# RTS-1 and RTS-1C, Personal bioreactors

Smart Plus
Product Class

Innovative Mixing
Technology: Reverse–Spin®

Product video is available on the website

See the Reverse–Spin® Technology — Innovative Principle of Microbial Cultivation on page 130 of the catalog

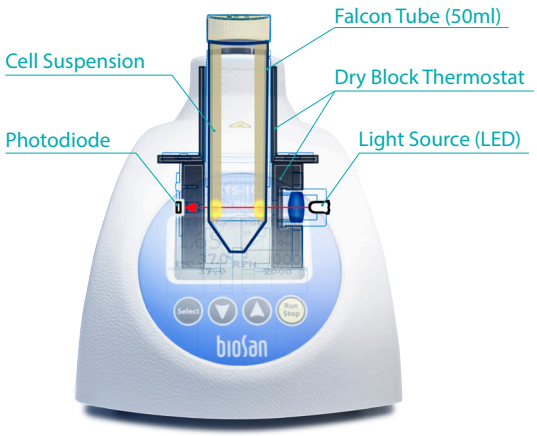
Users articles: biosan.lv/report

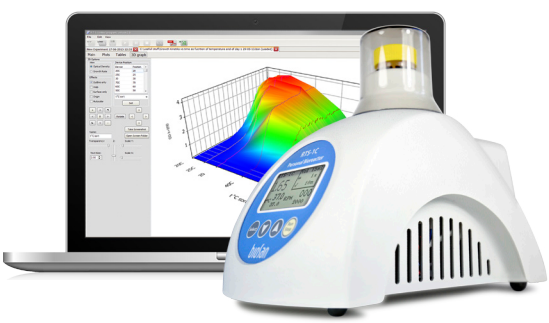
## SPECIFICATIONS

| | RTS-1 | RTS-1C |
|---|---|---|
| Theoretically possible measurement range in $OD_{850}$, at 10 ml working volume*:<br>Rod shaped bacteria (e.g. *E.coli*)<br>Yeast (e.g. *P. pastoris*) | <br>0-25 (0–45.6 $OD_{600}$ equivalent**)<br>0-50 (0–75 $OD_{600}$ equivalent) | |
| *E.coli BL21* Factory calibration measurement range, in $OD_{850}$:<br>at 10–20 ml volume<br>at 20–30 ml volume | <br>0 – 10 OD (0 – 19 $OD_{600}$ equivalent)<br>0 – 8 OD (0 – 15.2 $OD_{600}$ equivalent) | |
| Factory calibration measurement precision | ±0.3 $OD_{850}$ | |
| Mass transfer coefficient $k_La$ ($h^{-1}$) | Up to 350 ± 26 $h^{-1}$ at 5 ml | |
| Measurement Wavelength (λ) | 850 ± 15 nm | |
| Light source | LED | |
| Real time measurement (minutes) | 1 – 60 | |
| Temperature setting range | +25 °C ... +70 °C (increment 0.1 °C) | +4 °C ... +70 °C (increment 0.1 °C) |
| Bottom control range point | 5 °C above ambient | 15 °C below ambient |
| Top control range point | 70 °C | |
| Stability | ±0.1°C | |
| Sample temperature accuracy:<br>20 °C - 45 °C<br>< 20 °C<br>> 45 °C | <br>± 1<br>± 2<br>± 3 | |
| Sample temperature heating/cooling rate | 0.7 °C/min | |
| Sample volume | 5 – 30 ml | |
| Speed control range | 50 – 2,000 rpm (increment 10 rpm) | |
| Speed control precision | ±15 rpm | |
| Reverse Spin Time (seconds) | 1- 60 (increment 1 s) | |
| Display | LCD | |
| Minimum PC requirements | Intel/AMD Processor,<br>1 GB RAM, Windows XP***/Vista/7/8/8.1/10, 2.0 USB port | |
| Optimal PC requirements | Intel/AMD Processor, 3 GB RAM, Windows 7/8/8.1/10,<br>2.0 USB port | |
| Overall dimensions (W×D×H) | 130×212×200 mm | |
| Weight | 1.7 kg | 2.2 kg |
| Input current / power consumption | 12 V DC, 3.3 A / 40 W | 12 V DC, 5 A / 60 W |
| External power supply | Input AC 100–240 V 50/60 Hz; Output DC 12 V | |

