ELECTROcell B10 HV-LV

BIPOLAR
HIGH VOLTAGE PULSE GENERATOR
Dedicated to electroporation
User Manual – VERSION 0102

LEROY Biotech

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ILLUSTRATIONS

1.   INTRODUCTION

This document explains how to use the bipolar high voltage pulse generator, version 2009, ELECTROcell B10 HVLV.

1.1.   NOTES ON SADE OPERATION

ELECTROcell B10 HVLV allows the generation of voltages to 1000V. Therefore extreme caution is required during use.

This device must only be operated by users, who have the proper competence and knowledge. It is mandatory that all users have read and understood this manual completely before use.

In case of problems with the product, no reparation is allowed by the customer.

The product must always remain closed, only representatives of LEROY Biotech technical assistance have the right to open the device.

1.1.   GENERAL INSTRUCTION ON USE

To maintain the LEROY Biotech product guarantee, it must not be altered or modified in any way. Change or product modification, which are not explicitly approved by LEROY Biotech and described in this manual or received LEROY Biotech technical support as a statement of special maintenance, void your warranty. This system should only be installed in or connected to systems fully compatible with the technical requirements and environmental conditions.

1.2.   VERSION

This document describes the ELECTROcell B10 HVLV programmed with version 1.5.13v.

1.3.   GLOSSARY

CNRS	Centre National de la Recherche Scientifique.
TTL	Transistor-Transistor Logic.
µs	10^{-6} seconds.
ms	10^{-3} seconds.
PE	Full Scale.
MMI	Man – Machine Interface.
ADC	Analog to Digital Converter.

2. PRODUCT DESCRIPTION

The ELECTROcell B10 HVLV is an electroporator used to applied strong electronic pulses. The electroporator contains internal capacitors charged independently to programmable voltages within the range of 0 to +1000V for the first, and within the range of –1000V and 0V for the other. Once the capacitors have been charged, they are able to deliver a selected number of pulses while controlling the positive and negative pulses widths and pulse period.

Figure 1 shows the product and one can identify the following points:

1.- Ethernet Port: This connector allows the product to be connected to an Ethernet network or directly to a PC.

2.- Foot switch Connector: A foot switch can be connected to the product to start and stop pulsing. The use of the foot switch is authorized by configuring the product into External mode at the touch display.

3.- High Voltage Pulse Output Connector (with safety buckle): This is the connector by which the high voltage pulses are output. It must have connected an electrode and authorize the sending of pulses by pressing the trigger to have the product ready to generate pulses.

4.- LCD Touch Screen: The product's main interface with the user (MMI).

5.- Output "V/100": This output connector is designed to show the image of the pulse on an oscilloscope. It gives the exact image of the pulse output only with the voltage divided by 100.

6.- Output ''Trigger'': This output connector is designed to act as a trigger. It provides a TTL output showing the pulse state, giving a TTL "1" when a pulse is active, and a TTL "0" when it is not.

7.- Power Connector: This allows the product to be connected using a standard power cable, and also provides a local on/off switch.

The product also contains an internal buzzer that sends the following sounds:

Long Beep: The beep is about one second long and it signals an error to attract the attention of the user to a message on the screen of the product.

Two Short Beeps: Each beep lasts about ~10 ms and signals that the commanded action has successfully completed.

A long beep is expected if the ELECTROcell B10 HVLV is commanded to send a pulse, but there is a situation that exists which prohibits the pulse from being sent. An example would be when a pulse train is commanded, but the electrode is not connected. The long beep should draw the user attention to the display where an error message will be seen.

