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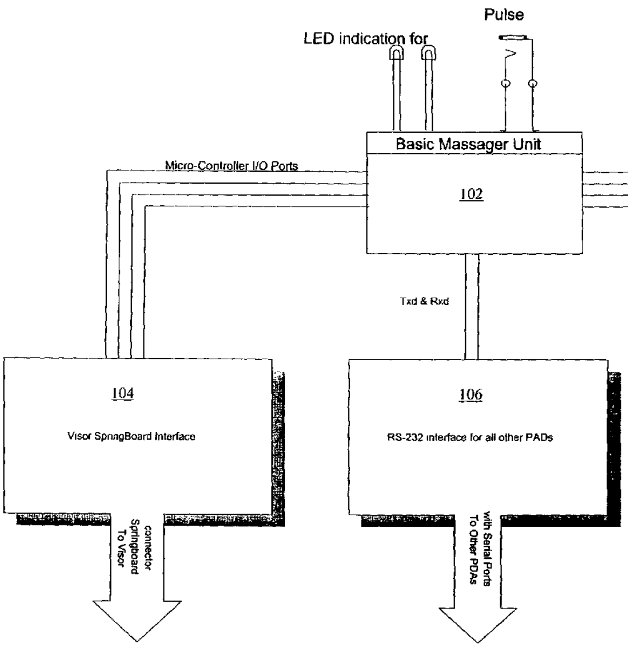
(54) **Title:** AN ELECTRIC THERAPEUTIC MASSAGE DEVICE




(57) **Abstract:** A massage device for generating and delivering electric pulses and which is capable of interfacing with a handheld computing device is disclosed. The massage device comprises a controller for performing and controlling massage operations in the massage device; an electric pulse generator dependent on the controller for generating electric pulses for delivery to a user; and an interface for providing communication interface with a handheld computing device for receiving instructions on which the controller is dependent for performing massage operations.

WO 02/102292 A2

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# AN ELECTRIC THERAPEUTIC MASSAGE DEVICE

## Field Of Invention

The invention relates generally to therapeutic massage devices. In particular, the invention relates to an electric therapeutic massage device for stimulating muscles.

## Background of the invention

There are many types of therapeutic massage devices, one of which is an electric therapeutic massage device for simulating body massages. The electric body massager is a massage device that generates and sends out minute electric pulses to the human body via conductive gel pads for therapeutic purposes. Using such a massage device, therapeutic effect on the human body is achieved by electric current flow consequent of the electric pulses applied to the human body through the conductive gel pads, which excites nerves in the human body thereby inducing contraction of muscles which the nerves control. After each electric current discharge, the contracted muscles slacken.

When coordinated properly and directed appropriately to particular groups of human muscles, such electrically induced muscular contractions and thereafter slackening cause sensations reminiscent of body massage sensations such as tapping, chopping and squeezing of the muscle groups. These body massage sensations are believed to have therapeutic effect by relieving tension and reducing stress to some degree.

Electric body massagers have already been available in the consumer market for a substantial period of time. Most conventional electric body massagers have features that would require much further improvement or expansion to meet the continuously evolving sophisticated needs of massage device end users. For example, many electric body massagers are implemented with fixed or predefined user interfaces with unfriendly buttons for selecting frequency and amplitude settings and modes of operation. Furthermore, due to the limited flexibility attendant on these massage devices, massage device software upgrade and addition of new massage patterns are not options for the massage device end users.

There is therefore clearly a need for an electric body massager that provides a friendly user-interface and allows the addition of new massage patterns.

**Summary**

A configurable electric pulse-generating massage device with an interface module for facilitating communication with a handheld computing massage device is disclosed. The massage device allows a massage device user to transfer data to the massage device using the interface module for configuring a user-interface and changing electric pulse parameters for providing different massage patterns. Through the interface module the handheld computing massage device communicates with the massage device to provide the user-interface on the handheld computing massage device for facilitating user input, and allow data transfer for effecting changes to existing massage patterns or add massage patterns.

In accordance with a first aspect of the invention, a massage device for generating and delivering electric pulses and which is capable of interfacing with a handheld computing device is disclosed. The massage device comprises a controller for performing and controlling massage operations in the massage device; an electric pulse generator dependent on the controller for generating electric pulses for delivery to a user; and an interface for providing communication interface with a handheld computing device for receiving instructions on which the controller is dependent for performing massage operations.

In accordance with a second aspect of the invention, a method for generating and delivering electric pulses via a massage device which is capable of interfacing with a handheld computing device is disclosed. The method comprises the steps of performing and controlling massage operations via a controller in the massage device; generating electric pulses for delivery to a user via an electric pulse generator dependent on the controller; and providing communication interface with a handheld computing device via an interface for receiving instructions on which the controller is dependent for performing massage operations.

**Brief Description Of Drawings**

Embodiments of the invention are described hereinafter with reference to the drawings, in which:

FIG. 1 is a block diagram showing a number of functional modules the combination of which provides a number of massage devices according to embodiments of the invention;

FIG. 2 is a block diagram showing a number of operational modules the combination of which provides the massage devices of FIG. 1;

FIG. 3 is a series of timing diagrams in relation to communication protocols used in the massage devices of FIG. 1;

FIG. 4 is a block diagram showing components in a Basic Massager Unit in the massage devices of FIG. 1;

FIG. 5 is a series of timing diagrams illustrating different electric pulse waveforms for different massage patterns;

FIGS. 6A, 6B and 6C collectively form a schematic diagram showing an electrical circuit relating to the operational modules of FIG. 2;

FIGS. 7A to 7E are flowcharts illustrating various processes and steps in the operational modules of FIG. 2, in which

FIG. 7A is a flowchart relating to the Basic Massager Unit,

FIG. 7B is a flowchart relating to the massage device main loop,

FIG. 7C is a flowchart relating to a PWM (pulse width modulation) interrupt routine,

FIG. 7D is a flowchart relating to a PNPP (positive negative polarity pulse) switch, and

FIG. 7E is a flowchart relating to an ADC (analog-to-digital converter) interrupt routine; and

FIG. 8 is a series of screenshots of user interfaces provided by a handheld computing massage device to which the massage device is connected.

**Detailed Description**

Electric body massage devices according to embodiments of the invention that provide friendly user-interfaces and allow the addition or amendment of massage patterns for addressing prior art deficiencies are described hereinafter. The massage devices provide further improvement over and expansion of conventional electric body massage devices and features thereof by facilitating communication with handheld computing devices, or the like handheld devices. The massage devices by interfacing with the handheld devices provide user-interfaces, allow changes to massage patterns, and access storage on the handheld devices for storing user massage profiles.

Basic features of conventional electric body massagers are preferably implemented in a massage device, in which electric pulses are generated and delivered to the body of a massage device user via a pair of left and right output channels to which a pair of conductive pads are connected. A handheld device provides a user-interface through which command, control and feedback relating to massage operations performed by the massage device is provided to the user when the massage device operates in an interface mode. The communication interface between the massage device and the handheld device is achieved preferably using standard communications connections such as the RS-232-C serial communications connection or Handspring, Inc.'s Springboard communications connection. The massage device may also operate without the handheld device in a standalone mode. According to a preferred embodiment of the invention, a message device is connectable with a docking device with preferably a small number of buttons for providing a simple keyboard interface for providing minimal control features.

In addition, massage patterns may preferably be modified and downloaded to the massage device via the handheld device. A massager application that preferably runs on the handheld device may also be updated to provide different types of controls and user-interfaces, and provide for the updating of massage patterns. Furthermore, a record of massage operations performed by the massage device on the user is preferably generated and stored on the handheld computing device via the interface with the massage device so that a massage history relating to the user is maintained in the handheld computing device.

A micro-controller is preferably used in the massage device for allowing off-line operation when the massage device is in the interface mode. Off-line operation refers to the independent operation of the massage device without the utilisation of computing resources in the handheld device. This then allows a handheld device user to run other applications while a massage operation performed by the massage device is in progress.

The micro-controller also receives instructions from and transmits information to the handheld device. When the massage device is operating in the standalone mode, the micro-controller receives instructions relayed preferably by the activation of two push buttons on the docking device forming a keyboard interface for receiving input from the user. In the case of a massage device according to an alternate embodiment of the invention, the massage device preferably provides two push buttons for forming a keyboard interface. A charge-pump circuit is also preferably used and controlled by the micro-controller. Pulse width modulation (PWM) signals are preferably generated and sent out by the micro-controller to the charge pump circuit to control the amplitude of the electric pulses generated and delivered to the user. A feedback circuit is also preferably provided in the massage device to detect the amount of electric current flow through the user's body. An Analog-to-Digital Converter (ADC) further preferably provided in the massage device then translates the detected electric current flow into a digital signal that the micro-controller receives and processes for adjusting the PWM signals accordingly. In this way, the massage device allows the user to define the amount of electric current flow through the body by tracking the same using the feedback circuit and the ADC.

Preferably, the massage device allows the user to manually set the parameters relating to the electric pulses for creating massage sensations such as tapping, chopping and squeezing. The parameters preferably relate to frequency, ramp rate, burst rate, modulation, and balance settings of the electric pulses in a massage operation.

By setting the parameter relating to the frequency, the rate at which the electric pulses are generated and delivered to the user is preferably set between 1 to 200 Hz. Generally, electric pulses set within the frequency range 1 to 10Hz relate to the tapping sensation, while electric pulses set within the frequency range 10 to 35Hz relate to the chopping sensation. Electric pulses set within the frequency above 35Hz provide the squeezing sensation.

When setting the parameter relating to the ramp rate, the number of electric pulses that are generated and delivered to the body before the electric current undergoes amplitude change and reaches a preset level, in which the amplitude change is preferably achieved through a series of discrete level changes of 3.3 mA each, is preferably set between 1 to 15 electric pulses per level change. This setting therefore determines the time duration for the electric current to reach the preset amplitude level, which indirectly affects the time for building up massage pressure. More importantly, this time duration is dependent on the frequency setting, because if the ramp rate setting remains the same, the setting to a higher frequency results indirectly the electric current reaching the preset amplitude level earlier. Changing the setting therefore results in longer or shorter intermissions between tapping, chopping or squeezing massage sensations when an increasing light to heavy massage pressure is applied.

The massage device preferably generates and delivers electric pulses intermittently to the body, in which every burst of electric pulses is followed by an intermission the duration of which is preferably 0.5 sec. Therefore the setting of the parameter relating to the burst rate, which relates to the number of electric pulses generated and delivered to the body during every burst, sets the burst rate preferably between 50 to 250 electric pulses. This setting gives the user long to short intermittent tapping, chopping or squeezing massaging sensations.

The massage device also preferably performs modulation for smoothening the effect of massaging sensations such as tapping and chopping on the user when the electric pulses relating thereto are generated and delivered to the body at low frequencies. A high frequency electric pulse of preferably 250 Hz is applied to modulate low frequency electric pulses set between 1 to 35 Hz by the user. The setting of the parameter relating to modulation sets the modulation preferably between 1 to 15 electric pulses for modulating every low frequency electric pulse set by the user.

The massage device also preferably allows the user to set the parameter relating to the balance of the left and right output channels. In choosing any of Left, Both and Right parameter settings, the user essentially chooses either or both output channels on which to affect changes to the massage pressure produced thereby according to any foregoing parameter setting.

Preferably, three basic massage profiles relating to massage patterns and three combination massage profiles thereof, each combination massage profile preferably consisting of a combination of the three basic massage profiles, are hard-coded into the micro-controller. Any of the three basic massage profiles when selected by the user provides parameters with which the massage device operates for generating and delivering electric pulses that produce the tapping, chopping or squeezing massage sensations. Each basic massage profile preferably consists of 12 massage patterns with varying ramp rates, burst rates, and modulation settings. The three combination massage profiles are preferably designed for shoulders, limbs and back, each combination massage profile also consisting of preferably 12 massage patterns, with each combination massage profile consisting of a combination of massage patterns relating to tapping, chopping and squeezing massage sensations. The total duration of each session of massage profile is preferably 15 minutes.

A memory, for example 256k bytes of non-volatile memory, is preferably included in the massage device, where the memory is used for storing up to three downloadable massage profiles. The three downloadable massage profiles are preferably downloadable from the handheld device via the interface module. With enough free memory space on the handheld device, the handheld device is typically capable of storing more than three downloadable massage profiles. These downloadable massage profiles may be further upgraded or changed by a massager application by using information downloadable from relevant websites to the handheld device if the handheld device is connected via the Internet to these websites. The downloadable massage profiles, each preferably consisting of up to 12 different massage patterns, may be given unique names and stored as downloadable massage profiles on the handheld device for providing different massage sensations. The user can choose up to three massage profiles from the list of downloadable massage profiles in the handheld device for downloading to the massage device.

A manual massage profile is also preferably stored in the memory, the manual massage profile consisting of only one massage profile. The parameters for the manual massage profile is preferably configurable by the user via the handheld device and transmitted to the massage device for storage in the memory and used for a massage operation.

