

PROGRAMMABLE THERMOMETER AND TEMPERATURE BADGE

5 FIELD OF INVENTION

Embodiments of the present invention relate to the field of thermometers for measuring human temperature. In particular, embodiments of the present invention relate to programmable thermometers that can be used as temperature badges to allow other persons to view the temperature of the wearer.

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BACKGROUND

Digital thermometers that measure the body temperature of a human being have been on the market for many years. These thermometers generally include a
15 temperature sensitive portion that may be placed, for example, under the tongue of the user, and a digital display which provides a readout of the user's temperature.

In hospitals, these thermometers are routinely used to measure the temperature of patients. During times of epidemic or heightened medical alert, all visitors to
20 hospitals or other public places are monitored upon entry to determine if they are running a fever. Such precautions may be very useful in preventing the spread of infectious diseases. However, these measures are very manpower intensive, as they require personnel to set up temperature measurement stations and physically man all entrance points into a facility.

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One prior art device attempts to overcome this problem by strapping a thermometer to a user's head. Unfortunately, this arrangement is very inconvenient for the user, as it is difficult to use. For example, reading a user's own temperature, or changing the battery in the unit can be very difficult.
30 Additionally, this prior device does not provide for advanced programming or alarms to alert a user that they may have developed a fever.

It would therefore be an improvement in the art if a device or system could be devised that overcomes one or more of the above mentioned problems.

5 SUMMARY

One aspect of the present invention provides a programmable digital thermometer for a human user comprising: a thermistor to allow the user to take a body temperature of the user; a digital display capable of showing the temperature of the user; a printed circuit board having an integrated circuit (IC) configured to allow the user to operate the thermometer in one of a temperature taking mode, a temperature badge mode and a programming mode; and a power source.

15 In alternate embodiments, the programmable digital thermometer may further include at least one of: a red LED to indicate a fever condition of the user when in the temperature badge mode; a green LED to indicate a no fever condition of the user when in the temperature badge mode; and an alarm buzzer to alert the user of a fever condition.

20 In further embodiments of the programmable digital thermometer, while in the programming mode, the user may set various operating parameters of the thermometer. The various operating parameters may be selected from a group consisting of a set temperature indicating a fever or no fever status for the user, a temperature display duration, and a reminder alarm time to prompt the user to retake their temperature.

25 An alternate aspect of the present invention provides a temperature badge comprising the programmable digital thermometer as described above, and means to attach the programmable digital thermometer to a user; wherein the means to attach the digital thermometer to a user further comprises: a holder configured to receive the digital thermometer; and a strap which allows the user to wear the temperature badge such that the temperature of the user is visibly displayed.

A further aspect of the present invention provides a method for indicating the body temperature of a user to others, the method including the steps of: providing a digital thermometer, the digital thermometer comprising: a thermistor
5 to allow the user to take a body temperature of the user; a digital display capable of showing the temperature of the user; a printed circuit board having an integrated circuit (IC) configured to allow the user to operate the thermometer in one of a temperature taking mode, a temperature badge mode and a programming mode; and a power source.

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In an alternate embodiment the digital thermometer further comprises at least one of: a red LED to indicate a fever condition of the user when in the temperature badge mode; a green LED to indicate a no fever condition of the user when in the temperature badge mode; and an alarm buzzer to alert the user
15 of a fever condition.

In further embodiments of the method, while in the programming mode, the user may set various operating parameters of the thermometer. The various operating parameters may be selected from a group consisting of a set
20 temperature indicating a fever or no fever status for the user, a temperature display duration, and a reminder alarm time to prompt the user to retake their temperature.

Additional embodiments of the method may further include a step for providing
25 means to attach the programmable digital thermometer to a user; wherein the means to attach the digital thermometer to a user further comprises: a holder configured to receive the digital thermometer; and a strap which allows the user to wear the temperature badge such that the temperature of the user is visibly displayed.

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BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the invention will be better understood and readily apparent to one of ordinary skill in the art from the following written description, by way of example only, and in conjunction with the drawings, in which:

- 5 Figure 1 illustrates a top perspective view of one embodiment of a temperature badge according to the present invention;

Figure 2 illustrates the temperature badge of Figure 1 with the thermometer and cradle separated;

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Figure 3A illustrates a front view of the temperature badge of Figures 1 and 2 in one operational configuration;

Figure 3B illustrates a side view of the temperature badge of Figure 3A;

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Figure 4 illustrates an exploded perspective view of possible components that may be used with the thermometer portion of the temperature badge of Figures 1-3B; and

- 20 Figure 5 illustrates a close-up view of one embodiment of a display that may be used with the temperature badge of Figures 1-4.

