



# Biostat<sup>®</sup> B-DCU

The Industry Standard  
Bioreactor for Advanced  
Process Optimization and  
Characterization

Simplifying Progress

**SARTORIUS**

## Introduction

# Biostat® B-DCU at a Glance

The Biostat® B-DCU is a fermenter | bioreactor specifically designed to accommodate the broad requirements of process optimization and characterization in the biotech and biopharmaceutical industry. It provides enhanced functionality and an unrivalled level of options for cell culture and microbial processes, making it the ideal scale-down model for your large scale process.



**Advanced sensor and software integration**

Reveal more information about your process and increase manufacturing efficiency and productivity. Facilitate development of advanced, automated process control strategies to improve titer and quality, and to reduce human error.

**Broad range of process control strategies**

Mimic your large scale process control approach and generate representative data. Benefit from our fully flexible aeration and feeding options.

**Connectivity to supervisory systems**

Easily connect your Biostat® B-DCU to our BioPAT® MFCS or third party supervisory software like DeltaV™. Straightforward integration into existing automation infrastructure provides you with data consistency across scales and throughout the entire development process.

**Industry standard technologies**

Reliable technologies ensure hassle-free process optimization and characterization. Benefit from decades of experience in the biopharmaceutical industry.

Save valuable bench space by equipping your Biostat® B-DCU with up to six bioreactor stations that are controlled independently from each other. Benefit from interchangeability of our Univessel® Glass and Univessel® SU.





# Advanced Process Solutions

## Scalability and Data Integrity

- Geometrical similarity of vessel design
- Consistent mixing and gassing strategies
- Similar user interface and controllers



Clone Screening | Media and Feed Optimization

Process Development | Process Parameter Optimization

Clinical Trial

BioPAT® MFCS – Turnkey SCADA Solution for

### Accelerated process development and process transfer require seamless scalability and integration of process data & controls.

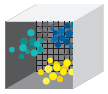
BioPAT® MFCS provides modules to meet your particular requirements. Designed as a “plug-and-play” tool, it is ideally suited for capturing, storing and visualizing process data of your Biostat® B-DCU and other process equipment including 3<sup>rd</sup> party units.

This software enhances your ability to build your own SCADA network using our preconfigured and bioprocess optimized solution.

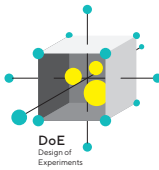
The advanced 21 CFR Part 11 compliant BioPAT® MFCS suite is a GAMP category 4 software package capable of supporting the most demanding research or production environment.

Besides the core functionality of a fullfledged SCADA system, BioPAT® MFCS in combination with the BioPAT® DCU is the most cost-effective and flexible platform specifically tailored for bioprocessing applications.

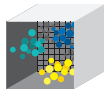




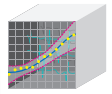
MVDA  
Multivariate  
Data Analysis



DoE  
Design of  
Experiments



MVDA  
Multivariate  
Data Analysis



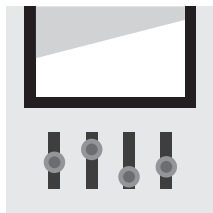
MVDA  
Online Multivariate  
Data Analysis

Manufacturing

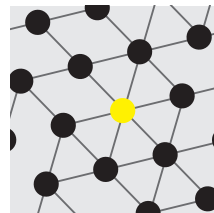
Process Characterization | Robustness Testing

Commercial Manufacturing

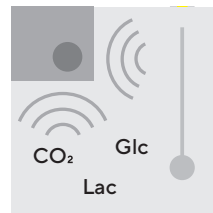
Reliable Supervisory Control and Data Acquisition



S88 recipe



Network



Connectivity



21 CFR Part 11

# Advanced Bioreactor Solutions

## Freely Configurable

Numerous configurations are available to enable different kinds of process control strategies, which make the Biostat® B-DCU the ideal scale-down and scale-up bioreactor system for all kind of microbial and cell culture processes.

