

# **Bipolar Stimulator End-stage & Battery Manager**

**BSE-4x series**  
(Battery-supplied model)

User Manual

**SUPERTECH** Instruments

## Important notes

The battery pack is very sensitive! It will be destroyed on irreversible way, if the End-stage has been forgotten switched on (the front plate switch in Power ON position) and the battery pack is over-discharged, even in one time. You should take special care of this aspect.

The battery pack can not be overcharged, because the Battery Manager equipment has got an automatic charger and conditioner circuit, what protects the battery pack. The Charging of Battery function of the Battery Manager can be activated even for prolonged periods without any bad side effect.

For the sake of the battery pack the Power ON switch should be turned on for the necessary time periods only. But there is a very important aspect to bear in mind always. **The Power ON switch should be turned on before connecting the output wires to the biological object! It is also necessary to disconnect the output of the End-stage from the biological object before turning the Power switch off!** The reason, why it is important is the following. This equipment is not a simple stimulus isolator unit, but a complete, isolated, electronic End-stage. It means, that the floating electronic circuits (the constant current generator) are isolated from the other circuits via optocouplers, providing 4 kV security isolation barrier and very small isolation capacity. But the isolated, floating sections are quite difficult electronic circuits. These circuits are powered from 120 V supply voltage, namely from the battery pack. During the switching on period (in a few milliseconds of time window) these circuits are "standing up". Similarly, in the switching off period the voltages of these circuits are "demolished". These circuits are designed to work perfectly in normal operating conditions, but the switching on and switching off transient times are not normal working periods. In these short time intervals huge transient voltage spikes (approximately 100 V in amplitude) appear at the output connectors. These spikes make catastrophic electrical shocks for the biological object.

## General Description

BSE-4x Bipolar Stimulator End-stage is a research grade stimulus isolator unit. It is optimized for biological measurements carried out on in-vivo subjects and on living animals.

It has been designed for the most sophisticated, noise-sensitive microelectrode experiments (for example multi-electrode or patch clamp recording). It passes extremely small, practically zero hum noise into the biological tissue.

There is a precision, bipolar constant current generator built into this End-stage. The bipolar constant current generator has two ranges: 100  $\mu\text{A}$ , and 10 mA of full scale. The output amplitudes in the selected range can be set using 10-turn calibrated helical potentiometers on the front panel.

Bipolar Stimulator End-stage is supplied from its built-in rechargeable battery pack. This equipment has got an optional accessory: the Battery Manager unit, which is an automatic and precision battery charger and conditioner equipment. With a new battery pack the average operation time (the efficient working period between two charging actions) is approximately 12 hours. If you take care of the battery pack, its lifetime will be at least two years, if the End-stage is used every day, the battery pack is charged if necessary, but the battery pack is never over-discharged.

Bipolar Stimulator End-stage can be controlled from any computer based data acquisition system, because its inputs are optically isolated standard TTL inputs.

Bipolar Stimulator End-stage is optimized for that goal, that it does not generate any electric noise, because of its battery-powered scheme. According to this feature it can be placed close to the experimental object anywhere, even in a seriously shielded environment.

## Specifications of the Bipolar Stimulator End-stage

The selectable ranges of the output current:

0 to 100  $\mu\text{A}$

0 to 10 mA

Compliance voltage: 120 V

Worst-case amplitude error of the constant current generator: < 5 %

Nonlinearity of the constant current generator: < 5 %

Output leakage current is internally trimmed to nearly absolute zero, it is less than 1  $\mu\text{A}$ .

Output overshoot: 0 (zero)

Output rise time:

50  $\mu$ s (on 1 kOhm load)

70  $\mu$ s (on 10 kOhm load)

Output fall time:

60  $\mu$ s (on 1 kOhm load)

80  $\mu$ s (on 10 kOhm load)

The output current can be set independently for the positive and for the negative polarity, with scaled, 10-turn, precision helical potentiometers

Resolution of the helical potentiometers: 0.1 %

Protected, optically isolated TTL signal conditioner circuits at the inputs

Active level at the control inputs: TTL High

Control inputs: TTL compatible, 1 unit-load

Control (Activate)

Polarity (Invert)

Double security isolation

Power source: built-in battery pack

Nominal voltage of the internal battery pack: 120 V

Nominal capacity of the battery pack: 170 mAh

Compatible with the Battery Manager equipment

## **Accessories**

Battery Manager equipment (optional)

Input BNC cables (optional)

Output cable (optional)

## **Security Rules**

The measuring equipments manufactured by Supertech Instruments are for experimental and/or lab animal purposes only and are not intended for human use.