DETAILED DESCRIPTION

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- Figure 1 illustrates a top perspective view of one embodiment of a temperature badge 10 according to the present invention. The temperature badge 10 includes a thermometer 20 and a cradle 50. Figure 2 illustrates the temperature badge 10 of Figure 1 with the thermometer 20 and cradle 50 separated. Figure 3A illustrates a front view of the temperature badge 10 of Figures 1 and 2 in one operational configuration. Figure 3B illustrates a side view of the temperature badge 10 of Figure 3A. Figure 4 illustrates an exploded perspective view of possible components that may be used with the thermometer 20 of the temperature badge 10 of Figures 1-3B. Figure 5 illustrates a close-up view of
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one embodiment of a display 30 that may be used with the temperature badge 10 of Figures 1-4

5 With continuing reference to Figures 1-5, the thermometer 20 includes a body 22, a temperature measuring portion 24, and a display 30. In a preferred embodiment, the thermometer 20 includes a printed circuit board (PCB) 40 secured within the body 20 via a frame 42. The PCB 40 includes a switch 41 that may be activated to enter the various operating modes for the temperature badge 10. In some embodiments, the PCB40 may be an integrated circuit that is
10 mounted within the body 22. This will be discussed in more detail below.

The thermometer 20 may also include a first LED 26a and/or a second LED 26b, as well as a button 28 that may be used to activate the switch 41 to engage the various modes of the thermometer 20. In a preferred embodiment, the first LED
15 26a is colored red, while the second LED 26b is colored green. It is understood that other colors may also be used.

The thermometer 20 may also include a battery tray 46 and battery retainer 48 connected to an end cap 49. The end cap 49 is slidably connected to the body
20 22 to allow the tray 46 to be slid outward to replace a battery 47. A buzzer or other vibration or noise producing device 45 may also be provided, and electrically connected to the PCB 40. The specific operation of the temperature badge 10 and the thermometer 20 will be discussed in detail below.

25 One means of wearing the thermometer 20 to provide a temperature badge 10 is to use the cradle 50. The cradle 50 may include a hook portion 52 that is configured to receive a strap or lanyard 54. A user may then wear the temperature badge around their neck using the strap 54. The cradle 50 is configured to receive the thermometer in a cavity 56 such the thermometer 20 is
30 securely held in place. It is understood that there are many other ways to provide for a wearable temperature badge 10, including but not limited to providing a hook on the body 22 of the thermometer 20. For example, a clip 53 may be affixed to the cradle 50 or to the body 22 of the thermometer 20 such

that it may be clipped onto any part of the clothing or belt to hold and visibly display the temperature measured by the thermometer 20.

5 In a preferred embodiment, the frame 42 may be made from polypropylene plastic. The cradle 50, body 22, end cap 49, and tray 46 may be made from acrylonitrile butadiene styrene (ABS) plastic. The ABS plastic may be of a biocompatible, medical grade. Alternately other types of plastics that may be made from an injection molding or other process may also be used. The battery
10 retainer 48 may be made from a conductive metal or metal alloy to provide an electrical connection between the battery 47 and the PCB 40. In one embodiment, the battery 47 may be a single Lithium ion CR2032 coin battery. It is understood that other types of batteries may also be used.

15 In a preferred embodiment, the buzzer 45 may be a 12mm disc piezo buzzer having a resonant frequency of 5.5 KHz to 6.5 KHz. It is understood that other types of buzzers or sound producing devices may also be used. The temperature measuring portion 24 may be, by way of example and not limitation, a 503ET thermistor as is known in the art for use with a standard oral digital thermometer.

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The PCB 40 may be a single or multi-layered PCB that is sized and configured to fit within the body 22 of the thermometer 20. The PCB 40 may include an integrated circuit (IC) such as a microcontroller or an Application Specific Integrated Circuit (ASIC) (not shown), that provides the various functionalities for
25 the thermometer 20, which will be described in more detail below. In a preferred embodiment, the chip may be a PIC16F913 Microchip manufactured by Microchip Technology Inc. Standard electrical connections may be provided between the battery 47, PCB 40, LED's 26a, 26b, display 30, temperature thermistor 24, and switch 29, as is known to those of skill in the art.