Comfortable operation with a 19" display that can also be operated with gloves

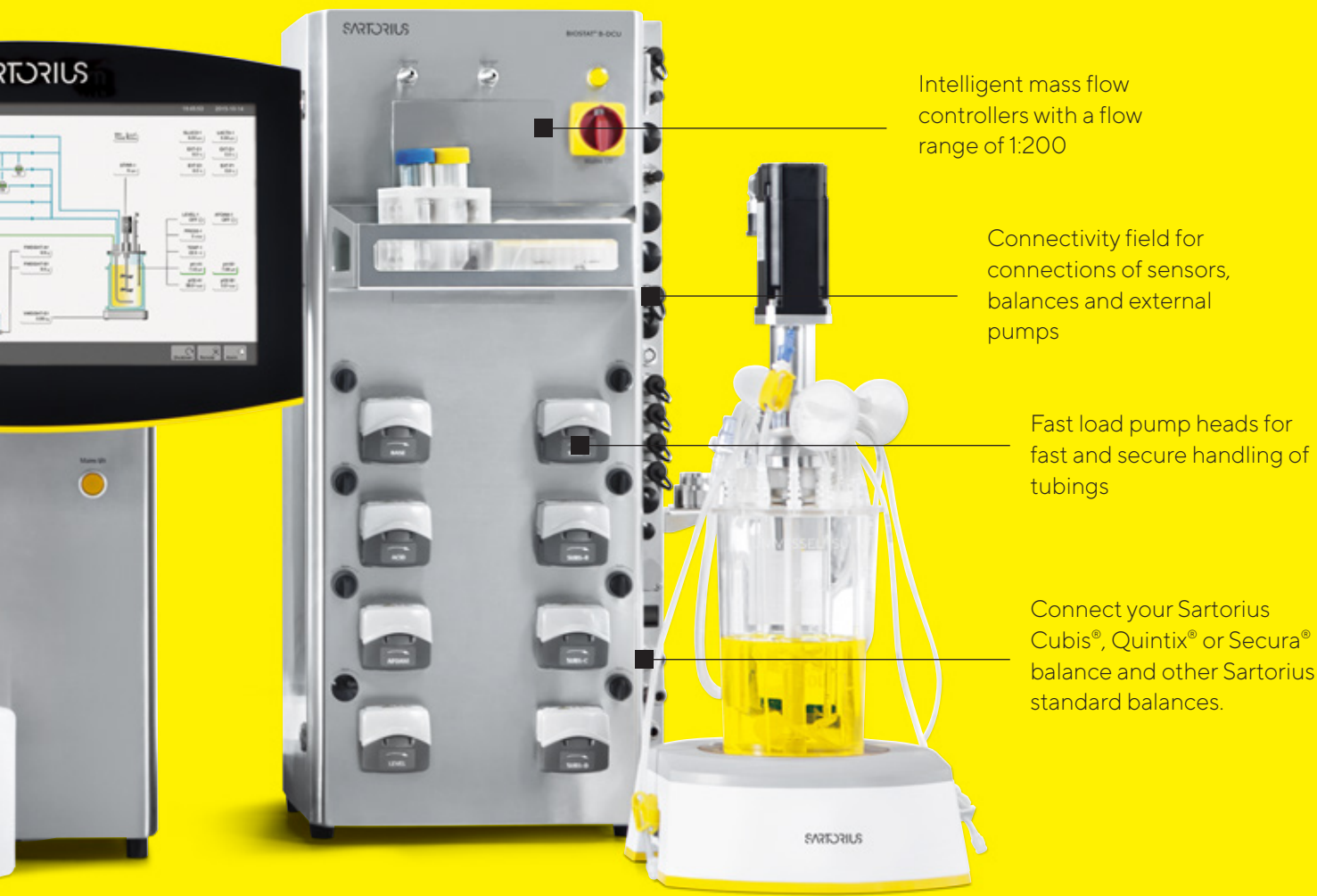


Optional flow meters

Choose up to four variable speed and up to four fixed speed pumps

Manual operation buttons for tube loading | unloading

Connect Univessel® Glass  
1 L, 2 L, 5 L and 10 L



Intelligent mass flow controllers with a flow range of 1:200

Connectivity field for connections of sensors, balances and external pumps

Fast load pump heads for fast and secure handling of tubings

Connect your Sartorius Cubis®, Quintix® or Secura® balance and other Sartorius standard balances.

Connect Univessel® SU 2 L

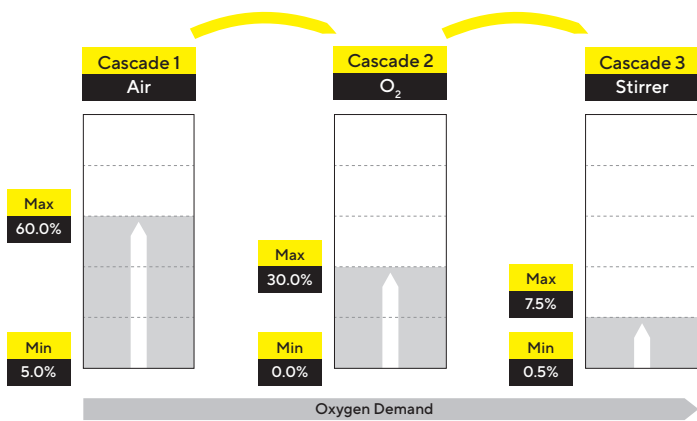
# Advanced Aeration Strategies

## Freely Configurable Gassing Lines

Intelligent mass flow controllers with a 1:200 flow range give you more flexibility in finding the optimal aeration strategy and enable a higher precision for more reliable and scalable processes. Moreover, not securely closing mass flow controllers are now a thing of the past, making additional

solenoid valves redundant. With mass flow controllers becoming a standard, the importance of flow meters for gas flow monitoring and control is decreasing. You can freely choose, if you want your Biostat® B-DCU gassing lines being equipped with or without flow meters.

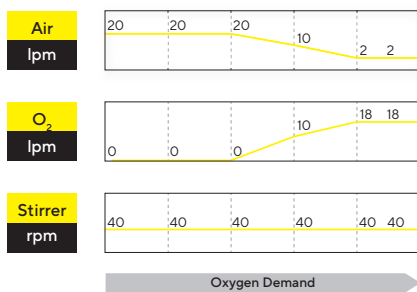
### Cascade Gassing Control



Automatic DO control is one of the most important functionalities of a bioreactor. It is designed to alter the volumetric oxygen transfer rate in order to meet process oxygen demands. As the measured DO moves off the set point, the system will change a parameter (over a defined range) such as the stirrer speed, air flow or oxygen percentage in order to re-establish the DO set point. Each parameter is placed in a cascade order. Once the parameter's limit has been reached the Biostat® B-DCU will shift to the next cascade until reaching the set point.

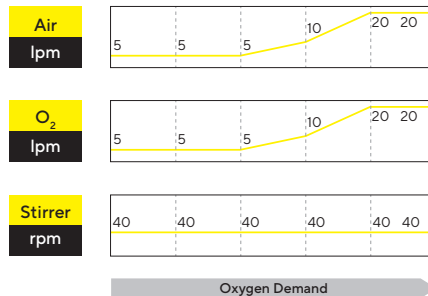
### Advanced DO Control

#### Constant Gas Flow



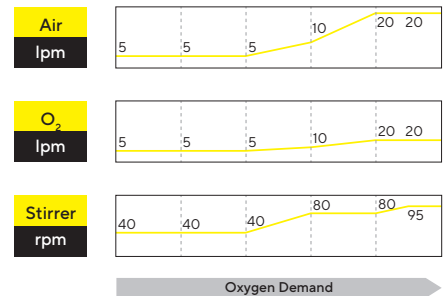
Constant gas flow decreases the flow of air and simultaneously increases oxygen flow keeping the total gas flow constant.

#### Constant Gas Ratio



Constant gas ratio, increases both air and oxygen flows at the same rate keeping the ratio constant

#### Bubble Size Optimization



Bubble size optimization enables fine tuning of the oxygen percentage and gas-liquid interface area

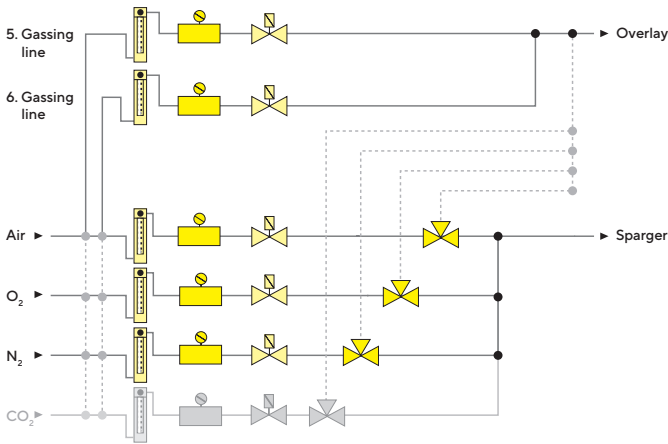
Compared to the classic DO control cascade, the advanced DO control allows parallel modification of all physical parameters such as stirrer speed, aeration rate for air | oxygen or other parameters.