Electrical safety measurements of proper operation of the 115/230 VAC mains electric system (from the equipments have been supplied) is the sole responsibility of the user.

Bipolar Stimulator End-stage and the Battery Manager work together and are connected together on a high voltage level. You must protect the high voltage cable against injury. Both ends of the high voltage cable always have to be plugged in. The connector at the free end of the unplugged high voltage cable must not be touched.

## **First Time Installation and Setup**

During the installation of the equipments, please keep every part of the system switched off. Please connect all the cables: the output cable and the control input cables of the Bipolar Stimulator End-stage, the high voltage cable between the Battery Manager and the Bipolar Stimulator End-stage and the mains cable of the Battery Manager.

After connecting the equipments together please switch them on. Check the condition of the battery pack. You can do it as described later in this manual. If the battery pack is not fully charged, please charge it. If the battery pack is charged, the system is ready to use.

## **Front Panel Controls**

Control LED: it shows the logic state of the Control (Activate) Input. If this LED is dark, there is logic Low level at Control Input, the current generator is inactive, the output current is zero. If this LED is lit, there is logic High level at the Control (Activate) input, the current generator is active, the output current is determined by the further controls (Polarity (Invert) input, range selector switch and current control potentiometers).

Polarity LED: it shows the logic state of the Polarity (Invert) Input. If this LED is dark, there is logic Low level at Polarity (Invert) input, the polarities of the output banana jacks are the same as written above them on the front plate, the output current is determined by the Positive potentiometer (in the selected range). If this LED is lit, there is logic High level at Polarity (Invert) input, the polarities of the output banana jacks are opposite to as written above them on the front plate, the output current is determined by the Negative potentiometer (in the selected range).

According to the above two paragraphs, if there is no signal connected to the Polarity (Invert) input at all, you can use the Bipolar Stimulator End-stage as a traditional monopolar stimulator end-stage. In this mode only the Control (Activate) input is effective and the Positive potentiometer determines the output current (in the selected range).

Range selector switch of the constant current generator: you can choose from two selectable ranges: 100  $\mu\text{A}$ , and 10 mA of full scale.

Most left at the bottom section there are the output connectors. These two connectors realize the floating output of the Bipolar Stimulator End-stage. The output

connectors are identical except their polarity. The polarity of the stimuli at the output connectors can be changed by the logic control signal applied to the Polarity (Invert) input. The output connectors are compatible with the 4 mm banana jacks axially. Furthermore they have got isolated plastic screws to fix simple wires in through holes, up to 1 mm in diameter. Be careful! The output connectors are high voltage connectors! They are especially dangerous to touch, because the compliance voltage (120 V) can be present here!

Pulse amplitude potentiometers: The amplitude of the output pulses (always in the selected range) can be set using these 10-turn calibrated helical potentiometers. There are two pulse amplitude potentiometers, for the two polarities, respectively. If the scale of these potentiometers show 10.00 than the full scale value of the actually selected range is passed to the output connectors. If the scale of these potentiometers show 0.00 than zero value is passed to the output connectors. Between the two extreme positions the output current is proportional to the position of the potentiometers.

Most right at the bottom section there is the Power switch. Never forget it in switched on position for prolonged periods, because the internal battery pack will be destroyed on irreversible way, because it can be over-discharged. There is no "power-on" indicator LED on the Bipolar Stimulator End-stage, because the current consumption of an LED is as high as the current requirement of the complete End-stage. By eliminating the LED the operation time (the efficient working period between two charging actions) of the End-stage was increased efficiently.

The Power switch should be turned on before connecting the output wires to the biological object. It is also necessary to disconnect the output of the End-stage from the biological object before turning the Power switch off (see the Important notes section, too).

