



User Manual v1.43

Quattrocento

Bioelectrical signal amplifier



Read this manual carefully before using the quattrocento amplifier

Index

1. GENERAL DESCRIPTION	6
2. QUATTROCENTO KIT CONTENT	7
3. END USER	7
3.1. Contraindications	7
3.2. Side effects	7
4. SAFETY CAUTIONS AND OTHER WARNINGS	8
5. SYMBOLS USED ON QUATTROCENTO AND IN THE USER MANUAL	10
6. TECHNICAL SPECIFICATIONS	11
7. DETAILED DESCRIPTION	13
7.1. Front panel	13
7.1.1. Input connectors IN1 to IN8	13
7.1.2. Multiple input connectors MULTIPLE IN1 to MULTIPLE IN4	13
7.1.3. PATIENT REF connector	14
7.1.4. DRL IN connector	14
7.1.5. DRL OUT connector	14
7.1.6. Liquid crystal display and button	14
7.1.7. Battery Charge	16
7.2. Rear panel	17
7.2.1. Power supply socket	17
7.2.2. Ethernet connector	17
7.2.3. USB connector	17
7.2.4. Auxiliary IN connectors	18
7.2.5. Trigger connector	18
7.2.6. Analog output connector	18
8. USE OF QUATTROCENTO	20
8.1. Quick setup	20
8.2. Quattrocento network interface	21
8.3. Webpage setup	22
8.4. Power Supply	23
8.5. Detection Mode	25
8.6. Amplification Gain	25
8.7. High pass and Low pass filters	26
8.8. Analog out setting	26
8.9. Patient connection	27

9. TROUBLESHOOTING	30
10. QUATTROCENTO MAINTENANCE AND STORAGE	31
11. TECHNICAL CHARACTERISTICS	32
12. WARRANTY	33
12.1. Warranty conditions	33

1 GENERAL DESCRIPTION

The quattrocento is a multichannel amplifier for bioelectrical signals. It can detect surface electromyographic (sEMG) signals, intramuscular electromyographic (iEMG) signals and electroencephalographic (EEG) signals.

The quattrocento allows the detection and recording of the electric signals generated by human body. The signals acquired by the instrument are amplified, filtered, digitally converted and then transferred to a PC, via an ethernet interface, for real-time visualization and storage. A freeware software called OT BioLab+ has been designed by OT Bioelettronica and is available for download on the website www.otbioelettronica.it, under the download page.

The quattrocento is a research instrument designed for clinical research carried out by qualified researchers.

Quattrocento is a modular system. Version with 96, 192, 288 and 384 bioelectrical signals plus 16 auxiliary inputs are available. The number of available channels depends on the number of amplification boards inserted.

Several configurations of electrodes can be used simultaneously by means of a number of cable adapters that allow to connect from electrode pairs to linear arrays or electrode grids to the quattrocento 12 inputs connectors (16 channels are available on the inputs IN1 to IN8 and 64 channels on the inputs: MULTIPLE IN1 to MULTIPLE IN4).

Quattrocento allows to acquire, in any configuration, 16 additional signals on the auxiliary inputs (AUX IN1 to AUX IN16). These signals can, for example, be generated by other amplifiers (e.g. force, torque, angle, position or trigger signals) and are treated by the non-insulated part of the amplifier, thus, they are insulated with respect to the biological signals that are conditioned and converted in the insulated part of the amplifier.

Custom amplification boards can be realized on user request to allow acquisition of other biological and non-biological signals (MMG, force, etc.).

Quattrocento is completely safe for the patient. The safety is achieved by means of medical grade electrical insulation of all the circuitry connected to the patient.

This user manual refers to all hardware instrument versions.

2 QUATTROCENTO KIT CONTENT

- 1 multichannel amplifier quattrocento
- cable adapters to connect electrodes to the amplifier (depending on the number of channels installed into the amplifier and on the customer request);
- 1 conductive cream package;
- 3 reference straps for the ankle;
- 3 reference straps for the wrist;
- 3 reference cables;
- 1 ethernet cable;
- 1 USB cable type A-A;
- 1 AC power adapter (36W 12V);
- Arrays and matrix of electrodes of different sizes, depending on the customer request;
- 1 quattrocento user manual.

3 END USER

Quattrocento multichannel amplifier allows invasive and non-invasive recording of biopotentials (iEMG, sEMG, EEG) detected by superficial and intramuscular electrode.

In case of sEMG and EEG recordings the end user must be familiar with the technique and received a proper training in EMG or EEG detection and interpretation. The detection of iEMG signals is subjected to the insertion of needles or wires into the muscle and must be supervised by trained medical staff.

3.1 Contraindications

Quattrocento has no particular contraindications when used jointly with personal computers, provided that all the electrical devices connected to it and the power line comply with safety rules and standards concerning grounding and leakage currents.

3.2 Side effects

In case of sEMG or EEG, no significant side effects are known. The materials used for manufacturing all the parts in contact with the patient are biocompatible. Possible slight cutaneous allergic reactions (e.g. skin reddening) are reduced to a minimum during short duration of bioelectrical signal acquisitions. In case of iEMG, the needles or wires used to detect the signals must be sterilized. No significant side effects are known.

4 SAFETY CAUTIONS AND OTHER WARNINGS

The use of the multichannel amplifier quattrocento is absolutely forbidden in the following conditions:

- While other monitoring devices are in use with the patient.
- While electro-surgery equipment, short waves or microwaves therapy devices are used.
- By mentally impaired people.
- Whenever the equipment is damaged.
- In proximity of inflammable substances (especially inflammable liquids and gases) or in environments with high concentration of oxygen.
- On patients carrying life-supporting equipment that might be adversely affected by electromagnetic interferences, such as pacemakers, etc.

The following cautions should be observed:

- The detection of iEMG signals must be supervised by trained medical staff.
- Only use electrodes supplied by the manufacturer: quattrocento is guaranteed to achieve tested performance only if used with electrodes supplied by the manufacturer.
- Contact the manufacturer immediately if extraneous materials permeate into the device (liquids, powders, etc.). In case of hard shocks suffered by the quattrocento (like a drop to the floor, etc.), verify that no crack or any other kind of damage of the box resulted from the shock. In case of doubt, please contact the manufacturer.
- The quattrocento is subject to electromagnetic interference that is not dangerous for the patient (such as electrostatic or electromagnetic interference generated by electrical motors and other sources). This interference may affect the measurements of the physiological variables derived from the EMG or EEG signals. These measurements are not meant to be used for diagnostic purposes, and thus these signal alterations cannot be dangerous for the patient, please always consider the presence of noise in your signal processing tasks and evaluations.
- Before making any measurement, it is mandatory to check the quality of the grounding of the power line to which the quattrocento is connected. **The use of electrical devices with grounding connections not compliant with safety standards represents a high risk for the patient and the operator.**
- The connection between quattrocento and other electrical devices (e.g. a PC) must be done in compliance with the European standard EN 60601-1-1 on medical devices.
- Always use the quattrocento with a PC manufactured in compliance with the European standards EN 60950 (safety standard for information technology devices), EN 55022 (EMC standard) and EN 55024 (immunity standard).