Two short beeps are expected at the end of successfully sending a series of pulses (the number of pulses programmed before).
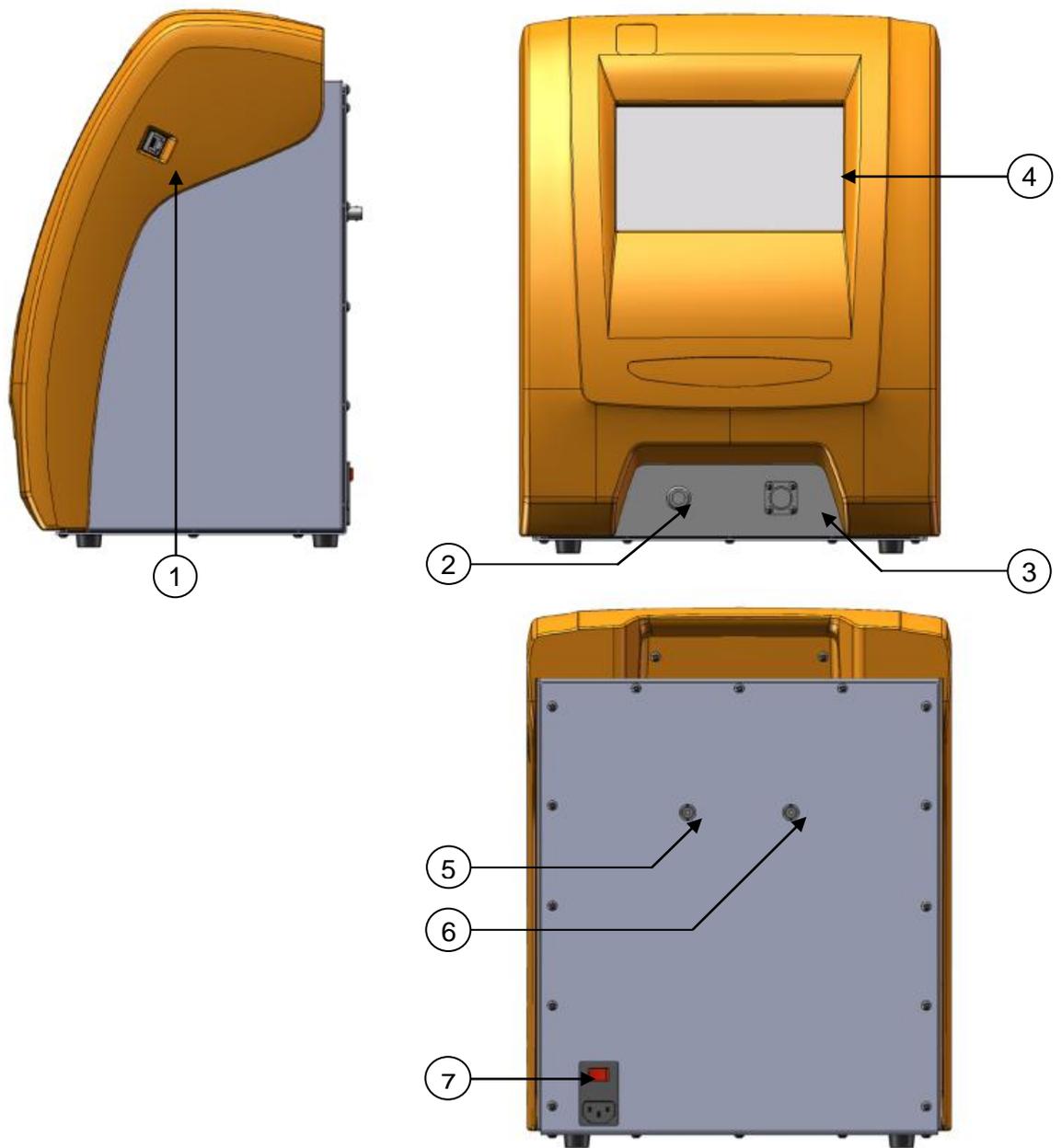
Figure 1 : cell B10 HVLV

3. WAVEFORM CONFIGURATION

The pulses generated by the ELECTROcell B10 HVLV are programmable. The user specifies the parameters **UP**, **UN**, **TP**, **TN**, **TI**, **P** and **R** - see Figure 2.
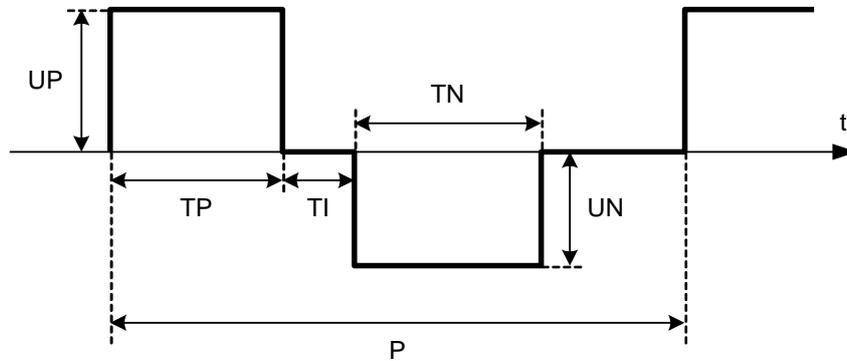
Figure 2 : Waveform of pulses