An auto cut-off feature is preferably also implemented in the massage device. When the micro-controller does not detect any electric current flow in the pair of conductive pads connected to the Left and Right output channels for a duration of 15 electric pulses, the massage device stops generating and delivering the electric pulses immediately. A soft start feature is preferably further implemented in the massage device to prevent the massage device from generating and delivering high electric currents upon starting up or at the beginning of each massage operation.

In the standalone mode, the massage device preferably allows the user to choose from a maximum of preferably nine massage profiles, of which six are hard-coded into the micro-controller to form the massage device firmware, and three massage profiles are stored in the non-volatile memory that are downloaded from the handheld device. Two light emitting diodes (LED) are preferably used for indicating the selection of the massage profiles as well as to indicate the amplitude level of the electric pulse generated and delivered to the user. The LEDs also preferably provide progress indication in the massage device operating in the standalone mode.

The massage devices according to the preferred and alternate embodiments of the invention are described in detail hereinafter with reference to the drawings, in which FIG. 1 shows the hardware architecture of the massage devices. The Basic Massager

Unit 102 is an integral part of a massage device, interfacing with the handheld device or the docking device via various sub-units in the massage device. A Springboard sub-unit 104 consists of a Springboard connector of which the detailed components is described in detail with reference to FIG. 2, for providing connectivity with Handspring, Inc.'s Visor personal digital assistant (PDA) using Handspring, Inc.'s proprietary Springboard connections. An RS-232-C sub-unit 106 consists of an RS-232-C interface for providing connectivity with all Palm Computing, Inc.'s Palm operating system-based PDAs with RS-232-C serial connections. A docking sub-unit 108 consists of a connector for providing connectivity with the docking device for providing operation of the massage device in the standalone mode. The docking sub-unit 108 is integrated into a massage device consisting of the Springboard sub-unit 104 according to a preferred embodiment so that this massage device, hereinafter referred to as the Visor massage device, may be used in conjunction with a Visor PDA in the interface mode, or the docking device in the standalone mode. The docking sub-unit 108 is however not integrated into an alternate massage device consisting of the RS-232-C sub-unit 106 according to an alternate embodiment because this massage device, hereinafter referred to as the non-Visor massage device, may be used in conjunction with a non-Visor PDA in the interface mode, or alone in the standalone mode and therefore does not need to provided with connectivity with the docking device.

When description is made herein that relates to a massage device, the description applies to both the massage devices, whereas when description is made herein that relates to specifically to the Visor massage device or non-Visor massage device, the description applies to the respective massage device as such.

The function of the docking device is for providing a massage device operating in the standalone mode with power and a keyboard interface to the Basic Massager Unit 102 in the absence of the user-interface provided by the handheld device, preferably in the case of the Visor massage device. If the massage device is the non-Visor massage device designed for use with a non-Visor PDA, for example a Palm V series PDA from Palm Computing Inc., batteries and a power circuit are required in the non-Visor massage device for powering the Basic Massager Unit 102. For the Visor massage device, however, power is drawn from the Visor PDA through the Springboard sub-unit

104 and hence batteries and a power circuit are not implemented in the Visor massage device. Consequently, a docking device is required for the Visor massage device to operate in the standalone mode.

With reference to FIG.2, the Basic Massager Unit 102 (section A), Springboard sub-unit 104 (section B), RS-232-C sub-unit 106 (section C), and docking sub-unit 108 (section B) are described in further detail, combinations of which form the Springboard or Non-Visor massage devices. The Basic Massager Unit 102 shown in section A and components of the Springboard sub-unit 104 and docking sub-unit 108 shown in section B together form essential components in the Visor massage device. A flash memory 202 is shown in section B, which contains software for the massager application that runs on a Visor PDA to which the Visor massage device is connected for providing the user-interface and other features. The flash memory 202 also allows the user to upgrade the software for the massager application. When the user plugs the Visor massage device into the Springboard connector on the Visor PDA, the software stored in the flash memory 202 is launched automatically. This is known as the Plug-and-Play feature of all Visor PDAs. A Programmable Logic Device (PLD) 204 performs address decoding and generates the necessary input/output (I/O) signals for providing serial communication with the Visor PDA. At least four signals are needed for ensuring proper communication with the Visor PDA, and these are the Chip Select, Data In, Data Out and Serial Clock signals.

For the Visor massage device to operate in the standalone mode, the Visor massage device needs to be connected to the docking device via the docking sub-unit 108 shown in section B. The docking device provides power and the keyboard interface to the Visor massage device. The Visor massage device detects the docking device through a 6-pin connection made between the docking device and the Visor massage device. One of the pins is pulled low when the Visor massage device is inserted into the docking device, which is then detected by the PLD 204.

The massage firmware in the Visor massage device then determines whether the Visor massage device is operating in the standalone mode or the interface mode so that the

Visor massage device may receive user input from the keyboard interface on the docking device or the user-interface respectively.

As shown in section C of FIG. 2, an RS-232-C driver 206 and a power circuit 208 are included in the RS-232-C sub-unit 106. A pair of push buttons 210 similar to those forming the keyboard interface in the docking device are also included in the RS-232-C sub-unit 106 so that the Non-Visor massage device built with the Basic Massager Unit 102 and the RS-232-C sub-unit 106 is able to operate in the standalone mode without the docking device. The Non-Visor massage device is therefore essentially made up of components shown in sections A and C of FIG. 2.

To interface with the Non-Visor massage device, the non-Visor PDA uses a serial port interface, and communication between the non-Visor PDA and the non-Visor massage device is accomplished via this serial port. Unlike the Visor PDA, the non-Visor massage device stores the massager application in the non-Visor PDA. The communication protocol that is used for interfacing the Non-Visor massage device with the non-Visor PDA remains the same with the Visor PDA, in which the handheld device or PDA functions as the master during the communication. When the RS-232-C signal level is not detected by the micro-controller in the Non-Visor massage device, the Non-Visor massage device switches operation to standalone mode.

The communication protocol is described in greater detail with reference to FIG. 3, which shows a series of timing diagrams in relation to the communication protocol. As described in the foregoing, the handheld device functions as a master during any communication established between the handheld device and the massage device. The communication protocols for the Visor and non-Visor PDAs are the same, with the only difference being the transfer modes, in which for the Visor PDA, synchronous transfer using the Springboard communications connection is used to transfer the commands from the Visor PDA to the Visor massage device. For non-Visor PDA, the standard RS-232-C communications connection, which applies asynchronous transfer, is used.

For communication with the Visor PDA, four control signals from the Visor PDA are decoded by the PLD 204 from data signals and provided as input to the Basic Massage

Unit 102. These control lines are Chip Select (PIC_CS), Serial Clock (PIC_SK), Data In (PIC_DI), and Data Out (PIC_DO) lines. All data transfers occur during low-to-high transitions of the PIC_SK signal, and each data transfer is 16-bit long.

In the case of the communication with the non-Visor PDA, the non-Visor massage device uses three signal lines, i.e. Transmit (Txd), Receive (Rxd), and Ground (Gnd) lines, to facilitate data transfers of 2 X 8 bits length according to the asynchronous RS-232-C-based transfer mode.

Shown hereinafter are tables for describing the instruction sets for serial communication in greater detail. Each instruction set contains two bytes, in which the first byte transmitted is a command byte, followed by a second byte containing information regarding amplitude, frequency, ramp rate, burst rate, duration, or mode relating to the electric pulses or operation, or control information. The amplitude and frequency of the electric pulses may be updated during operation of the massage device via the handheld device in the interface mode, and the docking device or the non-Visor massage device in the standalone mode. The massage profiles stored in the micro-controller and an electrically erasable programmable read-only memory (EEPROM) in the Basic Massager Unit 102 consist of frequency, ramp, burst, duration, and mode bytes.

**Command Byte Table**

| Command | Description |
|---|---|
| Bit 7# | Start=1,Stop=0 in relation to starting/stopping a massage operation. See start/stop byte table. |
| Bit 6* | Amplitude, 10~70 steps. Real time update possible during operation. See amplitude byte table. |
| Bit 5* | Frequency, 1~200 PPS. Real time update possible during operation. See frequency byte table. |
| Bit 4* | Ramp Rate, 1~15 pulses per level jump. See ramp byte table. |
| Bit 3* | Burst Rate, 50~250 pulses per burst. See burst byte table. |
| Bit 2* | Duration, 1min ~ 30min. See duration byte table. |
| Bit 1* | Mode, see mode byte table. |
| Bit 0# | 1=Status, read PIC_DO after sending this command. Read in amplitude (high byte) and frequency (low byte) in PIC_DO. See status byte table. |

For a bit which is marked * in the table, the setting of this bit means that a command is issued in relation to a parameter in a massage operation, the consequence of which is for the massage device to effect any changes using the parameter information contained in the following byte for massage operation. For a bit which is marked # in the table, the setting of this bit means that a command is issued in relation to the control of the massage operation, the control information being contained in the next byte, such as starting or stopping a massage operation, or providing status information relating to the massage operation to the handheld device. Only one bit in the command byte is set and valid at a time, and bit 7 is the highest priority, with the exception that the stop byte has bit pattern 00000000.

**Start/Stop Byte Table**

| | |
|---|---|
| Bit 7 | Decimal values 0~11 refer to the 12 massage patterns in a massage profile the information of which is to be used for performing massage operation or writing to the EEPROM. Decimal value 15 means to write the massage profile or pattern information to the EEPROM. |
| Bit 6 | |
| Bit 5 | |
| Bit 4 | |
| Bit 3 | Decimal values 0~9 refer to ten massage profiles. The ten profiles are 3 basic profiles, 3 combination profiles, 3 downloadable profiles, and 1 manual. |
| Bit 2 | |
| Bit 1 | |
| Bit 0 | |

This byte following the transmission of the Start/Stop command is used to provide information relating to the selection of the massage profiles and patterns therein for massage operation by the massage device, or write massage profiles and patterns into the EEPROM.

**Amplitude Byte Table**

| | |
|---|---|
| Bit 7 | Decimal values 10~150 refer to 10~150 unit pressure. 10 unit pressure translates to approximately 3.3 mA output electric current. |
| Bit 6 | |
| Bit 5 | |
| Bit 4 | |
| Bit 3 | |
| Bit 2 | |
| Bit 1 | |
| Bit 0 | |

The amplitude of the electric pulses may be updated during operation of the massage device via the handheld device in the interface mode.

**Frequency Byte Table**

| | |
|---|---|
| Bit 7 | Decimal values 1~200 refer to 1~200 cycles. |
| Bit 6 | |
| Bit 5 | |
| Bit 4 | |
| Bit 3 | |
| Bit 2 | |
| Bit 1 | |
| Bit 0 | |

The frequency of the electric pulses may be updated during operation of the massage device via the handheld device in the interface mode.

**Ramp Byte Table**

| | |
|---|---|
| Bit 7 | Decimal values 1~15 refer to 1~15 electric pulses for defining short burst modulation. |
| Bit 6 | |
| Bit 5 | |
| Bit 4 | |
| Bit 3 | Decimal values 1~15 refer to 1~15 electric pulses for defining ramp-up time, which is defined as pulses per level jump. |
| Bit 2 | |
| Bit 1 | |
| Bit 0 | |

Short burst modulation is used to smoothen the impact on the body when the electric pulse frequency is below 35Hz. Ramp-up time is use to control the time to reach the preset amplitude, and is defined as the number of pulses required to cause a level jump. A maximum of 50 mA of peak current may be delivered to the human body.

**Burst Byte Table**

| | |
|---|---|
| Bit 7 | Decimal values 50 ~ 250 refer to 50 ~ 250 electric pulses. |
| Bit 6 | |
| Bit 5 | |
| Bit 4 | |
| Bit 3 | |
| Bit 2 | |
| Bit 1 | |
| Bit 0 | |

The burst rate is defined as the number of electric pulses transmitted between every 0.5 sec intermission regardless of the frequency setting.

**Duration Byte Table**

| | |
|---|---|
| Bit 7 | 1=Second; 0=Minute |
| Bit 6 | |
| Bit 5 | Decimal values 1~240 refer to the same number of seconds. |
| Bit 4 | |
| Bit 3 | Decimal values 1~30 refer to the same number of minutes. |
| Bit 2 | |
| Bit 1 | |
| Bit 0 | |

Bit 7 in this byte determines whether the decimal values defined by bits 0-6 are in seconds or minutes.