- The use of the quattrocento is restricted to skilled personnel.
- Incorrect measurements can arise when unskilled personnel use the device in presence of strong sources electromagnetic interference (e.g. strong electromagnetic fields). The presence of interference in the signals is easily recognised by skilled personnel.
- Quattrocento is not designed to be portable equipment. Should it be necessary to move the quattrocento, it must be properly packaged to avoid typical vibrations and shocks arising from transportations. Vibrations could cause the release of metallic particles inside the appliance, such as screws, nuts and bolts, that could compromise the safety of the patient and the integrity of the appliance.

5 SYMBOLS USED ON QUATTROCENTO AND IN THE USER MANUAL



CE marking - Device in compliance with applicable Community directives.



Appliance with applied parts of type BF.



Device is double insulated, usually with an external cover. This could minimize the risk of electric shock.



Read the instructions of use



Do not dispose this product as unsorted municipal waste. Collection of such waste separately for special treatment is necessary following the 2002/96/EC Law of the European Parliament and Council of the European Union about the disposal of e-waste.



Serial number – Production year



Manufacturer

Degree of protection:

Protected against solid bodies larger than 12 mm

Protected against falling drops of water with a maximum inclination of 15 °

IP22



12VDC – 36W

Indicates that the equipment is suitable for direct current only; with indication of nominal voltage and power supply.

**Model: quattrocento
– OT0001x**

Variants: x = A 96 + 16 channels (OT0001A), x = B 192 +16 channels (OT0001B), x = C 288 + 16 channels (OT0001C), x = D 384 + 16 channels (OT0001D)



Read the operating instructions carefully before putting the device into service.



Dangerous voltage levels, mains voltage.



Input signals.



Output signals.

6 TECHNICAL SPECIFICATIONS

Quattrocento is a galvanically insulated device designed to guarantee a high safety level for the patient and the operator in all operating conditions. The galvanic insulation separates the circuitry connected to the patient from the circuitry connected to external non-medical devices, such as the PC used for data acquisition and user interface. An embedded circuitry, called Driven Right Leg (DRL) circuitry, is available to reduce common mode voltage noise arising from electrical interference from the power line. The DRL is particularly useful in monopolar acquisition mode.

Table 6.1 shows an example of possible probes configurations with the available versions of the QUATTROCENTO.

Device configuration	Example of probes configuration
384 channels	eight 16 channel probes and four 64 channel probes
288 channels	six 16 channel probes and three 64 channel probes
192 channels	four 16 channel probes and two 64 channel probes
96 channels	two 16 channel probes and one 64 channel probe

TAB. 6.1: *Examples of probes configurations with quattrocento amplifier.*

As shown in the examples, it is possible to simultaneously acquire signals with different probes. This is necessary when signals from different muscles need to be recorded at the same time or when EEG and EMG have to be recorded together.

Quattrocento technical specifications are shown in TAB. 6.2.

Amplification channels (IN1 to IN8 and MULTIPLE IN1 to MULTIPLE IN4)	
Fixed gain	150 V/V
Selectable bandwidth	High pass filter: 0.7, 10, 100, 200 Hz Low pass filter: 130, 500, 900, 4400Hz
Maximum input range	33 mV _{PP}
Noise level referred to input	< 4 μ V _{RMS}
Input resistance	> 10 ¹¹ Ω
CMRR	> 95 dB
Output range	0 ÷ 5 V
Insulation voltage	4.000 V _{DC}
Auxiliary channels (AUX IN1 to AUX IN16)	
Input range	± 5 V
Bandwidth	Channels are not filtered
Gain	0.5 V/V
Input resistance	> 10 ¹¹ Ω
A/D converter input dynamics	0 ÷ 5 V
Data conversion	
A/D converter resolution	16 bits
Data transfer to PC	Ethernet interface
Selectable sample frequency	512, 2048, 5120, 10240 Hz

TAB. 6.2: quattrocento technical specification

7 DETAILED DESCRIPTION

7.1 Front panel

FIG. 7.1 shows controls, indicators and connectors present on the front panel of the quattrocento and described in the following sections.

