Technical Specification

TC-3F bioreactor

Revision #6

March 3, 2019

OFFICES

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TC-3F mechanical stimulation bioreactor: Technical Specification

<table>
<tr><th>Ref. No</th><th>Description</th></tr>
<tr><td>90.030</td><td>
TC-3F Deformation system

- Mechanical stimulation system designed to provide uniaxial (tension/compression) deformation to a maximum of 3 culture chambers
- Controls and imparts the same level of deformation to every chamber
- Measures the applied force to the sample in each chamber
- To be used in combination with the control software #90.002, load cells #90.013, #90.014, #90.015, #90.018 and #90.019 and the attachment kits #90.025, #90.026, #90.027 and #90.028.
- Compatible with the single-cavity culture chambers refs. #90.007 and #90.009
- Mechanical stimulation features
  o Maximum speed of displacement: 10 mm/s
  o Maximum total force:
  ▪ 200 N @ 10 mm/s
  ▪ 400 N @ ≤1 mm/s
  ▪ For intermediate values of velocity, linear interpolation gives a reasonable approximation to the maximum force. Consult EBERS if the exact speed-force curve is needed. This is the total force, shared among all the chambers mounted on the system.
  o Maximum stroke: 21 mm
- Vertical configuration (#90.006 legs are mandatory)
- Easy assembly and disassembly of culture chambers
- Handles for easy transport and positioning
- Dimensions

<table>
<tr><th></th><th>Height (mm)</th><th>Width (mm)</th><th>Depth (mm)</th></tr>
<tr><td>Vertical configuration (with legs #90.006)</td><td>492 min./512 max. (adjustable height)</td><td>290</td><td>300</td></tr>
</table>

- Non autoclavable
- Compatible with the atmosphere of a cell culture incubator
</td></tr>
<tr><td>90.002</td><td>
TC-3F force measurement software

- Controls deformation applied to the samples by means of selecting velocity profiles (trapezoidal, senoidal and combinations thereof)
- Automatic graph monitoring of position and force
- Possibility of logging force data to file for postprocessing
- To be used in combination with the TC-3F deformation system (ref. #90.030)
- Requires Windows 7 or higher 64-bit operative system and .NET framework installed on the computer
- A comprehensive user manual is supplied for future reference
- Communication between the PC, the deformation system and the load cells via 2 USB ports
- The TC-3F control software must be run in a dedicated computer (must be purchased separately) that meets minimum requirements (e.g. ref. #BSP90.L) and that is devoted exclusively to the control of the TC-3F device. The execution of other programs in the same computer can cause an abnormal function of the TC-3F system and/or its control software.
</td></tr>
</table>

80.002	**TC-3F Control software** - Controls deformation applied to the samples by means of selecting velocity profiles (trapezoidal, senoidal and combinations thereof) - Automatic graph monitoring of velocity - To be used in combination with the TC-3F deformation system (ref. #80.030) - Requires Windows 7 or higher 64-bit operative system and .NETframework installed on the computer - A comprehensive user manual is supplied for future reference - Communication between the PC and the deformation system via 1 USB port - The TC-3F control software must be run in a dedicated computer (must be purchased separately) that meets minimum requirements (e.g. ref. #BSP80.L) and that is devoted exclusively to the control of the TC-3F device. The execution of other programs in the same computer can cause an abnormal function of the TC-3F system and/or its control software.
BSP.CS	**Adaptation of the TC-3F for compatibility with the multi-cavity chamber and grips** - Mechanical and electrical modifications to the TC-3F so it is compatible with the multi-cavity chamber and grips (refs. #80.022, #80.023 and #80.024). - REMARK: This adaptation allows for the use of the multi-cavity chamber and grips in combination with the TC-3F, but the force measurement capabilities of the TC-3F will not be available when the multi-cavity chamber is beingused.
BSP.CS2	**Adaptation of the TC-3F for compatibility with the hydrostatic pressure chamber** - Mechanical and electrical modifications to the TC-3F so it is compatible with the hydrostatic pressure chamber (refs. #80.012). - REMARK: This adaptation allows for the use of the hydrostatic pressure chamber in combination with the TC-3F, but the force measurement capabilities of the TC-3F will not be available when the hydrostatic pressure chamber is beingused.