The **UP** and **UN** parameters represent the positive and the negative pulses voltage levels in Volts (V). These parameters can be configured within the range of 0V – 1 000V.

The **TP** and **TN** parameters represent the positive and the negative pulses width in µs. These parameters can be configured within the range of 5µs – 50 000µs.

The **TI** parameter represents the duration between the end of the positive pulse, and the beginning of the negative pulse, within the range of 5µs – 50 000µs.

The **P** parameter represents the period of the pulses in ms. This parameter can be configured within the range of 1ms – 10 000ms.

The **R** parameter represents the number of pulses to generate. This parameter can be configured within the range of 0 – 10 000.

If **R** is configured within the range of 1 – 10 000, then it specifies the number of pulses to generate. If **R** is configured to 0, then a pulse series without an end is sent, and will continue until a stop is commanded.

The addition of the values assigned to the **TP** and **TN** parameters cannot be larger than half of the value assigned to the **P** parameter. If one of the values assigned invalidates this condition, the following warning message will be displayed, accompanied by a long beep: "*Period too short* ".

Moreover **P** must be at least greater than **Tp + Tn + Ti + 60µs** regardless of the configuration.

TP and **TN Inv** settings allow the generation of alternative forms of pulses.

When **TP Inv** is on, the polarity of the pulse is reversed after **TP**, so after **Ti**.

Due to the time taken by the device to perform this inversion time, **Ti** should then be greater than or equal to **20 000 µs**. If any parameters invalid that condition, the message of this alert will be displayed, accompanied by a long beep: "*inter-pulses time too short".*

Tp inversion (after Ti)
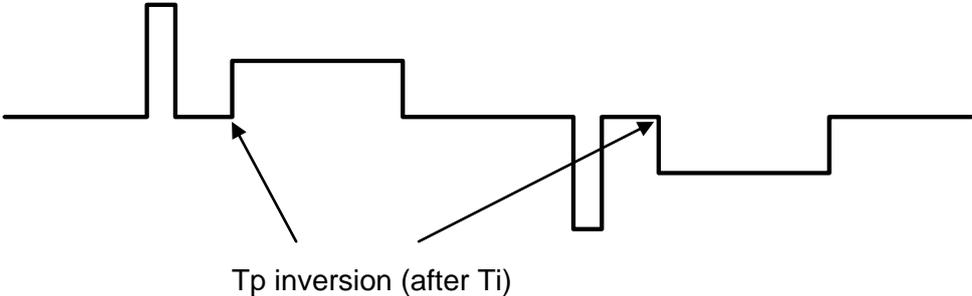
Figure 3 : Waveform pulses with TP Inv activated

When **TN Inv** is activated, the polarity of the pulse is inverted after **TN**.

Due to the time taken by the device to perform this inversion, **P** must then be greater than or equal to **TI + TP + TN + 20 060µs**. . If any parameters invalid that condition, the message of this alert will be displayed, accompanied by a long beep: "*period too short".*

TN inversion (after Tn)
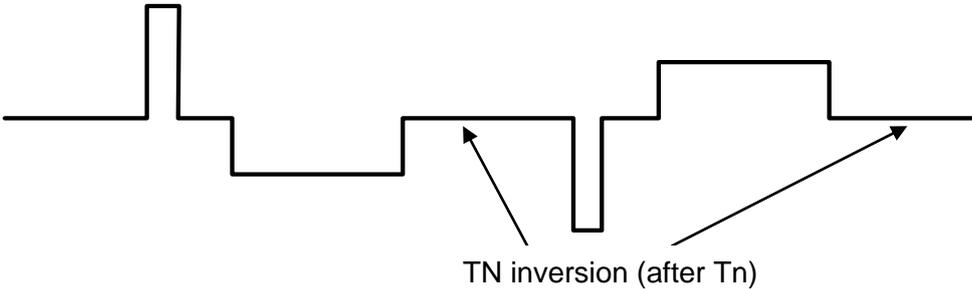
Figure 4 : Waveform pulses with TN Inv activated

When TP Inv and TN Inv are turned on, the polarity of the pulse is reversed after each pulse.