**Mode Byte Table**

| | |
|---|---|
| Bit 7 | Ramp bit: 1=Enable; 0=Disable |
| Bit 6 | Burst bit: 1=Enable; 0=Disable |
| Bit 5 | Repeat Previous: 1=Repeat the previous massage pattern |
| Bit 4 | Repeat All: 1=Repeat the massage profile from beginning |
| Bit 3 | 00-NONE 10-Positive only |
| Bit 2 | 01-Negative only 11-Both |
| Bit 1 | 00-Repeat Previous/All two more times |
| Bit 0 | 01-Repeat Previous/All four more times<br>10-Repeat Previous/All six more times<br>11-End of profile |

The mode byte controls the left, right or both side of the electric pulse generated and delivered to the user. Changing the control byte causes the massage pressure resultant of the electric pulses to be applied more on right or left side of the body, or equally on both sides. This byte also controls the turning on or off the ramp and burst mode. Repetitions of the massage profiles or patterns are also determined by particular bit setting in this byte. The mode byte is also used to control the sequence of massage pattern in a massage profile.

**Status Byte Table**

| | |
|---|---|
| Bit 7 | 1 = Read EEPROM or micro-controller ROM pointer, which is the same as the massage pattern number in the massage profile. |
| Bit 6 | 1 = Read Frequency |
| Bit 5 | 1 = Read Ramp |
| Bit 4 | 1 = Read Burst |
| Bit 3 | 1 = Read Seconds Lo |
| Bit 2 | 1 = Read Seconds Hi |
| Bit 1 | 1 = Read Mode |
| Bit 0 | 1 = Read Current Amplitude on conductors applied to the body |

This status byte is requested by handheld device to reflect the settings and operations of the massage device on the handheld device screen for the user to view. Therefore, upon receiving the command byte with the status bit set, the massage device generates and transmits this status byte to the handheld device.

The Basic Massager Unit 102 is described in greater detail with reference to FIG.4, in which is shown to consist of the micro-controller 402, a PWM controlled charge pump circuit 404, a positive-negative polarity pulse (PNPP) switch 406, the analog feedback circuit 408, the EEPROM 410, and a pair of LEDs 412. The micro-controller 402 interfaces directly with the PLD 204 as described in the foregoing, and is also connected directly to the pair of LEDs 412 for providing visual indication when the massage device operates in the standalone mode. The micro-controller 412 further communicates with the handheld device when the massage device is operating in the interface mode or with the keyboard interface when the massage device is operating in the standalone mode.

The analog feedback circuit 408 monitors the actual output electric current for controlling the generation and delivery of the electric current and handling the auto cut-off if more than 15 electric pulses are generated but not delivered to the body.

The micro-controller 402 also generates and delivers PWM signals to the charge pump circuit 404. The charge pump circuit 404 produces high voltages ranging from 10Vdc to 100Vdc. The high voltages vary according to the duty cycles of the PWM signals, and the frequency of the PWM signals remains constant at 5KHz throughout operation. The PWM signals are switched off when a massage operation is stopped to conserve power.

The high voltages are provided as input to the PNPP switch 406. The PNPP switch 406 controls the direction of the electric current flow to the body. The electric pulse width is controlled at 250usec and 500usec for frequency less than or equal to 10 Hz. Four control signals are used by the micro-controller for controlling the PNPP switch 406, which are PON, NON, PPULSE and NPULSE signals, which are described in greater detail hereinafter. The EEPROM 410 stores the downloadable massage profiles from the handheld device. Each massage profile consists of up to 12 massage patterns. Each massage pattern requires five bytes of information, these five bytes being the Frequency, Ramp, Burst, Mode and Duration bytes. A total of up to 60 bytes is therefore required for providing information relating to one complete massage profile. The massage device may store up to three downloadable massage profiles in the EEPROM 410, and therefore the size of the EEPROM 410 is at least 180 bytes large. A 256-byte EEPROM 410 is appropriate for this application.

The electric current flow through the body is provided as feedback to the massage device via the analog feedback circuit 408. Electric current is translated to voltage levels suitable for the micro-controller 402 and a built-in ADC in the micro-controller 402 then converts the voltage levels into 8-bit digital signals. These voltage levels are then compared all the time with the user preset electric pulse amplitude level. Based on the comparison, the micro-controller 402 then adjusts the PWM signals accordingly to bring the output electric current close to the preset level. The micro-controller 402 also contains I/O pins for interfacing with the handheld device via the PLD 204, and the docking device in the case of the Visor massage device. The massage firmware is embedded in the micro-controller 404 and the code size is less than 4k bytes.

FIG.5 shows the various waveforms that are generated by the Basic Massager Unit 102 for delivery to the user. By changing the frequency, burst, ramp and mode parameters relating to the electric pulses, the waveforms change accordingly and the outcome is the causation of different sensations on the body. Waveforms shown in FIG. 5 include electric pulses generated in the ramp mode, burst mode, short burst modulation mode, and combinations of ramp and burst modes.

FIGS. 6A, 6B and 6C collectively form a schematic diagram of the massage devices. The schematic diagram includes all circuit components for forming the Visor and Non-Visor massage devices. The circuit consists of three sections, namely the Springboard interface sub-unit 104, Basic Massager Unit 102, and RS-232-C interface sub-unit 106. For purposes of convenience and brevity, the docking device sub-unit 108 is subsumed under the Springboard interface sub-unit 104 and described accordingly.

In the Basic Massager Unit 102, transistors Q5 and surrounding components form the charge pump circuit 404. Transistors Q1 to Q4 and Q6 to Q9 and surrounding components form the PNPP switch 404. An integrated circuit (IC) U5 is used for the analog feedback circuit 408, while an IC U3 is used for the EEPROM 410 that stores the three downloadable massage profiles. A Philips micro-controller P87LPC767BD is used for the micro-controller 402.

The Springboard sub-unit 104 consists of the flash memory U1, the PLD U2, and a 68-pin Springboard communications connector JH1. The docking sub-unit 108 consists of a 6-pin connector JP1. The RS-232-C sub-unit 106 consists of an RS-232-C driver U7 and a 3.3V DC-DC step-up converter PS1 that steps up the voltage supply provided by two batteries in series to a supply voltage Vcc in the non-Visor massage device.

In the Visor massage device, the 68-pin Springboard communications connector JH1 is used for mating with a corresponding 68-pin connector in a Springboard receptacle provided by the Visor PDA into which the Visor massage device slots for providing connectivity between the two devices. The 6-pin connector JP1 is used for mating with a corresponding 6-pin connector in the docking device. An RS-232-C communications connection-based connector PS1 consisting of Txd, Rxd, and Gnd pins is used for providing connection with the non-Visor PDA.

FIGS. 7A to 7E are flowcharts relating to the massage firmware. With reference to a flowchart provided in FIG. 7A, the overall operation of the massage firmware is described hereinafter. The massage firmware in a step 702 initialises all variables and registers in the micro-controller 402, and then in a step 704 checks the massage device hardware to determine whether the massage device is connected to the handheld device for operation in the interface mode or to the docking device for operation in the standalone mode. In the case of the Visor massage device, detection is achieved via the 6-pin connector JP1, in which one of the pins is pulled low when the 6-pin connector JP1 is inserted in the docking device. The micro-controller 402 checks this pin at start-up and accordingly sets a plug-in flag. In the case of non-visor PDA, detection is achieved via detection of the RS-232-C level present at the RS-232-C driver U7. If the massage device is in standalone mode, the plug-in flag is set to zero in a step 706. Otherwise, the plug-in flag is set to one in a step 708.

With all the registers and variables initialised and the plug-in flag set, the massage firmware enters a main loop 710 and checks all events from the handheld device in the interface mode or the keyboard interface in the standalone mode and reacts accordingly. All events are interrupt-driven therefore enabling the massage firmware to process in real time. The interrupt events include the occurrence of a keyboard interrupt 712, an ADC interrupt 714, a PWM interrupt 716, and a PNPP switch interrupt 718.

In the main loop 710, as shown in FIG.7B, the firmware performs two different processes based on the plug-in flag, the status of which is checked in a step 720, where the two different processes are performed in relation to the standalone mode and interface mode. If the massage device is in the standalone mode, a corresponding process is performed which involves the massage firmware obtaining input from the two push buttons found either on the docking unit or the non-Visor PDA in a step 722 via the keyboard interrupt 712, in which events are driven from the two push buttons. The two push buttons used in the standalone mode consist of a Start/Up button and a Stop/Down button. If the massage firmware checks in steps 724 and 726 that the Start/Up button is pressed (step 724) and held down for more than 1 sec (step 726), the massage device begins massage operation using the current selected massage profile in a step 728. If the massage firmware checks in steps 730, 732, and 734 that the user presses (step 730) and holds down the Stop/Down button for more than 1 sec (step 732), and that the current massage profile is in operation (step 734), the massage device stops massage operation in a step 736. When the massage operation is not in progress and if the massage firmware checks in steps 738 and 742 that the user presses and releases in less than 1 sec the Start/Up (step 738) or Stop/Down (step 742) buttons, the massage firmware moves the massage profile pointer up in a step 740 or down in a step 744, respectively, thereby changing the massage profile selection. When the massage operation is in progress and if the massage firmware checks in steps 738 and 742 that the user presses and releases in less than 1 sec the Start/Up (step 738) or Stop/Down (step 742) buttons, the massage firmware changes the massage pressure by increasing the same by 5 units in a step 746 or decreasing the same by 5 units in a step 748, respectively. The massage firmware also checks in a step 750 to ensure that if the massage operation occurs for more than 15 minutes, the massage device stops the massage operation in a step 752.

If the massage device is in the interface mode, the massage firmware performs a corresponding process in which the massager firmware scans for instructions from the handheld device in a step 754 via a PWM interrupt routine shown in FIG. 7C. After receiving input from the handheld device, the massage firmware checks in steps 756, 760, 764, and 768 for instructions to start, stop, load parameters, and read status, respectively, and thereafter perform the corresponding events of starting or stopping the massage operation, loading parameters, or reading status in steps 758, 762, 766, and 770, respectively, when the relevant instructions are received.

In the PWM interrupt routine shown in FIG. 7C, which is entered every 200 usec upon a timer interrupt, the output electric current generated by an ADC interrupt routine shown in FIG.7E is obtained in a step 760. This output electric current is compared with the user preset level in steps 762 and 764, and the duty cycle of the PWM signal is adjusted in steps 766 and 768 with respect to the output electric current. If in the step 762 the massage firmware checks and finds the output electric current to be higher than the user preset level, a counter value PWM_COUNT which affects the duty cycle of the PWM signal is reduced by one in the step 766. If in the step 764 the massage firmware checks and finds the output electric current to be lower than the user preset level, the PWM_COUNT counter value is increased by one in the step 768. Otherwise the massage firmware turns on the PWM signal according to the PWM-COUNT counter value in a step 770.

This is done for every electric pulse that is generated and delivered to the body, and since the PWM interrupt routine is entered every 200 usec, this gives rise to the generation of the 5kHz PWM signal. The massage firmware performs housekeeping operations at this routine for all the timing related events such as monitoring the duration of the massage profile in a step 772 and also controlling the display of the

LEDs 412 in the standalone mode in a step 774. The massage firmware also scans instructions from the handheld device in a step 776.

With reference to FIG.7D, a PNPP switch interrupt routine is described, which is entered every time an electric pulse is turned off (pulse off) or every 4 msec after pulse off if the electric pulse frequency is less than 35 Hz. This routine essentially controls the timing of the electric pulse output by checking in a step 780 an electric pulse, and turning the electric pulse off in a step 782 if the electric pulse is turned on (pulse on), or on in a step 784 if the electric pulse is off. This routine also kicks off the ADC conversion once the positive or negative pulse is turned on in a step 786. Before the massage firmware exits this routine, a new timer event is set based on the mode of operation in a step 788 according to the frequency and burst settings. This therefore allows the massage firmware to monitor all the electric pulse currents.

The ADC interrupt routine as shown in FIG. 7E is described in further detail hereinafter. This routine is entered at every pulse on and when the PNPP switch interrupt routine kicks off the ADC conversion. The ADC result is stored as a global variable in a step 790 after the output electric current is captured, and an open loop, when the pair of conductive pads is not attached to the body, count is also tracked. The routine checks if the ADC result is equal to the open load value in a step 792, and if yes, further checks if there are more than 15 open loop/no load counts at the output in a step 794. If there are more than 15 counts, the massage operation stops immediately in a step 796. If there are less than 15 counts, the open load count is incremented by one in a step 798. If the ADC result is not equal to the open load value, the open loop count is reset to zero in a step 799.

This routine helps to prevent the output electric pulse amplitude from reaching high levels so that when the pair of conductive pads accidentally contacts the body, the electric pulse amplitude levels do not cause any discomfort. The actual output electric current is translated to an 8-bit binary voltage value which is used to control the PWM signal duty cycle. Because of this arrangement, a constant output electric current is achieved. This is important because different parts of the body offer different resistance values. Therefore the output current is maintained when the conductive pads are shifted to other body locations.