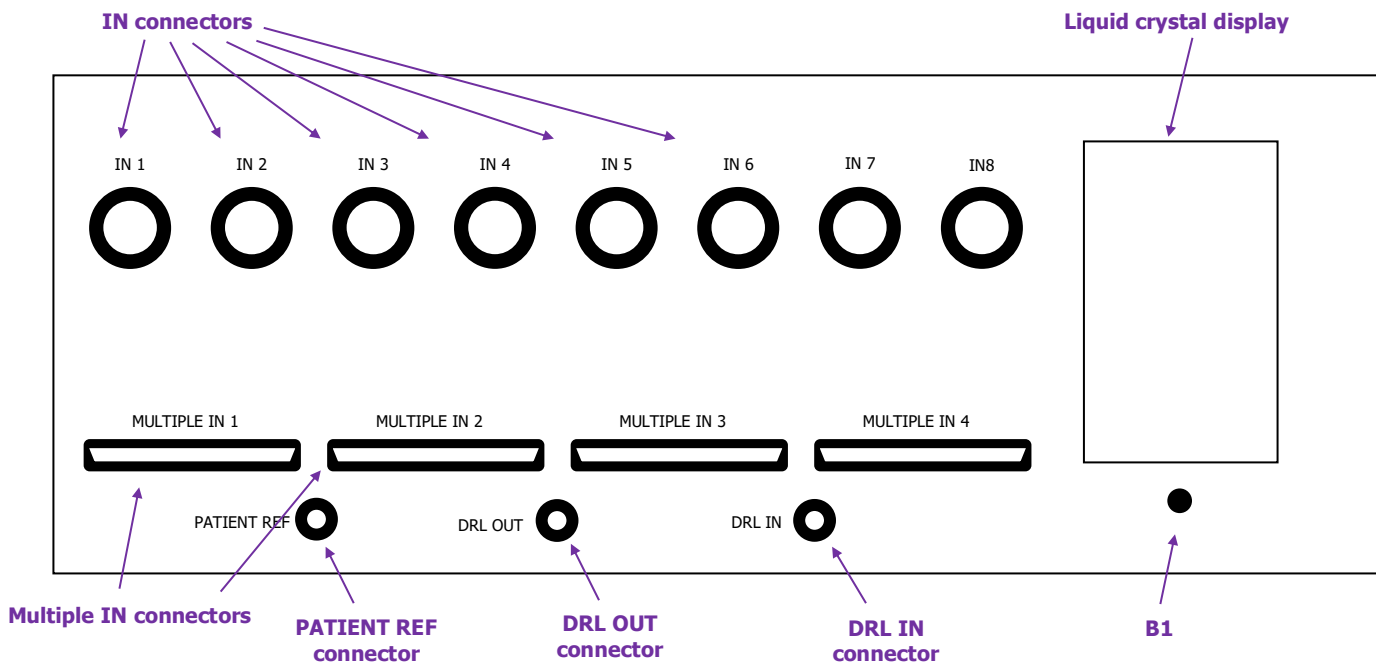


FIG. 7.1: Quattrocento front panel

7.1.1 Input connectors IN1 to IN8

Each *IN* connector provide the input to 16 amplification channels. These inputs allow the connection of different type of adapters. The adapters are active devices that are used to interface one or more electrode arrays or matrixes to the amplifier. For sEMG are available different type of adapters that allow the connection of one 16-electrode array or two 8-electrode arrays or four 4-electrode arrays. For a complete list of available adapters, refer to the website www.otbioelettronica.it

7.1.2 Multiple input connectors MULTIPLE IN1 to MULTIPLE IN4

Each *MULTIPLE IN* connector provide the input to 64 amplification channels. For sEMG it is available one adapter for the connection of a 64-electrode electrode grid.

7.1.3 PATIENT REF connector

The *PATIENT REF* connector is used to connect the amplifier reference point (at middle supply) to the patient. The reference point must be connected to a point on the patient's body without myoelectric activity (e.g. the ankle or the wrist) using the supplied ground strip. The strip must be wet with water to ensure a good electric contact with the patient.

 **REMARK: failure in connecting this electrode prevents the correct acquisition of the EMG signal.**

7.1.4 DRL IN connector

The *DRL IN* is the input of the interference reduction circuitry DRL. In case of high levels of electromagnetic interference, it may be necessary to activate the DRL noise reduction circuitry. To activate the DRL noise reduction circuitry a ground strip must be connected to the patient at a point with no bioelectrical activity (wrist or ankle). Using the provided cable, the strip must be connected to the *DRL IN* connector. An additional ground strip must be connected at a point with no bioelectrical activity on the patient and, using the provided cable, to the *DRL OUT* connector.

 **REMARK: failure in connecting this electrode prevents the correct acquisition of biopotentials in case of high levels of electromagnetic interference.**

7.1.5 DRL OUT connector

The *DRL OUT* is the output of the DRL interference reduction circuitry. The *DRL OUT* should be connected with the provided cable to a ground strip. The strip must be wet to ensure a good electric contact with the patient. It is not strictly required to connect this strip at a point without bioelectrical activity, whereas this is strictly required for *DRL IN* and *PATIENT REF*.

 **REMARK: failure in connecting this electrode prevents the correct acquisition of biopotentials in case of high levels of electromagnetic interference.**

7.1.6 Liquid crystal display and button

The liquid crystal display is turned on when the quattrocento is powered with the external power adapter or when keep pressed the button for 2 seconds, if the power is applied with the USB cable. If no external power is provided, the display doesn't turn on. After an introducing screen-shot (where the firmware version is shown), the IP address and the power mode are presented as shown in FIG. 7.2.

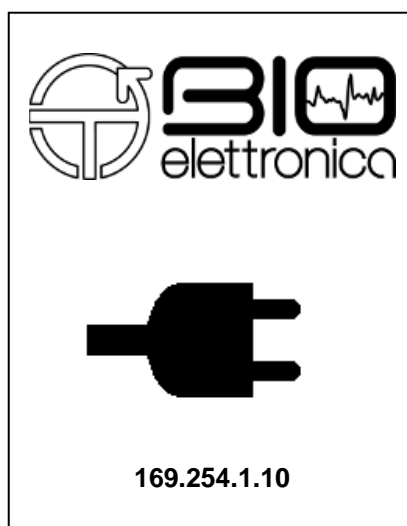


FIG. 7.2: Liquid crystal display screen-shot example displaying the IP Address

The IP Address shown in Fig 2 is the address of quattrocento. Opening a browser, it is possible to reach the its configuration web page.

In Fig 7.3 it is available a sample of screen reporting the settings of one input. The button under the display can be used to check the parameters settled for each input. Pressing the button, it is possible to loop among the inputs settings.

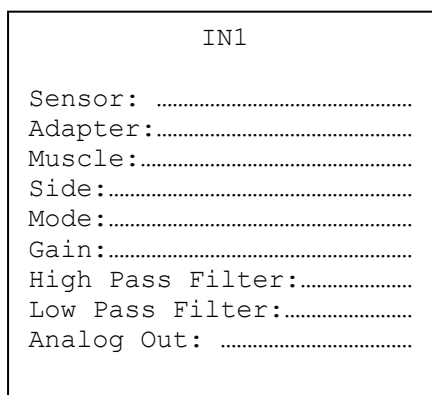


FIG. 7.3: Liquid crystal display screen-shot example displaying the IN1 menu

This user interface only shows the settings that can be applied through a PC. Refer to the *QUATTROCENTO CONFIGURATION* section for detail about instrument settings.

7.1.7 Battery Charge

The liquid crystal display also shows the power mode and the battery level. The quattrocento is charged automatically when the device is powered with the external power adapter, is not transferring data to the PC and the analog supply mode is different from "Always from battery" (see section 8.3).

7.2 Rear panel

Figure 7.4 shows the connectors on the rear panel of quattrocento described in the following sections.

