(54) Title: BATTERY SAVER FOR WIRELESS TELEPHONE

The process of the present invention conserves battery power for a cordless telephone, comprising a base unit and a remote unit. The remote unit has a receiver (205), keypad (222) and a battery saver switch (601) for enabling a power conservation mode or a normal mode. The process consists of first determining which mode the battery saver switch (601) is enabling. If the normal mode is enabled, power is periodically applied to the receiver (205) and the keypad (222) is scanned for a depressed key. If the power conservation mode is enabled, the keypad (222) is scanned periodically for a depressed key while the receiver (205) remains in an unpowered state.
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BATTERY SAVER FOR WIRELESS TELEPHONE

Field of the Invention

The present invention relates generally to the field of communications and particularly to wireless telephones.

Background of the Invention

Cordless or wireless telephones are typically home units that consist of a base unit and one or more remote units. An example of such a cordless telephone is seen in U.S. Patent No. 4,989,230 to Gillig et al., assigned to Motorola, Inc., and is incorporated herein by reference. The remote units communicate with the base unit over radio frequencies (RF) typically within a range of 1000 feet of the base unit. The base unit is connected to the land-line telephone system, thus allowing a remote user to communicate with other land-line telephones.

The remote unit, in order to conserve power, leaves the receiver in a power off state, applying power periodically for a brief period. The receiver is powered up in order to check for a depressed key on the keypad or an incoming ring signal from the base unit, since the remote unit has the alert transducer to announce an incoming call. When the receiver is powered up, it draws a large amount of power from the remote's battery, thus reducing the amount of time the remote can be used for a telephone call. There is a resulting need for way to reduce the power used by the remote unit when not in a telephone call.

Summary of the Invention

The process of the present invention conserves battery power for a wireless communication device. The device has receiving means, data entry means, and a battery saver
switch for enabling a power conservation mode or a normal mode. The process consists of first determining which mode the battery saver switch is enabling. If the normal mode is enabled, power is periodically applied to the receiving means and the data entry means is scanned for a depressed key. If the power conservation mode is enabled, the data entry means is scanned periodically for a depressed key while the receiving means remains in an unpowered state.

**Brief Description of the Drawings**

FIG. 1 shows a block diagram of a base unit of a cordless telephone.

FIG. 2 shows a block diagram of a remote unit of a cordless telephone.

FIG. 3 shows a flowchart of the process for enabling a scrambling demonstration mode.

FIG. 4 shows a block diagram of a scrambler integrated circuit.

FIG. 5 shows a flowchart of the power saving process of the present invention.

FIG. 6 shows a block diagram of a battery saver circuit of the present invention.

**Detailed Description of the Preferred Embodiment**

The process of the present invention reduces the time that power is being used by the remote unit's receiver. By placing a switch in the power conservation mode position, the receiver is not turned on periodically as in the normal mode, thus reducing power consumption.

The block diagram of FIG. 1 illustrates a preferred embodiment of a cordless telephone base unit having a controllable scrambling or encryption circuit for encrypting and decrypting signals. This particular base unit also includes a speakerphone. FIG. 2 illustrates a preferred embodiment of a
remote unit for communicating with the base unit, the remote
also having a controllable scrambling or encryption circuit for
encrypting and decrypting signals.

Referring to FIG. 1, the base unit is comprised of an an-
tenna (101) that is coupled to the receive and transmit paths of
the base. The receive path is comprised of a bandpass filter
(102) that allows the frequencies of 49.670 - 49.990 MHz to pass.
The filter is connected to a receive amplifier (103) that ampli-
ifies the filtered signal by approximately 18 dB. The output of
the amplifier is then filtered by another bandpass filter (104)
before being input to the receiver (105). In the preferred emb-
embodiment, the receiver is an MC3363 available from Motorola,
Inc.

The receiver (105) mixes the signal down to 10.7 MHz
and then to 455 kHz. This signal is then demodulated. The lo-
cal oscillators in the receiver (105) are controlled by a phase
locked loop (120) whose frequency is controlled by a micropro-
cessor (112). The microprocessor (112) also receives a carrier
detect signal and the demodulated signal, labeled RX Data,
from the receiver (105). The demodulated signal is used by the
microprocessor (112) to interpret coded data messages trans-
mitted by the remote unit. These coded data messages are
used for DTMF dialing, telephone hook switch control, and
control of the scrambling circuit. The carrier detect signal is
used to detect the presence of a transmitter occupying the base
unit receive channel. In the preferred embodiment, the mi-
croprocessor (112) is an MC68HCL05C4 available from
Motorola, Inc.

The output of the receiver (105) is filtered again by an-
other bandpass filter (106). The output of the filter (106) is in-
put to the scrambling circuit (107). In the preferred embodi-
ment, the scrambling circuit (107) is an MX108DW Full-
Duplex Voiceband Scrambler integrated circuit available from
MX - Com, Inc.