* — Highest $k_La$ ($h^{-1}$) is achieved at 5 ml working volume which is optimal for aerobic cultivation
** — Conversion coefficients from $OD_{850}$ to $OD_{600}$ vary between strains and phases of growth
*** — Not guaranteed because OS not supported by producer

# RTS-1 and RTS-1C, Personal bioreactors



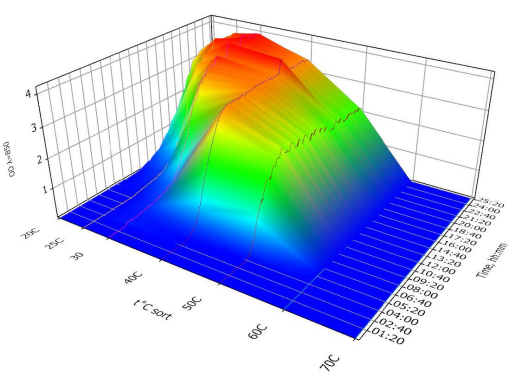



Figure 1. 3D graph of *E.coli BL21* growth kinetics showing the effect of different temperatures in 7 parallel RTS bioreactors.

**RTS-1** and **RTS-1C** are personal bioreactors that utilize patented Reverse-Spin® technology that applies non-invasive, mechanically driven, low energy consumption, innovative type of agitation where cell suspension is mixed by the single-use falcon bioreactor tube rotation around its axis with a change of direction of rotation motion resulting in highly efficient mixing and oxygenation for aerobic cultivation. Combined with a near-infrared optical system it is possible to register cell growth kinetics non-invasively in real time.

FEATURES

- Reverse–Spin® mixing principle in 50 ml falcon tubes allows to achieve high $k_La$ ($h^{-1}$) up to 450 which is essential for efficient aerobic cultivation
- Individually controlled bioreactor accelerates optimization process
- Possibility to cultivate microaerophilic and obligate anaerobic microorganisms (not strict anaerobic conditions)
- Reverse–Spin® mixing principle enables non-invasive biomass measurement in real time
- Near-infrared optical system makes it possible to register cell growth kinetics
- Free of charge software for storage, demonstration and analysis of data in real time
- Compact design with low profile and small footprint for personal application
- Temperature control for bioprocess applications
- Active cooling for rapid temperature control, e.g. for temperature fluctuation experiments
- Task profiling for process automatization
- Cloud data storage to remotely monitor the process of cultivation while at home or using a mobile phone

## SOFTWARE FEATURES:

- Real–Time cell growth logging
- 3D graphical representation of OD or growth rate over time over unit
- Pause option
- Save/Load option
- Report option: PDF and Excel
- Connect up to 12 units (recommended) simultaneously to 1 computer
- Remote monitoring option (requires internet connection)
- Cycling/Profiling options
- User manual calibration possibility for most cells

## TYPICAL APPLICATIONS:

- Fermentation real time growth kinetics
- Clone candidate screening
- Protein expression
- Temperature stress and fluctuation experiments
- Media screening and optimization
- Growth characterization
- Inhibition and toxicity tests
- Strain quality control

## ORDERING INFORMATION:

| | Cat. number |
|---|---|
| **RTS-1C** including TubeSpin® Bioreactor 50, TPP®, 20 pcs. | BS-010160-A04 |
| **RTS-1** including TubeSpin® Bioreactor 50, TPP®, 20 pcs. | BS-010158-A04 |

### Optional accessories:

| | |
|---|---|
| TubeSpin® Bioreactor 50, TPP®, 20 pcs. | BS-010158-AK |
| TubeSpin® Bioreactor 50, TPP®, 180 pcs. | BS-010158-CK |
| USB 2.0 Hub 10 × ports | BS-010158-BK |

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Medical–Biological Research & Technologies

