

Physiological Measurements

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Physiological signals

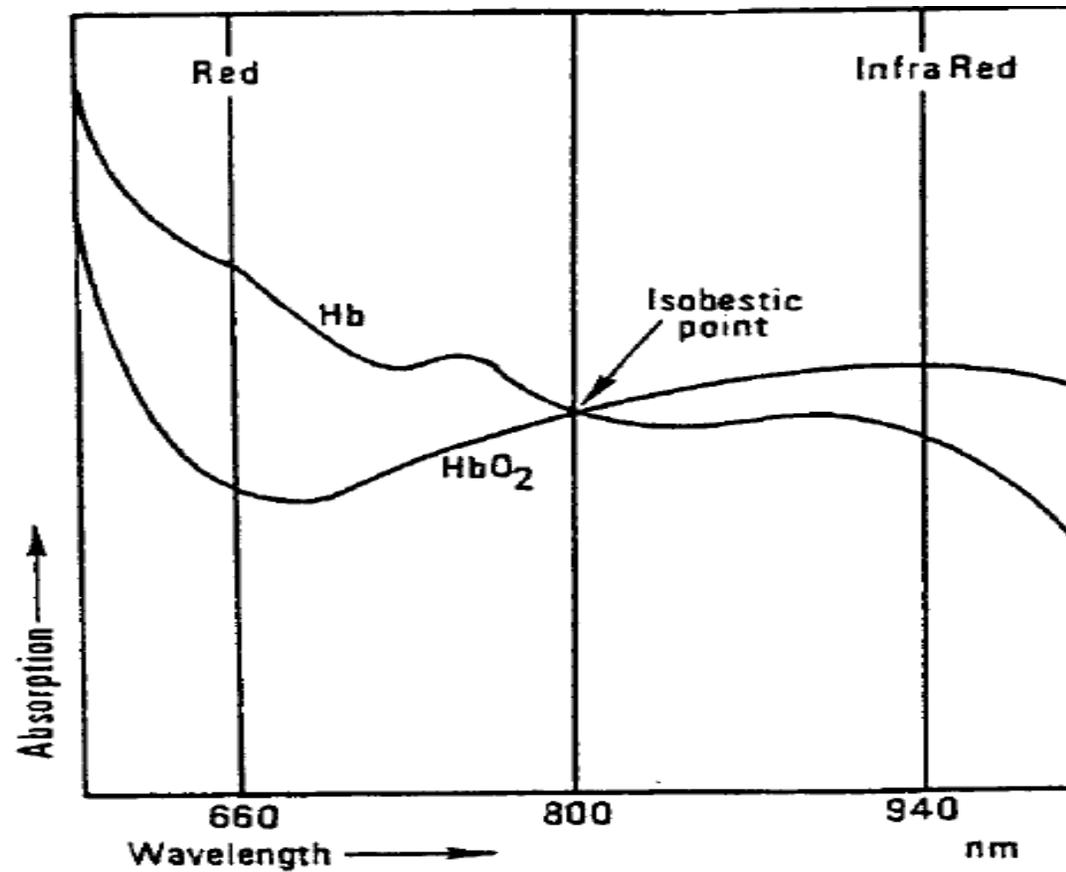
- **Human physiological signals** are the mechanical, physical, bioelectrical, and biochemical signals of human's organs and the cells.
- Electrocardiogram (ECG)
- Electroencephalography (EEG)
- Pulse Oximetry
- Blood Pressure measurement, etc

Oxygen Saturation level

The oxygen chemically combined with haemoglobin inside the red blood cells makes up nearly all of the oxygen present in the blood (there is also a very small amount which is dissolved in the plasma). Oxygen saturation, which is often referred to as SaO₂ or SpO₂, is defined as the ratio of oxyhaemoglobin (HbO₂) to the total concentration of haemoglobin present in the blood (*ie* oxyhaemoglobin + reduced haemoglobin):

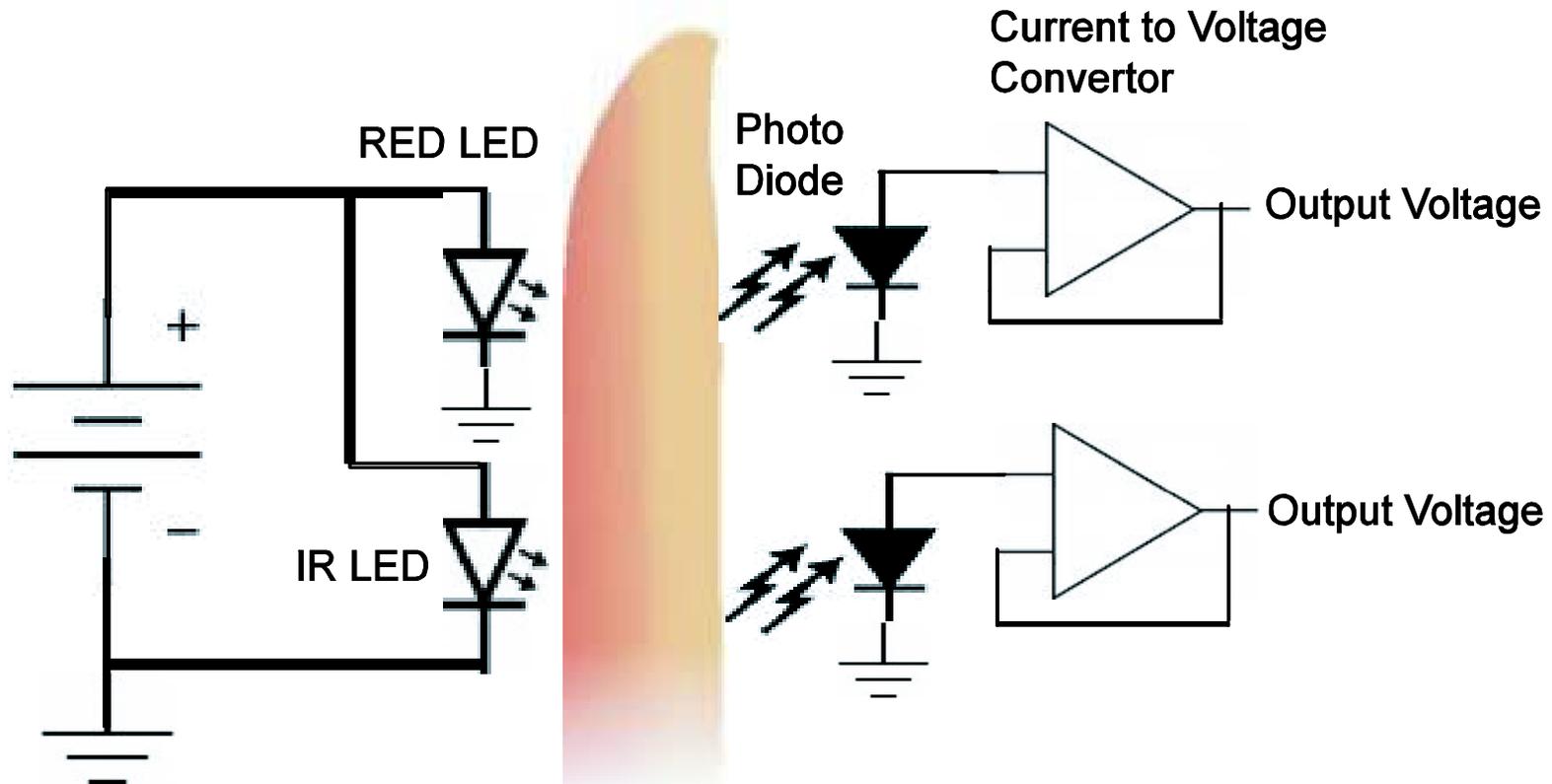
$$\text{SaO}_2 = \frac{[\text{HbO}_2]}{[\text{Total haemoglobin}]}$$