Inversions
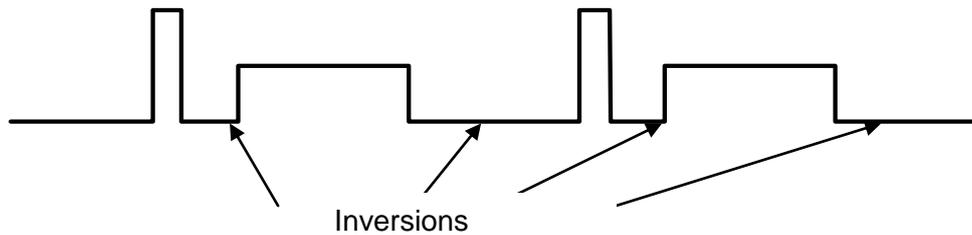
Figure 5 : Waveform pulses with TN Inv and TP Inv activated

The precautions on Ti and P are still valid, and are cumulative.
There is a condition :
P ≥ TP + TN + IT + 20060 µs and **TI ≥ 20 000 µs.** If any parameters invalid that condition, the message of this alert will be displayed, accompanied by a long beep: "*inter-pulses time too short".*

4.   MANUAL/EXTERNAL MODE

ELECTROcell B10 HVLV allows 2 different modes: Manual and External.

<u>Manual Mode</u>: In this mode the product can be commanded only by its LCD touch screen.
The pulse parameters are modified, and pulses commanded to start and stop touching this screen.
Manual Mode is the default mode that the ELECTROcell B10 HVLV is switch on.

<u>External Mode</u>: This mode is similar to Manual Mode in that the configuration and specification of the pulses is set via the LCD touch screen on the product. However in this mode, the starting and stopping of the pulses can only be commanded via the foot switch attached to the front panel of the device.

5. PRODUCT'S TECHNICAL CHARACTERISTICS

Tableau 1 : Technical Characteristics

Weight: 11,2 Kg		Dimensions: 320 x 250 x 410 mm	
Material: stainless steel		Operating system: Linux	
Version: 1.5.13v		Screen: LCD touch screen, 8 inches	
Operating temperature	5 - 40		°C
Storage temperature	0 - 70		°C
Relative humidity	0 - 70		%
Input Voltage	90 - 264		VAC
Alternating current frequency	47 - 63		Hz
Consummate power	10 - 50		w
Power			
Maximum Voltage (U)	1 000		V
Maximum Current	6 - 10		A
Typical Capacity	94 +/-20%		µF
Safety Disconnect Activation	> 6		A
Recharge Time to 90% of FS	< 20		s
Number of Pulses	1 to 10000 (possibility to send continuously)		
Pulses Length (**TP, TN**)	5 to 50000 (steps=5µs)		µs
Resolution	5		µs
Precision	>1		%
Pulse Frequency (1/P)	0,1 to 1000		Hz
Switching			
Time to reach 10 to 90% of FS	400		ns