# RTS-1 and RTS-1C, Personal bioreactors

## Recommendations for creating personal settings for cultivation of microorganisms. Points that should be considered:

### CELL GROWTH DEPENDING ON ROTATION INTENSITY

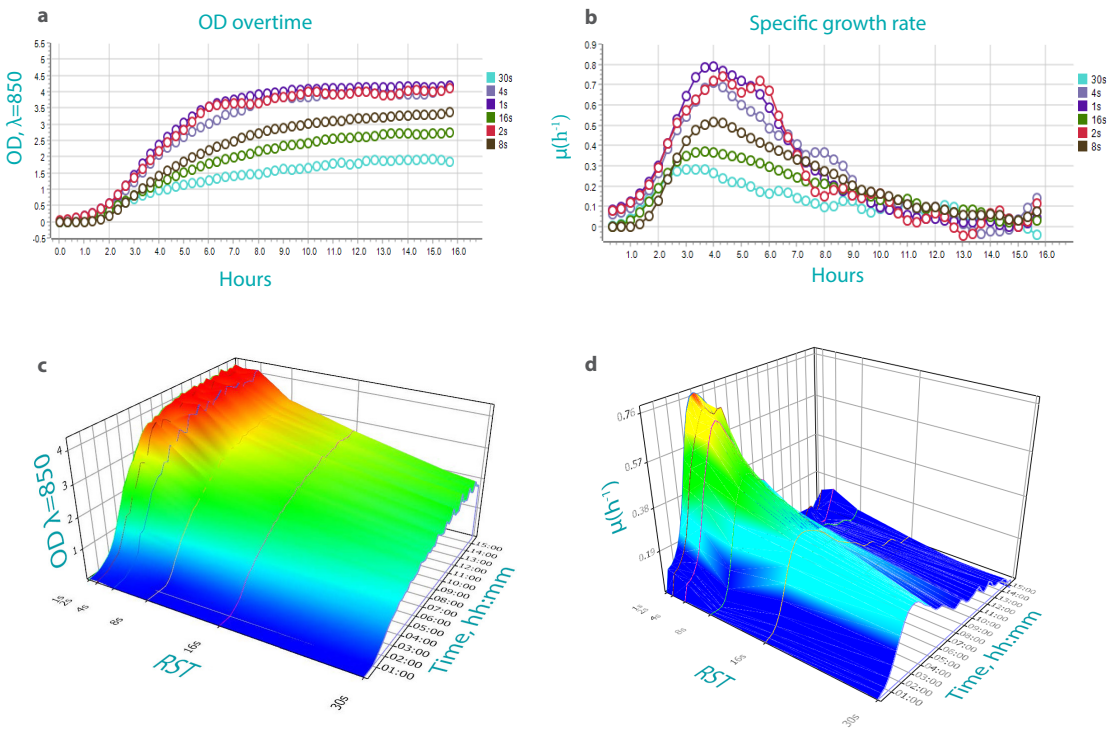
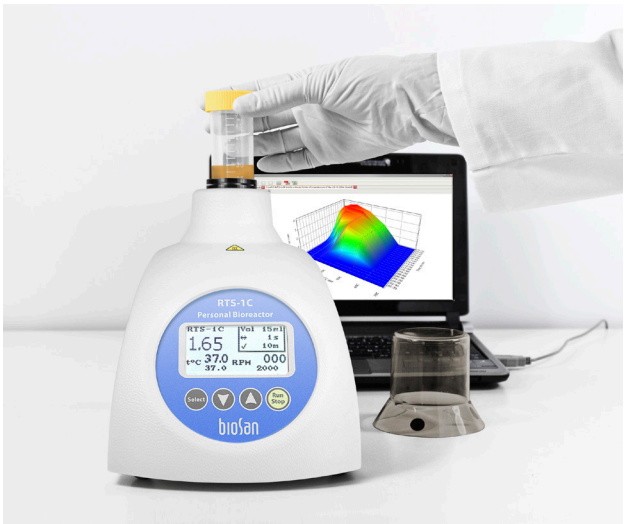



Figure 2, a-c. Influence of Reverse Spin Time (RST) on growth kinetics of *E.coli BL21* in $OD_{600}$. (a-c) Biomass growth; (b-d) Specific growth rate; throughout cultures were grown in 50 ml TPP Bioreaktor tubes, 30% filling volume, 2000 RPM, RST 1, 2, 4, 8, 16, 30 seconds, LB medium and 37 °C temperature, to convert $OD_{850}$ to $OD_{600}$ simply multiply $OD_{850}$ by 1.9.