Pulse Oximetry Basics



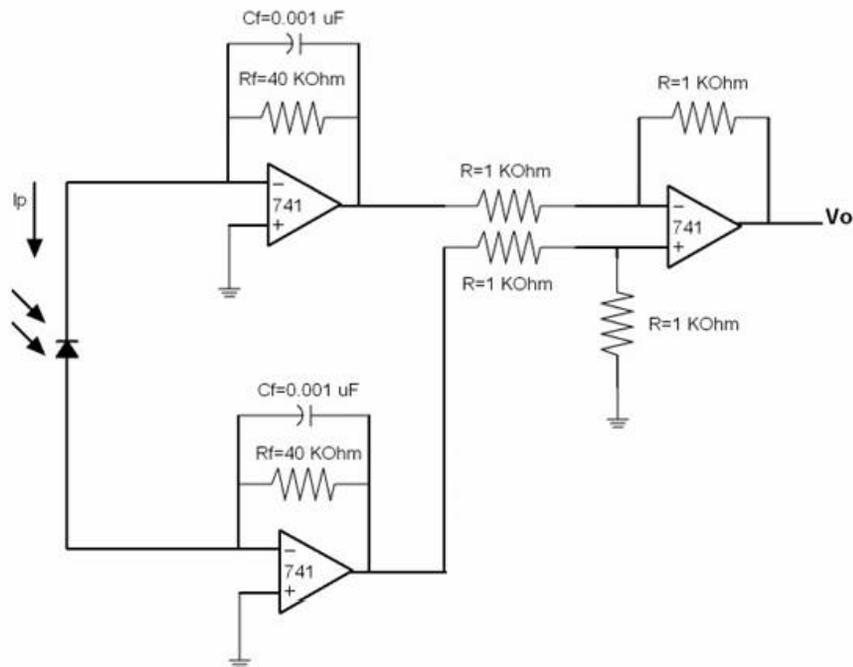
Absorption spectra of Hb and HbO₂ (the isobestic point is the wavelength at which the absorption by the two forms of the molecule is the same)

