

Appendix

Ambulatory Impedance Cardiography System: Reomonitor

Technical Specification of the Recorder

Analogue part	
The system of measurement	Alternating current, tetrapolar
Current generator	1 mA, 95 kHz, sinusoidal, stabilised, LC type
Output impedance	$R > 100 \text{ k}\Omega$
Number of the channels	4 (ECG, dz/dt, ΔZ , Z0)
Parameters of each channel	ECG (1 mV/1 V, $f = 0\text{--}200 \text{ Hz}$, 3 dB, $R > 200 \text{ M}\Omega$) dz/dt (1 Ω /s/1 V, $f = 0\text{--}15 \text{ Hz}$, 3 dB) ΔZ (100 m Ω /1 V, $f = 0.2\text{--}40 \text{ Hz}$, 3 dB) Z0 (10 Ω /1 V)
Input impedance of the ICG receiver	$>200 \text{ M}\Omega$
Digital part	
Processor	80C552 Family micro-controller 4 \times 8 Bits A/D converters, input range 0–5 V
Sampling frequency	200 Hz
Memory medium	PCMCIA type II card, capacity $>20 \text{ MB}$ (Memory mapped mode)
Power consumption of digital part	10 mA during 99% of the recording time
Recording time	approx. 13 h for 20 MB card
Power source	9 V (6 \times AA alkaline, or AA rechargeable batteries $>1,200 \text{ mAh}$)
Physical specification	
Dimensions L \times H \times D (mm):	200 \times 111 \times 50
Weight (g)	665 g (\sim 810 g with batteries),

Graphic Interface

Technical specification

Programming environment	Windows 3.1 and upper
2 modes of signal presentation	Bio-scope and Strip mode

Available options:

- independent on/off switching for each of the four channels,
- independent for each channel setting for zero level,
- four levels of amplification, according to the series: 0.5, 1.0, 1.5, 2.0,
- preliminary scaling factors according to the series: 0.125, 0.25, 0.5, 1.0, ..., 8.0,
- typical four levels of time scale: 10, 25, 50 and 100 mm/s plus full disclosure (FD-1-min per line),
- independent pre-setting of calibration parameters,
- static/scope presentation,
- colour of lines, background and grid selection,
- Two mode of selections of displayed strip: by scroll bar and by dialog window,
- cursor position display,
- calliper function for time and amplitude measurements,
- printing of a selected strip, fragment or full disclosure at different scaling levels: 33, 50, 75, 100, 150, 200 and 300%.

User-programmable features for data analysis module:

Display parameters (speed, amplification)

Separate grid lines on/off for amplitude and time calibration

Each channel separate pre-scaling: 0.125; 0.25;0.5; 1; 2; 4; 8.

Number of recording channels: up to 4

Data averaging time: 5–250 s

Data units: mV, Ω , $\Omega \text{ s}^{-1}$, m Ω (selection)

The Vrije Universiteit Ambulatory Monitoring System: Specifications and Features

This appendix was prepared based on the materials published by the Vrije Universiteit on their web page (<http://www.psy.vu.nl/vu-ams/information/index.html>)

The system allows to perform the following measurements:

- Heart rate measurement
- Beat-to-beat or averaged inter beat interval (IBI recording for any desired period

- Thorax impedance measurement to obtain respiratory signal and systolic time intervals
- Motility measurement as an indicator of the physical activity analysis.

Technical Specification

- Dimensions L × W × H: 120 × 65 × 32 mm.
- Weight with battery: 225 g
- Data memory: 2 MB solid state memory.
- Settings: wide range of sample rate settings for beat-to-beat recording, motility, GSR, thorax impedance, ICG ensembled average
- Recording time: 48 h for heart rate and motility at default sample rate settings.
- Current: 0.35 mA, 50 kHz
- Battery: 9-V Battery cell PP3, 14 mAh

