 1681771 B1 (NORHOP GRUMMAN CORP.) 03 December 2008 See abstract, paragraphs [0031]-[0035] and figures 3-5.</td>
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<td>US 2005-0159116 A1 (WEI XIONG) 21 July 2005 See abstract, paragraphs [0019]-[0012], [0034]-[0039] and figures 1-2.</td>
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Further documents are listed in the continuation of Box C.

See patent family annex.

Date of the actual completion of the international search
23 August 2013 (23.08.2013)

Date of mailing of the international search report
23 August 2013 (23.08.2013)

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