Pulse Oximetry Block Diagram

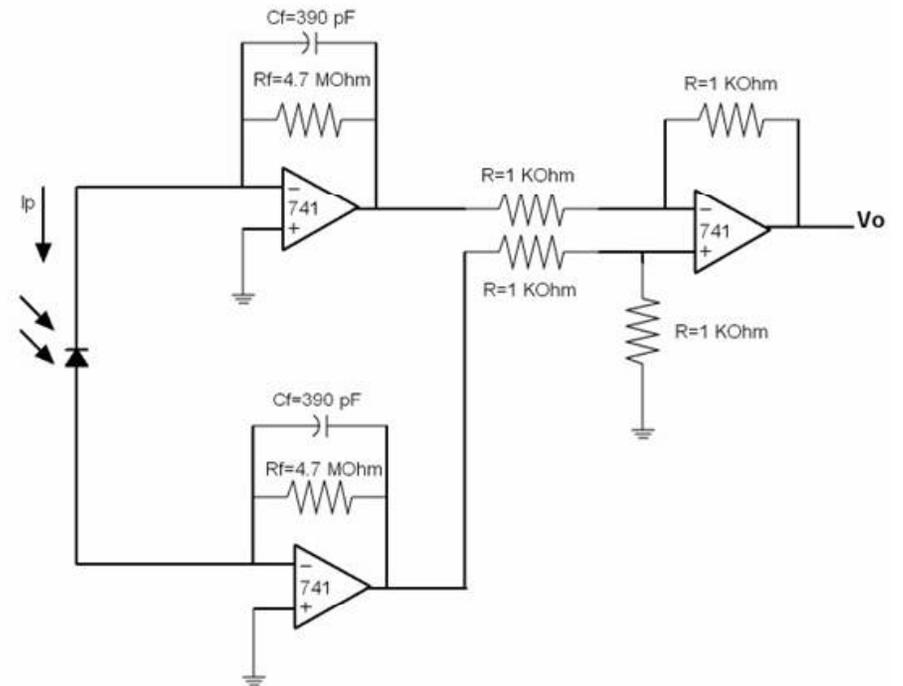


Pulse Oximetry Amplifiers

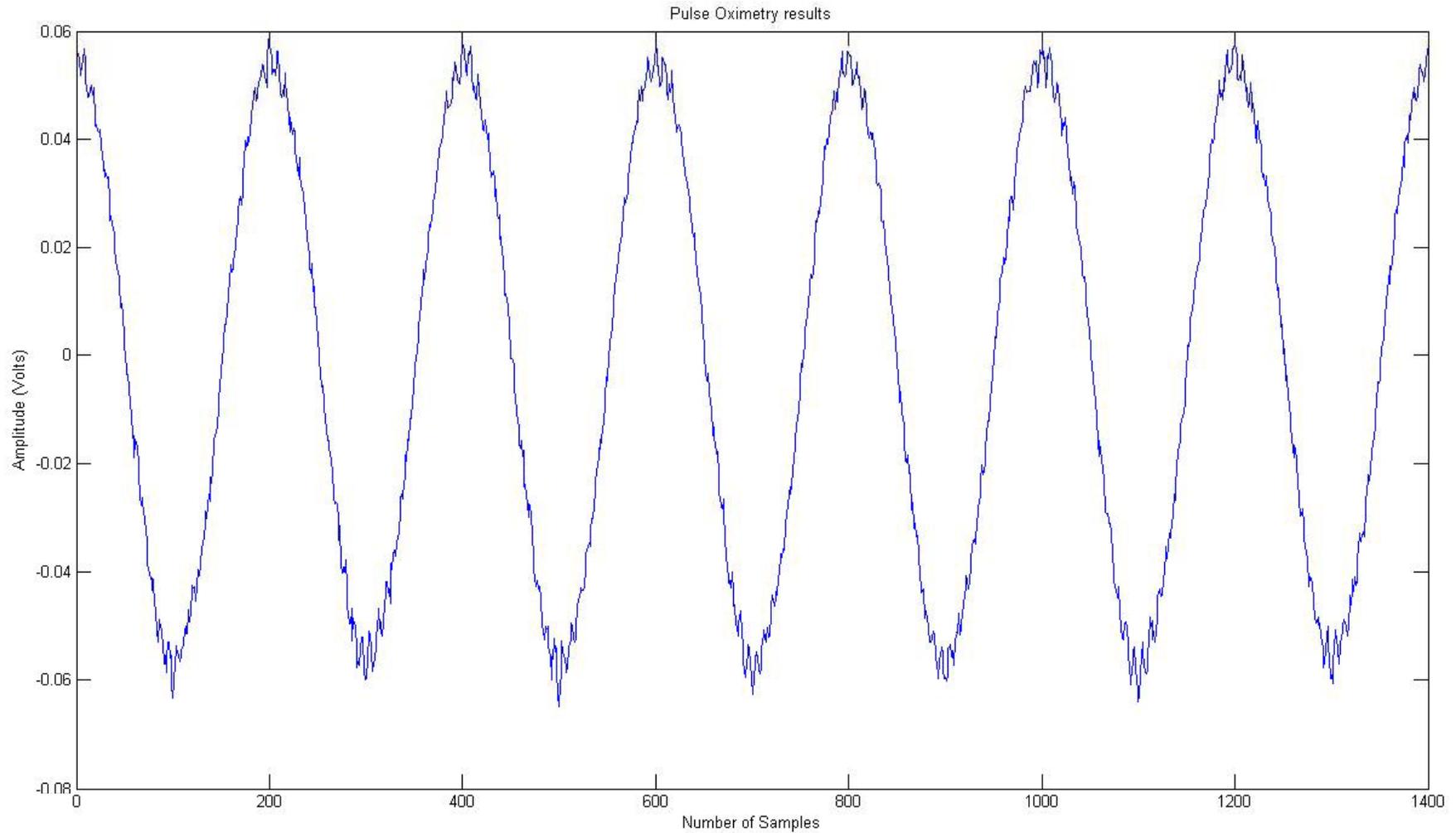
Infrared Photodiode Transimpedance Amplification Circuit



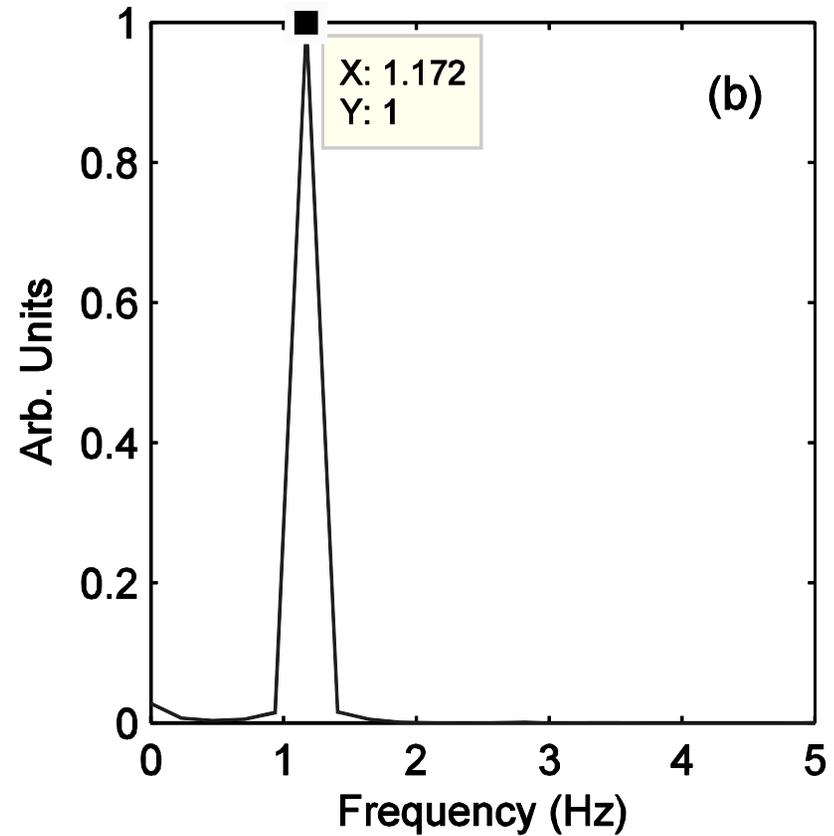
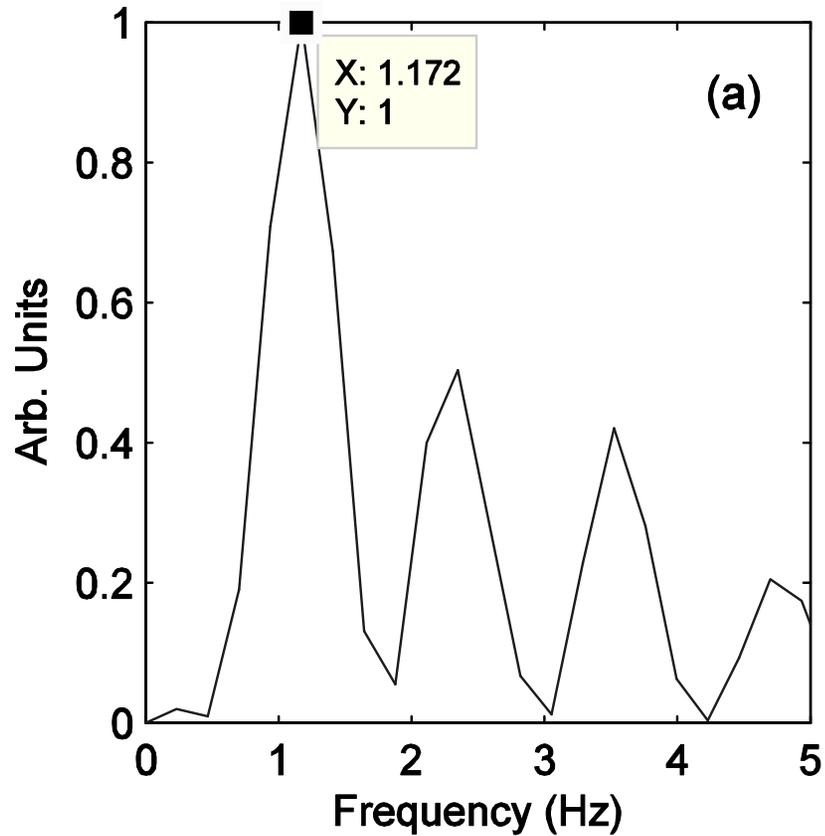
Red Photodiode Transimpedance Amplification Circuit