This allows simultaneous activation or change of multiple parameters. Therefore, allowing you to perform all gassing strategies and to be resource efficient.



## Aeration Modules for Cell Culture

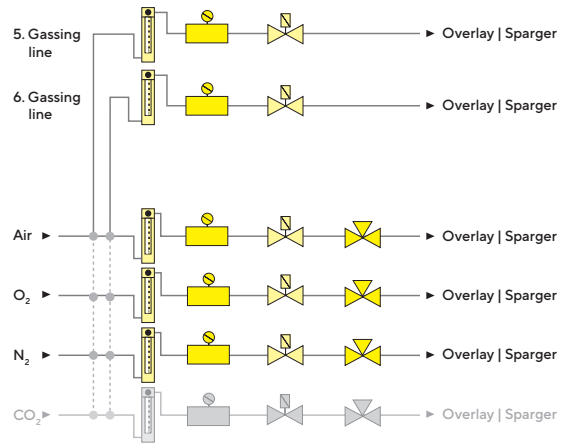
### Advanced Additive Flow with outlets for sparger and overlay



Our Advanced Additive Flow module is available with two gas outlets for sparger and overlay or with a single outlet per gassing line.

This gassing strategy allows to direct air, O<sub>2</sub>, N<sub>2</sub> and CO<sub>2</sub> to the sparger and to the overlay. Intelligent mass flow controllers can be installed for each flow path, and gas switching between overlay and sparger is available. Two additional gas flow paths can be freely configured. This enables a maximum in operation flexibility: low flow and high flow aeration applications are possible with the same aeration system.

### Advanced Additive Flow with single outlets

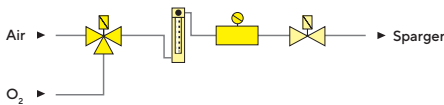


In combination with the new mass flow controller flow range of 1:200, you can run 1 L cell cultivations and 10 L microbial fermentations in the same Biostat® B-DCU system.

The detailed design of the Advanced Additive Flow gassing approach depends on the configuration you select. Please contact your local Sartorius representative for further details.

## Aeration Modules for Microbial Fermentation

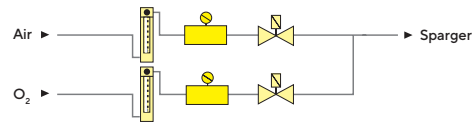
### O<sub>2</sub> Enrichment



The Additive Flow strategy for microbial applications allows individual flow rate control for air and O<sub>2</sub> to a sparger outlet.

Our O<sub>2</sub> Enrichment module uses a 3|2-way solenoid valve to select either an air or O<sub>2</sub> flow to the sparger. O<sub>2</sub> is pulsed via a solenoid valve, when required to maintain the dissolved oxygen setpoint. Air is not provided at this time.

### Additive Flow



An intelligent mass flow controller can be integrated to measure and control the total gas flow rate via manual adjustment or automatically in conjunction with the controller, based on the signal from the DO probe and the selected setpoint.

# Risk is Inverse to Process Understanding

Unlock the superior potential of your Biostat® B-DCU by incorporating our advanced BioPAT® sensor technologies. They enable you to use Process Analytical Technology (PAT) approaches for a maximum in process understanding and for effective automation of your cell cultivation or fermentation process.



### **BioPAT® Viamass**

Determine the viable biomass volume inline and continuously. BioPAT® Viamass is based on the proven principle of capacitance measurement.

- Reduce operator-to-operator variability
- Reduce manual sampling and lower risk of contamination



### **BioPAT® Trace**

The BioPAT® Trace is ideal for simultaneous online monitoring of glucose, lactate and alcohol during cultures of microorganisms or animal cells.

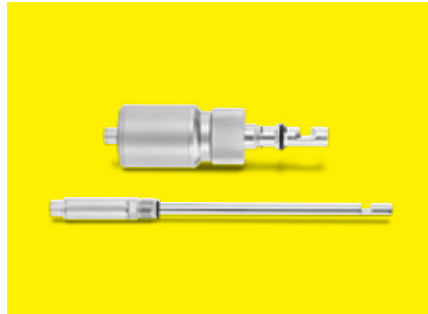
- Fully disposable sensor and fluidics set for easy setup and immediate use
- Fast concentration determination without any loss of volume



### BioPAT® Xgas

Precisely track O<sub>2</sub> | CO<sub>2</sub> concentration changes in respiratory gas emission from a cultivation vessel with the compact BioPAT® Xgas.

- Highest accuracy by automatic moisture and pressure compensation
- Compact design and parallel measurement in a single analyzer saves space in your lab



### BioPAT® Fundalux

The BioPAT® Fundalux turbidity systems are based on an integrated absorption-based probe using near infrared light for total biomass determination.

- Range of optical path lengths (1, 5 and 10 mm) yields optimal total biomass coverage for your specific process
- Robust LED light source with up to 10-year lamp lifetime



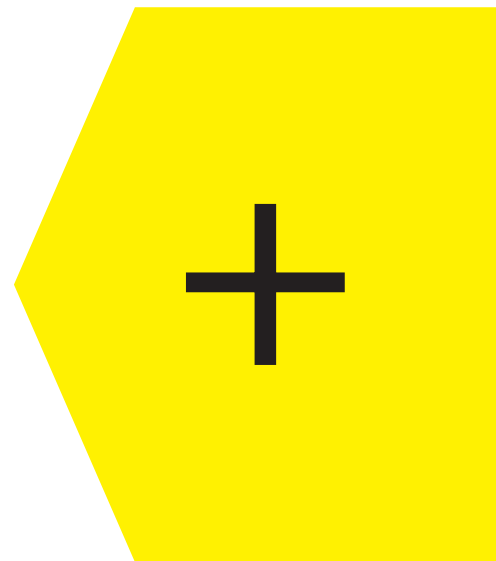
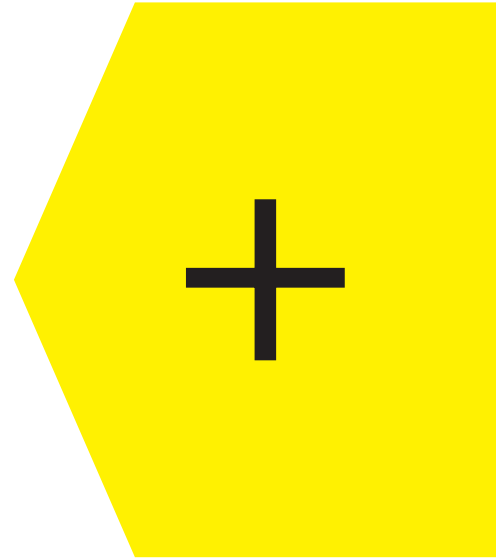
### Hamilton Arc (pH | DO)

The Arc μ-transmitter located in the sensor head stores all relevant sensor data, including calibration and diagnostic information.