6. USER INTERFACE

6. <u>USER INTERFACE</u>

The main page of the user interface is shown in Figure 6. This page is shown just after the switch on, and when first displayed gives two beeps to indicate that it is ready.
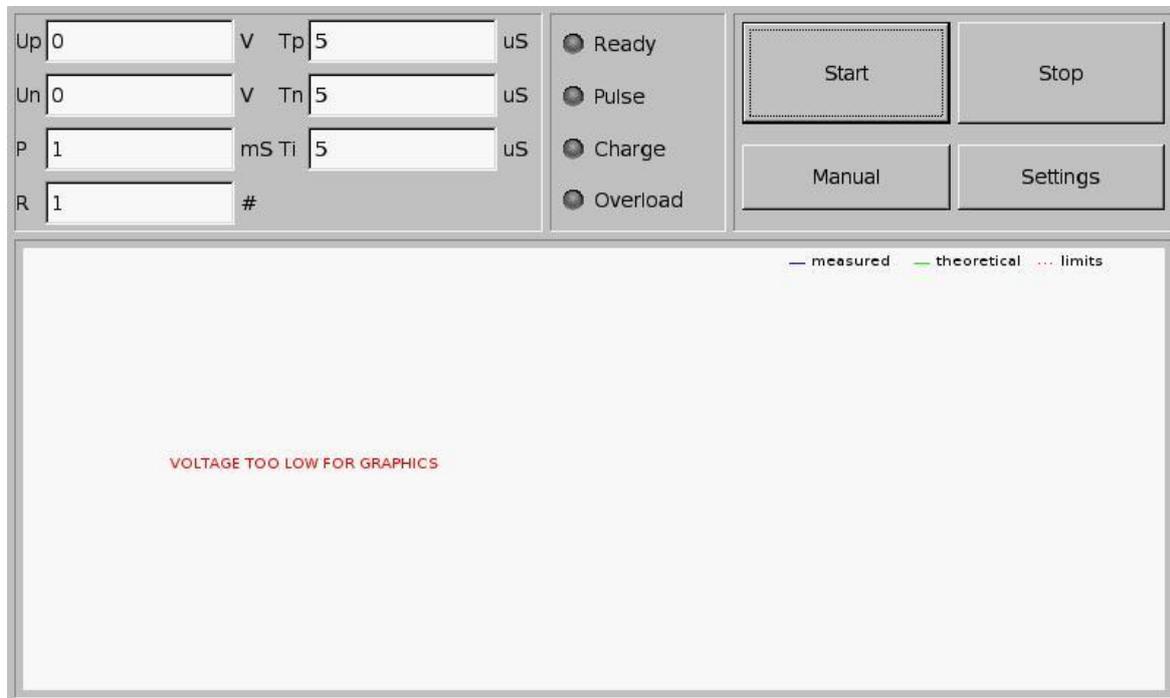
Figure 6 : Main Window.

The main window contains the following zones:

- **Waveform Configuration**: within this zone, the user can configure the values of the parameters **UP**, **UN**, **TP**, **TN**, **TI**, **P** and **R**.

- **Status Display Device charge**: this zone contains the LEDs Ready, Pulse, Charge and Overload.

    The Ready LED indicates whether or not the device is ready to send pulses.
        LED on (Green):   The device is ready.
        LED off (Gray):   The device is not ready.
    The Pulse LED indicates whether pulsing is presently in progress.
        LED on (Blue):   The device is presently sending pulses.
        LED off (Gray):   The device is presently NOT sending pulses.
    The Charge LED indicates if the capacitor is currently charging.
        LED on (Orange):   The capacitor is charging (not yet a target voltage).
        LED off (Gray):   The capacitor is charged.

- **Control and configuration:** this area includes the buttons Start, Stop, Manual and Options.

Start button to send pulses (manual or external control).

Stop button to stop sending pulses, once emissions are launched on the output (Manual or External mode).

Manual button to configure the operating mode of the device, pressing this button allows you to configure the device in the remote mode and then return to Manual mode with new support.

Options button to configure the brightness of the LCD, Ethernet network IP address, the date / time system and interface.

Last area is used to display graphics, submenus or messages if necessary. For example: numeric keypad to set one of the parameters of the pulse (UP, UN, TP, TN, IT, P and R) or error messages.

6.1. PULSES CONFIGURATION

To configure the waveform of the pulses, the values of the parameters **UP**, **UN**, **TP**, **TN**, **TI**, **P** and **R** have to be validated.

The user only needs to press the white rectangle associated with a given parameter and the system will provide a numeric keyboard to enter the value desired for that parameter.

Figure 7 : Modifying the parameter UP

Several items are shown within this view:
- A line displaying the parameter being entered as well as the allowed range for that parameter.
- A zone showing the value entered.
- An erase button for erasing erroneous digits (←).
- Numeric buttons 0 to 9 for entering the value.
- A green V button (validate).
- A red C button (cancel).