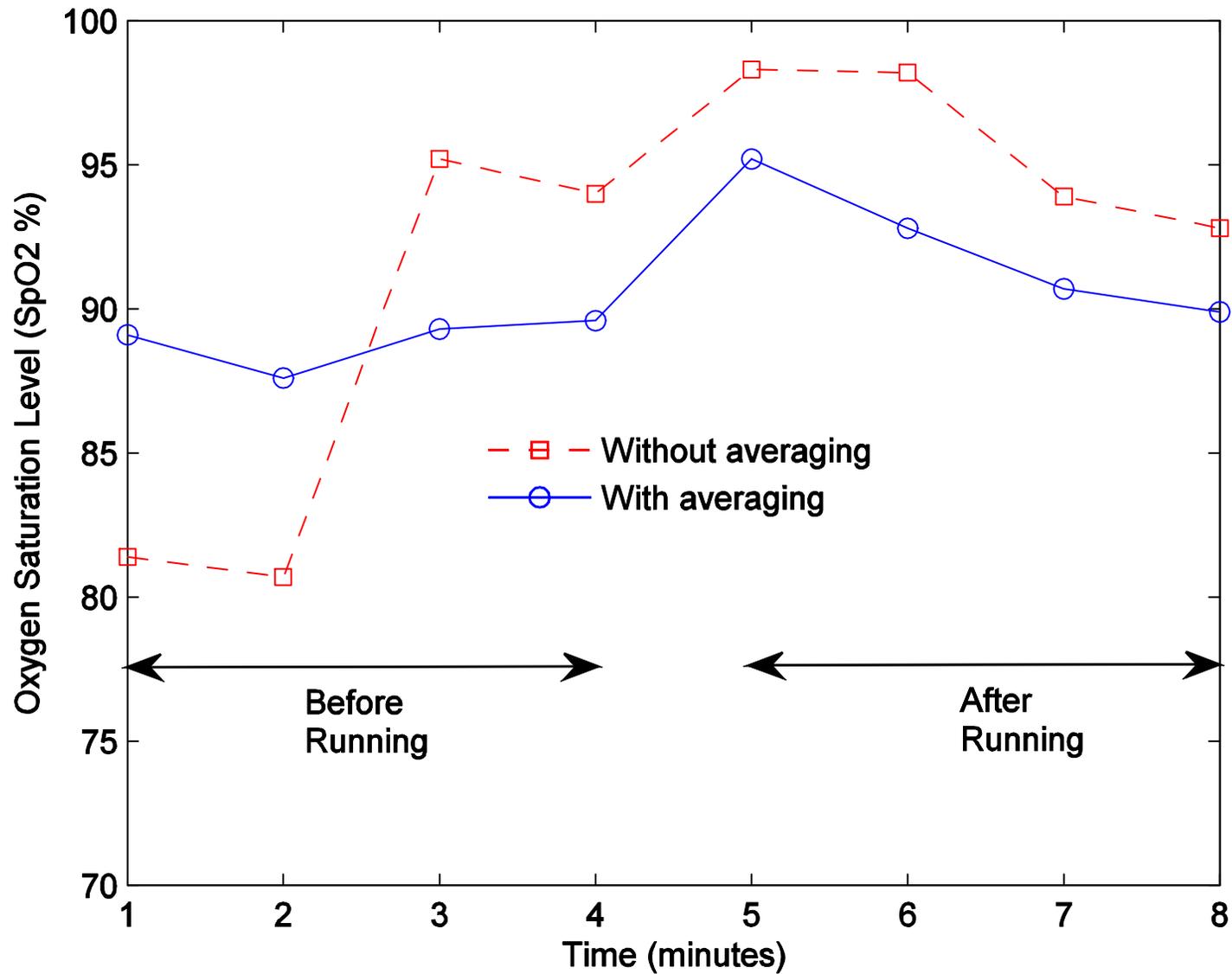
Pulse Oximetry Signal



Frequency Spectrum of the Pulse Oximetry Signal

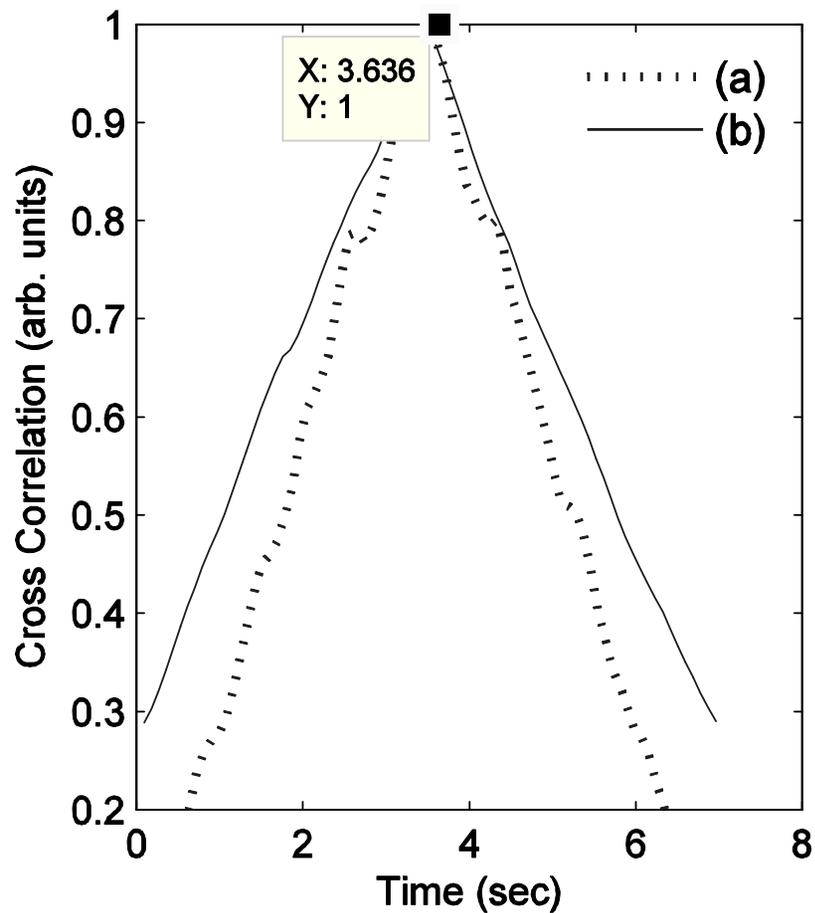


Oxygen Levels in the Blood

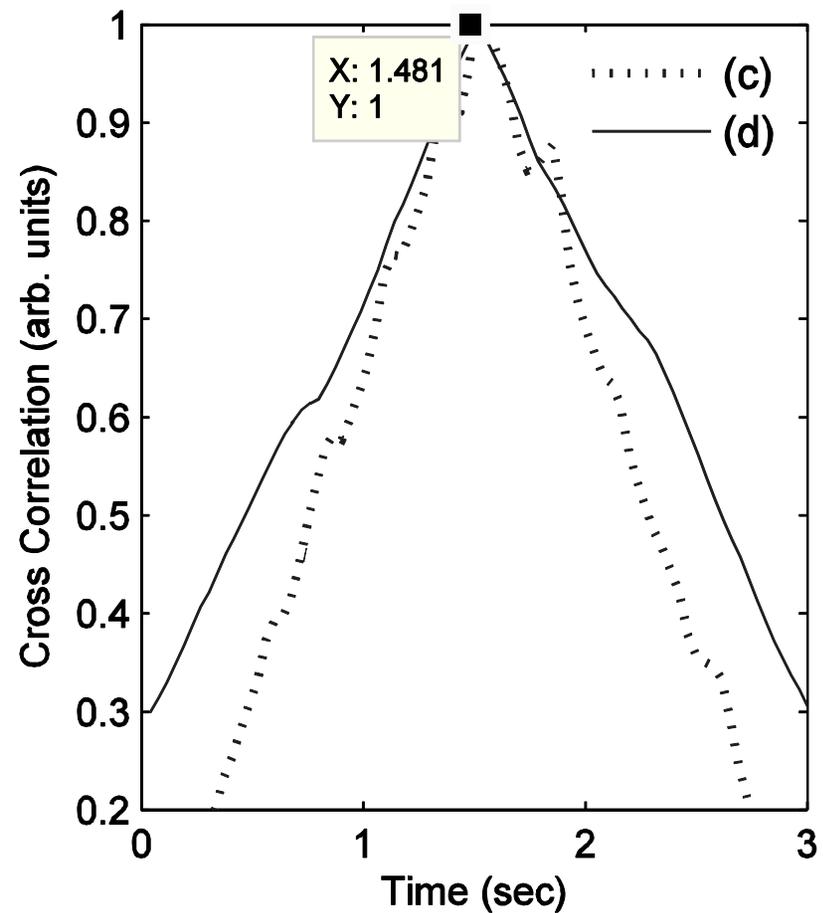


Estimating Speed of Blood Flow

Before running



After running



Electrocardiogram (ECG)

- **Electrocardiograph** interpretation of the electrical activity of the heart over time captured and externally recorded by skin electrodes.
- The ECG works mostly by detecting and amplifying the tiny electrical changes on the skin that are caused when the heart muscle "depolarizes" during each heart beat. At rest, each heart muscle cell has a charge across its outer wall, or cell membrane. Reducing this charge towards zero is