- Digital pH and DO sensors provide more reliable signals than traditional analog sensors, e.g. eliminate signal noises
- Maintenance-free pressurized pH sensor
- Optical VisiFerm outperforms traditional polarographic sensors in terms of measurement performance and maintenance
- Optional automatic GMP reporting, wireless monitoring with ArcAir mobile

# Advanced Process Control Solutions

## Cell Cultivation





## Control of Glucose Concentration

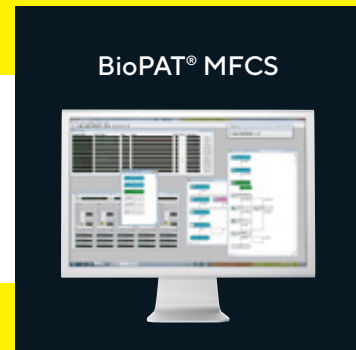


- Control the glucose level with the local control software of the Biostat® B-DCU
- Automated glucose set point control
- Establish profiles for your glucose concentration set point
- Monitor lactate concentration directly on the local control screen of your DCU
- Select up to four variable speed pumps for substrate addition
- Create advanced control loops based on glucose and lactate concentration
- Develop your specific process strategy for event-based glucose feeds

## Control of Perfusion Processes



- Operate the BioPAT® Viamass probe without any external software
- Monitor the viable cell volume directly on the local control screen of your DCU
- Make information about the viable cell volume available to supervisory control software
- Implement advanced perfusion control strategies, e.g. via automatic control of feeds and bleeds
- Robust and reliable determination of time of harvest or transfer of inoculum



## Parameter optimization and robustness testing with BioPAT® MODDE and MFCS

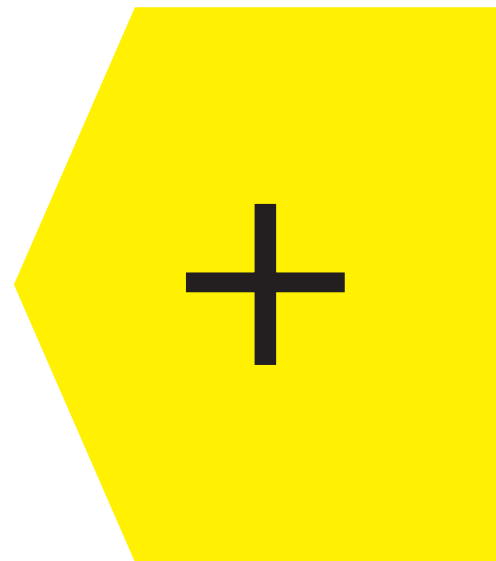
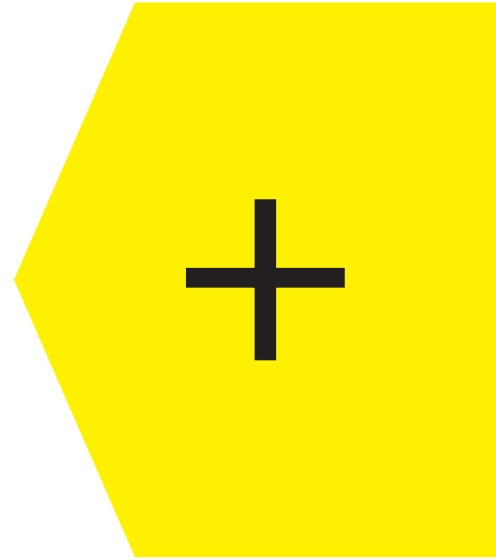


- Increase efficiency of bioprocess development, reduce project timelines and support Quality by Design (QbD) programs.
- Transfer your designed parameter setpoints automatically to your BioPAT® MFCS
- Our DoE module for BioPAT® MFCS ensures reliable and seamless integration of DoE procedures into control strategies.

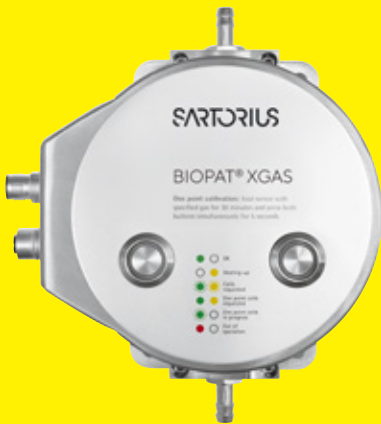


Advanced Process Control Solutions

# Microbial Fermentations

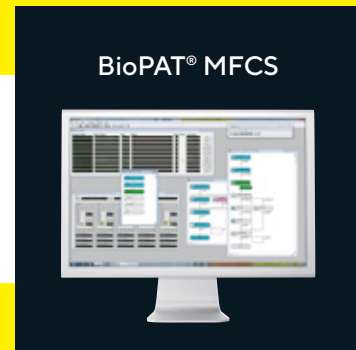


## Metabolic Respiration Control



- High precision of gas flow control by intelligent mass flow controllers
- Realtime monitoring of exhaust gas is directly available in your Biostat® B-DCU
- Facilitate insights into critical metabolic changes during your fermentation process
- Ensure optimal growth conditions, ultimately increasing the productivity of your process
- Obtain an automatic calculation of oxygen uptake rate, carbon dioxide evolution rate and respiratory quotient
- Apply reliable, advanced gassing or feeding strategies to improve production rates and reduce cultivation time
- Receive a complete batch record of O<sub>2</sub> | CO<sub>2</sub> in the off-gas to reveal more information about your process

## Control of Glucose, Ethanol and Methanol Concentration



- Monitor glucose, ethanol or methanol levels with the local control software of the Biostat® B-DCU
- Automated glucose set point control
- Establish profiles for the glucose concentration set point
- Select up to four variable speed pumps for substrate addition
- Create advanced control loops based on glucose, ethanol, or methanol concentration
- Develop your specific event-based control strategies

