Lost Item Pager

Hardware description

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**Lost Item Pager Overview:**

The Lost Item Pager, which is a wireless system consisting of a base module and three pager/keychain units. Each unit of the system consists of many of the same parts, but the base has a few more components such as more buttons and an LCD. The pagers will be powered with a 3.3V battery and every effort to conserve the battery’s life is implemented. This document will list the components in each device and an explanation of the reasons for using those specific components along with their purpose.

**The Microcontroller:**

The microcontroller selected for the system is the Freescale MC1321x. This chip has a HC08 microcontroller with a 2.4GHz Zigbee compliant transceiver modem. Having the transceiver and microcontroller in one chip will help conserve battery life in the pagers and also reduce the number of components in the system. Using this family of microcontrollers is cost effective and will keep the size of the pagers small since each unit of the system requires both the microprocessor and transceiver. The MC1321x has three low power modes to conserve the batteries in the pagers. There is a low voltage detector built into the MC1321x also, which will allow for a low battery signal and a safe transition into a reset mode for the appropriate stages of the batteries in the pagers.

The pager units will have the MC13211 model of the MC1321x family with the least onboard memory; contains 1K of RAM and 16K of Flash memory. I chose the smaller memory design to cut down on the overall cost of the system, and also because it provides plenty of memory of the simple time-slice loop the pagers will operate on. The base unit will need enough memory to use micro C/OS however, so the MC13213 was
selected for this unit, because it contains 4K of RAM and 60K of Flash; the model with
the largest memory available.

The Antenna:

The antennas will be constructed as part of the printed circuit board (the PCB) on each of
the devices (only one channel will be necessary). The connecting circuit design used in
the schematic is taken from a reference design provided by Freescale, to be used on a
PCB design with the Zigbee chips. The circuit is a network of capacitors and inductors
working with a 2.45GHz Balun transformer to help match the impedances of the antenna
and the modem. The range of this antenna will be sufficient for this system, which is
meant for use inside a typical house (about 50-100ft).

Power:

Base

The base is be powered with a 5V switching power supply that will be connected to a
3.3V regulator. Fortunately the LCD selected in the schematic is capable of operating
with an input voltage range of 2.8V to 5.5V, so only one voltage regulator will be
necessary for the base unit, because the MC1321x is a 3.3V device. The 3.3V supply will
be connected to VDD, Vbatt and VDDINT to power the MCU and the modem. Each of
the supply pins are decoupled to ground to protect the device from noise and voltage
spikes. The Vbatt pin is an input to an internal voltage regulator, whose output is the
VDDA pin. To power the modem, pins 29 and 30 (VDDLO1, and VDDLO2) are
connected to VDDA, pin 33. The schematics don’t show Vss, because it is pin 71 located
on the bottom of the chip (and isn’t really a pin), but it is present on both the base on the
pagers.
Pagers

The pagers will run off a coin sized 3.3V lithium battery. When the battery gets lower in voltage the internal voltage detector will be able to provide a high low-voltage signal, which will be processed in software to tell the user the battery is low. When the battery voltage reaches the low low-voltage range the device will be held in reset until the battery is replaced and the voltage level is sufficient. To conserve the battery the MC13211 microcontroller and modem will be placed in sleep modes for most of the time when the pagers are not in use. The audio amplifier will also be disabled during sleep mode, using the chip disable pin which disconnects the outputs to the speaker, reducing the power consumed in sleep mode. The supply from the battery will be connected the same as the base; 3.3V to VDD, VDDINT and Vbatt, all decoupled to ground. The output VDDA is connected to VDDLO1 and VDDLO2 to supply power to the modem.

User Interactive Components:

The Base Unit:

The base unit will feature an LCD to show the user several messages, making the device more useful and user-friendly. The LCD will be connected to port B pins 0-7 on the MC13213. To conserve pins the LCD will be connected using only 4 data line pins, the read/write_L pin on the LCD will be tied low, so that it communication from the microcontroller to the LCD is only in one direction (it will not be necessary to read the LCD at anytime). The LCD is powered with a 3.3V source from the voltage regulator, instead of the typical 5V which creates the need for only one voltage regulator. The A and K pins on the LCD (pins 15 and 16) control the backlight. PortB pin 7 is connected
to A on the LCD to switch on the backlight, while PortB pin 5 is connected Vo on the LCD to adjust the contrast of the LCD characters.

The base will also feature three buttons corresponding to three red LEDs. Each of the pushbuttons will also correspond to one of the pagers. The port that the pushbuttons are connected to have internal pull-ups, the pin will be pulled low from a press from the user. When the button is pressed to page a pager, the corresponding LED will light up to show the user the button press is acknowledged, or shut off the LED if the button was pressed again to end the “page” call.

**The Pager Units:**

The pagers don’t have LCDs, but they use an audio amplifier, the MC34119, to power a small 8 ohm speaker. The amp and speaker will be given a signal composed of three tones, from the MCU, to make the device more locate-able to the ear (the tones are approximately 1 KHz, 2 KHz and 3 KHz). The MC34119 has a chip disable pin to help conserve the life of the battery; applying 3.3V to this pin turns off the outputs to the speaker.

The pagers will have two red LEDs and one pushbutton. The pushbutton is used only to silence the pager when it is put into the page mode from the base. When the pager is being paged it will flash the two LEDs and emit the three tones described in the paragraph above in a beeping fashion. These devices are designed to use two LEDs to help make it easier to locate to the eye (two LEDs are better than one).

**Background Debug Port**

Each device will contain a six pin BDM port to allow future tests or corrections to the system or devices. The pins are connected to VDD, ground, reset_L and PortG0/BKGD.
The system cost (to the consumer) is not cheap at this point and allowing for reprogramming of the devices is a valuable ability.