called de-polarization, which activates the mechanisms in the cell that cause it to contract. During each heartbeat a healthy heart will have an orderly progression of a wave of depolarisation that is triggered by the cells in the sinoatrial node, spreads out through the atrium, passes through "intrinsic conduction pathways" and then spreads all over the ventricles. This is detected as tiny rises and falls in the voltage between two electrodes placed either side of the heart which is displayed as a wavy line either on a screen or on paper. This display indicates the overall rhythm of the heart and weaknesses in different parts of the heart muscle.

Metal Electrodes

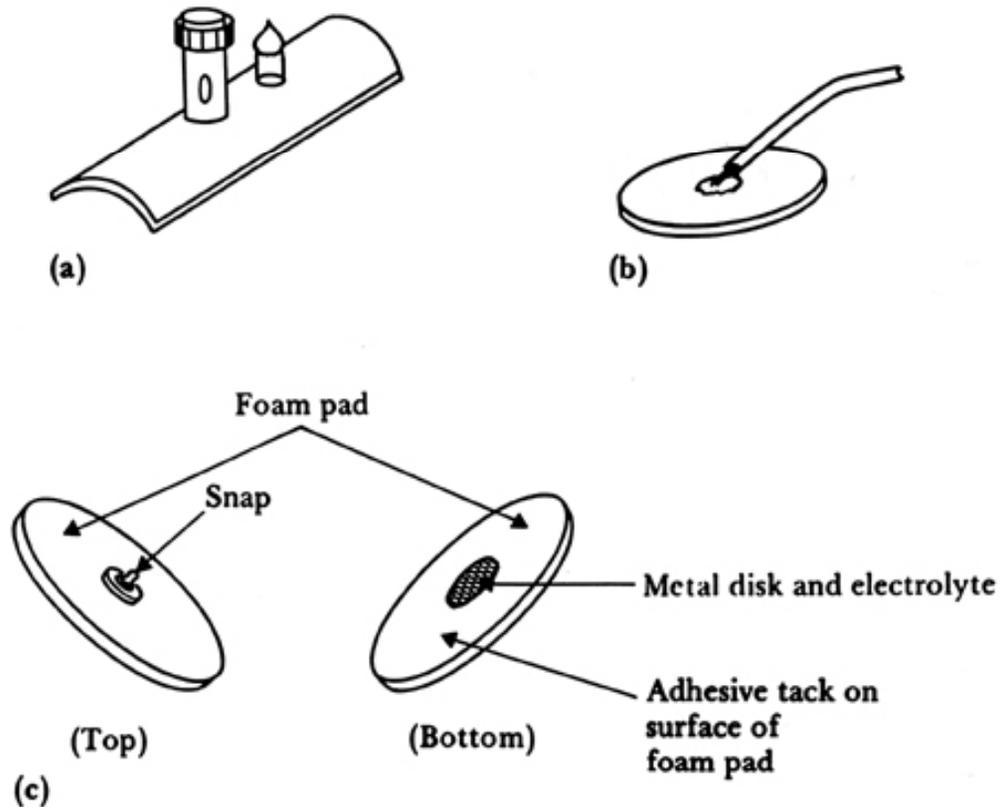
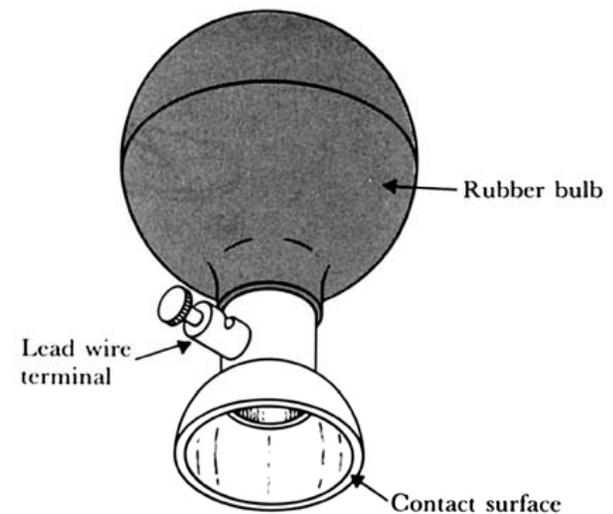