## **Controls and Connectors at the Back Side**

At the left side there is a 3-pole, high voltage connector. It is used to connect the Bipolar Stimulator End-stage to the Battery Manager with a high-voltage cable. You should always use the special, secure cable provided by Supertech Instruments. Never touch the pins in the plugs of this interconnecting cable, because high voltage is present at both ends of this cable! The only safe position, if this cable is connected to both equipments. Avoid to use other battery charger equipment than the Battery Manager by Supertech Instruments, because the internal battery pack has got special requirements to meet.

In the middle there is the Internal Floating Shield connector. It is compatible with the 4 mm banana jacks. Furthermore it has got an isolated plastic screw to fix a simple wire up to 1 mm in diameter. Since the Bipolar Stimulator End-stage is designed to work in seriously shielded environments, it is essential to shield the internal circuitry rigorously. The Internal Floating Shield connector is used for this purpose. You should connect it to the common Ground point of the Faraday-cage. The best point where it

should be connected exactly can be located during the pilot experiments, when the lab is set up at the first time.

Above the Internal Floating Shield connector there is a switch, what can be used to disconnect the Bipolar Stimulator End-stage from the Battery Manager. Usually the Battery Manager does not generate too much hum noise if its mains switch is turned off, but under special circumstances (e.g. with extremely high impedance electrodes, or with very high gain set in the amplifier) you can find hum noise in the Faraday-cage. In such situations you can disconnect the End-stage, and the Battery Manager completely (galvanically) with this switch.

At the right side there are the isolated TTL control inputs: Control (Activate) and Polarity (Invert). They are used to control the Bipolar Stimulator End-stage from any computer based DAQ system. The functions of these digital control signals are already explained earlier in this manual.

## **Description of the Battery Manager**

It is very important to keep in mind always to take care of the battery pack. The battery pack is very sensitive. It can not be overcharged, because the sophisticated Battery Manager equipment prevents against it. The only danger for the battery pack is, if the End-stage is forgotten in switched on position for a prolonged period, and the battery pack is over-discharged, below its nominal lowest voltage. This action destroys the battery pack. To reach the longest lifetime of the battery pack, it is the best way to charge it fully, and discharge it fully, but not below the lowest voltage level, what can be indicated by the Battery OK LED on the Battery Manager.

During the working periods, in other words during stimulator usage of the Bipolar Stimulator End-stage (if its Power switch is ON) the green mains switch of the Battery Manager should be switched off, because its line frequency transformer generates a rude noise in the shielded environment. The Battery Manager has been designed to support Charging of Battery, and Checking of Battery operating modes. The mains switch of the Battery Manager should be turned on only in these two operating modes.

The Charging Current LED at the front of the Battery Manager is a visual indicator. Its brightness is proportional to the actual charging current. It is always lit a little (in the Charging of Battery function), even when the battery pack is charged completely, because a small current is always provided for the battery pack against its self-discharge.

The Battery OK LED at the front of the Battery Manager is an indicator driven by an internal comparator circuit. If you push the Battery Test button (in Checking of Battery function), a dummy load of 20 mA is connected to the battery pack. This load is higher, than the total current consumption of the End-stage. During the application of this huge load current, the comparator checks the voltage of the battery pack. If its voltage is higher than the nominal lowest voltage, then the Battery OK LED is lit.

There is a summary of the operating modes of the Bipolar Stimulator End-stage with the Battery Manager at the end of this manual.

## **Calibration**

BSE-4x Bipolar Stimulator End-stage and the Battery Manager equipments are calibrated by the factory. You can check the calibration of the Bipolar Stimulator End-stage any time using a calibrated current meter (a precise multimeter), with different settings of polarities and output currents. The users are not allowed to check the calibration of the Battery Manager, because its output is a dangerous high voltage.

## **Further development**

Until now we have developed many fancy features for the Bipolar Stimulator End-stage and the Battery Manager equipments, as it is presented above. In spite of this, if you can not find the appropriate function for your special task in our equipment, and that function seems to be interesting for other users as well, we will develop that function especially for you. It is our method, how we improve the features of our equipments. We collect all notices and feedbacks of our customers, and we implement their (we hope, your) knowledge into the features of the equipments manufactured by Supertech Instruments.

## **Warranty**

Supertech Instruments gives you 5 years of full warranty for electronic products and 3 years of full warranty for mechanical products by default. Longer warranty periods can also be defined and agreed (the actual conditions should be discussed before placing the order).