A number of user-interface screen shots are shown in FIG. 8, and these are achieved using the Visor PDA touch screen. The user-interface may be changed easily and port over to other handheld devices. The software for the massage application may be upgraded easily by installing new software into the handheld device. For example, items A, B, and C show screens depicting the selection of the squeezing, shoulder, and tapping massage profiles, respectively. Item D shows a custom massage profile screen, where through the touch screen, the massage device allows the user to transfer predefined massage profiles from the handheld device to the massage device. Item E shows a manual setting screen, where through this screen, the user may operate the massage device in the manual mode. In the manual mode, the user is allowed to change the frequency, ramp, burst, modulation and duration settings to generate different kinds of massage sensation on the body. Item F shows a screen providing a graphical representation of a body with recommended locations on which to place the pair of conductive pads.

In the foregoing manner, massage devices according to embodiments of the invention for addressing the foregoing disadvantages of conventional massage devices are described. Although only a number of embodiments of the invention are disclosed, it will be apparent to one skilled in the art in view of this disclosure that numerous changes and/or modification can be made without departing from the scope and spirit of the invention. For example, the electrical components and functional/operational modules described with reference to the foregoing block diagrams and schematic diagrams may be replaced with the like electrical components and functional/operational modules, respectively.

**Claims**

1. A massage device for generating and delivering electric pulses and which is capable of interfacing with a handheld computing device, comprising:

a controller for performing and controlling massage operations in the massage device;

an electric pulse generator dependent on the controller for generating electric pulses for delivery to a user; and

an interface for providing communication interface with a handheld computing device for receiving instructions on which the controller is dependent for performing massage operations.

2. The device as in claim 1, wherein the electric pulse generator receives a PWM signal from the controller and converts the PWM signal into an electric pulse the voltage level of which is dependent on the width of the PWM signal.

3. The device as in claim 2, further including a polarity switch for controlling the direction of current flow induced by the application of the electric pulse on the user by providing both negative and positive polarities of the electric pulse.

4. The device as in claim 1, further including a read-only-memory wherein at least one permanent massage profile is stored in the read-only-memory, the permanent massage profile containing at least one massage pattern that defines at least one parameter relating to the electric pulse.

5. The device as in claim 4, further including a non-volatile memory wherein at least one temporary massage profile is written to and stored in the non-volatile memory, the temporary massage profile containing at least one massage pattern that defines at least one parameter relating to the electric pulse.

6. The device as in claim 5, wherein the temporary massage profile is transmitted from the handheld computing device to the memory via the interface.

7. The device as in claim 1, wherein a user-interface is provided via the interface for the user to provide user input to the controller.

8. The device as in claim 7, wherein the user-interface includes a display for the user to receive information from the controller.

9. The device as in claim 8, further including storage for storing instruction codes on which the handheld computing device is dependent for operation to provide the user-interface, the instruction codes being retrievable by the handheld computing device via the interface.

10. The device as in claim 1, further including an open-load detector for sensing open circuits at the output of the polarity switch and cutting off the electric pulse when an open circuit is detected.

11. A method for generating and delivering electric pulses via a massage device which is capable of interfacing with a handheld computing device, the method comprising the steps of:

performing and controlling massage operations via a controller in the massage device;

generating electric pulses for delivery to a user via an electric pulse generator dependent on the controller; and

providing communication interface with a handheld computing device via an interface for receiving instructions on which the controller is dependent for performing massage operations.

12. The method as in claim 11, wherein the electric pulse generator receives a PWM signal from the controller and converts the PWM signal into an electric pulse the voltage level of which is dependent on the width of the PWM signal.

13. The method as in claim 12, further including the step of controlling the direction of current flow induced by the application of the electric pulse on the user via a polarity switch by providing both negative and positive polarities of the electric pulse.

14. The method as in claim 11, further including the step of providing a read-only-memory wherein at least one permanent massage profile is stored in the read-only-memory, the permanent massage profile containing at least one massage pattern that defines at least one parameter relating to the electric pulse.

15. The method as in claim 14, further including the step of providing a non-volatile memory wherein at least one temporary massage profile is written to and stored in the non-volatile memory, the temporary massage profile containing at least one massage pattern that defines at least one parameter relating to the electric pulse.

16. The method as in claim 15, further including the step of transmitting the temporary massage profile from the handheld computing method to the memory via the interface.

17. The method as in claim 11, further including the step of providing a user-interface is provided via the interface for the user to provide user input to the controller.

18. The method as in claim 17, wherein the step of providing the user-interface includes providing a display for the user to receive information from the controller.

19. The method as in claim 18, further including the step of providing storage for storing instruction codes on which the handheld computing method is dependent for operation to provide the user-interface, the instruction codes being retrievable by the handheld computing method via the interface.

20. The method as in claim 11, further including the step of providing an open-load detector for sensing open circuits at the output of the polarity switch and cutting off the electric pulse when an open circuit is detected.

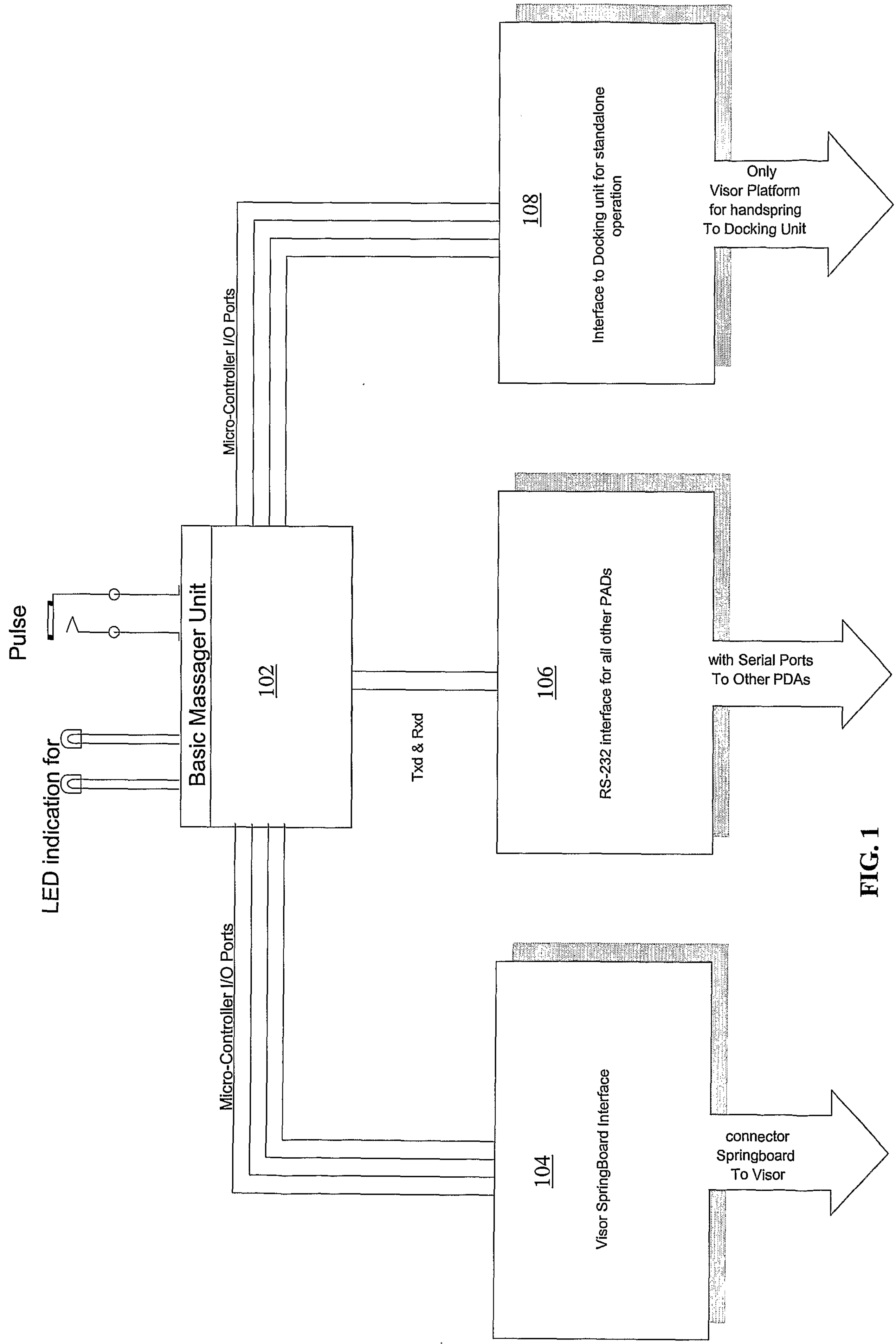
Pulse
LED indication for
Basic Massager Unit
102
Micro-Controller I/O Ports
Micro-Controller I/O Ports
Txd & Rxd
108
Interface to Docking unit for standalone operation
Only Visor Platform for handspring To Docking Unit
106
RS-232 interface for all other PADs
with Serial Ports To Other PDAs
104
Visor SpringBoard Interface
connector Springboard To Visor

FIG. 1

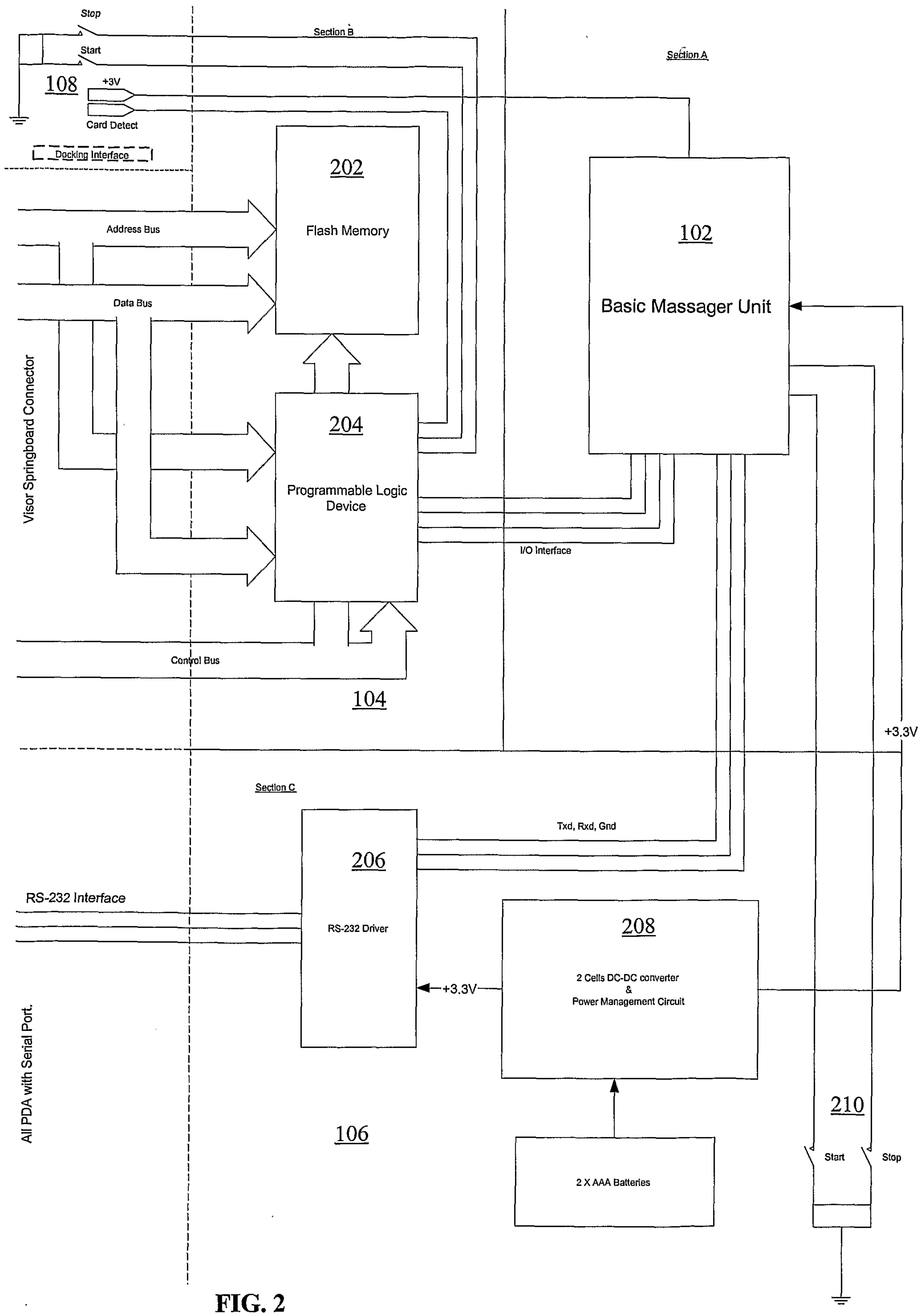
Stop
Section B
Start
Section A
108
+3V
Card Detect
Docking Interface
202
Flash Memory
102
Basic Massager Unit
Address Bus
Data Bus
Visor Springboard Connector
204
Programmable Logic Device
I/O Interface
Control Bus
104
+3.3V
Section C
Txd, Rxd, Gnd
206
RS-232 Interface
RS-232 Driver
208
2 Cells DC-DC converter
&
Power Management Circuit
+3.3V
All PDA with Serial Port.
210
106
Start
Stop
2 X AAA Batteries

