

# An ECG electrode-mounted heart rate, respiratory rhythm, posture and behavior recording system

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## INTRODUCTION

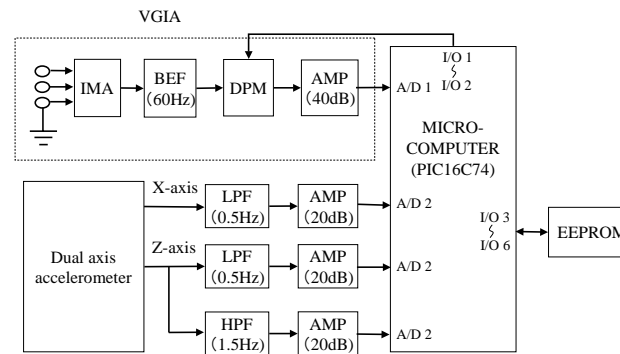
It has been observed that changes in heart rate and respiratory rhythm occur before, during, or following behavior such as posture changes, walking and running. Therefore, it is often very important to record heart rate and respiration rhythm, along with posture and behavior, for continuously monitoring a patient's cardiovascular regulatory system during their daily life activity and sleep states.

In this study, a compact ECG R-R interval, respiration and activity recording system has been developed for monitoring heart and respiration functions accompanying posture and behavior. The recording system is a compact and single module, which is attached directly onto three ECG chest electrodes.

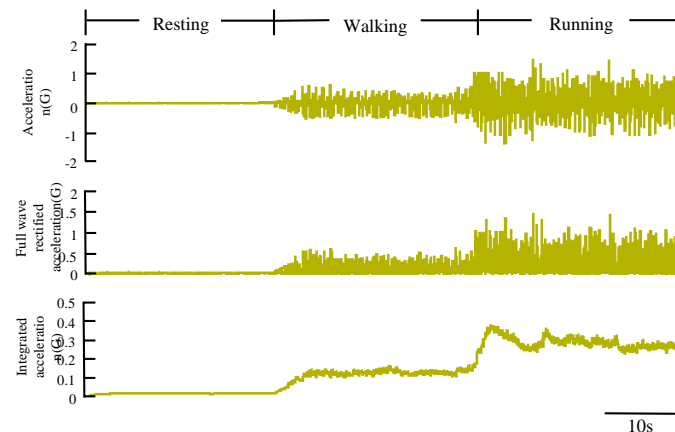
## SYSTEM DESCRIPTION



**Figure 1** The R-R interval, posture and activity recording device attached on the center of the chest with three disposable ECG electrodes. The device is 5 x 13 cm, the thick is 1 cm and the weight is 30g.

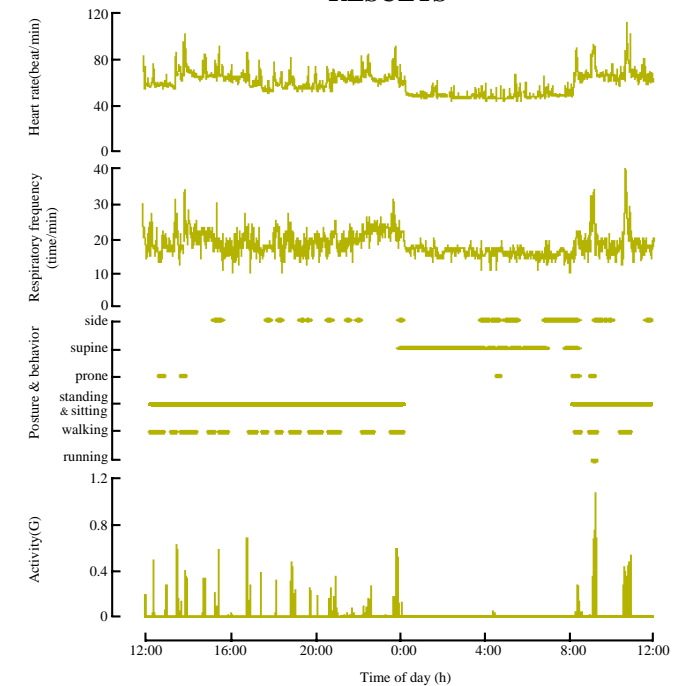


**Figure 2** The block diagram of the R-R interval, respiratory rhythm, posture and behavior recording device. The VGIA (Variable Gain Instrumentation Amplifier) records ECG, and accelerometer records the X (back and forth direction) axis static acceleration force and the Z (vertical direction) axis dynamic acceleration force. The microcomputer detects R-R interval, respiration and activity. These detected data are stored to the EEPROM.



**Figure 3** The Z axis dynamic acceleration force recorded by the various behaviors such as resting, walking and running. The Z axis dynamic acceleration force detected by the high-pass filter is rectified and integrated by a RC integrator with a time constant of 20 ms, and then behavior such as resting, walking and running is detected from the integrated dynamic force.

## RESULTS



**Figure 4** The heart rate, respiratory frequency, posture & behavior and activity recorded over 24 hours. The heart rate during wakefulness changed from 55bpm to 110bpm with behaviors such as posture changes, walking and running. The average was 62bpm. During sleep, from 0:00 to 8:00, the heart rate decreased to 50bpm. The mean frequency of respiration decreased from 20/minute while awake to 15 during sleep. The major activity level was recorded during wakefulness.

## CONCLUSION

The developed system can record the R-R interval, respiration, posture, behavior and activity in daily life. The subject's general health condition and living patterns can be obtained from these data.