90.005	**Rod-like samples grips (F)**
	
	- Grips for the fixation and application of tensile loads to rod-like samples
	- Compatible with the tension and compression chamber (ref. #90.007)
	- Sample dimensions
	  o Maximal width: 30 mm
	  o Maximal distance between grips: 21.5 mm
	  o Minimal distance between grips: 0.5 mm
	- Autoclavable and bioinert

90.006	**Vertical positioning legs** - Set of 2 legs that permit to hold the deformation system in vertical position - Includes 4 levelling feet - Non autoclavable - Compatible with the atmosphere of a cell culture incubator
90.007	**Tension-compression chamber (F)** - Accommodates a variety of samples, permitting the delivery of uniaxial tension or compression

	- To be used in conjunction with one set of EBERS's grips. Compatible with the following types of grips:
	  o #90.004: Compression grips (F)
	  o #90.005: Rod-like samples grips (F)
	- 1 set of grips per chamber
	- All the parts in contact with the liquid that bathes the sample are bioinert and can be autoclaved
	- FDA approved O-ring seals
	- Grip fixation for chamber transport
	- Compact chamber size. Inner chamber volume: ~90 mL
	- Maximum sample size depending on the type of grip (refer to the corresponding grip for further information)
	- Optimized visualization
	  o Lower lid: optical grade glass window compatible with standard microscopy techniques
	  o Upper lid: transparent plastic window
	- Multiple ports
	  o Gas exchange port at the lid
	  o Optional additional ports available upon request (ref. #BSP90.LP1)
	- Grips not included

90.009	**Tension-compression and flow chamber (F)**
	
	- Accommodates a variety of samples, permitting the delivery of two combined stimuli: (i) uniaxial tension or compression and/or (ii) flow of culture medium through the sample
	- To be used in conjunction with one set of EBERS's grips. Compatible with the following types of grips:
	  o #90.010: Compression and flow grips (F)
	  o #90.011: Tension and flow grips (F)
	- 1 set of grips per chamber
	- All the parts in contact with the liquid that bathes the sample are bioinert and can be autoclaved
	- FDA approved O-ring seals
	- Grip fixation for chamber transport
	- Compact chamber size. Inner chamber volume: ~90 mL
	- Maximum sample size depending on the type of sample (refer to the corresponding grip for further information)
	- Optimized visualization
	  o Lower lid: optical grade glass window compatible with standard microscopy techniques
	  o Upper lid: transparent plastic window
	- Multiple ports
	  o Gas exchange port at the lid
	  o Optional additional ports available upon request (ref. #BSP90.LP1)
	- Grips not included

90.010	**Compression and flow grips (F)** - Grips with flat disks for the application of (i) compression loads and (ii) flow to the sample - Compatible with the tension-compression and flow chamber (ref. #90.009) - Sample dimensions: the grips are supplied with a set of three perforated disks that can be interchanged to adapt to different sizes of the sample:

	<table><tr><th>disk</th><th>sample (mm)</th><th>grips (mm)</th></tr><tr><td>#1</td><td>10</td><td>0-19.5</td></tr><tr><td>#2</td><td>13</td><td>0-19.5</td></tr><tr><td>#3</td><td>18</td><td>2.5-23.5</td></tr></table> - Autoclavable and bioinert
90.011	**Tension and flow grips (F)** - Grips for the fixation and application of tensile loads and luminal flow to tubular samples - Compatible with the tension-compression and flow chamber (ref. #90.009) - Sample dimensions: the grips are supplied with a set of different types of tips that can be interchanged to adapt to different sizes of the sample: <table><tr><th>No. of tip</th><th>Type</th><th>Diameter of the sample (mm)</th><th>Useful distance between the tips of the grips (mm)</th></tr><tr><td>#1</td><td>Barbed end, stainless steel</td><td>6.4-8</td><td>9-30</td></tr><tr><td>#2</td><td>Barbed end, plastic</td><td>6.4-8</td><td>0-7</td></tr><tr><td>#3</td><td>Barbed end, plastic</td><td>3.2-6.4</td><td>5-26</td></tr><tr><td>#4</td><td>Barbed end, plastic</td><td>3.2-6.4</td><td>22-43</td></tr><tr><td>#5</td><td>Barbed end, plastic</td><td>1.6-3.2</td><td>11-32</td></tr><tr><td>#6</td><td>Barbed end, plastic</td><td>1.6-3.2</td><td>26-47</td></tr></table> *NOTE: It is possible to adapt the system to work with other sizes of samples (e.g. small vessels with diameters below 1 mm). Consult your EBERS' representative if you are interested in this option.* - Autoclavable and bioinert

