Technical Description of the Timex Corporation Wireless Heart Rate Monitor Transmitter and Watch Receiver

Principle of Operation

The heart rate monitor is composed of two units; a transmitter (M515) chest strap and a receiver (M818, M838, M846, M516) watch.

The transmitter measures the weak electrical signal generated on the surface of the user's skin by the beating of the heart, transforms this information into a digital format, and transmits the data to the receiver watch. A special auto power-on circuit ensures that the transmitter is only active while it is placed on a chest, so as to conserve battery power.

The receiver watch receives the transmitted radio signal, decodes it, and displays the measured heart rate value on the LCD screen of the watch. The watch also functions as a full feature digital time piece.

The system uses an FSK (Frequency Shift Keying) based simplex data communication scheme. The data communications rate is 1024 baud. The transmitter is operating with a carrier frequency of 139.25 KHz with a mark frequency of 137.5 KHz and a space frequency of 141.0 KHz, and the transmitting antenna is a loop type with a ferrite core.

Distance and Angles

The system is specified to work up to a maximum distance of 120 cm between chest strap and the watch receiver in air. The range, however, is dependant on the relative orientation between the receiver and the transmitter.

Overview

The M515 transmitter uses a standard EOC6008 Epson 4-bit microcontroller to measure the heartbeat, encode this information, and transmit it to the receiver. An ECG sensor circuit senses each heartbeat by measuring the voltage potential across the user's chest. A so called auto power-on circuit allows the M515 device to conserve power by ensuring that it is only powered up when the device is placed on a chest.

Three back-end circuits allow the microcontroller to transmit information to the receiver - a modulator circuit modulates the information to generate the required FSK signal; a pulse shaper circuit prepares the signal for transmission; and an antenna driver circuit handles the actual transmission.

The heart rate chest strap transmitter obtains power from an internal 3.0 Vdc coin cell battery, and the receiver watch obtains power from its own internal 3.0 Vdc coin cell battery.

Overall Operation of the Transmitter

At the beginning of the exercise session the strap is placed on the chest. The auto power-on circuit senses this and sends a signal to the microcontroller (SENSOR_EN goes high). This signal also enables the ECG Sensor circuitry which allows heart beat pulses to be read into the microcontroller.

For as long as SENSOR_EN is high, the ECG Sensor circuit will continue to send a signal to the microcontroller whenever it senses a heartbeat from the user's chest. Each heartbeat is signaled with a positive pulse – PULSE_IN is pulsed high.

For the duration of the exercise session, the microcontroller will transmit a digital data packet over the air to the watch receiver every 2 seconds. This data packet contains ID information as well as the user's heartbeat rate.

A packet transmission takes places as follows: the transmitter is first powered up by the microcontroller pulling RF_EN high, then the data line is activated by pulling DATA_OUT high, after which actual transmission commences by pulling FSK_EN high. The microcontroller may now transmit the data packet by toggling DATA_OUT high and low. After each transmission , FSK_EN is pulled low followed by DATA_OUT and lastly RF_EN.

At the end of the exercise session the strap is removed and SENSOR_EN again goes low. The ECG Sensor circuitry is immediately powered down, and after the microcontroller senses the change on the SENSOR_EN line all transmitting is terminated.

M515 Block Diagram