## Parameter optimization and robustness testing with BioPAT® MODDE and MFCS



- Increase efficiency of bioprocess development, reduce project timelines and support Quality by Design (QbD) programs.
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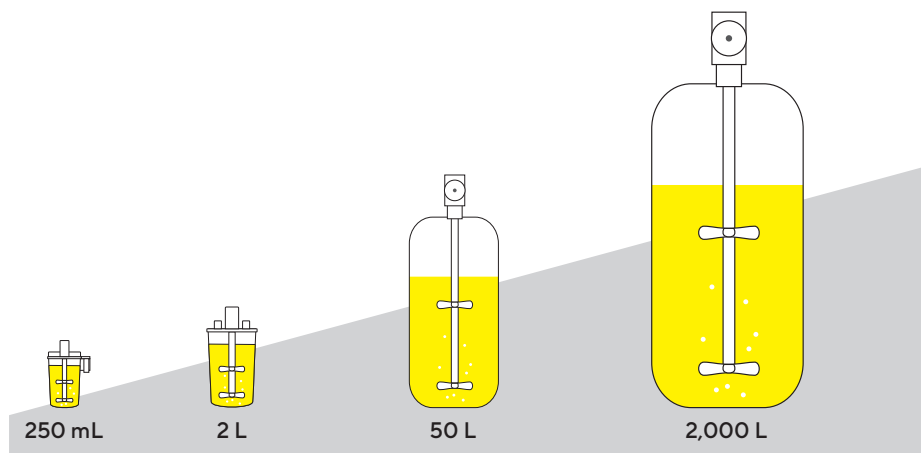
# Advanced Process Characterization Solutions

# The Optimal Scale Down Model

*“Small-scale models can be developed and used to support process development studies. The development of a model should account for scale effects and be representative of the proposed commercial process.”*

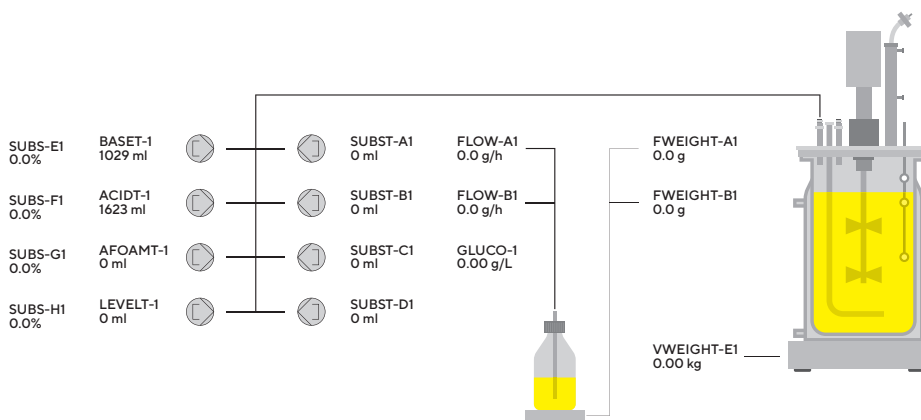
ICH Q11 Step 4

## Seamless scalability from early process development to commercial production



Classic, stirred-tank design and geometric similarity of our range of bioreactors from bench scale to production scale.

## Emulate control strategies of your production scale bioreactor in benchtop scale with our Biostat® B-DCU



- Similar sensor technologies in benchtop scale and in manufacturing scale
- High flexibility in gas mixing strategies in combination with smart mass flow controllers. Learn more about our aeration strategies on pages 8 ff.
- Select up to four substrate addition lines with integrated, wide range variable speed pumps to mimic production scale feeding strategies

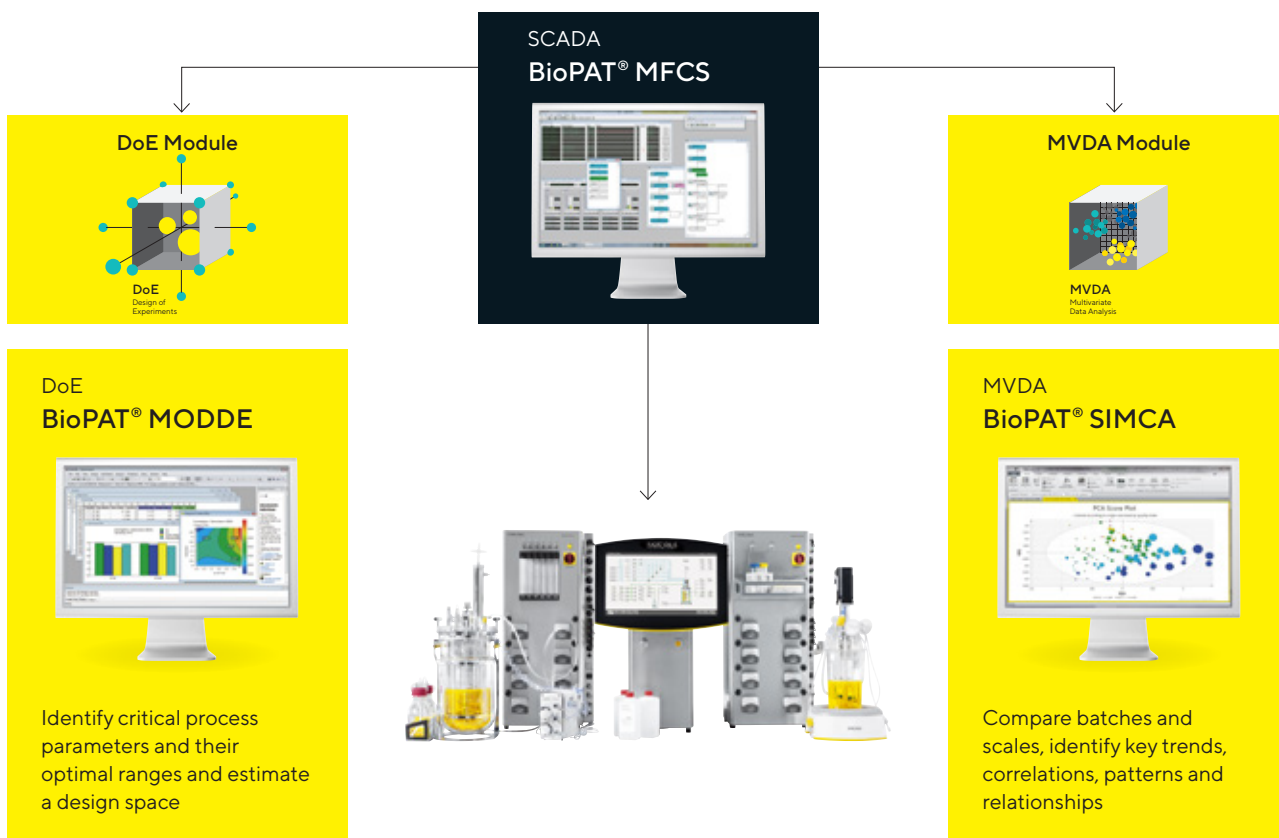


*“It is important to understand the degree to which models represent the commercial process, including any differences that might exist, as this may have an impact on the relevance of information derived from the models.”*

FDA Process Validation Guidance



Process characterization made easy with Biostat® B-DCU and our BioPAT® Chemometrics Toolbox



Take advantage of the BioPAT® Chemometrics Toolbox and integrate advanced multivariate methods into your process control software BioPAT® MFCS | win.