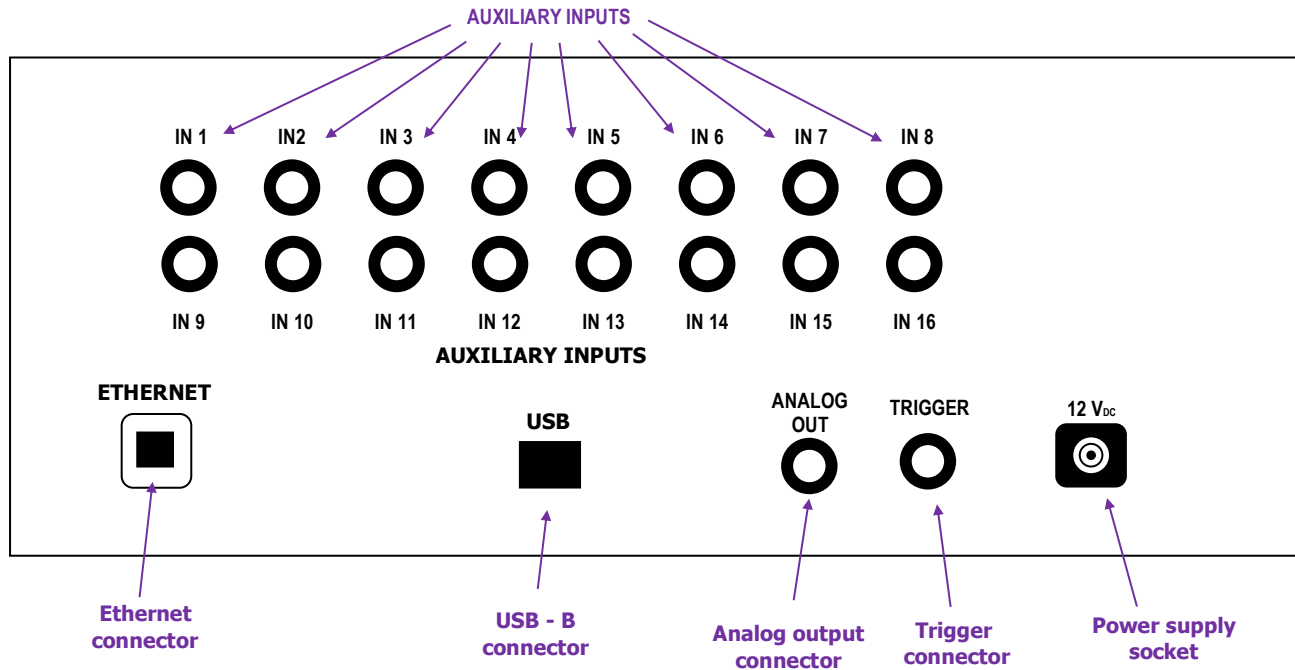


FIG. 7.4: QUATTROCENTO rear panel view

7.2.1 Power supply socket

The quattrocento can be supplied by connecting to the 12 V_{DC} voltage generated by its AC/DC power adapter or alternatively by the USB port. The internal battery is only recharged if the power adapter is used.

⚠ DANGER: the use of different AC/DC power adapter than the one provided by the seller can modify the performance of the QUATTROCENTO.

7.2.2 Ethernet connector

The quattrocento ethernet port can be connected directly to a PC, or to a switch/router, by means of an ethernet cable.

7.2.3 USB connector

The USB port can be used to provide power supply to the non-isolated part of the device, that include the ethernet interface, the digital isolator, the auxiliary inputs, the analog output and the trigger circuit.

When quattrocento is supplied in this way, all the isolated part (including the amplification boards, all the adapters connected to the inputs and the display) are supplied by the internal battery, regardless of any other settings.

If case the quattrocento is directly connected to the PC with the ethernet cable, and supply is provided from a USB port of the same PC in battery mode, the whole system is completely floating, increasing the rejection to external interferences.

No communication is implemented on the USB at the moment, but it could be done in future upgrades.

7.2.4 Auxiliary IN connectors

These BNC type connectors can be used to acquire external amplified signals, in the range ± 5 V, together with the bioelectrical signals. The sixteen auxiliary inputs work even if no other inputs of the front panel are used. Thus, the quattrocento can be used as a sixteen channels ethernet acquisition board. To properly set and acquire these channels refer to the OT BioLab+ user manual.

7.2.5 Trigger connector

This BNC type connector can be used as digital input or output. When used as an input, logic 0 level correspond to voltages lower than 0.8V, logic 1 level to voltages higher than 2V. Do not exceed 5.5 V. The digital signal at this BNC control the start and stop recording in OT BioLab+ software.

When the trigger is used as an output, it will reflect the status of the recording in OT BioLab+: 0V indicate that the data recording is not in progress, 5V indicate that the data recording is in progress.

The signal at this connector is sampled/generated synchronously with the sampling of the bioelectrical and auxiliary signals. The misalignment between a level change of this signal and the first or last sample recorded in the OT BioLab+ software is lower than $1/f_{\text{samp}}$. Where f_{samp} is the sampling frequency of the signals set from OT BioLab+.

7.2.6 Analog output connector

This BNC type connector outputs one of the amplified and filtered signals over the insulation barrier, for safety connection to other instruments. The output range is $0 \div 5$ V (with 2.5V intended as the reference level) and the bandwidth range from DC to 4100 Hz with a first order low pass filter acting as a post DAC filter.

The signals at this output is updated at at the same sampling frequency used for the input signals.

Due to a low fixed gain in the amplification of signals equal to 150V/V, a digital amplification gain can be set for the analog output from OT BioLab+ equal to 1, 2, 4 o 16 V/V.

A possible use of this output is to provide the input to an audio amplifier to play the EMG signal. The signal can also be sent to other instruments to provide some kind of biofeedback or synchronization. The OT Bioelettronica is available to design any kind of adapter or instrument to manage this output on request.



REMARK: the analog signals is available only after quattrocento has been connected to the PC by means of a ethernet cable and the signal visualization has been started on OT BioLab+.

8 USE OF QUATTROCENTO

The quattrocento can be interfaced to any computer with a network interface and running any kind of operative system. This manual refers to the use of quattrocento together with PC with Windows and the freeware software OT BioLab+. In case a different type of operative system is used, or if the user interface needs to be customized, the configuration and communication protocol of quattrocento is available as well as Matlab examples. Please contact OT Bioelettronica to receive the additional manual and examples.

8.1 Quick setup

Follow these steps for connection and a quick setup of the device:

1. Connect the ethernet port of quattrocento (see section 7.2.2) to the ethernet port of a PC.
2. Supply quattrocento with the AC power adapter provided (see section 7.2.1).

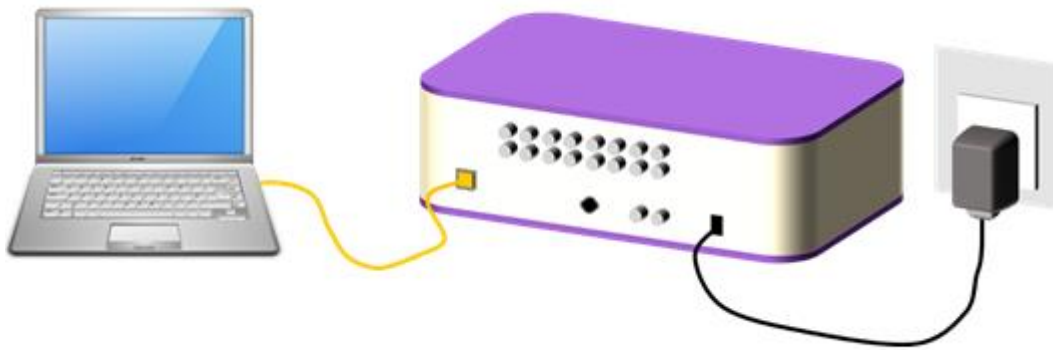


FIG. 8.1: Standard connection set up quattrocento

3. Click the button on the front panel to turn on quattrocento (see section 7.1.6), in few seconds you will see the IP Address of the device on the display.
4. If the IP address shown is in the range 169.254.X.Y, the PC network card can be set as default: "Obtain an IP address automatically".
5. Run OT BioLab+.
6. On the OT BioLab+ main menu select Acquisition ->Setup or press Setup icon or press F2. Set quattrocento as device, choose the proper acquisition frequency and the number of channels to transfer between quattrocento and the PC (refer to the OT BioLab+ manual for details), and create an acquisition setup.