80.022	**Multi-cavity (20x) chamber for uniaxial deformation**
	
	- Multi-cavity chamber for the delivery of uniaxial tension or compression to 20 independent samples (one sample per cavity)
	- The culture media contained in each cavity is isolated from the rest of cavities, although all are exposed to the same atmosphere
	- Cavity volume
	  o Empty, without grips: ~16 mL
	  o With compression grips (#80.023): ~5 mL
	  o With tension grips (#80.024): ~11 mL
	- Dimensions of the cross-section of each cavity
	  o Width: 12 mm
	  o Height: 16 mm
	- Maximum sample size depending on the type of grip (refer to the corresponding grip for further information)
	- Upper lid made of transparent plastic with gas exchange port. Optional additional ports available upon request (ref. #BSP80.LP1).
	- Solid base of the chamber, made of opaque material (does not include an optical grade glass window at the base)

	- To be used in conjunction with one set of EBERS's grips (grips not included in this reference).
	- Compatible with the following types of grips:
	  o #80.023: Pack of 20 compression grips
	  o #80.024: Pack of 20 tension grips
	- All the parts in contact with the liquid that bathes the sample are bioinert and can be autoclaved
	- FDA approved O-ring seals
	- Grip fixation for secure transport of the chamber
	- Compatible only with the horizontal configuration of the TC-3

80.023	**Pack of 20 compression grips**
	
	- Set of 20 grips compatible with the multi-cavity chamber (ref. #80.022); one grip per cavity.
	- Grips with flat surface for the application of compression loads
	- The 20 grips apply the same level of deformation to the samples
	- Sample dimensions
	  o Maximum cross-sectional dimension: 10 mm
	  o Maximal distance between grips: 24 mm
	  o Minimal distance between grips: 0 mm
	- Autoclavable and bioinert

80.024	**Pack of 20 tension grips**
	
	- Set of 20 grips compatible with the multi-cavity chamber (ref. #80.022); one grip per cavity.
	- Grips for the fixation and application of tensile loads to planar samples
	- The 20 grips apply the same level of deformation to the samples
	- Sample dimensions
	  o Maximum width: 10 mm
	  o Maximal distance between grips: 24 mm
	  o Minimal distance between grips: 0 mm
	- Autoclavable and bioinert

BSP.FL20	**Customization of the multi-cavity chamber to have inlet/outlet of culture medium in each cavity** - Adaptation to include one inlet and one outlet port in each cavity of the multi-cavity chamber - These ports give access to the culture medium of each cavity and allow the user to renew the medium using a peristaltic pump - The user will be able to extract medium from each cavity through the outlet port and introduce medium through the inlet port. However, the medium will be introduced directly inside the cavity, not perfused through the scaffold.
90.015	**Load cell 200 N** - Force range: ±200N - Breaking force: ±400N - Resolution: 50 mN - Reproducibility error: < 0.2% - Cable length: 1.5 m - Degree of protection: IP67 - Non autoclavable

	- Compatible with the atmosphere of a cell culture incubator
90.025	**Central attachment kit (50/100/200 N)** - Holding frame for mounting load cells #90.013 (50N), #90.014 (100N) and #90.015 (200N) in the central position of the TC-3F deformation system - Made of stainless steel - Non autoclavable - Compatible with the atmosphere of a cell culture incubator - Compatible only with the #90.030 TC-3F deformation system. Old discontinued #90.001 deformation systems require the use of the #90.016 attachment kit.
90.026	**Lateral adjustable attachment kit (50/100/200 N)** - Holding frame for mounting load cells #90.013 (50N), #90.014 (100N) and #90.015 (200N) in the lateral positions of the TC-3F deformation system - Adjustable: allows modifying the axial position of the sliding part of the grip. In this way, it is possible to work simultaneously with samples of different length/thickness. - The adjustment range is ± 3 mm. - Made of stainless steel - Non autoclavable - Compatible with the atmosphere of a cell culture incubator - Compatible only with the #90.030 TC-3F deformation system. Old discontinued #90.001 deformation systems require the use of the #90.016 attachment kit.
90.018	**Load cell 1 lbf/4.5 N** - Force range: ±1lbf (±4.5 N) - Breaking force: ±5lbf (±22.2 N) - Resolution: 0.6 mN - Reproducibility error: < 0.05% - Cable length: 1.5 m - Degree of protection: IP40 - Non autoclavable - Compatible with the atmosphere of a cell culture incubator
90.027	**Central attachment kit (1/5 lbf)** - Holding frame for mounting load cells #90.018 (1 lbf) and #90.019 (5 lbf) in the central position of the TC-3F deformation system - Made of stainless steel - Non autoclavable - Compatible with the atmosphere of a cell culture incubator - Compatible only with the #90.030 TC-3F deformation system. Old discontinued #90.001 deformation systems require the use of the #90.016 attachment kit.
90.028	**Lateral adjustable attachment kit (1/5 lbf)** - Holding frame for mounting load cells #90.018 (1 lbf) and #90.019 (5 lbf) in the lateral positions of the TC-3F deformation system - Adjustable: allows modifying the axial position of the sliding part of the grip. In this way, it is possible to work simultaneously with samples of different length/thickness.