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In a preferred embodiment, the thermometer 20 uses a standard interrupt driven push button 28 interface. It may have a measurement accuracy of 0.02°C or better, and a measurement range from 32.0°C to 42.0°C. The red and green LEDs 26a, 26b may have a minimum luminous intensity of 90mcd. Additionally, the

thermometer 20 may be provided with test pads (not shown) for automatic self testing.

5 The display 30 may be a standard 3.5 digit LCD display, as is known in the art for use with thermometers. It is understood that other types of displays may also be used. The display 30 is illustrated in Figure 5.

10 In a preferred embodiment, the microcontroller Input/Output (IO) pins may drive the LEDs 26a, 26b directly at not more than 10mA forward current. The microcontroller may have one IO pin that generates a hardware interrupt to wake up the microcontroller from the sleep mode, and one IO pin to activate an automatic self-test routine. In some embodiments, the microcontroller may come with in-circuit programming capability and code protection features, and may have at least two ADC channels with a minimum 10-bit resolution and internal reference voltage tied to 15 Vdd and Vss (power supply voltage of the IC). The microcontroller may have at least 16 bytes of EEPROM to accommodate the storage of operating parameters.

In a preferred embodiment, the microcontroller may be programmed to operate the thermometer 20 in three different operational modes, Thermometer mode, 20 Temperature Badge mode, and Menu Adjustment mode. In this embodiment, the current consumption for each operating mode would not exceed the following:

Thermometer Mode: less than 250uA average with LCD 30 and the analogue circuit switched on.

25 **Temperature Badge Mode:** less than 10uA average with one LED 26a, 26b flashing for 2 milliseconds at 1 second intervals.

Menu Adjustment Mode: less than 100uA average with LCD 30 enabled and the analogue circuit switched off.

30 With continuing reference to the drawings, the various operational aspects of the thermometer badge 10 will now be discussed. It is understood that there are many variations in operating frequencies, mode selection, power consumption, operating times, button 28 press times, etc., and that all such variations are deemed to fall within the scope of the appended claims.

In a preferred embodiment, the microcontroller in the thermometer 20 may operate at two different frequencies. For example, the microcontroller may operate at a low frequency (e.g. 32KHz) for normal operation, which consumes less than 11uA of power; and at a high frequency (e.g 4MHz and above) in order to sound the buzzer 45 at 4MHz, 5MHz and 6MHz. The switching of the operating frequency (from low to high and vice versa) may be seamless and may not generate or require any internal reset. The microcontroller may also have a low power sleep mode that consumes less than 100nA of power.

During operation, the microcontroller may enter sleep mode whenever it is required to delay for a predetermined duration, eg. 0.25 sec, 0.5 sec, 1 sec and 2 sec, and wake up automatically using the internal timer that is part of the microcontroller. Alternately, the microcontroller may provide for a "Long sleep mode" in which the unit remains dormant until awoken by a push of the button 28.

In a preferred embodiment, once the temperature badge is turned on by inserting a battery into the thermometer portion, the temperature badge 10 will enter the Thermometer mode to allow a user to take their temperature. Similarly, when in the long sleep mode, pressing the button 28 will activate the Thermometer mode. The user may press the push and release button 28 to take their temperature. The display 30 could, for example, read "Lo" on the LCD display 30 until the measured temperature exceeds a minimum measurement range. The temperature reading may be updated at 0.5 second intervals. The thermometer 20 may then automatically enter Temperature Badge mode after the user's temperature is taken.

In Temperature Badge mode, the microcontroller may be programmed to flash the Red LED 26a if the temperature of the user is more than or equal to a set-point temperature. Similarly, the microcontroller may be programmed to flash the Green LED 26b if the temperature of the user is less than the set point temperature. In a preferred embodiment, the thermometer 20 may include both a red and a green LED 26a, 26b. The LED's 26a, 26b may flash, by of example and not limitation, for a duration of 2 milliseconds at 1 second intervals.

The user may push and release the button 28 to recall their last taken temperature (after displaying "dL"), set-point temperature (after displaying "SP") and flashing duration (after displaying "Hr"). The user may push and hold the button 28 for 2 seconds to return to Thermometer mode. It is understood that other durations may also be used.

While in the Thermometer mode, the user may push and hold the button 28 for 2 seconds to enter the Menu Adjustment mode. A default display, such as "dL" may be shown. The user may then push and release the button 28 to toggle from "dL" to "SP" to "Hr" and back to "dL". The user may push and hold the button 28 for 2 seconds to confirm selecting "dL" (to recall the last 10 temperature readings), "SP" (to adjust the Set-Point temperature) or "Hr" (to adjust the flashing duration).