Figure 5.9 Body-surface biopotential electrodes (a) Metal-plate electrode used for application to limbs. (b) Metal-disk electrode applied with surgical tape. (c) Disposable foam-pad electrodes, often used with electrocardiograph monitoring apparatus.

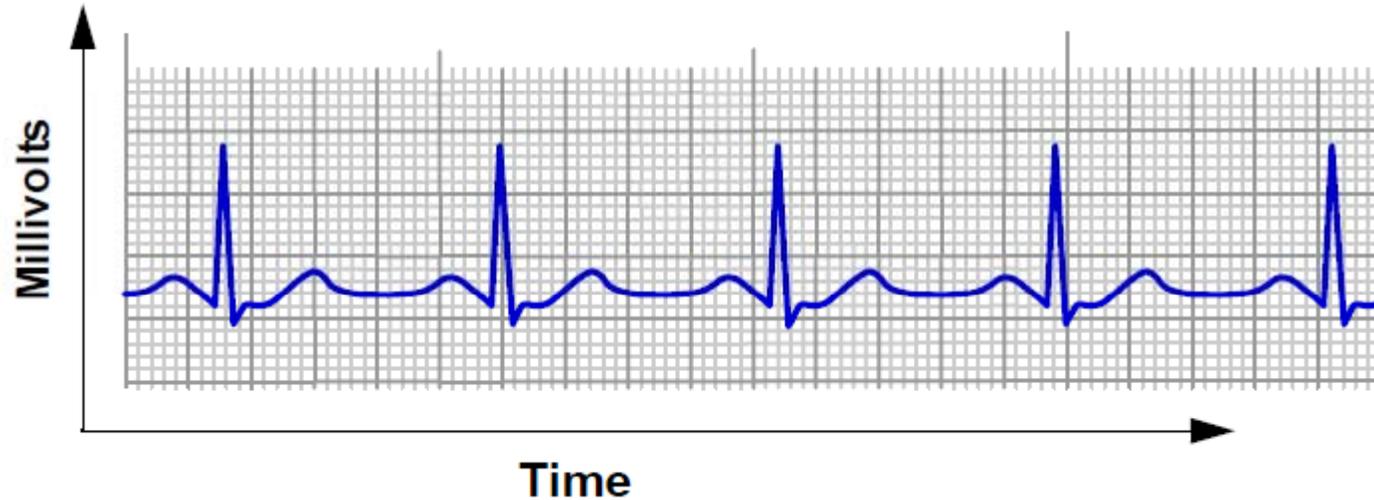
Metal Suction Electrodes

A paste is introduced into the cup.
The electrodes are then suctioned
into place.

Ten of these can be with the
clinical electrocardiograph – limb
and precordial (chest) electrodes