The unscrambled output of the scrambler circuit (107) is
filtered in a de-emphasis filter (108) before being input to an
expander (109). The expansion process applies gain to the input signal that is varied as a function of the signal magnitude. The effective gain being greater for large magnitude signals and less for small magnitude signals. After this signal has been filtered by a highpass filter (110), it is input to a speakerphone circuit (111) and is also output to the land-line telephone system. If the speakerphone is being used, such as in a three way call between the base, the remote, and a land-line party, the audio signal is output to the base unit's speaker.

The transmit path of the base is comprised of the audio signal, either from the microphone (121) of the speakerphone or the land-line party, being bandpass filtered (113) before going through a compressor (114). The compressor (114) applies gain to the audio signal that is varied as a function of the signal magnitude, the effective gain being greater for small signals. An example of a compander (compressor/expander) is MC33110 manufactured by Motorola, Inc. The dynamic range of the compander is 80 dB.

The output of the compressor (114) is input to a pre-emphasis filter (115) before being scrambled by the scrambler circuit (116). The scrambler circuit (116) is the second half of the same integrated circuit used to unscramble the received signal. The scrambled audio signal is bandpass filtered (117) before being modulated by the transmitter (118) to a frequency in the range of 46.610 - 46.970 MHz. The actual frequency used by the telephone can be user selectable by a switch or other control on the telephone base or remote. Both the receive and transmit frequency ranges are set by the FCC for all cordless telephones. An example of a transmitter is MC2833 manufactured by Motorola, Inc.

The output of the transmitter is bandpass filtered (119) to filter out the signal outside the 46.610 - 46.970 MHz range. This signal is then transmitted from the antenna (101) to the remote unit.

The remote unit is comprised of the antenna (201) that receives the signal from the base unit. A bandpass filter (202)
removes that part of the signal outside the range of 46.810 - 46.970 MHz. A gain of approximately 18 dB is then applied to the signal by a receive amplifier (203) before it is bandpass filtered (204) again. This signal is then input to the receiver (205).

The remote unit receiver (205) mixes the signal down to 10.7 MHz and then to 455 kHz. This signal is then demodulated. The demodulated signal, labeled RX Data, is input to the microprocessor (212) to interpret the coded data messages transmitted by the base unit. These coded data messages are used to control the remote ringer and the scrambling circuit.

The demodulated signal is also bandpass filtered (206) before being input to the scrambler circuit (207) for descrambling. The scrambler circuit (207) is identical to the integrated circuit used in the base unit.

The unscrambled output is filtered by a de-emphasis filter (208) before going through an expander (209). The expanded signal is bandpass filtered (210) and amplified (211). The amplifier (211) is controlled by the microprocessor (212).

By operating a control on the remote unit, the user can increase or decrease the speaker (220) volume by increasing or decreasing the gain applied to the signal at this point. The amplified signal is input to the earpiece speaker of the remote unit.

The microphone (221) of the remote generates the audio signal that is bandpass filtered (213), compressed (214), and filtered by a pre-emphasis filter (215) before being processed by the scrambler circuit (216). This circuit (216) is the second half of the integrated circuit used to unscramble the received signal.

The scrambled signal is bandpass filtered (217) before being modulated to a frequency in the range of 49.67 - 49.99 MHz by the transmitter (218). The modulated signal is bandpass filtered (219) to remove the signal outside this frequency range and is transmitted on the remote's antenna (201).
The keypad on the remote (222) is used to take the telephone off hook, enter telephone numbers, change the frequency used to communicate with the base, and to enable the scramble demonstration function. The keypad enables the scrambling demonstration function by telling the microprocessor to generate a control signal to the scrambling integrated circuit. In the preferred embodiment, the base unit also has a keypad.

The control signals in both the remote and the base units are connected to the transmitter after the scrambling function so that these signals are not scrambled. The control signals, generated by the microprocessor, are wire-ORed with the scrambled voice signal to the transmitter input.

The scrambling of the signal between the remote and the base is operating continuously. This scrambling, however, is not evident to the telephone user or the party on the other end of the call. It would not be known, therefore, if the scrambling was operating properly. The scrambling demonstration process of the present invention provides both parties to the telephone call the ability to hear the scrambled version of the signal.

The scrambling demonstration process is illustrated in FIG. 3. While the telephone is in a call, the keypad is scanned (301) by the microprocessor for the depression of a key, such as a Secure Demo key, that indicates that the remote unit user wishes to enter the scrambling demonstration mode. In the preferred embodiment, this mode is referred to as the Secure Demo mode.