Transfer data from your Biostat® B-DCU to BioPAT® MODDE and SIMCA in order to reduce effort associated with data management and comparison of current and historical batches.

- Unlock process understanding to ultimately improve the quality, safety and efficiency of your drug product.

## Advanced Communication Options

# Integration and Connectivity at Its Best

If you need data acquisition or want full control of your Biostat® B-DCU by your supervisory control and data acquisition system (SCADA) or distributed control system (DCS), the Biostat® B-DCU provides the right interfaces and tools to connect to.



### BioPAT® MFCS – Turnkey SCADA Solution

Specialized for bioprocesses, BioPAT® MFCS is designed as a “plug-and-play” tool for advanced SCADA functionalities.

It is ideally suited for capturing, storing and visualizing process data of all Biostat® and Ambr® bioreactors and other process equipment.

One source bundle with full Sartorius responsibility and lifecycle concept

Specifically tailored for biopharmaceutical industry

Cost-effective & flexible automation platform



Setpoints | Actuator Access

DCU Modbus fieldbus | DCU OPC interface

Process Values | Alarms

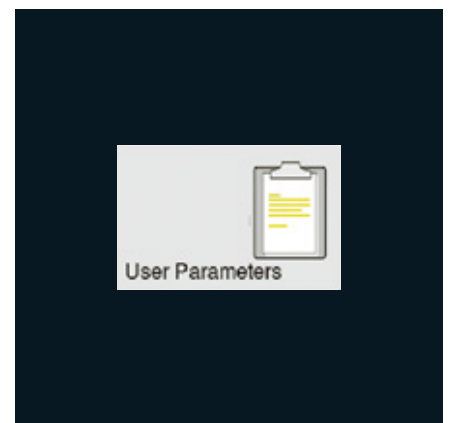
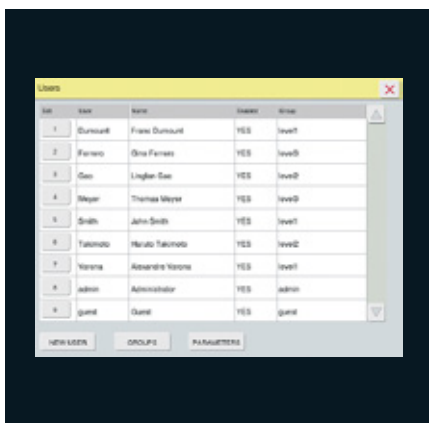
Siemens Simatic  
PCS 7

Rockwell  
Automation

Emerson Process  
Management  
DeltaV™

For the straightforward integration of your Biostat® B-DCU into a DeltaV™ network, we provide a Modbus mapping of your system in digital format. Once imported into your

DeltaV™ configuration it enables you to access process values, set controller parameters or even access actuators in a direct manner – e.g. pumps or valves.



### Centralized User | Password Management Utilizing Windows® Domain Login

Central management of user rights for your bioprocess equipment has never been easier – the Biostat® B-DCU can connect directly to your user management data implemented on your Microsoft® Server and your user can work with their well-known user names and passwords.

### Import and Export Process Relevant Settings of Instruments

Easily store your individual process settings and user authentication data and transfer them between Biostat® B-DCU instruments.

The Biostat® B-DCU has the tools to smoothly integrate into your individual control & IT infrastructure.

Microsoft® and Windows® are registered trademarks of Microsoft Corporation, USA.

## Advanced Services

# Maximized Process Security

To keep your biopharmaceutical process robust and reliable, we provide a comprehensive range of services to ensure the highest reliability and uptime of your Biostat® B-DCU, regulatory compliance and best quality of results.

From installation and qualification to regular preventative maintenance: Our service team will be happy to assist you on site and will be with you quickly thanks to our worldwide service network.



**Installation and Commissioning**  
Safe and proper operation of your equipment - right from the start



**Qualification (SAT)**  
Compliance with GMP requirements, easy integration into your quality management system



**Operator Training**  
Quality through greater expertise: Sartorius trains the personnel operating our equipment

### Installation Phase

### Utilization Phase



**Repairs and Spare Parts**  
In the event of service requests, we are quickly at your side with the necessary spare parts - worldwide



**Maintenance and Contracts**  
Optimal equipment operation and protection against potential downtimes



**Calibration**  
Accurate results in the long term and compliance with regulatory requirements























## Service Contracts for the Entire System Lifecycle

With our Bioprocess Service Program, Sartorius offers service contracts to protect your equipment through its entire lifetime. Based on your specific risk assessment and requirements, you can choose between three Service Level Agreements: Essential, Advanced and Comprehensive. Protect your Biostat® B-DCU by choosing the appropriate service contract. For maximum productivity and minimum downtimes.

|                          | Essential  | Advanced   | Comprehensive   |
|--------------------------|--|--|---|
| <b>You benefit from:</b> | <ul style="list-style-type: none"> <li>▪ A plannable annual maintenance</li> <li>▪ A fast support at the technical helpdesk within one business day and priority on-site-response</li> <li>▪ In case of repair: a discount on all time and material based cost elements</li> </ul> | <ul style="list-style-type: none"> <li>▪ A plannable annual maintenance</li> <li>▪ Technical helpdesk reaction time within 8 hours and 72 hours on-site response</li> <li>▪ In case of repair: labor and travel costs are covered, a discount of 10% on spare parts</li> </ul> | <ul style="list-style-type: none"> <li>▪ A plannable annual maintenance</li> <li>▪ Technical helpdesk reaction time within 4 hours and 48 hours on-site response</li> <li>▪ In case of repair: all costs are covered</li> </ul> |

|                      | Essential  | Advanced   | Comprehensive  |
|----------------------|--|--|--|
| <b>Reaction time</b> |    |    |    |
| <b>Repair</b>        |  <br>  |  <br>  |  <br>  |
| <b>Maintenance</b>   |   |   |   |

### Your Benefits

- Process stability and minimized downtime
- Maximized system uptime, higher profitability
- Optimized total cost of ownership

