Heart Alert

Hardware Description

Steve Nelson
Introduction

The Heart Alert product consists of two units; an on-person unit, and a computer connected unit. The two units communicate via Zigbee wireless communication using the 2.4 GHz region in the ISM frequency band. The on-person unit acquires the user’s heartbeat via a finger plethsmography and analysis within the microcontroller. In the event that the on-person unit deduces that there is an irregularity in the user’s heartbeat, an alert is sent out to the computer connected unit. The computer connected unit will constantly monitor for an alert from the on-person unit. If an alert is received, in future development, the unit would contact help. For the purpose of this product, the alert will be indicated on the computer. The computer connected unit also interfaces with the user in allowing them to input the heart rate range found to be regular for the particular user. This interaction will be done via the SCI and a terminal emulator. Once the new heart rate range is obtained from the user, it is sent wirelessly to the on-person unit.

On-Person Unit

Power Supply: The on-person unit will be powered by a 3V lithium coin cell battery rated at 1000mAh. The battery is 0.96" in diameter x 0.34" in height and has PCB pins attached to the battery. The system will go to a low power mode in between heart rate measurements to conserve power. The battery will supply power to the microcontroller as well as directly to the BDM connector. The external hardware including: the instrumentation amplifier, the LED, and the optical sensor will be powered by the microcontroller’s pulse width modulator.

Microcontroller: The microcontroller for the on-person unit is the Freescale MC13213. The MC13213 contains an RF transceiver which is an 802.15.4 standard compliant radio that operates in the 2.4 GHz ISM frequency band. The MC13213 also contains 60K of flash and 4KB of RAM. Port D pins 2, 4 and 5 will be used as pulse width modulator outputs to power the instrumentation amplifier, the LED and the optical sensor package. Port B bit 0 will be used as the analog to digital converter input that will read the voltage on the output of the instrumentation amplifier. The high and low references for the analog to digital converter are taken from a voltage divider connected from the battery to ground to make the high reference 1V and the low reference ground. The external RF antenna circuit will be connected to RFIN_P and RFIN_M. A three pin switch will be used as an on/off switch since the purpose of this product is to be fully on at all times while the product is being used.

Antenna system: The antenna used by the microcontroller to receive the RF signal will just be a trace on the printed circuit board. In order to achieve a matching of about 50 ohms three inductors are used in conjunction with the trace on the PCB. A balun is also used in order to transform the differential signal to a single-ended signal to interface with the PCB antenna.

Crystal: The specifications for the external crystal require the use of a 16MHz crystal with a load capacitance lower than 9 pF. The external 6.8 pF capacitors in addition to the internal capacitance of the crystal provide the characteristics necessary for normal operation.

Plethysmograph: The plethysmograph function is achieved by parts external to the microcontroller. A high power LED emitting infrared light at 940 nm will be powered by the
microcontroller's pulse width modulator with an output of 3V. The LED has a rise time and fall time of 800 ns and will be modulator at a 10% duty cycle with a period of 50 ms. The light from the LED will shine through the finger and be received by a TSL262 light-to-voltage optical sensor. The optical sensor will be powered by the same 50 ms period and 10% duty cycle modulator configuration as the LED. The optical sensor receives light with a wavelength of 940 nm and can be powered by a supply voltage as low as 2.7V. The maximum output voltage of the optical sensor with 3V for the supply voltage is about 2V. The light intensity will always be low when the product is in use so the output voltage should be in the 10's mV range based on the Output Voltage vs. Irradiance curve given by the manufacturer. The optical sensor does not respond to light with a wavelength lower than 800 nm so household lights should have very little to no effect on the sensor. The output of the optical sensor will be fed into the positive input of an AD620 instrumentation amplifier. The AD620 is a low cost, low power instrumentation amplifier that's gain can be set by an external resistor. A 5.49K ohm resistor is connected between pin 1 and pin 8 to set the gain at approximately 10. The amplifier will be powered by the previously mentioned pulse width modulator configuration. The output of the amplifier will be in the 100's mV and will be fed into the ADC of the microcontroller.

**Computer Connected Unit**

**Power Supply:** The power supply used to power the computer connected unit is a wall transformer with an output of 5Vdc. The MAX232 used to communicate; via RS-232 cable to the microcontroller requires a supply voltage of 5V. A 5V to 3V voltage regulator provides the necessary 3V to power the microcontroller.

**Microcontroller:** The microcontroller for the base station is the Freescale MC13213. The MC13213 contains an RF transceiver which is an 802.15.4 standard compliant radio that operates in the 2.4 GHz ISM frequency band. The MC13213 also contains 60K of flash and 4KB of RAM. An RS-232 cable will be used to communicate between the computer and the microcontroller. A MAX232 is used as an adapter between the RS-232 cable and the microcontroller. Four external capacitors are used to configure the adapter.

**Antenna system:** The antenna used by the microcontroller to receive the RF signal will just be a trace on the printed circuit board. In order to achieve a matching of about 50 ohms three inductors are used in conjunction with the trace on the PCB. A balun is also used in order to transform the differential signal to a single-ended signal to interface with the PCB antenna.

**Crystal:** The specifications for the external crystal require the use of a 16MHz crystal with a load capacitance lower than 9 pF. The external 6.8 pF capacitors in addition to the internal capacitance of the crystal provide the characteristics necessary for normal operation.