	- The adjustment range is ± 3 mm. - Made of stainless steel - Non autoclavable - Compatible with the atmosphere of a cell culture incubator - Compatible only with the #90.030 TC-3F deformation system. Old discontinued #90.001 deformation systems require the use of the #90.016 attachment kit.
80.012	**Hydrostatic pressure chamber** - Accommodates a variety of samples, permitting the delivery of hydrostatic pressure - No grips required; samples are completely immersed and optionally kept inside holding racks - All the parts in contact with the liquid that bathes the sample are bioinert and can be autoclaved - To be mounted in any of the two lateral positions of the TC-3 deformation system, the hydrostatic pressure chamber must be used in combination with the adjustable anchoring system (ref. #80.026, one adjustable anchoring system per chamber). - Incorporates two ports for air purge, media sampling, etc. - FDA approved O-ring seals - Compact chamber size. Inner chamber volume: ~80 mL - Internal dimensions: 40 x 45 x 45 mm - Maximal hydrostatic pressure: 4 bar
80.026	**Adjustable anchoring system** - Adjustable system to modify the axial position of the sliding part of all the available grips of the TC-3 system (refs. #80.003, #80.004, #80.005, #80.010, #80.011) and the hydrostatic pressure chamber (ref. #80.012). - Appropriate to work simultaneously with samples of different length/thickness or to adjust individually the pressure inside each hydrostatic pressure chamber mounted on the TC-3. - To be used only in the lateral positions of the TC-3 deformation system (maximum 2 adjustable anchoring systems per TC-3 unit). - The adjustment range is ± 5 mm (related to the central position of sample). - Made of stainless steel. - Non autoclavable. - Compatible with the atmosphere of a cell incubator.

BSP80.PS1	**Digital pressure transmitter and software**
	
	- Connects to up to 3 pressure sensors (ref. #BSP80.PS2) and produces a data output signal to a PC
	- Includes control software for the PC
	  o Compatible with Windows 7, 8 and 10
	  o Requires the Java Runtime Environment (JRE) 1.6.0 (or older) installed on the computer
	  o Capabilities: graph visualization, numeric value visualization, datalog to a CSV file, “set zero” function
	- Connection to the PC through a USB cable (included)
	- The transmitter is not designed, intended or authorized for use as component in life support or medical devices. The product is not designed for any application in which the failure of the product could result in personal injury, death or property damage.

<table>
<tr><td>BSP80.PS2</td><td>Kit of 6 pressure sensors

- Pressure range: -0.4 to 5 bar
- Accuracy
<table><tr><th>Range</th><th>Accuracy (% of reading)</th></tr><tr><td>0-0.4 bar</td><td>± 2%</td></tr><tr><td>0.4-2.0 bar</td><td>± 3%</td></tr><tr><td>2-4 bar</td><td>± 5%</td></tr></table>- Inline
configuration with unobstructed and straight flow path
- Barbed ends for connection to ¼’’ tubing (consult us for availability of other sizes)
- Must be connected to the pressure transmitter (ref. #BSP80.PS1) for visualization and datalogging via PC
- Can be repeatedly cleaned and reused
o Can be sterilized by ethylene oxide and irradiation
o Can be disinfected with common clinical disinfectants (e.g. isopropyl alcohol), although strong alkaline cleaning agents must be avoided
- The sensor is not designed, intended or authorized for use as component in life support or medical devices. The product is not designed for any application in which the failure of the product could result in personal injury, death or property damage.</td></tr>
<tr><td>90.021</td><td>Electrical stimulation module - 1 voltage source

- Optional module for the application of voltage pulse trains of adjustable magnitude and duration up to three samples
- Same pulse train duration and voltage amplitude applied to the three samples
- Pulses are synchronized with the mechanical stimulation profiles applied by means of the TC-3F
- Includes wire-like platinum/iridium electrodes to be inserted in the sample
- Voltage level selected from display, duration of the pulse and mode of synchronization selected via software
- To be used in combination with the TC-3F system; includes a software extension for the TC-3F control software (ref. #90.002)
- Voltage output: 0-30 V
- Voltage accuracy: ± 1%
- Pulse duration: 3-1000 ms
- Maximum current: 1 A
- Pulse type: Unipolar
- Includes short-circuit and open-circuit electronic protections</td></tr>
</table>