The numeric buttons are used to obtain the desired value for the parameter, and then the validate button is pressed to make the value entered into the present value for the parameter. The numeric entry display disappears.

If the cancel button is pressed, the parameter value remains unchanged and the numeric entry display disappears.

If any invalid value is entered and the validate button pushed, a long beep will sound, an error message will be displayed and the numeric display remains.

If the **R** parameter is configured with the value 0, the repeat parameter is taken a value infinite. This indicates to the device that when it starts sending pulses, it should send them continuously until commanded to stop. When the device is sending pulses in this mode, it will only stop when the Stop button is pressed (Manual Mode) or foot switch is released (External Mode).

6.2.   SENDING PULSES

Once the pulse waveform parameters have been set, the pulse sequence can be started.

Manual Mode

In Manual Mode, the designated sequence of commands is started by pressing the Start button.

To generate pulses, it is necessary that the electrode is connected to the device and that the security interrupter is in non-interrupt position. If this is not the case then the following will happen:

- An error message will appear - ''ERROR: Electrode missing!''.
- A long beep will sound to draw the user's attention to the situation.
- No pulses will be produced.

When pulses are sent, the Pulse LED is on with a blue color. It is also possible that the Charge LED will be orange indicating that while the pulses are being sent, the capacitor is charging.

When the sequence of pulses has been successfully sent, a double short beep will be given by the device and the Pulse LED will return to off/gray.

It is possible to stop the pulse sequence at any time by pressing the Stop. If the pulse sequence is stopped in either of these ways, the double short beep will not be given, but the Pulse LED will return to off/gray.

External Mode

In External Mode, the designated sequence of commands is started by pressing on the foot switch.

Releasing the foot switch will stop the pulse sequence if it is in process. A normal end of pulses results in two short beeps, but an interrupted sequence of pulses (by the interrupter or by the foot switch release) does not. In either case at the end of the pulsing, the Pulse LED returns to off/gray.

6.1. WAVEFORMS DISPLAY

Following the pulses generation and the two short beeps, the LCD screen displays the theoretical waveform in green color, based on the selected parameters, and the measured waveform in blue. The red lines show the maximum and minimum Voltage levels (UN and UP).

7. SETTINGS

Settings buttons allows the configuration of the screen brightness, the TCP/IP address of the device, and the system date/time settings.

If this button is pressed, the display will change to that shown in Figure 8 (brightness configuration of the LCD Screen).

7.1. CONFIGURATION OF THE SCREEN BRIGHTNESS
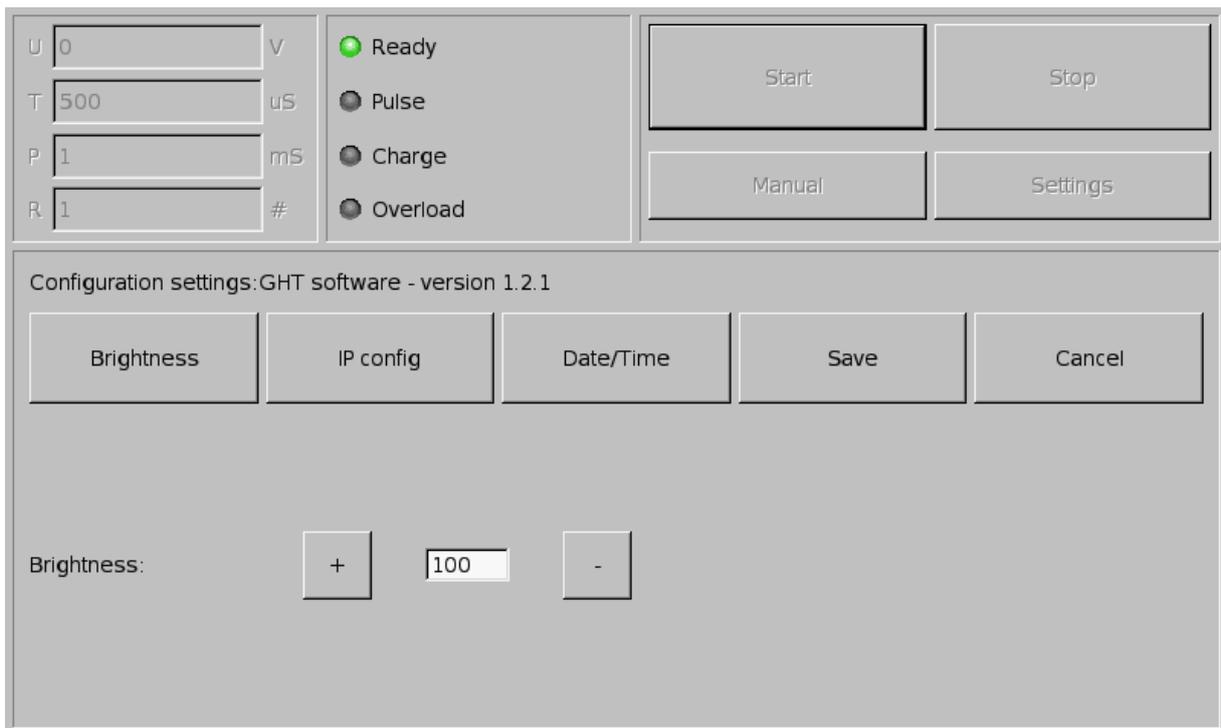
Figure 8 : Screen Brightness Configuration Menu.