FIG. 2

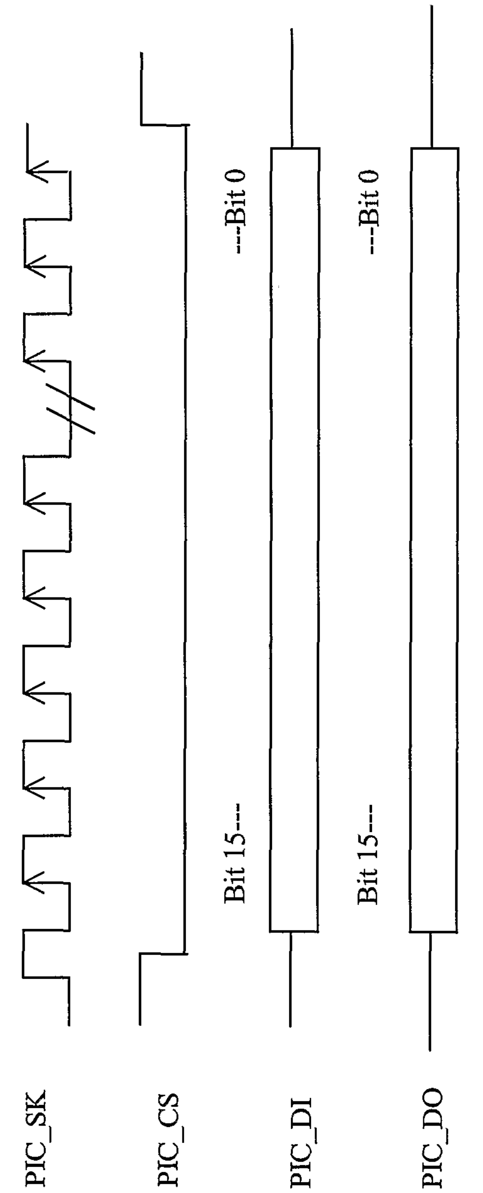


**FIG. 3**

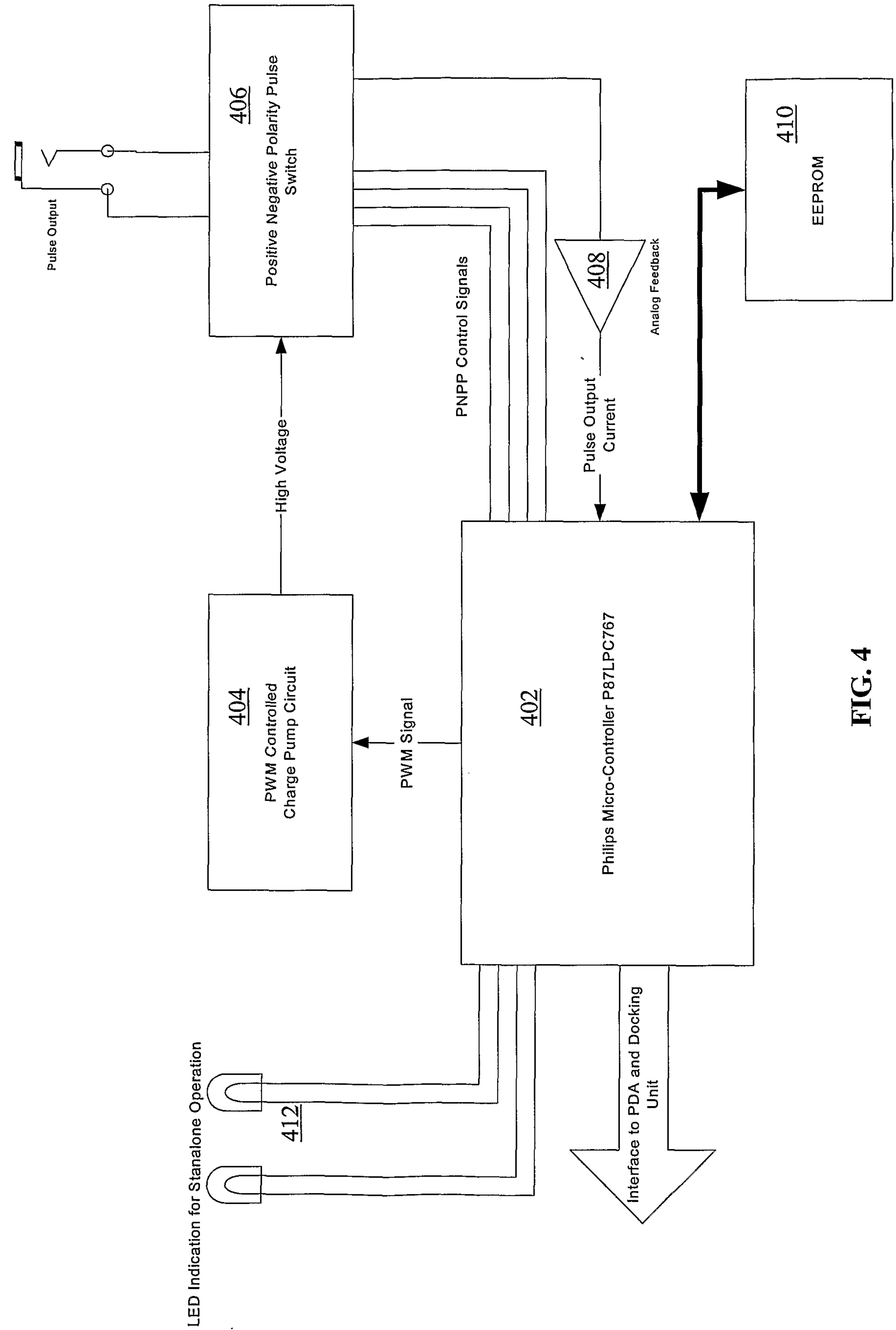
Pulse Output
406
Positive Negative Polarity Pulse Switch
410
EEPROM
408
Analog Feedback
PNPP Control Signals
Pulse Output Current
High Voltage
404
PWM Controlled Charge Pump Circuit
PWM Signal
402
Philips Micro-Controller P87LPC767
Interface to PDA and Docking Unit
412
LED Indication for Stanalone Operation

FIG. 4

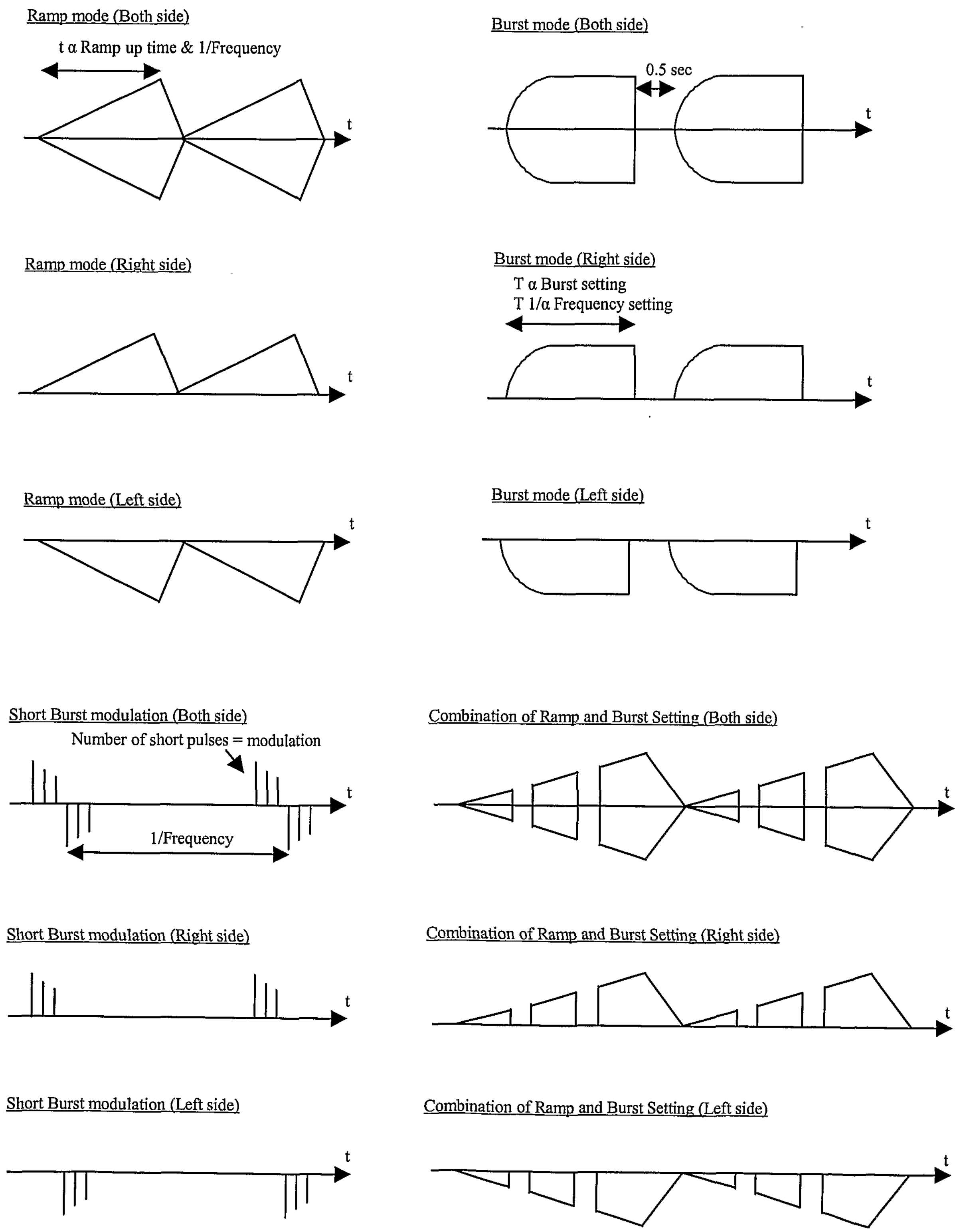
Ramp mode (Both side)
t α Ramp up time & 1/Frequency
t
Burst mode (Both side)
0.5 sec
t
Ramp mode (Right side)
t
Burst mode (Right side)
T α Burst setting
T 1/α Frequency setting
t
Ramp mode (Left side)
t
Burst mode (Left side)
t
Short Burst modulation (Both side)
Number of short pulses = modulation
t
1/Frequency
Combination of Ramp and Burst Setting (Both side)
t
Short Burst modulation (Right side)
t
Combination of Ramp and Burst Setting (Right side)
t
Short Burst modulation (Left side)
t
Combination of Ramp and Burst Setting (Left side)
t