If the key is depressed (302), a timer in the microprocessor is started (303). If the key is released immediately (304), the timer is cleared (305) and the keypad scanned again (301). If the key is still depressed (304), the timer is incremented (306) and checked to determine if the key has been depressed for at least 3 seconds (307). This time check is continued until the key has been depressed for 3 seconds. At this point, the scrambling demonstration mode is operating (308). This can
be indicated on the remote or the base by flashing indicator lights (309). The remote keypad may be used for the above process or, if the base has a keypad, this keypad may be used to enter the scrambling demonstration mode.

The block diagram of the MX108DW Full-Duplex Voiceband Scrambler integrated circuit is illustrated in FIG. 4. Since this integrated circuit uses frequency inversion scrambling, a signal that is input to the circuit that has already been scrambled will be returned to normal by the circuit.

In order to put the telephone into the scrambling demonstration mode, the MX108DW must be able to transmit the input signal without scrambling. This is accomplished by the control input labeled Clear/Scramble. By applying a logic one to this input, the signal is transmitted through the path via the clear path. A logic zero on this control input will cause the signal to be transmitted through the path via the scramble path.

The preferred embodiment of the cordless telephone disables the entire scrambling integrated circuit in the remote unit when the scrambling demonstration mode is initiated. This allows the scrambled audio signal to be heard by both the telephone user and the land-line party to the conversation.

The power saving process of the present invention, illustrated in FIG. 5, begins with the microprocessor in a stop or sleep mode (501). The microprocessor then receives an interrupt (502) by an external clock. This interrupt is done periodically to enable the microprocessor to check for inputs from the base unit or the keypad on the remote unit.

The microprocessor then checks the battery saver switch to determine the mode of the telephone (503). If the switch is in the normal operation mode, power is applied to the receiver and the received signals are monitored for data from the base unit (504). If the battery saver switch is in the power conservation mode position, power is not applied to the receiver.
The keypad is scanned to determine if a key has been depressed (505). If a key was depressed (506), the key is processed (507). An example of such a key is a last number redial key or number key for dialing a telephone number.

If a key was not depressed (506), it is determined if power was applied to the receiver (508). If the receiver is on, it is determined if data was received (509). If data was received, the data is processed (510). An example of the type of data received is a ring signal from the base unit instructing the remote unit to activate the alert tone.

A software timer is next checked to determine if the microprocessor has been active for the required time (511). In the preferred embodiment, the microprocessor is awake for 40 ms in the power conservation mode and 125 ms in the normal mode. The shortened time for the power conservation mode reduces the power load on the remote's battery.

If the time has not elapsed (511), the process repeats from scanning the keypad (505). If the time has elapsed (511), the power to the receiver is removed (512), if it had been applied initially.

If the battery saver switch is in the power conservation mode (513), the time is reset to 40 ms (515). If the switch is in the normal mode, the time is reset to 125 ms (514). The microprocessor then returns to the sleep state for 1.2 seconds, in the preferred embodiment, after which the process starts over.

The battery saver circuit of the present invention is illustrated in FIG. 6. This circuit is comprised of a switch (601) to the microprocessor (602) input. When the switch (601) is closed, a logic one is input to the microprocessor (602), thus indicating the telephone is in the power conservation mode. The interrupt to bring the microprocessor (602) out of the sleep mode comes from either the keypad (603) or the sleep timer (604). A transistor switch (605) is coupled to the microprocessor to allow the microprocessor (602) to turn the transistor (605) on and apply power to the receiver. The recovered data
received from the base unit is input from the receiver to the microprocessor.

The cordless telephone, while in the power conservation mode, can still make or receive calls by pressing a key on the keypad or, in the preferred embodiment, opening the flip of the remote unit. When the call has ended, the remote automatically returns to the power conservation mode, if that was the mode selected before the call.

Also in the preferred embodiment, the user can use the remote to enter telephone numbers to be stored in the base unit's memory for memory dialling later. These numbers can be entered while the remote is in the power conservation mode. In this case, the microprocessor automatically turns on the transmitter and sends the numbers to the base unit for storage. After a certain time, the transmitter turns off and the remote automatically reverts to the power conservation mode if that was the mode previously selected.

In summary, a wireless or cordless telephone having controllable scrambling between the remote unit and the base unit has been shown, thus providing secure conversations between the telephone user and the land-line party. The telephone also has a mode for normal power consumption and a power conservation mode. By placing the telephone in the power conservation mode, the telephone can be used for longer periods between battery charging.
Claims

1. A method for battery power conservation in a wireless communication device having receiving means, data entry means, and a battery saver switch for enabling a power conservation mode or a normal mode, the method comprising the steps of:
   determining which mode the battery saver switch is enabling;
   if the normal mode is enabled, periodically applying power to the receiving means;
   if the normal mode is enabled, scanning the data entry means for a depressed key when power is applied to the receiving means; and
   if the power conservation mode is enabled, periodically scanning the data entry means for a depressed key while the receiving means remains in an unpowered state.