While in the temperature recall sub menu "dL", the display 30 may show "001" for one second, followed by the latest temperature taken. The user may push and release button 28 to display "002" for one second followed by the second latest temperature taken, etc. The display 30 may show "End" when at the end of the data records. The user may push and release button 28 to repeat the sequence again. It is understood that more than 10 temperature readings may be stored as desired.

While in the Set-Point adjustment sub menu "SP", the display 30 may show the current Set-Point value. The user may push and release button 28 to increment the set-point by, for example, 0.1°C . In a preferred embodiment, the valid set-point temperature is between 37.0°C and 38.0°C . It is understood that other set points may also be used. While programming the thermometer 20 using the "SP" sub menu, when 38.0°C is reached, pushing and releasing the button 28 one more time will return the display 30 to 37.0°C . The user may push and hold button 28 for 2 seconds to confirm and save the value.

While in the flashing duration adjustment sub menu "Hr", the thermometer 20 will display the current flashing duration value. The user may push and release button 28 to decrease the flashing duration by, for example, 0.5 Hour. It is understood that other intervals may also be used. In a preferred embodiment, the flashing duration may be between 1.0 and 12.0 hours. While programming the thermometer 20 using

the "Hr" sub menu, when one hour is reached, pushing and releasing the button 28 will return to the 12 hour duration. The user may push and hold button 28 for 2 seconds to confirm and save the value.

- 5 While in the Menu Adjustment mode, if the button 28 is not pressed for more than, by way of example and not limitation, 10 seconds, the thermometer 20 of the Temperature Badge 10 will automatically return to Thermometer mode. Other default values may also be used.
- 10 During power up, the firmware of the microcontroller may check the calibration flag in the EEPROM to see if it has been calibrated. The microcontroller may enter the calibration routine automatically if the thermometer portion 20 of the Temperature Badge 10 has not been calibrated. By way of example and not limitation, calibration may be done at 37.0°C by immersing the thermometer portion 20 of the Temperature
- 15 Badge 10 into a liquid bath of 37.0°C for at least 10 seconds, followed by pressing and releasing the button 28. When calibration is completed, the buzzer 45 will sound and LEDs 26a, 26b may flash 5 times to indicate the end of the calibration process. The user may remove the battery 47 and re-insert to start normal operations. After the Temperature Badge 10 is calibrated, it can be forced to redo the calibration. This
- 20 may be done, for example while in the Thermometer mode, by immersing the thermometer portion 20 of the Temperature Badge 10 into cold water of less than 2.0°C for 10 seconds, and pressing and releasing the button 28. The user may then enter the calibration routine as described above.
- 25 During initial power up at the factory, if the test pad is activated by the tester, the firmware automatically enters the self-test mode. A 30K Ω resistor may be connected to the pads of the thermistor 24 (at this stage the thermistor is not soldered yet) to simulate the temperature of 37.0°C. Upon detecting the button 28 being pushed and released the firmware may sound the buzzer 45, flash the Red and Green LEDs 26a,
- 30 26b, and display from "00.0 °C" to "99.9 °C" in sequence. It then converts the analogue input to digital and compares it with pre-determined pass band limits. If it is outside the pass band limits the Red LED 26a may light up continuously. If it is within the pass band limits the Green LED 26b may light up continuously.

It is understood that the various operational parameters discussed above, including but not limited to button 28 push times, temperature limits, self test procedures, flash durations, and other programmable features may be adjusted as desired. All such changes in operating parameters are deemed to fall within the scope of the appended claims.

Embodiments of the temperature badge 10 of the present invention provide several advantages over the prior art. The temperature badge combines functions of a clinical thermometer as well as single or multiple-level temperature indicators. The temperature levels are user configurable. There is a timing mechanism which allows users to set the intervals between temperature measurements. The temperature badge also provides an internal logging function to keep a history of measured temperatures.

One example usage of the temperature badge of the present invention is in the monitoring of community temperatures during, for example, SARS, H1N1, or other disease outbreaks. This temperature badge removes the need to set up temperature measurement stations at the entrance to various locations in order to measure the temperature of each individual. Instead, the temperature badge allows a user to measure their own body temperature and display it prominently to indicate the level at which the measured temperature falls. The level at which the measured temperature falls may be prominently displayed, and may time out after a user configured interval. Users may be reminded to re-measure their temperature once the device has timed out. The temperature threshold needed to trigger an alarm may be user configurable. The LCD display provides easy user configuration and a highly visible temperature display which allows others to view the user's temperature. The timeout period for re-taking the user's temperature may also be set according to different guidelines.