7. Pay attention to set the same IP Address shown on the display of quattrocento. Change it if necessary in the OT BioLab+ option window and check the Default Mode checkbox.
8. Start the signals visualization with Acquisition->Start Visualization or press F5 or press Start Visualization icon.
9. Acquire the signals using the Start Acquisition and Stop Acquisition buttons (refer to the OT BioLab+ manual for details).
10. Stop the data transfer and signals visualization by going back to the review mode in OT BioLab+.
11. Disconnect the AC power adapter to completely turn off quattrocento.

8.2 Quattrocento network interface

The network interface available for quattrocento is similar to the interface available for other devices like printers, routers or access points. As any other device connected to a network, quattrocento has its own IP address that is shown on the display. When quattrocento is connected to a network with the same IP range, it is accessible for data transfer, ping or configuration through its web configuration page.

Configuration of quattrocento can be changed connecting to the IP address (shown on the display) using a web browser (refer to section 8.9). Please take care: the PC must be connected to the same network and with the same address range.

The IP address can be fixed by the user or can be assigned automatically from a DHCP server on the network. When the DHCP option is enabled, quattrocento wait for 20 seconds after power is applied through the AC power adapter or the USB port to receive a configuration from a DHCP server. If no configuration is received, then the default IP, subnet mask and gateway set by the user are applied.

A service called *Auto IP* is available on windows computer. When the computer does not have any fixed IP and no DHCP server is present on the network, the *Auto IP* service automatically assign an IP address in the range 169.254.X.Y (with subnet mask 255.255.0.0). For this reason, quattrocento has, by factory default, the IP address is set in the same range, in particular 169.254.1.10. Thus, connecting directly the quattrocento to a Windows computer, without a fixed IP, they will have the same IP address range and will be able to communicate. When changed are performed to the network interface (disconnecting the quattrocento from a network and connect it to another) it is necessary to remove power and then apply it again in order to receive new settings for the DHCP protocol.

8.3 Webpage setup

Using a web browser and connecting to the IP address written on the display, the webpage of quattrocento will be shown (see Fig 8.2)



FIG. 8.2: Embedded web page of quattrocento.

This webpage let you configure parameters like default IP address, TCP Port or Analog Supply mode. In order to submit and save changes, you must press the button "Apply and Restart".

When DHCP is enabled, quattrocento waits from server the IP address for 20 seconds. If it does not receive any IP address, it sets as IP address the default one (see section 8.2)

Analog Supply mode can be set among:

- Battery when acquiring
- Always from battery
- Always from ext supply

This setting specifies how the isolated part of quattrocento (where resides the analog amplification chains of the bioelectrical signals) is supplied when the AC power adapter is used. Factory default setting is *Battery when acquiring*. It means that during data transfer the internal battery is used, but when the visualization of the signals is stopped, the insulated part of the instrument take power from the external AC adapter.

When quattrocento is supplied through the USB port, regardless of this setting, the internal battery always supplies the insulated part of the device (see section 8.4 for details).

Power supply for the internal amplification boards switches on and off automatically when the data transfer towards the PC starts or stops. Thus, if the instrument is on but not transferring data to a PC the power consumption is restricted to the supply of the user interface: microcontroller and display.

Firmware upgrade requires a file .bin provided by OT Bioelettronica. Do not start any firmware upgrade procedure if you do not have been instructed on how to do it and without the proper file.

8.4 Power Supply

Quattrocento has an insulation barrier that divide the part applied to the patient (isolated part) to the part that makes available the connections to other instruments or PC (non-isolated part).

The isolated part can be supplied by an internal battery or, through an insulated DC-DC converter, by the main 12V from the back panel of quattrocento. The non-isolated part can be powered by the main 12V or through the USB port (see Fig 8.3).

When the AC power adapter is connected to the quattrocento, the internal battery start recharging and the display shows the battery level at full screen. This is identified as stand-by mode. By pressing the button on the front panel quattrocento is activated and the data acquisition can be started. The battery is charged also if: quattrocento is active, data transfer is not in progress and the supply mode is *Battery when acquiring* or *Always from ext supply* (see section 8.4).

When the USB port is used to provide power to quattrocento, the isolated part is supplied automatically by battery. To activate the device, the button on the front panel has to be pressed for at least 2 seconds. Through the USB port it is never possible to recharge the internal battery.

In figure 8.3 three schematic representation show the different possible supply mode. When the supply mode selected on the embedded web page is set to *Battery when acquiring* quattrocento automatically switch between configuration a and b.

Configuration c allows to have a completed floating setup if the computer used for the acquisition is a laptop running with battery.

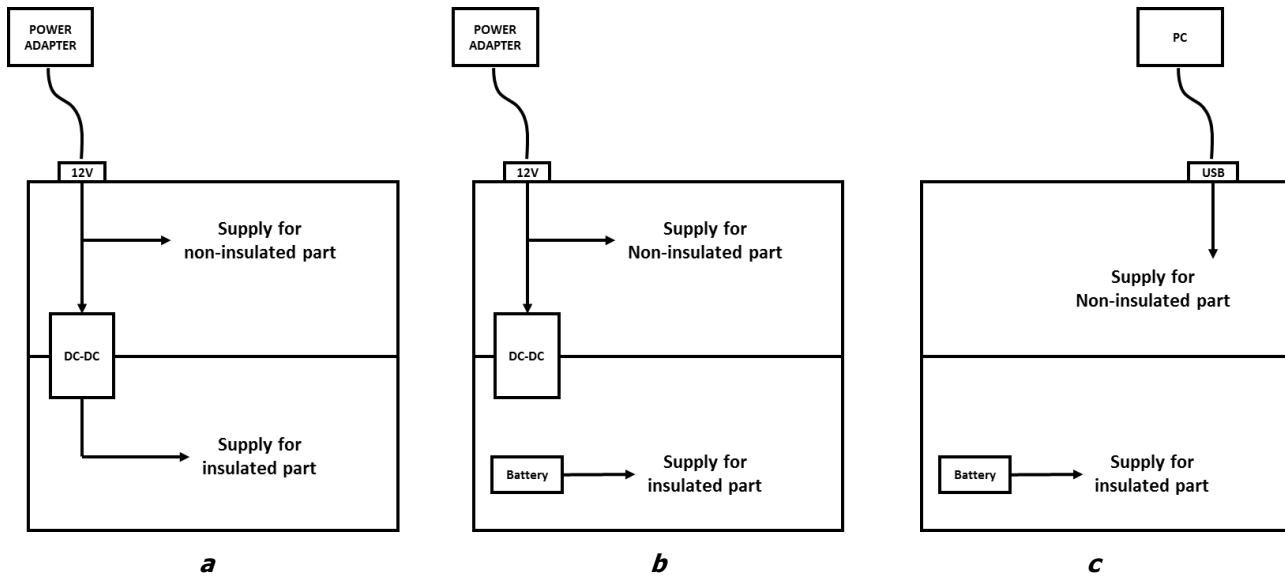


FIG. 8.3: Supply scheme available for quattrocento: a) the supply for both insulated and non-insulated part is provided by the external power adapter. b) power for the non-insulated part is provided by the AC power adapter and the insulated part is supplied by the internal battery. c) power for the non-insulated part is provided by the USB port and the insulated part is supplied by the internal battery.