Measurements

- Electrocardiography (ECG)
 - Full ECG is not recorded, RR intervals are stored with resolution of 1 ms
 - Sensitivity: 0.5–10 mV
 - Input impedance: 1 mV
 - Common mode rejection: >70 db
 - R–R time accuracy: 1 ms
 - R-wave detection procedure: auto trigger level
- Thorax impedance
 - Frequency: 50 kHz
 - Current: 350 μ A
 - Range: 3–18 Ω
 - Resolution Z_0 : 0.0233 Ω
 - Resolution ΔZ : 0.0030 Ω
 - Resolution dz/dt : 0.0010 Ω/s
- Motility (vertical acceleration)
 - Sensitivity: 3.2 gs (full scale)
 - Resolution: 0.008 gs
 - Frequency range: 1.6–50 Hz
 - Sample rate: 10–300 s
- Skin conductance level (SCL)
 - Range: 1–100 ms
 - Resolution: 0.0125 ms
 - Procedure: 0.5 V (constant voltage)
 - Sample rate: 100–30,000 ms

Producer/Distributor: Vrije Universiteit Amsterdam

Division for Instrumentation of the Department of Psychophysiology,
Vrije Universiteit, FPP/ITM,
Van der Boechorststraat 1, room K1E-09,
1081 BT Amsterdam,
The Netherlands.
Web Page: <http://www.psy.vu.nl/vu-ams/information/index.html>
Phone: +31-20-5988854
Fax: +31-20-5988719
Email: vu-ams@psy.vu.nl

The MindWare MW1000A System: Specification and Features

All data given in this specification are taken from the materials published on the web page <http://mindwaretech.com>

System Features

- The system collects waveforms for ECG, Z0, dZ/dt and GSC channel with 14 bits resolution
- Computes and displays real time cardiac and systolic measures such as: LVET, PEP, SV, CO, HR, dZ/dt_{max}, Z0, mean inter beat interval (IBI) and RSA for heart rate variability, and skin conductance
- User-selectable sampling frequency: 500 or 1,000 Hz
- Source current specifications: 0.4 mA
- Precision oscillator: 100 kHz sinus waveform
- Built in 60 Hz hardware notch filter for ECG
- Real time waveform display on PDA
- Very low power consumption powered by internal PDA battery, optimizes run time
- User programmable collection epochs using simple tab delimited input file that can be edited on desktop and transferred to PDA
- The PDA ACQ software application can collect data in periodic or continuous modes
- User configurable settings for flexible acquisition
- File format compatible with MindWare desktop analysis applications IMP, HRV, and EDA.
- Personal data assistant: HP IPAQ

- Included accessories: patient cable, SD storage card (512 MB),
- Included software: data acquisition Wi-Fi Transmit software
- Physical dimensions: 45 × 95 × 160 mm
- Weight: 400 g
- Signal channel characteristics is presented in the Table A.1

Table A.1

Channel description	Channel symbol	Scale factor/gain	Units	Range
Impedance of thorax	Z0	0.05 V/ Ω	Ω	0–40 Ω
First derivative of Z0	dZ/dt	0.8 V/s	Ω /s	0–3 Ω /s
Electrocardiogram	ECG	Gain = 500	V	0–2.5 V
Galvanic skin conductance	GSC	Gain = 125 μ S/V	μ S	0–200 μ S

Mindware Technologies LTD

1020F Taylor Station Rd.

Gahanna, OH 43230, USA

Phone: +1-614-6264888

US Toll Free: 888 765-9735

Fax: +1-614-6264915

<http://mindwaretech.com>

The PhysioFlow Enduro System: Specification and Features

Size: 115 × 85 × 18 mm

Light weight: less than 200 g (with batteries)

Power supply: standard AA batteries or rechargeable, 6 h autonomy

Twenty-four-h MMC memory

USB or BlueTooth wireless memory download

Real time wireless monitoring using BlueTooth

The system works with PhysioFlow PF106 MS WindowsTM XP based Software for display, data analysis, and storage

Producer/ distributor:

Manatec Biomedical France

10bis, rue Jacob Courant

8300 Poissy

France

+33-9-65032401

http://www.physioflow.com/files/Fichiers_Manatec/Preliminary_brochure_Enduro.pdf

NeuMeDx

2014 Ford Rd, Unit G
Bristol, PA 19007
USA
Tel.: +1-215-8269998
Fax +1-215-8268102
<http://www.neumedx.com>

AIM-8-V3 Wearable Cardiac Performance Monitor

This system is also known as “Ambulatory Bioelectric Impedance Monitoring for Assessing Cardiac Performance”. This note was prepared based on their web page information and the scientific papers (Sherwood et al. 1998). According to the information from the producer the production of this type is discontinued although a several copies (April 2010) were still available.