2. The method of claim 1 and further including the steps of:
   if the normal mode is enabled, checking for data after power has been applied to the receiving means; and
   removing power from the receiving means.

3. A method for battery power conservation in a wireless communication device having receiving means, data entry means, and a battery saver switch for enabling a power conservation mode or a normal mode, the method comprising the steps of:
   determining which mode the battery saver switch is enabling;
   if the normal mode is enabled, periodically applying power to the receiving means;
   if the normal mode is enabled, scanning the data entry means for a depressed key when power is applied to the receiving means;
if the power conservation mode is enabled, periodically scanning the data entry means for a depressed key without applying power to the receiving means;
if the normal mode is enabled, checking for data after power has been applied to the receiving means; and
if power has been applied to the receiving means, removing power from the receiving means.

4. A method for battery power conservation in a wireless telephone having a base unit and a remote unit, the base unit transmitting data signals to the remote unit over a communications medium, the remote unit having receiving means, data entry means having a plurality of keys, processing means, and a battery saver switch for enabling a normal mode or a power conservation mode, the method comprising the steps of:
   a) periodically interrupting the processing means;
   b) if the normal mode is enabled when the processing means is interrupted, applying power to the receiving means;
   c) if the power conservation mode is enabled when the processing means is interrupted, retaining the receiving means in a power off state;
   d) scanning the data entry means for a depressed key;
   e) if a key was depressed, processing the key;
   f) if power was applied to the receiving means, checking for data signals transmitted by the base unit,
   g) repeating from step d for a first predetermined time if the normal mode is enabled or a second predetermined time if the power conservation mode is enabled; and
   h) if power was applied to the receiving means, removing power from the receiving means.

5. The method of claim 4 wherein the first predetermined time is 125 milliseconds and the second predetermined time is 40 milliseconds.
6. A wireless telephone apparatus having a remote unit and a base unit coupled to a telephone system, the remote unit communicating with the base unit over a communications medium, the remote unit having a receiver, a keypad, and processing means, the apparatus comprising:

   power switching means, coupled to the processing means, for controlling power to the receiver;

   mode switching means, coupled to the processing means, for enabling either a power conservation mode or a normal mode; and

   the processing means controlling the power to the receiver in response to the mode switching means and a method for power conservation, the method comprising the steps of:

   determining which mode the mode switching means is enabling;

   if the normal mode is enabled, periodically applying power to the receiver;

   if the normal mode is enabled, scanning the keypad for a depressed key when power is applied to the receiver; and

   if the power conservation mode is enabled, periodically scanning the keypad for a depressed key while the receiver remains in an unpowered state.
**FIG. 3**

- Handset in call with base unit
  - Scan keypad
  - Is secure demo key pressed?
    - Yes: Start secure key timer
    - No: Clear timer
  - Is secure demo still pressed?
    - Yes: Increment timer
    - No:
  - Is timer > 3 sec.?
    - Yes: Enter secure demo mode
    - No:

**FIG. 4**

Scrambling circuit
107, 116, 207, 216

- Scramble control from microprocessor
- Clear circuitry
- Signal input
- Scramble circuitry
- Signal output
- Alternately flash red and green LED's to indicate secure demo mode
FIG. 5

MICROPROCESSOR ENTERS STOP MODE

MICROPROCESSOR RECEIVES EXTERNAL INTERRUPT

IS BATTERY SAVER SWITCH ENABLED?

ENABLE RECEIVER B+ MONITOR RECEIVED DATA

SCAN KEYPAD

WAS KEY PRESSED?

IS RECEIVER B+ ON?

DID TIMER ELAPSE?

DISABLE RECEIVER B+

IS BATTERY SAVER SWITCH ENABLED?

STORE TIMER VALUE = 40ms

STORE TIMER VALUE = 125ms
FIG. 6
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
   IPC(5) : H04M 11/00
   US CL : 379/58
   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)
   U.S. : 455/38.3, 127, 343

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic database consulted during the international search (name of data base and, where practicable, search terms used)
   USPTO APS - Battery, power, saving, conservation, consumption, scan, check, keypad, key, dial, data entry

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<td>US.A. 4,731,814 (BECKER ET AL) 15 MARCH 1988 Abstract, col. 2-5.</td>
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<td>Y</td>
<td>US.A. 5,040,204 (SASAKI ET AL) 13 AUGUST 1991 Figures 8.9 and col 7, line 25 to col. 8 line 7.</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
19 SEPTEMBER 1992

Date of mailing of the international search report
25 NOV 1992

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