8.5 Detection Mode

Quattrocento features different detection modalities. The selected detection mode can be different for each input and is displayed in the first line of the front panel display. OT BioLab+ sets the detection mode depending on the setup created by the user. In table 8.1 are listed and described all the available options. To better understand how the different mode works, it is important to remember that each input of the amplifier is associated to 16 amplification channels (in case of IN1 to IN8) or 64 amplification channels (in case of MULTIPLE IN1 to MULTIPLE IN4). Each channel amplifies the difference between two signals.

Parameter	Available options	Description
MODE	Differential	<p>It is a single differential mode. Each channel amplifies the difference between a subsequent signals of each input. The last channel of each input is obtained as difference between the last signal of the same input and the first signal of the subsequent input. For example, in this mode, the channel 16 is obtained as difference between the signal 16 (last signal of IN1) and the signal 17 (first signal of IN2).</p> <p>We suggest to use this detection mode when the signals are detected with a linear electrode array.</p>
	Monopolar	<p>All the channel makes the difference between the corresponding input signal and the amplifier reference point.</p> <p>This mode has to be used jointly with adapter with suffix M5. This kind of adapters are specially designed to reduce interferences in monopolar detection.</p>
	Bipolar	<p>This modality require special adapters, like the AD8x2JD that allow the signals detection from electrode pairs as standard bipolar EMG.</p>

TAB. 8.1: Detection mode details

8.6 Amplification Gain

The amplification gain for all the bioelectrical signal input channels is fixed and equal to 150 V/V. Since the resolution of the analog to digital converters is 16 bits and the input range is 5V, the LSB referred to the input is:

$$LSB_{RTI} = 5/(150 \cdot 2^{16}) \approx 0.5 \mu V$$

that is lower than the electrode-skin contact noise level.

8.7 High pass and Low pass filters

In table 8.2 are listed all the available cut off frequencies.

Parameter	Available options	Description
HP Filter	0.7 Hz	All the signals related to the corresponding input are high pass filtered and low pass filtered with the 3 dB cut off frequency displayed. It is up to the user to select the correct filters value for the conditioning of the desired signals. OT BioLab+, in any case provide a warning when the cut off frequencies do not respect standard values for a given type of signal. Refer to the OT BioLab+ user manual for further details.
	10 Hz	
	100 Hz	
	200 Hz	
LP Filter	130 Hz	
	500 Hz	
	900 Hz	
	4.4 kHz	

TAB. 8.2: Selectable filters description

8.8 Analog out setting

The quattrocento features an analog out BNC connector where one of the signals filtered and amplified by the available channels can be output. This signal is internally sampled and converted in digital form, cross the insulation barrier and then is re-converted in an analog signal. The output of the digital to analog converter is filtered with a 4100 Hz low pass first order filter to remove the staircase shape on the output signal. The delay between the data sampling of the channel used to feed the analog output and the generation of the same sample at the output of the digital to analog converter is lower than the sampling time:

$$DEL_{AN_OUT} < 1/F_{samp}$$

The user can choose the channel to feed the analog output using OT Biolab+. It is possible sets the analog output from Acquisition -> Setup or press Setup icon.

It is also possible to introduce an additional gain on the analog output from Settings form in OT BioLab+. The gain can be 1, 2, 4 or 16V/V. Please consider that this gain is obtained digitally by shifting the bits position of the samples.



REMARK: even if any of the 400 channels can be selected, only the signals sent to the PC through the ethernet (refer to the OT BioLab+ manual) are useful signals. A flat line is generated by the analog output when a channel not sent to the PC is selected.

Patient connection

In order to perform a biopotential recording, follow the instructions listed below:

- For each input, select the suitable adapter for the measurement to perform and plug it into one of the *IN* or *MULTIPLE IN* connectors.
- Connect the adapters, the electrodes arrays or matrix, the wires or needles or standard electrode suitable for the desired application.
- Connect a patient ground strip to *PATIENT REF* plug with the enclosed cable. The strip must be wet with water to assure a good electric contact with the patient and has to be connected on a point without bioelectrical activity (e.g. the ankle or the wrist, see FIG. 8.4).

⚠ REMARK: the lack of this connection prevents the correct acquisition of the bioelectrical signals.

Figures 8.4, 8.5, 8.6 and 8.7 show some connections example to acquire bioelectrical signals in different modalities available using quattrocento.

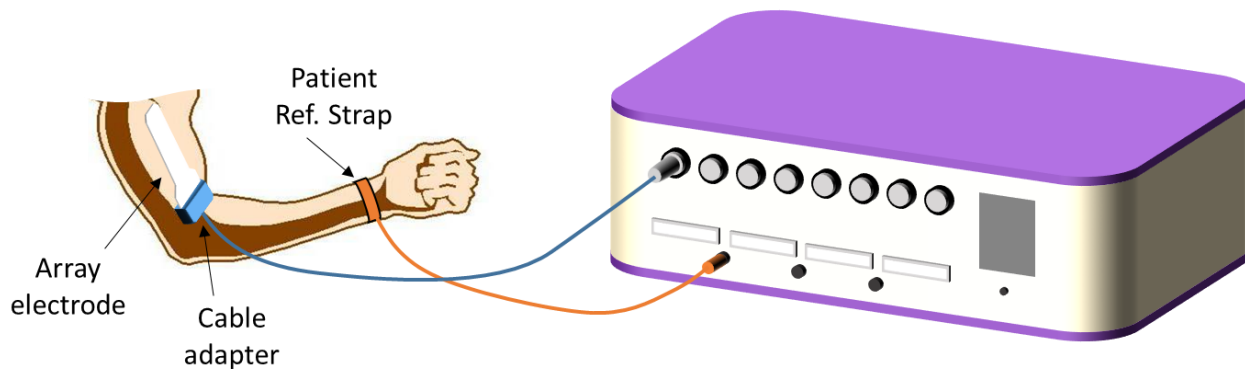


FIG. 8.4: Patient connection diagram for signal acquisition in differential mode. The patient reference strap is the mid-point of the 5 V dynamic range of quattrocento. Both, patient and quattrocento isolated part, are floating and the patient reference connection is used to have a fixed common point. The first amplifier channel will amplify the difference between electrode 1 and electrode 2 of the array, the second channel will amplify the difference between electrode 2 and electrode 3 etc...