Using embodiments of the temperature badge as described above, individuals can track their own body temperature by recalling the previous temperature measurements. The Temperature Badge may operate in 3 different modes: Badge mode to indicate a "Fever" or "No Fever" status; Thermometer mode to function as

a normal clinical thermometer; and Menu Mode for configuring the Temperature Badge.

5 In the Badge mode, the display or LEDs may indicate whether a measured temperature of a user is above or below a user configured threshold temperature. An alarm buzzer may also be activated if the temperature is above a user configurable threshold temperature. This provides additional functionality of the badge to indicate not only "fever" or "No Fever", but other situations as well. For example, the display, LEDs and buzzer may help to ensure that a subject is
10 maintained at an optimal temperature preset by the user. The operating temperature range may be pre-programmed to ensure that the subject maintains a temperature which is below an optimal temperature. In some embodiments, the subject need not be a human being. The temperature badge may thus be used by, for example medical personnel when monitoring persons coming into a medical
15 facility. Alternately, the temperature badge may be used, for example, by academic personnel to monitor a condition of their students, and to identify students who may be running a fever. Such students could then be referred to medical personnel for further follow-up prior to spreading disease throughout the classroom.

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It will be appreciated by a person skilled in the art that numerous variations and/or modifications may be made to the present invention as shown in the specific embodiments without departing from the spirit or scope of the invention as broadly described. The present embodiments are, therefore, to be considered in all respects
25 to be illustrative and not restrictive.

CLAIMS

1. A programmable digital thermometer for a human user comprising:
 - 5 a thermistor to allow the user to take a body temperature of the user;
 - a digital display capable of showing the temperature of the user;
 - 10 an integrated circuit (IC) configured to allow the user to selectively operate the thermometer in one of a temperature taking mode, a temperature badge mode and a programming mode; and
 - a power source.
2. The programmable digital thermometer of claim 1, wherein the digital thermometer further comprises at least one of:
 - 15 a first LED to indicate a fever condition of the user when in the temperature badge mode;
 - a second LED to indicate a no fever condition of the user when in the temperature badge mode; and
 - 20 an alarm buzzer to alert the user of a fever condition.
3. The programmable digital thermometer of claim 2, wherein the first LED is colored red and the second LED is colored green.
4. The programmable digital thermometer of any one of the previous claims, wherein while in the programming mode, the user may set
 - 25 various operating parameters of the thermometer.
5. The programmable digital thermometer of claim 5, wherein the various operating parameters are selected from a group consisting of a set
 - 30 temperature indicating a fever or no fever status for the user, a temperature display duration, and a reminder alarm time to prompt the user to retake their temperature.

6. A temperature badge comprising the programmable digital thermometer of any one of the previous claims, and means to attach the programmable digital thermometer to a user;
wherein the means to attach the digital thermometer to a user
5 further comprises:
a holder configured to receive the digital thermometer; and
a strap which allows the user to wear the temperature badge such that the temperature of the user is visibly displayed.
- 10 7. A method for indicating the body temperature of a user to others, the method comprising the steps of:
providing a digital thermometer, the digital thermometer comprising:
a thermistor to allow the user to take a body temperature of
15 the user;
a digital display capable of showing the temperature of the user;
an integrated circuit (IC) configured to allow the user to selectively operate the thermometer in one of a temperature taking mode, a temperature badge mode and a programming mode; and
20 a power source.
8. The method of claim 6, wherein the digital thermometer further comprises at least one of:
25 a first LED to indicate a fever condition of the user when in the temperature badge mode;
a second LED to indicate a no fever condition of the user when in the temperature badge mode; and
an alarm buzzer to alert the user of a fever condition..
- 30 9. The method of claim 8, wherein the first LED is colored red and the second LED is colored green.

10. The method of any one of claims 7-9, wherein while in the programming mode, the user may set various operating parameters of the thermometer.

5 11. The method of claim 10, wherein the various operating parameters are selected from a group consisting of a set temperature indicating a fever or no fever status for the user, a temperature display duration, and a reminder alarm time to prompt the user to retake their temperature.

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12. The method of any one of claims 7-11, further comprising a step for providing means to attach the programmable digital thermometer to a user;

15 wherein the means to attach the digital thermometer to a user further comprises:

a holder configured to receive the digital thermometer; and

a strap which allows the user to wear the temperature badge such that the temperature of the user is visibly displayed.

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