## Technical Specifications

# Technical Specifications

## Control Tower

### General

|                       |   |
|-----------------------|---|
| Weight                | ca. 30 kg (ca. 66 lbs)  |
| Dimensions (W×H×D)    | 490 mm × 730 mm × 535 mm (19.3" × 28.7" × 21.1")  |
| Power supply          | <ul style="list-style-type: none"><li>▪ 100 – 240 V, 50 – 60 Hz, max. power consumption 4 A</li><li>▪ Potential equalisation</li></ul>                    |
| Housing               | <ul style="list-style-type: none"><li>▪ Stainless steel, AISI 304   EN 10020 1.4301</li><li>▪ International protection rating: IP 30</li></ul>            |
| Display               | <ul style="list-style-type: none"><li>▪ Touch screen, 19", glass, capacitive</li><li>▪ Resolution: 85 dpi</li></ul>                                       |
| SCADA communication   | <ul style="list-style-type: none"><li>▪ Industrial Ethernet (standard)</li><li>▪ Modbus TCP (optional)</li></ul>  |
| Interfaces            | <ul style="list-style-type: none"><li>▪ USB</li><li>▪ Ethernet</li><li>▪ Potential-free alarm contact</li><li>▪ 6 × interfaces to supply towers</li></ul> |
| Regulatory compliance | CE, NRTL recognized by the U.S. OSHA<br>(Occupational Safety and Health Administration)   |



# Supply Tower

## General

|                        |  |  |
|------------------------|--|--|
| Weight                 | ca. 45 kg (99 lbs); depends on configuration   |  |
| Dimensions (W × H × D) | 360mm × 768mm × 432mm (14.2" × 30.2" × 17.0")  |  |
| Power supply           | <ul style="list-style-type: none"> <li>▪ 230 V (± 10 %), 50 Hz, max. power consumption 10 A</li> <li>▪ 120 V (± 10 %), 60 Hz, max. power consumption 12 A</li> <li>▪ Average power consumption during cell cultivation (incl. control tower): ~ 190 kWh</li> <li>▪ Potential equalisation</li> </ul>   |  |
| Housing                | <ul style="list-style-type: none"> <li>▪ Stainless steel, AISI 304</li> <li>▪ International protection rating: IP 30</li> </ul>  |  |
| Gases                  | <ul style="list-style-type: none"> <li>▪ Gas supply pressure 1.5 barg (22 psi)</li> <li>▪ Gasses must be dry, oil and dust-free</li> <li>▪ Hose barbs for tubings with Ø internal = 3.2 mm (0.13"); hose barbs removable for direct push-in connection of gas hoses with Ø external = 6 mm (0.24")</li> </ul>  |  |
| Water                  | <ul style="list-style-type: none"> <li>▪ Water supply pressure: 2 – 4 barg</li> <li>▪ Flow rate up to 20 lpm</li> <li>▪ Temperature min. = 4°C</li> <li>▪ Discharge pressure-less</li> <li>▪ Hose barb for tubings with Ø internal = 8 mm (0.31")</li> <li>▪ Degree of hardness: 12° dH max.</li> <li>▪ Integrated water pressure reduction down to: 1.5 barg (22 psi)</li> </ul>  |  |
| Interfaces             | <ul style="list-style-type: none"> <li>▪ 3 × external signal inputs 0 – 10 V</li> <li>▪ 3 × external signal inputs 4 – 20 mA</li> <li>▪ Interface to control tower</li> <li>▪ Fieldbus for serial or ethernet devices</li> <li>▪ Digital output 24 V for on   off control of external devices</li> <li>▪ Up to 4 analogue outputs for external pumps</li> <li>▪ Connection for control of external drive motor (0 – 10 V)</li> <li>▪ Further interfaces depend on configuration</li> </ul> |  |
| Regulatory compliance  | CE, NRTL recognized by the U.S. OSHA (Occupational Safety and Health Administration)   |  |

## Motor drive

|   |  |  |
|---|--|--|
| Maintenance-free, quiet direct drive                    | Power: 200 W (400 W optional)  |  |
| Maintenance-free top drive with magnetic motor coupling | Power: 200 W (400 W optional)  |  |
| Rotation speed motor, direct coupling                   | 1L Glass: 20 – 2,000 rpm<br>2L Glass: 20 – 2,000 rpm<br>5L Glass: 20 – 1,500 rpm | 10L Glass: 20 – 800 rpm<br>2L Single-use: 20 – 400 rpm |
| Rotation speed motor, magnetic coupling                 | 1L Glass: 20 – 2,000 rpm<br>2L Glass: 20 – 2,000 rpm                             | 5L Glass: 20 – 1,500 rpm<br>10L Glass: 20 – 800 rpm    |

## Process Control | Sensors

|                              | Sensor   Measurement Range   Display Resolution  | Univessel®<br>Glass | Univessel®<br>SU |
|------------------------------|--|---------------------|------------------|
| Temperature                  | Pt100   0–150°C (temperature control 0–80°C)   0.1°C   | ■                   | ■                |
| Dissolved oxygen, reusable   | Polarographic or optical   0–100%   0.1%   | ■                   | ■                |
| Dissolved oxygen, single-use | DO sensor patch   0–100%   0.1%  |                     | ■                |
| pH, reusable                 | Combined measuring electrode   2–12 pH   0.01 pH   | ■                   | ■                |
| pH, single-use               | pH sensor patch   6.5–8.5 pH   0.1 pH  |                     | ■                |
| Foam control                 | Electrical conductive sensor, stainless steel, ceramic insulated   | ■                   |                  |
| Level                        | Electrical conductive sensor, stainless steel, ceramic insulated   | ■                   |                  |
| Turbidity                    | 1-channel NIR absorption sensor   0–6 AU   0.01 AU   | ■                   |                  |
| Redox                        | Combined measurem. with pH sensor   –1,000 –1,000 mV   1 mV  | ■                   | ■                |
| Balance substrate            | 7 kg (15.4 lbs) max.   1 g (0.035 oz)<br>60 kg (132.3 lbs) max.   10 g (0.35 oz)                                 | ■                   | ■                |
| Balance culture vessel       | 60 kg (132.3 lbs) max.   10 g (0.35 oz)  | ■                   | ■                |
| Gravimetric flow controller  | Accuracy for 7 kg balance: 5 g/h<br>Accuracy for 60 kg balance: 50 g/h   | ■                   | ■                |
| Pressure measurement         | Pressure   0–1,000 mbarg (control range: 0–500 mbarg)   1 mbar   | ■                   |                  |
| Glucose                      | Enzymatic sensor   0–40 g/L   0.01 g/L   | ■                   | ■                |
| Lactate                      | Enzymatic sensor   0–10 g/L   0.01 g/L   | ■                   | ■                |
| Viable biomass               | Capacitance sensor   0–400 pF/cm or 0–400 E <sup>6</sup> cells/mL  <br>0.1 pF/cm or 0.01 E <sup>6</sup> cells/mL | ■                   |                  |
| O <sub>2</sub> offgas        | Zirconium dioxide   0–50 vol%   0.1 vol%   | ■                   | ■                |
| CO <sub>2</sub> offgas       | Infrared   0–10 vol%   0.1 vol%  | ■                   | ■                |