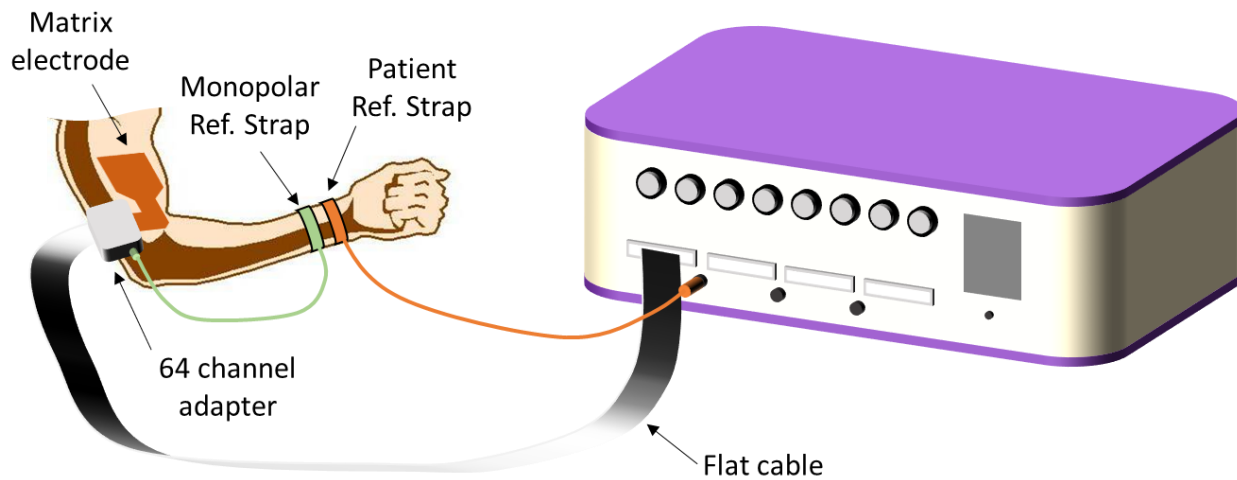


FIG. 8.5: Patient standard connection diagram for signal acquisition in monopolar mode. The 64 channel adapter provide an additional connection for a reference. A strap or a standard adhesive electrode can be used. This connection is used as the negative input for all the preamplifiers of the 64 channel adapter, while the positive inputs are feeded with the signals from the electrode grid. The switch on the adapter have to be set in the M position in order to use the monopolar reference as the negative inputs of the preamplifiers, otherwise the internal reference is used. It is really important that the monopolar reference is on a point without EMG activity, close to the electrode matrix and not in contact with the patient reference.

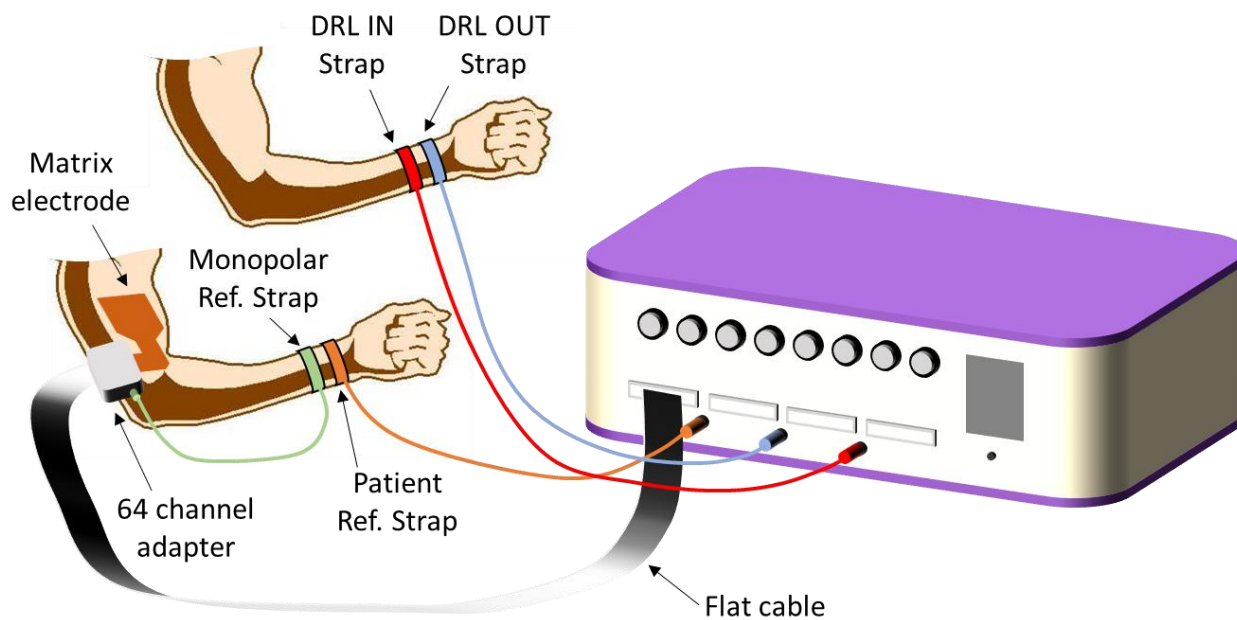


FIG. 8.6: Patient DLR connection diagram for signal acquisition in monopolar mode. The DRL circuit can be used to reduce the common mode interferences on the patient body. It implements a closed loop system by inverting and reapplying on the subject the common mode detected from the DRL IN. The effectiveness of the circuit in reducing the common mode on the signals acquired depends on many factors including all the parasitic impedance between the patient and the sources of interferences.