Supertech Instruments gives you full warranty for its products against defects in materials or workmanship as long as the equipment has been subjected to normal and proper use. During the warranty period, faulty products will be repaired or replaced free of charge provided they are returned to our workshop. Postage of the warranty repair actions is paid by the Customer. The exceptions are the Vibration Isolation Tables. There are special conditions introduced for repairing of Vibration Isolation Tables (see the appropriate User Manual). Supertech Instruments will undertake the servicing and calibration after the expiration of the warranty period for a nominal fee.

The warranty does not cover the faults made by the user.

Bipolar Stimulator End-stage is supported with 5 years of full warranty, except the internal battery pack. Since the lifetime of the battery pack is a subject of the care of the user, Supertech Instruments can not provide warranty for the battery pack. Battery pack is a consumable product, reasonably expected to be used up or damaged during use.

## **Further information sources**

For further technical information please visit our websites. Supertech Instruments continuously uses several domain names (websites) with the same content. Please use that one, which is the easiest for you to remember:

[www.superte.ch](http://www.superte.ch)  
[www.supertechinstruments.co.uk](http://www.supertechinstruments.co.uk)  
[www.supertech-instruments.co.uk](http://www.supertech-instruments.co.uk)  
[www.supertech-instruments.com](http://www.supertech-instruments.com)  
[www.super-tech.eu](http://www.super-tech.eu)

Technical hotline via email (all of them work):

[office@superte.ch](mailto:office@superte.ch)  
[office@supertechinstruments.co.uk](mailto:office@supertechinstruments.co.uk)  
[office@super-tech.eu](mailto:office@super-tech.eu)

## Operating Modes of the Bipolar Stimulator End-stage with the Battery Manager

The most important operating mode selector is the Power switch of the Bipolar Stimulator End-stage. If it is in Power ON position, Stimulation operating mode is selected, the End-stage is working. Even in this operating mode (during stimulating actions) the battery pack is accessible by the Battery Manager, if the appropriate switch at the back side of the End-stage allows the Battery Manager to reach the battery pack. But consider, if the mains transformer of the Battery Manager is working, a hum noise may be generated at the output of the Bipolar Stimulator End-stage, disturbing the experiment. The Battery Manager can access the battery pack in Switched OFF operating mode of the End-stage as well. The battery handling functions can be selected by the Check/Charger function switch and the Mains switch of the Battery Manager. During Checking of Battery, and Charging of Battery operating modes the Mains switch of the Battery Manager should be switched on. According to the actual positions of these switches, the following operating modes can be selected:

| <b><i>Operating Mode</i></b> | <b><i>Switch positions</i></b>  | <b><i>Description</i></b>   |
|------------------------------|---|---|
| <b>Switched OFF</b>          | End-stage: Power OFF<br>Bat. Man.: Mains OFF<br>Bat. Man.: Charger  | This is that operating mode, when the equipments are completely switched off. If you do not want to use them, select this mode to take care of the battery pack.  |
| <b>Stimulation</b>           | End-stage: Power ON<br>(optionally: select completely floating by the back side switch)<br>Bat. Man.: Mains OFF | This is the stimulating operation mode of the End-stage. In this mode the End-stage is working, supplied by the battery pack. Never forget the equipment in this mode, if you do not use it! If you operate the equipment in this mode, it is sometimes necessary to switch to Checking of Battery mode to test the actual condition of the battery pack. The position of the Check/Charger switch is not important in the Stimulation mode.  |
| <b>Charging of Battery</b>   | End-stage: Power OFF<br>Bat. Man.: Mains ON<br>Bat. Man.: Charger   | If the battery pack is chargeable (it is not faulty), the Charging Current LED indicator is shining. The intensity of the LED's light is proportional to the charging current. If the battery pack reaches the fully charged state, the Charging Current LED is fading away.  |
| <b>Checking of Battery</b>   | End-stage: Power OFF<br>Bat. Man.: Mains ON<br>Bat. Man.: Check   | In this mode the battery test circuit is switched on. If you push the Battery Test button, it applies a strong load current (about 20 mA) to the battery pack. The battery test circuit checks the voltage of the battery pack under this extra load. If the battery pack is in good condition, the Battery OK LED is lit. If you can not see the Battery OK LED shining in this situation, please stop any other stimulating activity and select Charging of Battery mode, because the battery pack is in dangerous condition! |