### Aeration Module

|                                     |   |
|-------------------------------------|---|
| Dimension outlets to culture vessel | Hose barbs for tubings with d internal = 3.2 mm (0.13");<br>removable for direct push-in connection of gas hoses with d external = 6 mm (0.24") |
|-------------------------------------|---|

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**Univessel® Glass MO (Microbial)****Two-gas mixing with sparger outlet**

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O<sub>2</sub> Enrichment or Additive Flow 2-Gas (Gas Flow Ratio) aeration modules;  
for further information, please see pages 8 ff. on "Aeration Strategies"

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|                                   |  |
|-----------------------------------|--|
| Gas outlets                       | 1  |
| Max. total flow                   | Up to 20 lpm per gassing line            |
| Mass flow controllers             | Up to 2                                  |
| Range of mass flow controllers    | 1 : 200                                  |
| Accuracy of mass flow controllers | ± 0.3% full scale + ± 0.5% current value |
| Flow meters                       | Up to 2                                  |
| Range of flow meters              | 1 : 10                                   |
| Accuracy of flow rate controllers | ± 5% full scale                          |
| Solenoid valves                   | Up to 2                                  |

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**Univessel® Glass CC (Cell Culture) |****Univessel® SU****Four-gas mixing with sparger and headspace outlet**

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Additive flow 4-gas (Air, O<sub>2</sub>, N<sub>2</sub>, CO<sub>2</sub>) aeration module plus optional 5th and 6th aeration line;  
for further information, please see pages 8 ff. on "Aeration Strategies"

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|  |  |
|--|--|
| Gas outlets  | 2 (sparger   overlay) or single gas outlets per gassing line |
| Max. total flow  | Up to 20 lpm per gassing line                                |
| Gas switching valves sparger to overlay<br>(only for aeration module with 2 gas outlets) | Up to 4  |
| Mass flow controllers  | Up to 6  |
| Range of mass flow controllers   | 1 : 200  |
| Accuracy of mass flow controllers  | ± 0.3% full scale + ± 0.5% current value                     |
| Flow meters  | Up to 6  |
| Range of flow meters   | 1 : 10   |
| Accuracy of flow rate controllers  | ± 5% full scale  |
| Solenoid valves  | Up to 6  |



# Pump Module

| Pump heads   | Watson Marlow 114, fast load pump head   |
|--|--|
| <b>Built-in pumps</b>                                  | <b>Flow rate (tubing wall thickness 1.6 mm)</b>  |
| Fixed speed (on   off controlled)<br>Speed 5 rpm       | Int. dia.: 0.5 mm (0.2"): 0–0.1 mL/min<br>Int. dia.: 0.8 mm (0.31"): 0–0.2 mL/min<br>Int. dia.: 1.6 mm (0.63"): 0.01–0.7 mL/min<br>Int. dia.: 2.4 mm (0.94"): 0.03–1.5 mL/min<br>Int. dia.: 3.2 mm (1.26"): 0.05–2.4 mL/min<br>Int. dia.: 4.8 mm (1.89"): 0.09–4.3 mL/min          |
| Fixed speed (on   off controlled)<br>Speed 44 rpm      | Int. dia.: 0.5 mm (0.2"): 0.02–0.9 mL/min<br>Int. dia.: 0.8 mm (0.31"): 0.04–1.8 mL/min<br>Int. dia.: 1.6 mm (0.63"): 0.12–6.2 mL/min<br>Int. dia.: 2.4 mm (0.94"): 0.26–12.8 mL/min<br>Int. dia.: 3.2 mm (1.26"): 0.41–20.7 mL/min<br>Int. dia.: 4.8 mm (1.89"): 0.75–37.4 mL/min |
| Speed-controlled in low speed mode<br>Speed 0.15–5 rpm | Int. dia.: 0.5 mm (0.2"): 0–0.1 mL/min<br>Int. dia.: 0.8 mm (0.31"): 0.01–0.2 mL/min<br>Int. dia.: 1.6 mm (0.63"): 0.02–0.7 mL/min<br>Int. dia.: 2.4 mm (0.94"): 0.04–1.5 mL/min<br>Int. dia.: 3.2 mm (1.26"): 0.07–2.4 mL/min<br>Int. dia.: 4.8 mm (1.89"): 0.13–4.3 mL/min       |
| Speed-controlled in high speed mode<br>Speed 5–150 rpm | Int. dia.: 0.5 mm (0.2"): 0.1–3 mL/min<br>Int. dia.: 0.8 mm (0.31"): 0.2–6 mL/min<br>Int. dia.: 1.6 mm (0.63"): 0.7–21 mL/min<br>Int. dia.: 2.4 mm (0.94"): 1.45–43.5 mL/min<br>Int. dia.: 3.2 mm (1.26"): 2.35–70.5 mL/min<br>Int. dia.: 4.8 mm (1.89"): 4.25–127.5 mL/min        |
| <b>External pumps</b>                                  |  |
| Speed-controlled                                       | Watson Marlow WM120<br>Fast load pump head<br>Up to 200 rpm, speed range selectable<br>Speed range controllable by DCU = 1 : 100   |

## Temperature Control Module

### For Univessel® Glass Single-wall Culture Vessels

- Electrical heating system and automatic cooling water valve; connection to heating blanket and cooling finger
- Temperature control of 8°C above cooling-water inlet temperature up to 60°C
- Heating blanket capacities  
1L | 2L | 5L | 10L:  
100 | 170 | 400 | 780W

### For Univessel® Glass Double-wall (Jacketed) Culture Vessels

- Open thermostat system with recirculation pump and automatic cooling water valve
- Temperature control of 8°C above cooling-water inlet temperature up to 80°C
- Heating capacity: 1,000W

### For Univessel® SU Single-use Culture Vessels With Heating Blanket

- Electrical heating blanket
- Temperature control up to 50°C
- Heating capacity 2L: 200W

### For Univessel® SU Single-use Culture Vessels With Heating | Cooling Water Jacket

- Open thermostat system with recirculation pump and automatic cooling water valve; connection to heating | cooling jacket
- Temperature control up to 50°C
- Heating capacity: 1,000W




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