**FIG. 5**

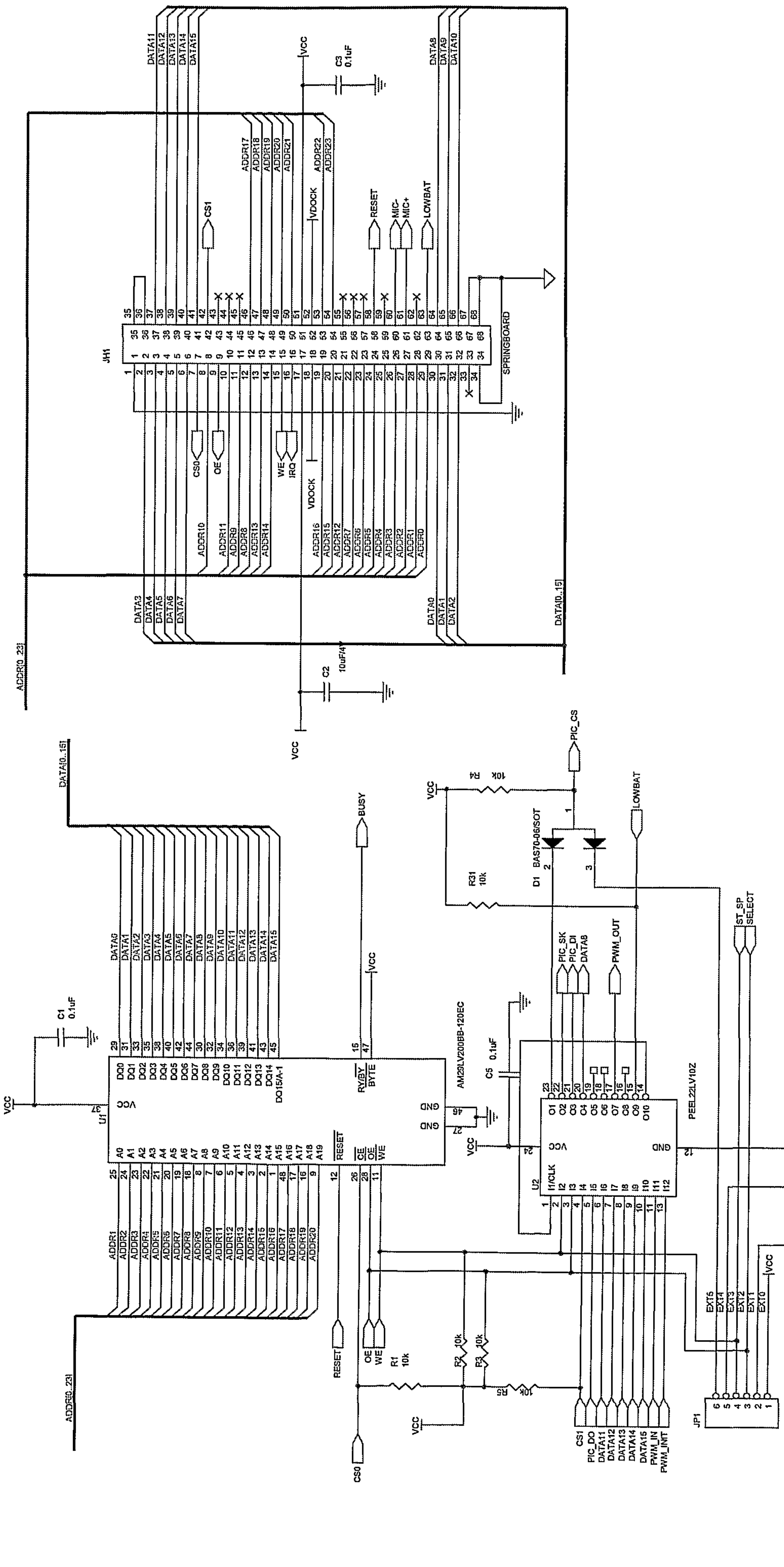
JH1
SPRINGBOARD
AM29LV200BB-120EC
U1
U2
PEEL22LV10Z
D1 BAS70-06/SOT
JP1
HEADER 6
ADDR[0..23]
DATA[0..15]
C1 0.1uF
C2 10uF/4V
C3 0.1uF
C5 0.1uF
R1 10k
R2 10k
R3 10k
R4 10k
R5 10K
R31 10k
VCC
VDOCK
CS0
CS1
OE
WE
IRQ
RESET
MIC-
MIC+
LOWBAT
BUSY
PIC_CS
PIC_SK
PIC_DI
PIC_DO
PWM_OUT
PWM_IN
PWM_INIT
ST_SP
SELECT

Fig. 6A

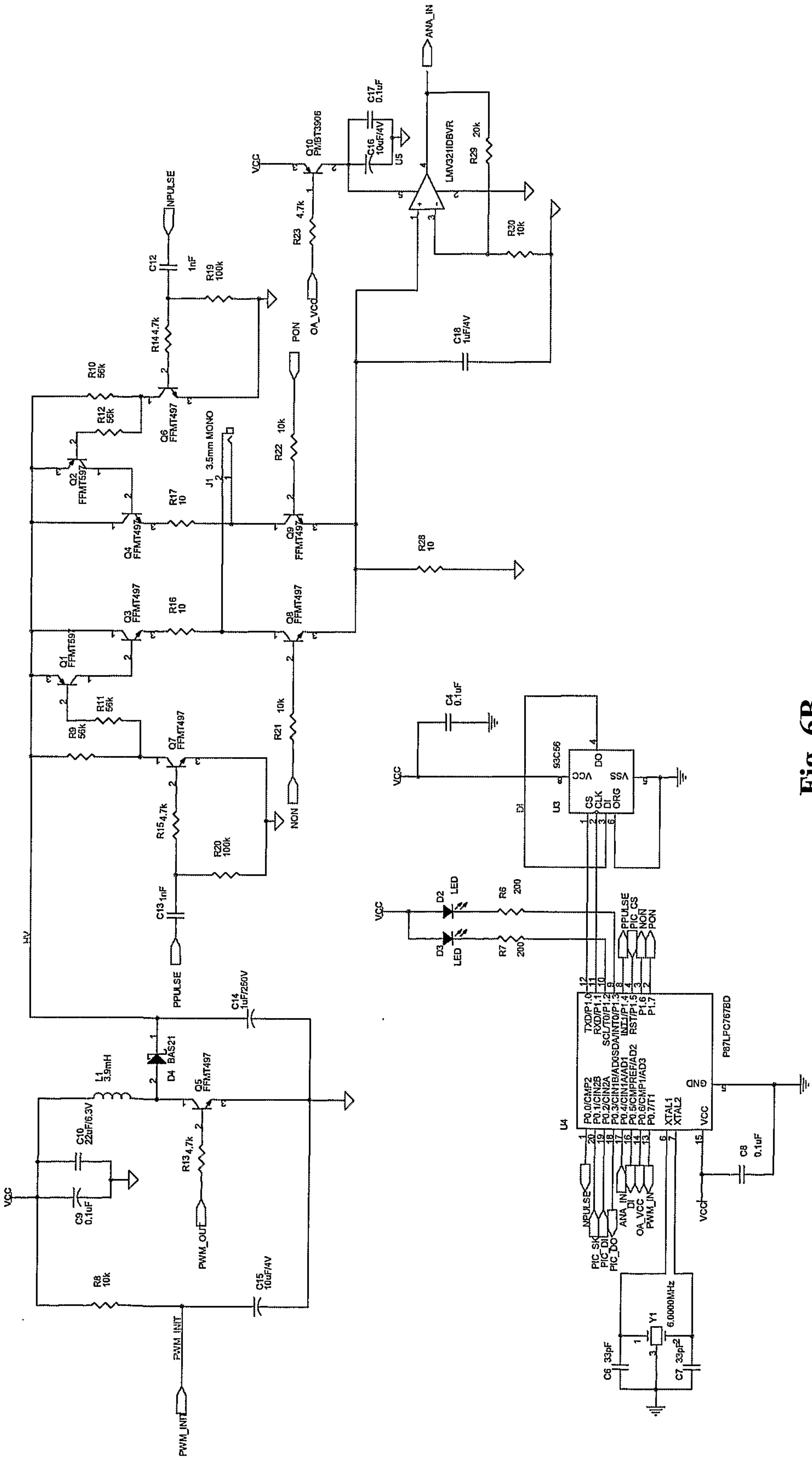
ANA_IN
NPULSE
C12 1nF
R19 100k
R14 4.7k
R10 56k
R12 56k
Q6 FFMT497
Q2 FFMT597
J1 3.5mm MONO
R17 10
Q4 FFMT497
Q3 FFMT497
R16 10
Q1 FFMT597
R9 56k
R11 56k
Q7 FFMT497
R15 4.7k
R20 100k
C13 1nF
PPULSE
HV
C14 1uF/250V
L1 3.9mH
D4 BAS21
Q5 FFMT497
R13 4.7k
PWM_OUT
C10 22uF/6.3V
C9 0.1uF
VCC
R8 10k
C15 10uF/4V
PWM_INIT
Q10 PMBT3906
C17 0.1uF
C16 10uF/4V
U5
LMV321IDBVR
R29 20k
R23 4.7k
OA_VCC
R30 10k
PON
C18 1uF/4V
R22 10k
Q9 FFMT497
R28 10
Q8 FFMT497
R21 10k
NON
C4 0.1uF
U3
93C56
CS
CLK
DI
ORG
VCC
VSS
DO
D2 LED
D3 LED
R6 200
R7 200
PPULSE
PIC_CS
NON
PON
U4
P87LPC767BD
TXD/P1.0
RXD/P1.1
SCL/T0/P1.2
SDA/INT0/P1.3
INT1/P1.4
RST/P1.5
P1.6
P1.7
P0.0/CMP2
P0.1/CIN2B
P0.2/CIN2A
P0.3/CIN1B/AD0
P0.4/CIN1A/AD1
P0.5/CMPREF/AD2
P0.6/CMP1/AD3
P0.7/T1
XTAL1
XTAL2
GND
C8 0.1uF
NPULSE
PIC_SK
PIC_DI
PIC_DO
ANA_IN
OA_VCC
PWM_IN
Y1 6.0000MHz
C6 33pF
C7 33pF

Fig. 6B

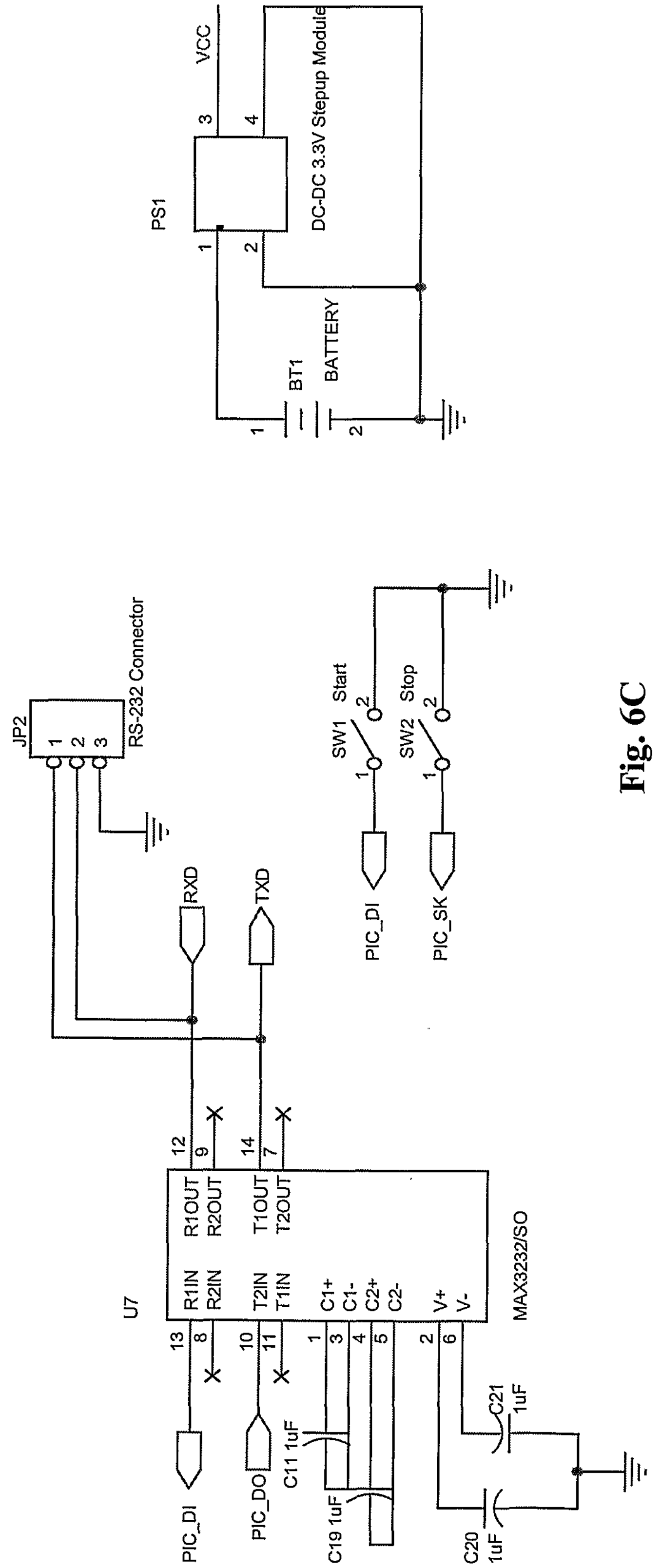
VCC
DC-DC 3.3V Stepup Module
PS1
1
2
3
4
BT1
BATTERY
1
2
JP2
RS-232 Connector
1 2 3
RXD
TXD
SW1 Start
SW2 Stop
PIC_DI
PIC_SK
U7
MAX3232/SO
R1IN
R2IN
T2IN
T1IN
C1+
C1-
C2+
C2-
V+
V-
R1OUT
R2OUT
T1OUT
T2OUT
13 8 10 11 1 3 4 5 2 6
12 9 14 7
PIC_DI
PIC_DO
C11 1uF
C19 1uF
C20 1uF
C21 1uF