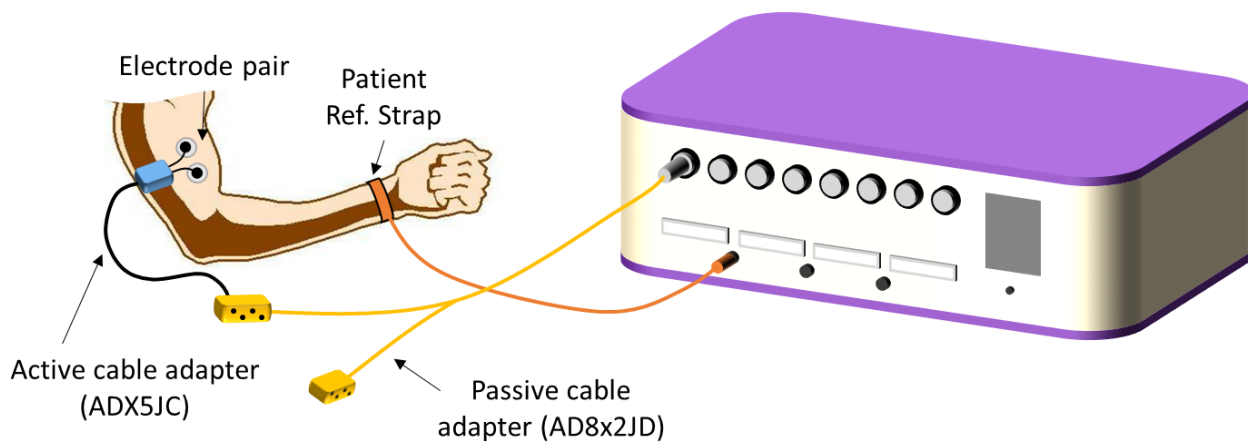


FIG. 8.7: Patient connection diagram for signal acquisition in bipolar mode. Up to 16 electrode pairs can be connected to each IN connector. In the figure, a passive adapter splits the IN1 to 16 jack connectors. An active adapter (it can be terminated with snap-on, banana or concentric connectors) makes the difference between the signals collected from the two electrodes and preamplify it.

9 TROUBLESHOOTING

This section describes the most common problems that may be found by quattrocento users, with some suggestions to solve them.

For problems not described in this section contact the technical support service of OT Bioelettronica.

GENERAL PROBLEMS		
Problem	Possible causes	Solution
The quattrocento does not turn on	Power supply cable is not inserted properly in the amplifier or into the wall socket	Check the power supply cable and the socket connection
	If the supply is provided through the USB port, the quattrocento is not activated automatically.	The button has to be pressed for more than 2 seconds to activate the quattrocento
The embedded webpage is not displayed at the IP address shown on the display	The PC is not connected on the same the same network of quattrocento or they are not in the same address range.	Check the connection on the same network and verify the network adapter settings on the PC.
	If quattrocento is connected directly to the computer maybe some initialization of the ethernet board failed.	Unplug all the power cables (USB and/or AC power supply cables) and then provide power again to re-initialize the ethernet board.
Connecting the quattrocento to a different network the quattrocento has not the new IP address assigned correctly	The assignment of the IP address with quattrocento is only managed in the initialization phase.	Restart the quattrocento by removing the supply (from the AC adapter and/or the USB).
Signals are not displayed on OT BioLab+	The IP address set in OT BioLab+ is not correct.	Set the correct IP address under Tool->Settings
	The network interface has not completed the initialization. If the DHCP mode is active it, wait 20 s before to fall down in the default settings.	Wait until the IP address is shown on the quattrocento display
	Problems on the ethernet connection or the address range.	Try to open the web page of quattrocento in your browser and refer to "The embedded webpage is not displayed at the IP address shown on the display" problem on this table.

TAB. 9.1: Troubleshooting of the general problem that can occur using the quattrocento

10 QUATTROCENTO MAINTENANCE AND STORAGE

Quattrocento must be used in the following ambient conditions:

Temperature:	from 0°C to +40°C
Maximum relative humidity:	75%
Atmospheric pressure:	from 700 hPa to 1060 hPa

It is recommended to turn off the quattrocento at the end of each measurement session, and to remove all the cables and connections. The quattrocento should be stored with all the enclosed accessories on a safe desk far from all the situations listed in the section *Warnings*.

Quattrocento should be stored in the following ambient conditions:

Temperature:	from -20°C to +40°C
Maximum relative humidity:	75%
Atmospheric pressure:	from 700 hPa to 1060 hPa

Cleaning: use only a dry cloth to clean the device.

It is recommended to plan a device check every 24 months with the manufacturer. The quattrocento should be repaired by the manufacturer only. Every repair executed by unauthorized personnel will be considered as a device violation voids the manufacturer's warranty.

Disposal

The device and the accessories should be disposed in compliance with the relative standards in special equipped areas or with special waste.

11 TECHNICAL CHARACTERISTICS

<i>Model:</i>	<i>quattrocento</i>	
<i>Risk class:</i>	I in compliance with the standard 93/42/CEE.	
<i>Insulation class:</i>	BF type applied part, in compliance with the European standard EN 60601-1.	
<i>Classification:</i>	<ul style="list-style-type: none">- class II, about the protection from indirect contact.- IP22, about the penetration of fluids and dust; device not protected.	
<i>Case:</i>	painted plexiglas case.	
<i>Power supply:</i>	$12 V_{DC}$	
<i>Consumption:</i>	20 W	
<i>Limitations:</i>	the device is not suitable for use in environments with high oxygen concentration and/or flammable fluids and/or gases; do not use with electro-surgery or short wave/microwave therapy equipment.	
<i>Working conditions:</i>	device suitable for continuative work.	
<i>Input channels:</i>	up to 400 independents	
<i>Amplifier:</i>	Maximum input range:	33 mV _{pp}
	Bandwidth:	0.7 ÷ 4400 Hz
	Total noise (RTI)	< 4 μ V _{RMS} (monopolar) < 1 μ V _{RMS} (differential)
	Bioelectrical signal gain:	150 V/V
	Auxiliary signal gain:	0.5 V/V
	Resolution:	16 bits
	Input resistance	> 10 ¹¹ Ω on the entire bandwidth
	CMRR	> 95 dB
<i>Visualization:</i>	graphic LCD 320x240 pixel display	
<i>Commands:</i>	1 key	
<i>Dimensions:</i>	395 x 271 x 130 mm	
<i>Weight:</i>	5 Kg	

12 WARRANTY

Quattrocento is covered by a 24 months warranty starting from the purchasing date of the electronic parts.

Connection cables are covered by a 24 months warranty.

The warranty is void in case of device violation or in case of intervention from unauthorized staff.

Warranty conditions are reported hereinafter.

12.1 Warranty conditions

1. The warranty lasts 24 months on the electronic parts. Warranty is provided by the manufacturer.
2. The warranty covers only device damages that cause malfunctioning. The product must have the same serial number indicated on this certificate, or the warranty is released.
3. The warranty covers only the cost of repair or substitutions of defective components, including the costs of labour.
4. The warranty is void in case of damages caused by negligence, use not compliant with the instructions supplied, unauthorized repairs and accidental circumstances, especially for the external part.
5. The warranty is void with damages caused by incorrect power supply.
6. The warranty is not applied on all the parts subject to wear and tear.
7. The warranty does not include the shipment costs.
8. After 24 months, the warranty is released. All the substituted parts, the labour costs and the shipment costs will be charged to the purchaser according to the rates in force.

Designed and produced by:

OT Bioelettronica s.r.l.

C.so Unione Sovietica 312

10135 – Torino (TO) - ITALY

Tel: +390116198498

Fax: +390116198498

www.otbioelettronica.it

mail@otbioelettronica.it