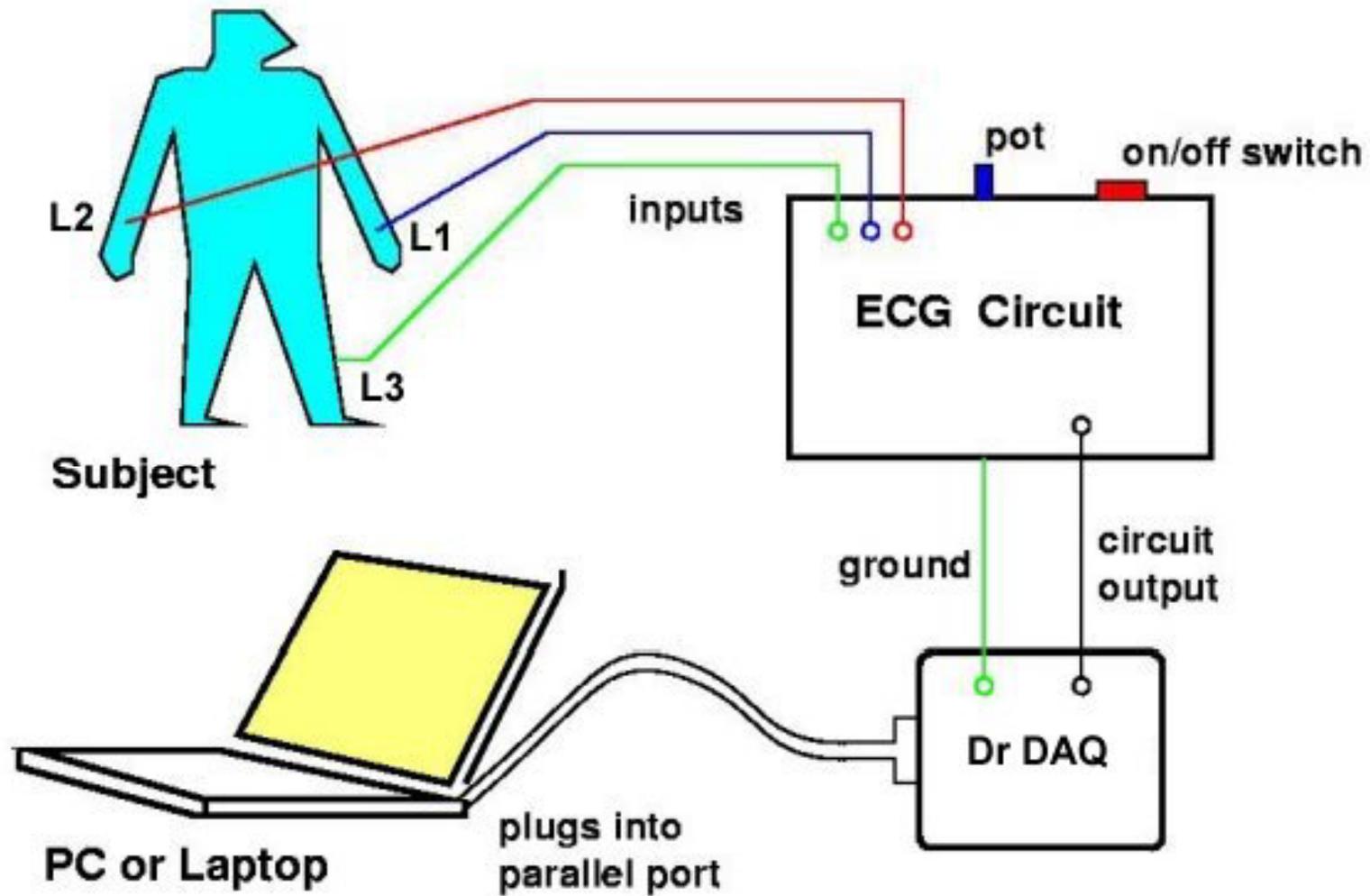


ECG Paper

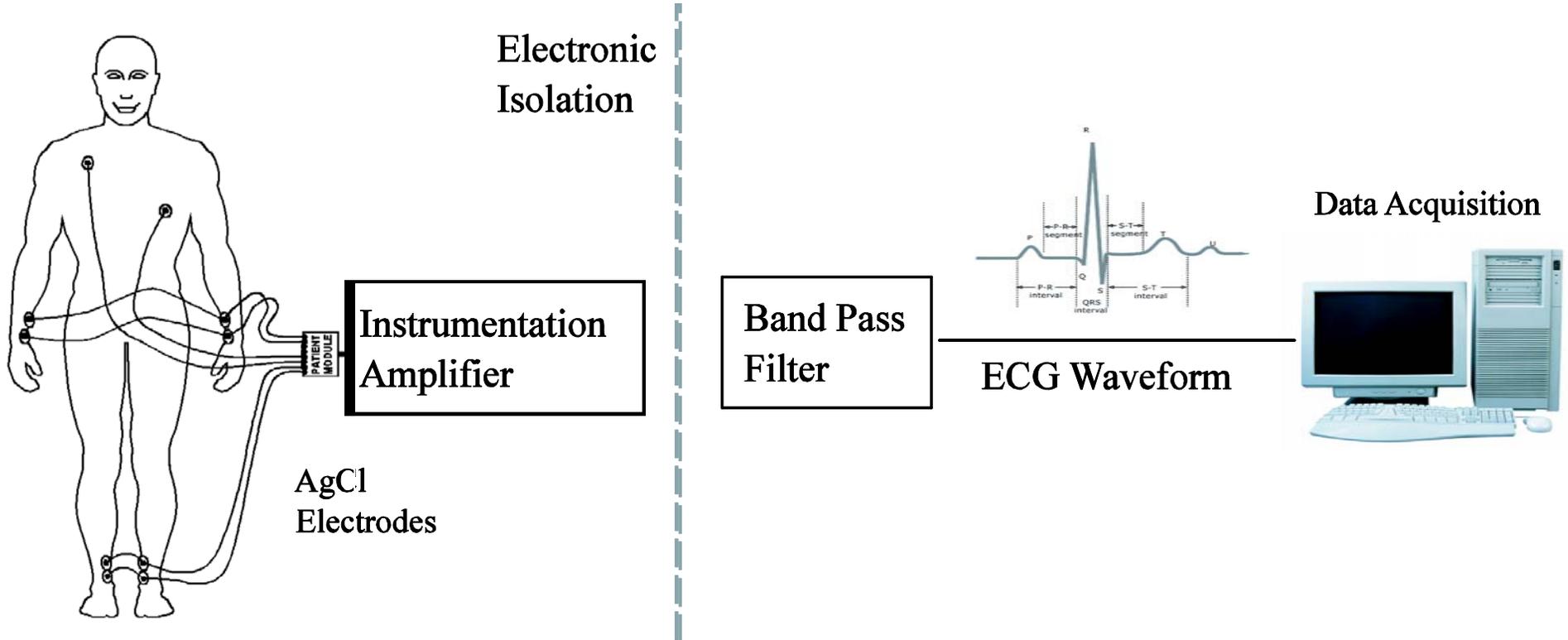


Height of tracing represents millivolts and width time interval
1 small division give 0.1 mV
1 small division give 0.04 sec