Fig. 6C

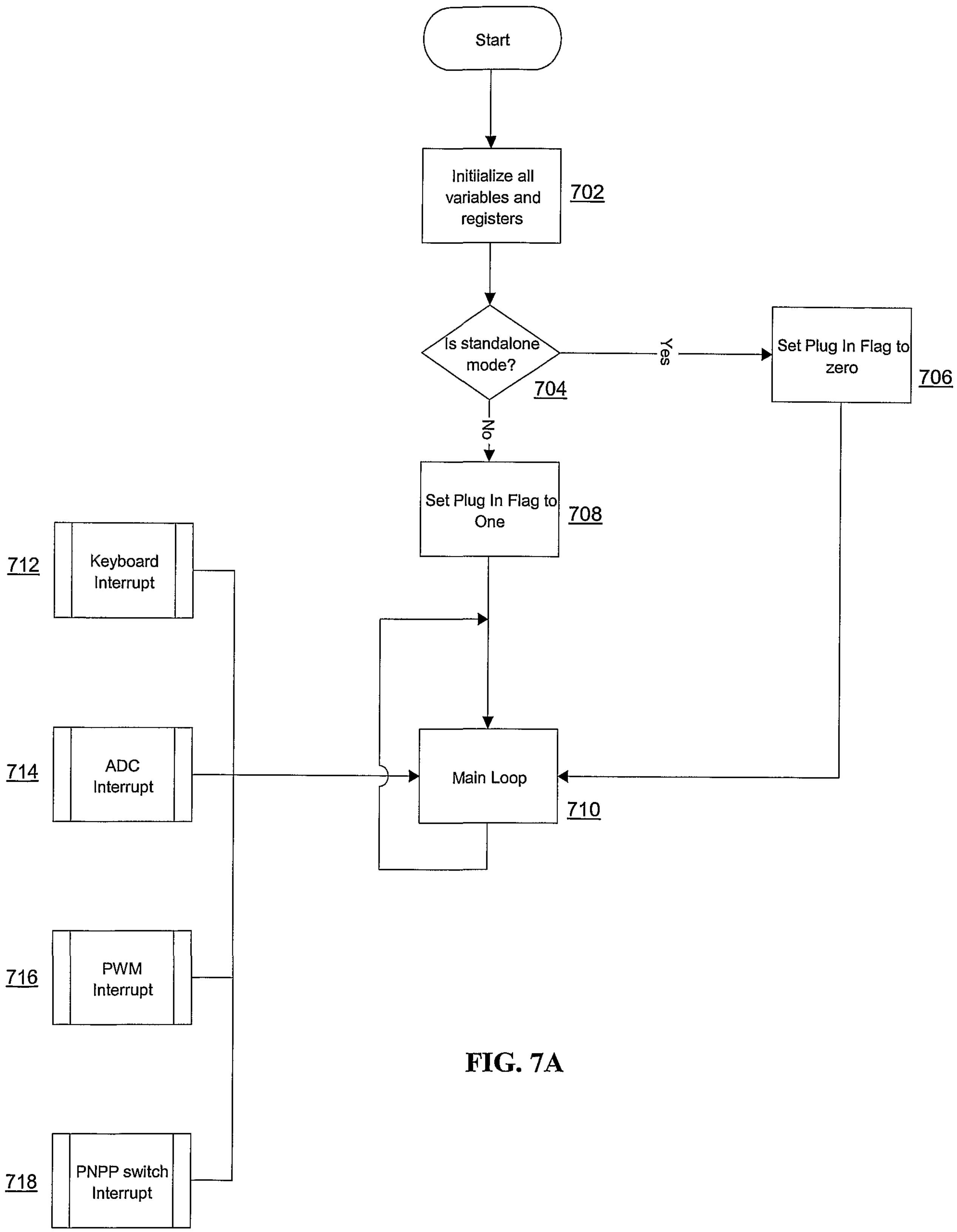
Start
Initiialize all variables and registers
702
Is standalone mode?
704
Yes
No
Set Plug In Flag to zero
706
Set Plug In Flag to One
708
Main Loop
710
Keyboard Interrupt
712
ADC Interrupt
714
PWM Interrupt
716
PNPP switch Interrupt
718

FIG. 7A

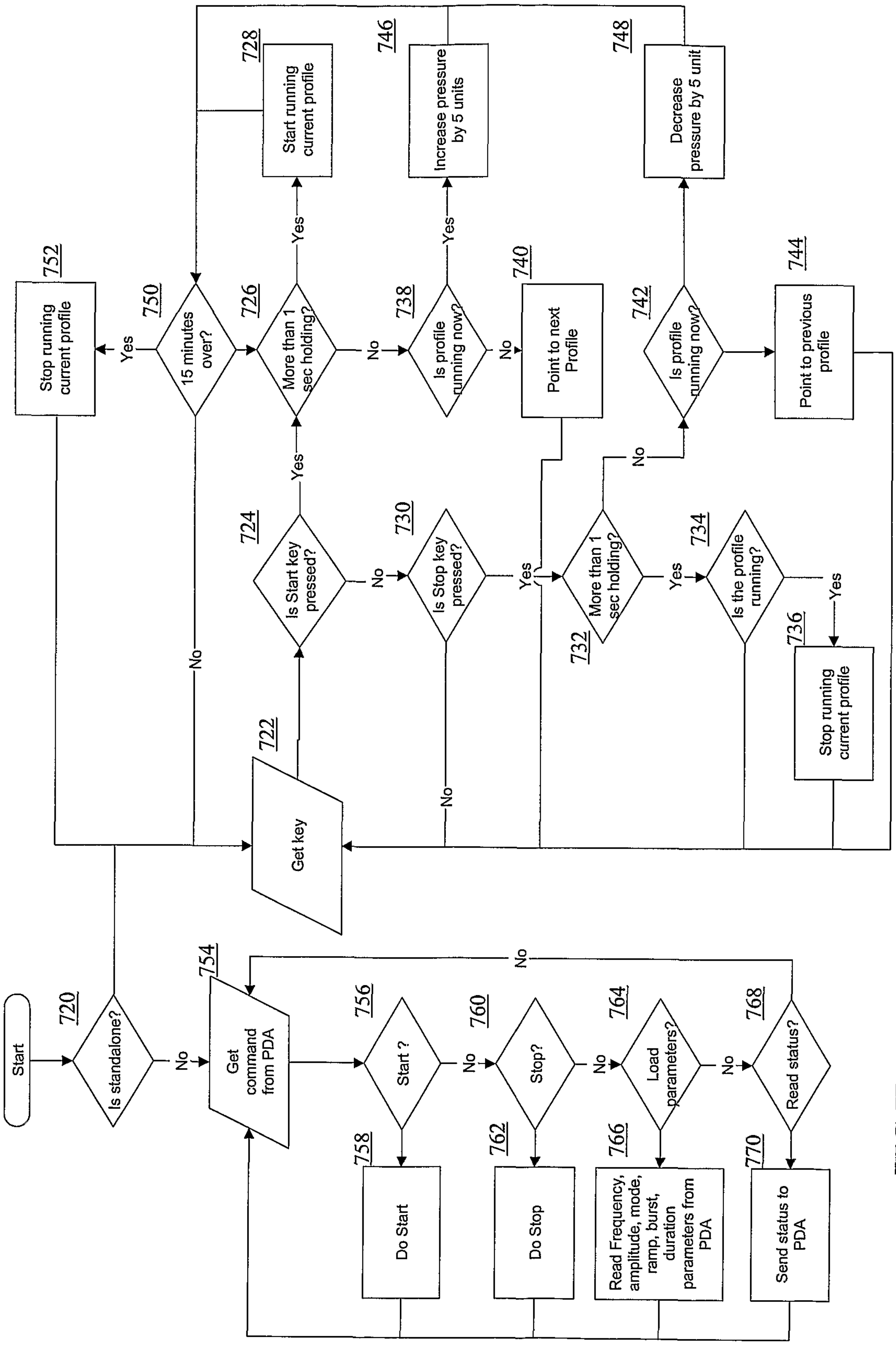
Start
720
Is standalone?
No
754
Get command from PDA
756
Start ?
758
Do Start
No
760
Stop?
762
Do Stop
No
764
Load parameters?
766
Read Frequency, amplitude, mode, ramp, burst, duration parameters from PDA
No
768
Read status?
770
Send status to PDA
No
722
Get key
724
Is Start key pressed?
Yes
No
730
Is Stop key pressed?
No
Yes
732
More than 1 sec holding?
Yes
734
Is the profile running?
Yes
736
Stop running current profile
No
742
Is profile running now?
744
Point to previous profile
748
Decrease pressure by 5 unit
726
More than 1 sec holding?
Yes
728
Start running current profile
No
738
Is profile running now?
Yes
746
Increase pressure by 5 units
No
740
Point to next Profile
750
15 minutes over?
Yes
752
Stop running current profile
No

FIG.7B

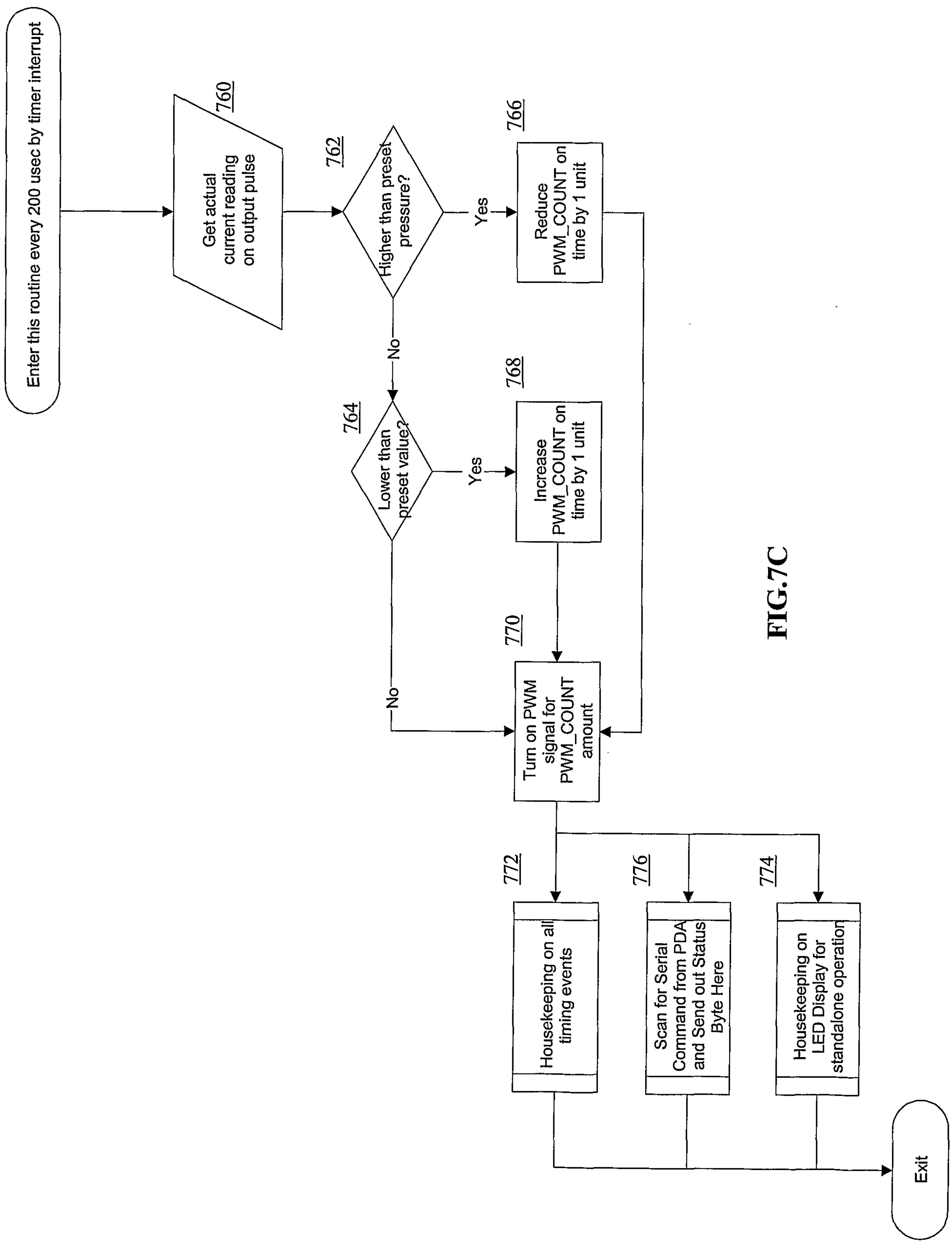
Enter this routine every 200 usec by timer interrupt
Get actual current reading on output pulse
760
Higher than preset pressure?
762
Yes
No
Reduce PWM_COUNT on time by 1 unit
766
Lower than preset value?
764
Yes
No
Increase PWM_COUNT on time by 1 unit
768
Turn on PWM signal for PWM_COUNT amount
770
Housekeeping on all timing events
772
Scan for Serial Command from PDA and Send out Status Byte Here
776
Housekeeping on LED Display for standalone operation
774
Exit