Upon pressing the Settings button, the user finds the configuration menu.

To modify the brightness of the screen, the + and – buttons are used until the desired value is reached. A value of 100 corresponds to the maximum brightness and a value of 0 corresponds to the brightness minimal.
Once the desired brightness is reached, the value may be kept as the device norm by pressing on the Save button. If the new value is not wanted and the user desires to return to the previous setting, the Cancel button may be pressed.

When the Save button is pressed, all of the values from the pages Brightness, IP config and Date/Time are saved. If any of these pages have not been accessed or if their values on these pages have not been modified, the previous values are just saved again and no related changes occur.

After pressing either the Save button or the Cancel button, the system returns to the page that was displayed before entering into the Settings menu.

7.1. IP ADDRESS CONFIGURATION

Figure 9 : Address Configuration Menu

IP Address Configuration Menu is accessed by pressing the IP configuration button under the Settings menu.

Modification of the IP address is done using the + and – buttons.

Once the desired IP address is set, it is possible to make this the new value by pressing the Save button (although the new address will not take effect until the machine has been re-started). If the operator decides that he should not change the address after all, the Cancel button must be pushed.

If the Save button is pushed, all of the modifications for Menu Brightness, IP Configuration, and Date/Time are saved (installed as the system values).

After the Save button or the Cancel button is pushed, the system returns to the main menu.

7.2. SETTING DATE/TIME

Figure 10 : System date/time configuration menu.

Menu for modifying the date is displayed when the Date/Time button on the Settings screen is pushed.

The date and time can each be modified by using the + and – buttons.

Once all the date fields have the desired values displayed, they can be installed into the system using the Save button. If the user decides to keep the old values, the Cancel button is pushed.

If the Save button is pushed, all of the modifications for Menu Brightness, IP Configuration, and Date/Time are saved (installed as the system values).
The new Date and Time will then be functional, but the configuration will be lost when the machine is turned off.

After the Save button or the Cancel button is pushed, the system returns to the main menu.

8.   **ANNEX 1**

Support technique

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9.   **ANNEX 2**

Error and Warning Messages

ELECTROcell B10 HVLV can give the following messages of error or warning when functioning.

- ● ERROR : Electrode missing !

This message is shown if a pulse is commanded and electrode is not connected to ELECTROcell B10 HVLV or the security interrupter is off.

- ● Warning: Parameter check: Period too short.

ELECTROcell B10 HVLV does not allow a cumulated value for the parameters **TP** and **TN** (pulse duration) that is greater than half of the parameter **P** (pulse period). If **TP** or **TN** is increased or **P** is decreased in a way such that this rule is not respected, the above message is displayed.

- ● ERROR: Overload indicated. Lower voltage or change load.

ELECTROcell B10 HVLV has a protection system that limits the intensity delivered while the pulses are being generated.
If the system detects that the intensity being delivered is too high, it stops the pulses and displays a message.