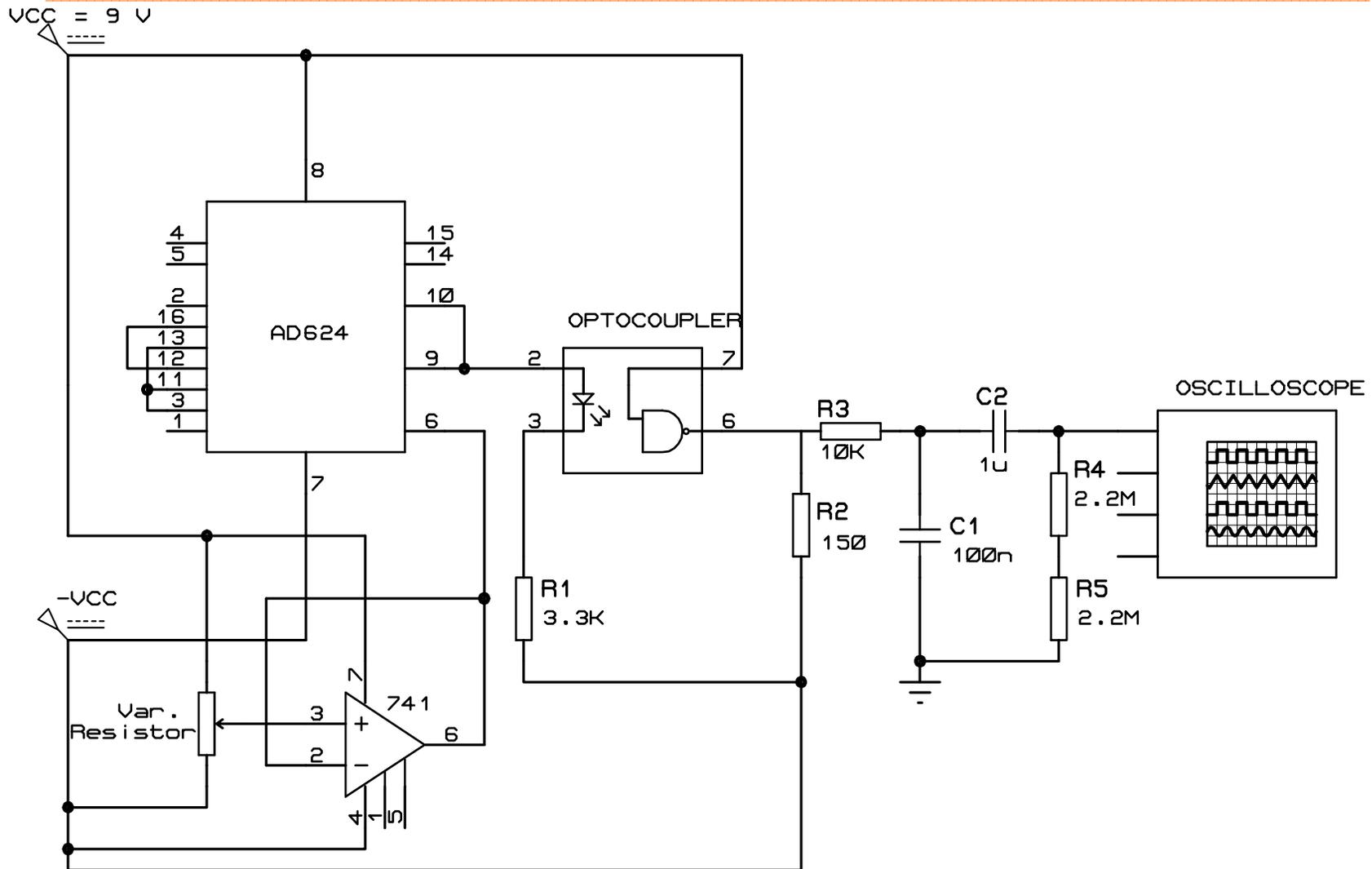
Eithoven Triangle



ECG Experimental Setup



ECG Detection and Amplification Circuit



ECG Electrodes

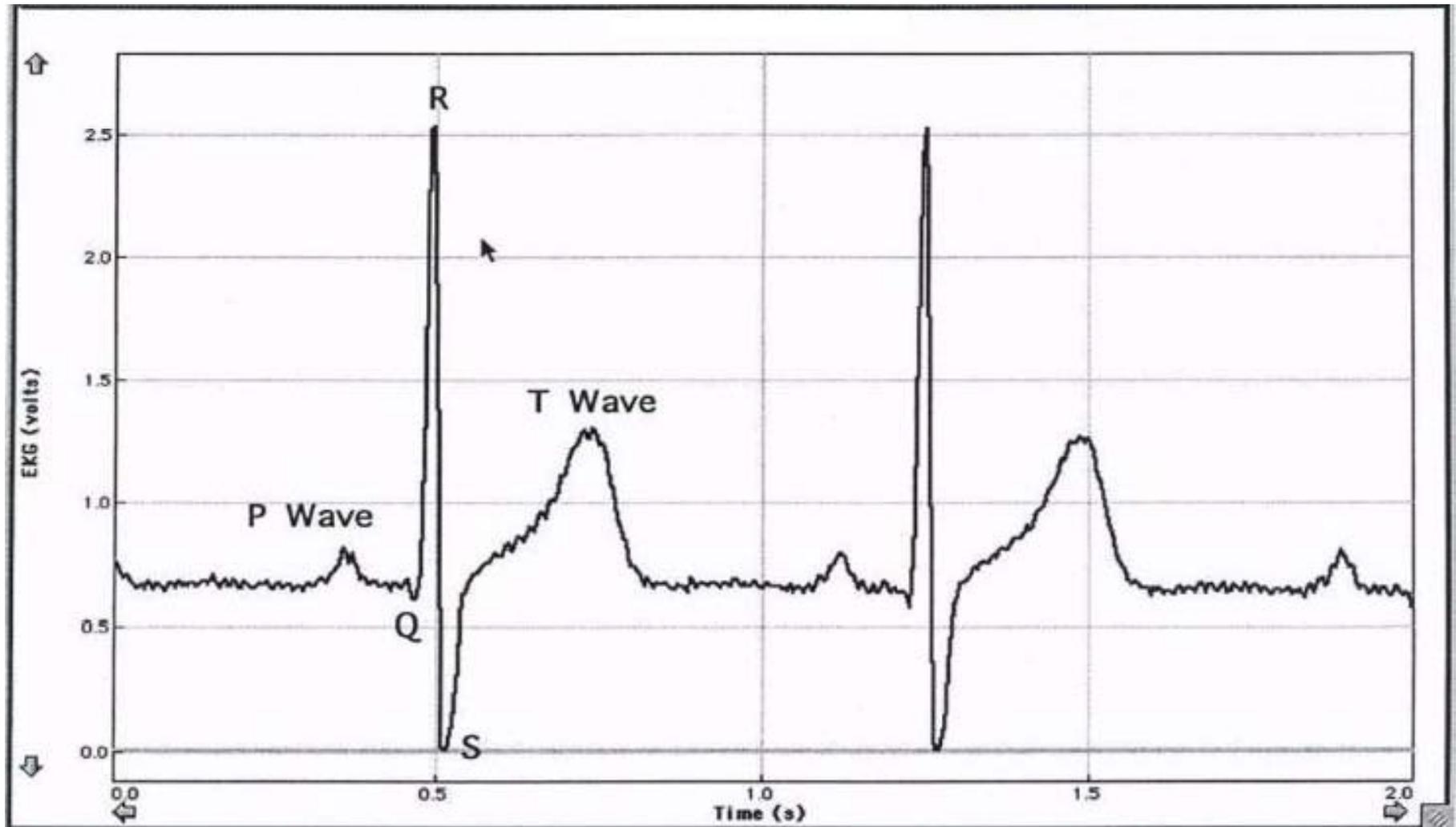
Amplifier

Opto
Coupler

Band pass filter

Data
Acquisition

Typical ECG Waveform



ECG Signal Waveform