Technical specification and features

Dimensions: 76 × 100 × 38 mm

Bioelectric impedance cardiograph (labeled the “WHIC8” for Wearable Hutcheson Impedance Cardiograph): tetrapolar, 80 kHz sine wave, 2 mA alternating current

Microcomputer/data logger: credit card size

Power supply: 9-V battery

Power consumption: 200 μ A

From their web page (<http://www.microtronics-bit.com/BIT/Products.html>) we can learn that the AIM-8 device contains the firmware software that implements the following functions:

- Controls the various WHIC8 modes of operation, including calibration, operation on either a manual basis or an automatic fixed time-interval basis, and operation under a blood pressure monitor’s control.
- Controls the displays, visual indicators, and audible alarms of the device.
- Detects user inputs and controls.
- Acquires and processes all analogue signals from the WHIC8 impedance cardiograph.
- Handles all timing for the system including real time, the timing of physiological waveforms and events (e.g. electrocardiogram R to R intervals), and data transfers.
- Performs all signal averaging and digital signal processing tasks.
- Handles the data analysis of the ensemble averaged waveforms and measured cardiac parameters.

- Performs the automatic computation of the various cardiac indices for each measurement.
- Manages the storage of ensemble averaged waveforms (Z_0 , dZ/dt , and ECG), along with the “Data Scan” information regarding each cardiac cycle that makes up the ensemble averages.
- Stores all of the important measured parameters and the computed cardiac indices.
- Handles the serial data communication between the IBM-Type PC host computer and the AIM-8 monitor.

The AIM-8 system either measures or derives the following cardiac indices:

- Heart rate (HR)
- Stroke volume (SV)
- Cardiac output (CO)
- Pre-ejection period (PEP)
- Left ventricular ejection period (LVET)
- Cardiac contractility index (PEP/LVET)
- Basal impedance (Z_0)
- Heather index (HI)
- Maximum amplitude of the first derivative of the impedance signal $[(dz/dt)_{\max}]$
- Total peripheral resistance (TPR) (when blood pressure data are provided)
- Gross body activity-act (using body-activity sensor)

Producer/Distributor:

Bio-Impedance Technology, Inc.

88 VilCom Center, Suite 165

Chapel Hill, NC 27514

USA

<http://www.microtronics-bit.com/BIT/Products.html>

Ambulatory Impedance Cardiograph: AZCG

This information was provided basing on the papers by Nakonezny et al. (2001)

Technical Data and Specification

Dimensions: 45 × 95 x 160 mm

Weight: 400 g with batteries

Three-lead ECG: bandwidth 0.05–100 Hz

Four-lead electrical impedance system (tetrapolar):

Sine current of constant amplitude –2 mA, RMS at 50 kHz

Filters

Z_0 : DC-100 Hz

ΔZ : DC-40 Hz

dz/dt : DC-40 Hz

The ECG and ICG have a digitally controlled, sampled-signal rebalance method for waveform stability.

The digital subsystem:

Motorola MC68332-based microcomputer

A–D conversion: 12-bit A–D converter, selectable sampling rate (100–1,000 Hz), 256 kB RAM

Data storage: 20 MB Flash Card (PCMCIA)

Ambulatory impedance cardiography AZCG

Producer/distributor: World Wide Medical Instruments

The Useful Links to Ambulatory Monitoring and Impedance Cardiography Web Pages

<http://www.impedancecardiography.com>

<http://www.hemosapiens.com/teb.html>

<http://www.microtronics-bit.com/BIT/Products.html>

<http://mindwaretech.com>

<http://www.sonosite.com/products/bioz-dx>

<http://www.physioflow.com/clinicalinformation.htm>

http://www.physioflow.com/files/Fichiers_Manatec/Preliminary_brochure_Enduro.pdf

<http://www.neumedx.com/13.html>

<http://www.cardiolertsystems.com>

<http://www.psy.vu.nl/vu-ams/manuals/index.html> (VU-AMS manual)

<http://www.psy.vu.nl/vu-ams/information/index.html> (VU-AMS web page)

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