FIG.7C

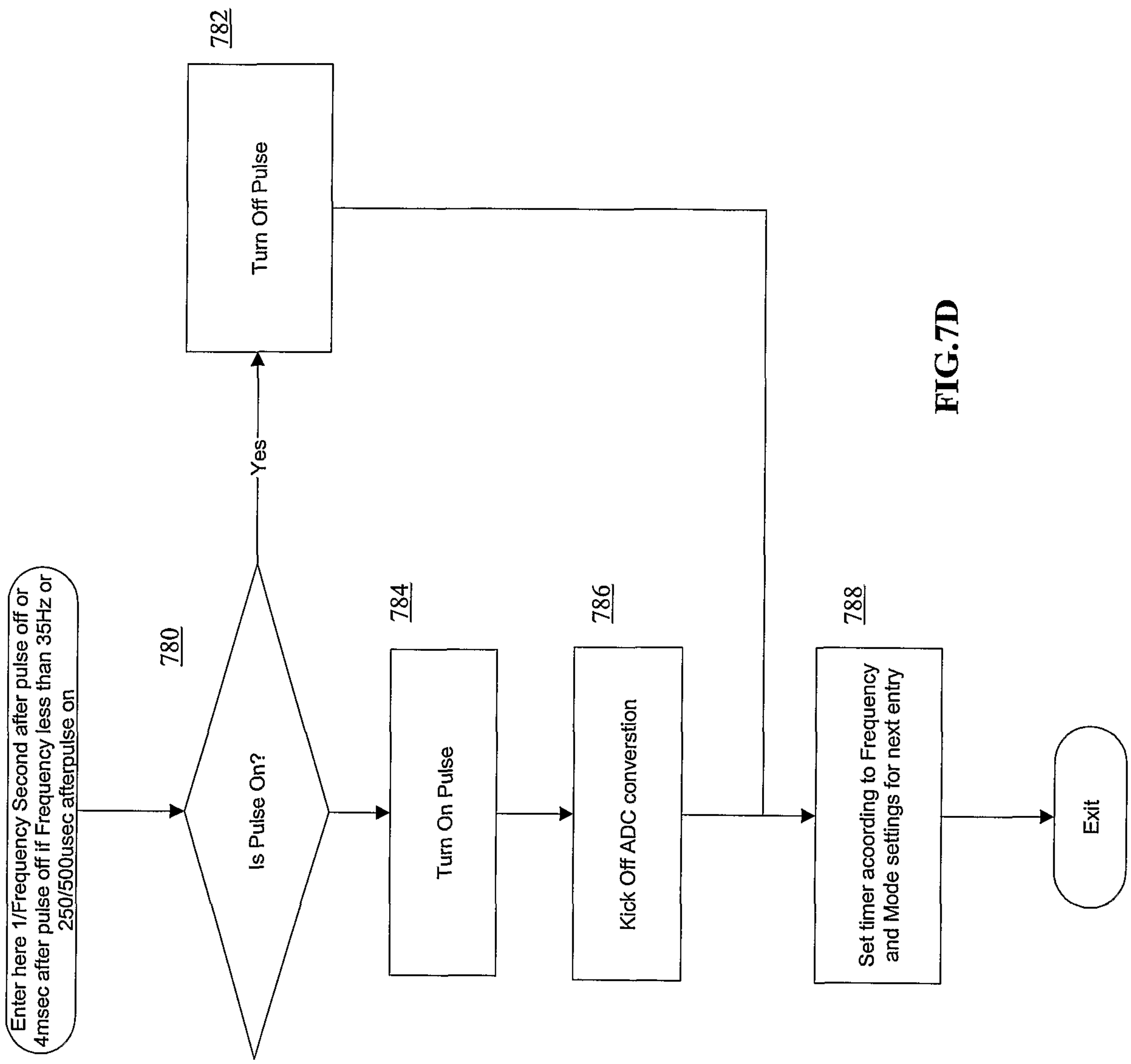
Enter here 1/Frequency Second after pulse off or 4msec after pulse off if Frequency less than 35Hz or 250/500usec afterpulse on
780
Is Pulse On?
Yes
782
Turn Off Pulse
784
Turn On Pulse
786
Kick Off ADC converstion
788
Set timer according to Frequency and Mode settings for next entry
Exit

FIG.7D

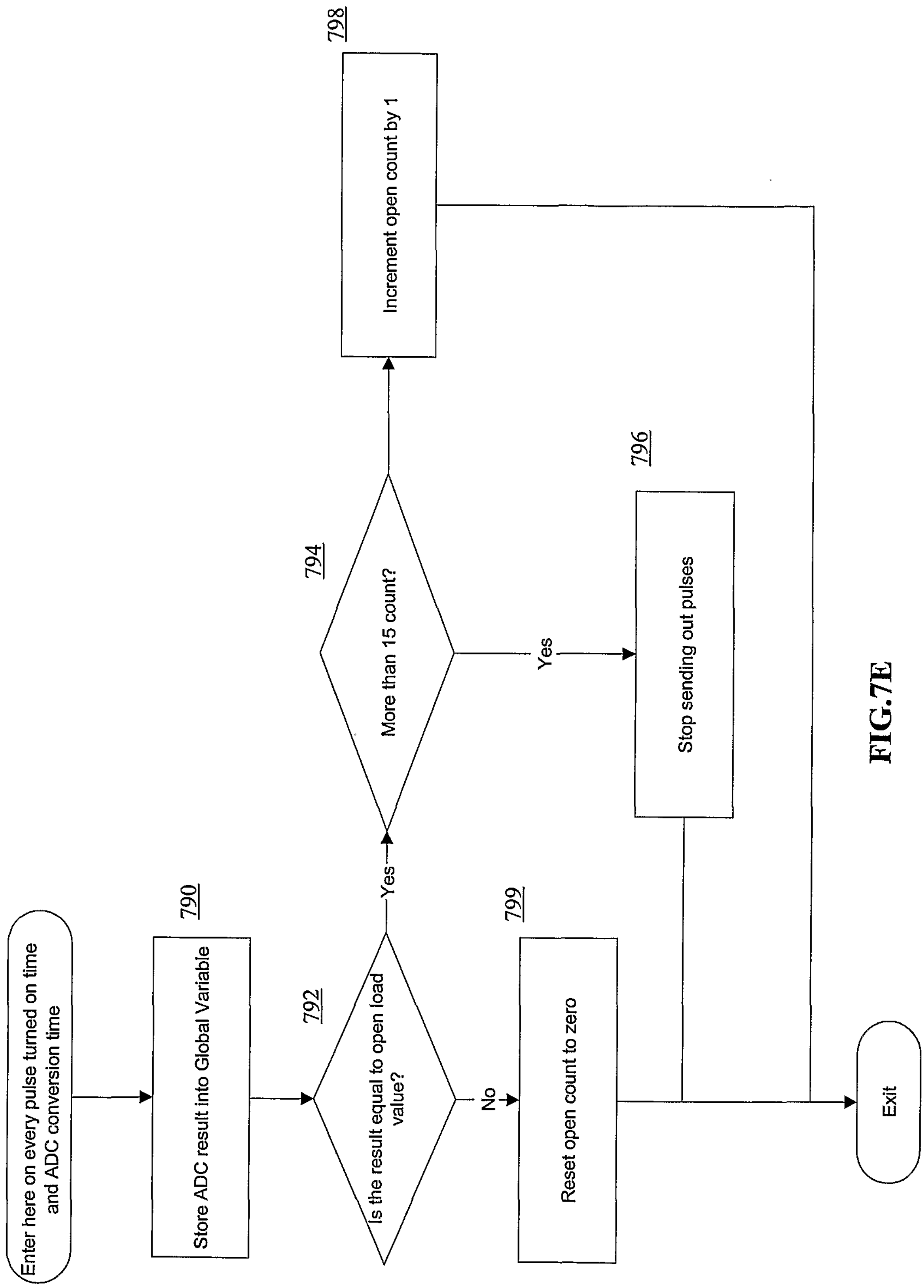
Enter here on every pulse turned on time and ADC conversion time
790
Store ADC result into Global Variable
792
Is the result equal to open load value?
Yes
No
794
More than 15 count?
Yes
796
Stop sending out pulses
798
Increment open count by 1
799
Reset open count to zero
Exit

FIG.7E

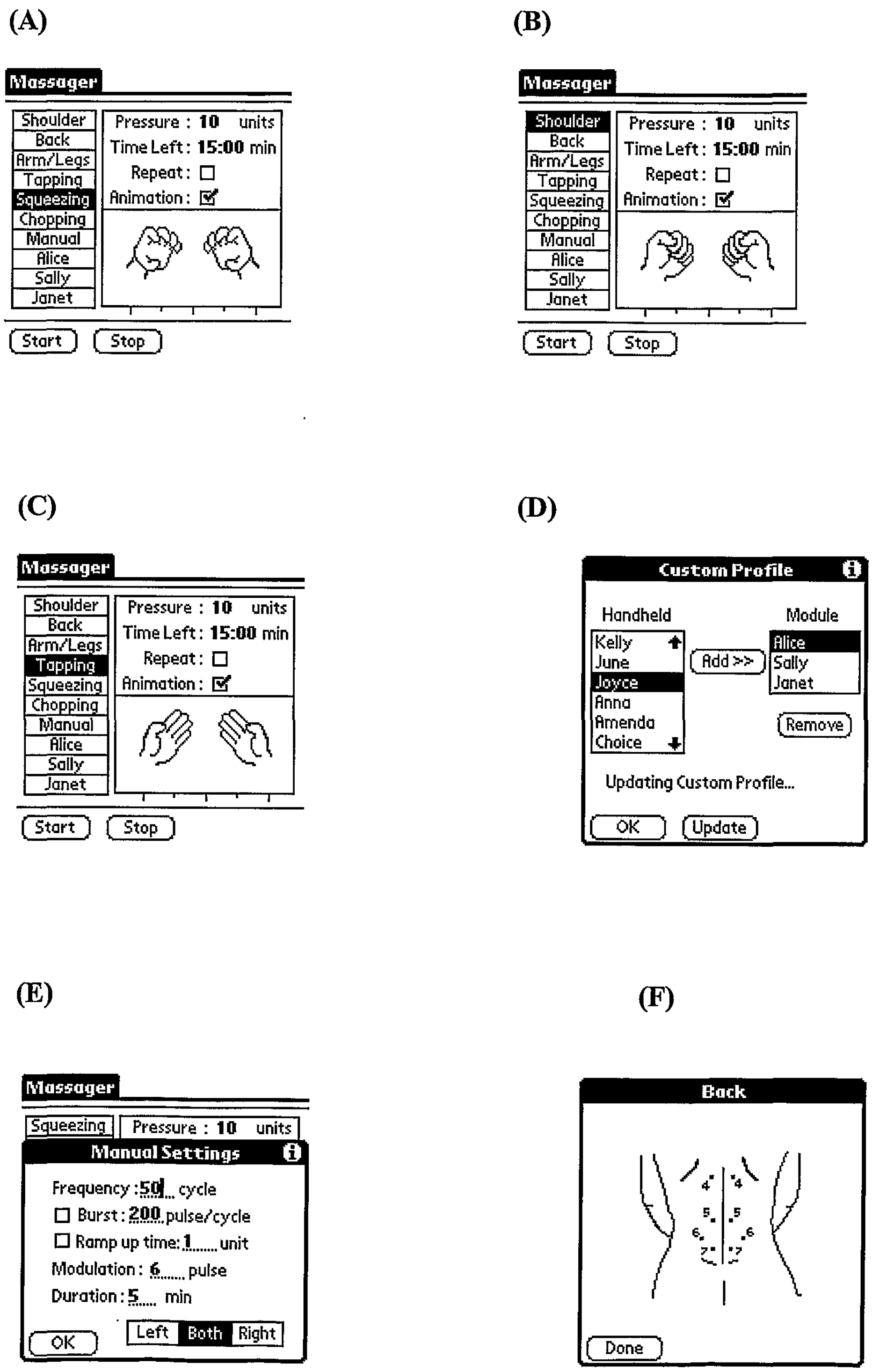
(A)
Massager
Shoulder
Back
Arm/Legs
Tapping
Squeezing
Chopping
Manual
Alice
Sally
Janet
Pressure : 10 units
Time Left : 15:00 min
Repeat :
Animation :
Start
Stop
(B)
Massager
Shoulder
Back
Arm/Legs
Tapping
Squeezing
Chopping
Manual
Alice
Sally
Janet
Pressure : 10 units
Time Left : 15:00 min
Repeat :
Animation :
Start
Stop
(C)
Massager
Shoulder
Back
Arm/Legs
Tapping
Squeezing
Chopping
Manual
Alice
Sally
Janet
Pressure : 10 units
Time Left : 15:00 min
Repeat :
Animation :
Start
Stop
(D)
Custom Profile
Handheld
Module
Kelly
June
Joyce
Anna
Amenda
Choice
Add >>
Alice
Sally
Janet
Remove
Updating Custom Profile...
OK
Update
(E)
Massager
Squeezing
Pressure : 10 units
Manual Settings
Frequency : 50 cycle
Burst : 200 pulse/cycle
Ramp up time: 1 unit
Modulation : 6 pulse
Duration : 5 min
OK
Left
Both
Right
(F)
Back
4
4
5
5
6
6
7
7
Done

**FIG.8**