It is known that the aerobic bacterial growth is influenced by efficient gas exchange. Figure 2 a-c, serves as an example of growth optimization and illustrates the relationship between RST and gas exchange. As RST decreased the specific growth rate and biomass yield increased, thus the highest aeration and optimal growth conditions for *E.coli BL21* were optimized at 2000 RPM 1 s RST.

# RTS-1 and RTS-1C, Personal bioreactors

## $k_La$ ($h^{-1}$) RESULTS IN RTS-1/C

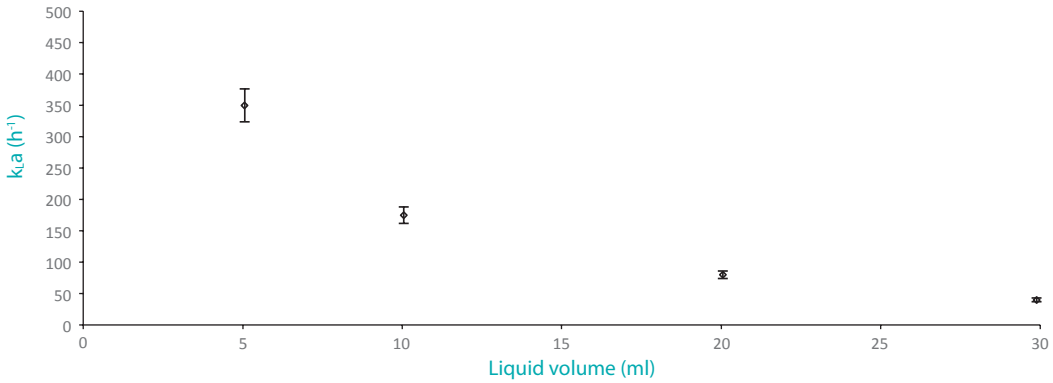



Figure 3. Determination of $k_La$ in 50 ml TPP Bioreaktor tubes. The bioreactor vessels were filled with 5, 10, 20, 30 ml deionized water, and measurements were made by non-invasive $O_2$ sensors and optics (PreSens, Regensburg, Germany) at 37 °C using the gassing-out method. Mean and standard deviation of at least five independent experiments are shown.

The $k_La$ was measured in 5, 10, 20, 30 mL of deionized water in 50 ml TPP Bioreaktor tubes at agitation rate of 2000 rpm and 1 s RST, this agitation rate was found optimal for Reverse–Spin® mixing principle during initial optimization studies. Over the working volume range, the $k_La$ increased with the decrease of liquid volume (Figure 3). At smallest working volume of 5 ml, the highest $k_La$ of 350 ± 26 $h^{-1}$ was reached.

### CELLS SUCCESSFULLY CULTIVATED

*Saccharomyces cerevisiae, Pichia pastoris, Yarrowia lipolytica, Bacillus subtilis, Escherichia coli, Lactobacillus acidophilus, Bifidobacterium bifidum, Pseudomonas aeruginosa, Hybridoma, Jurkat* and CHO cells.

### TYPES OF RECOMMENDED TUBES

For aerobic microorganisms, it is recommended to use tubes that are supplied by TPP - TubeSpin® Bioreactor 50ml. For obtaining optimal results growing aerotolerant anaerobes, it is required to seal the screw cap of TPP TubeSpin® Bioreactor 50ml by tape or purchase TPP TubeSpin® 50ml falcon tubes without the membrane filter. It is also possible to use other manufacturer tubes of the same type, e.g. Corning® 50ml Mini Bioreactor, but the device rotor must be modified. It is possible to request this specific modification.

### FACTORY CALIBRATION PARTICLE SIZE AND CALIBRATION COEFFICIENTS 600nm/850nm

Factory calibration of the instrument is designed for rod-shaped bacteria size of *E.coli BL21*. In case of exceeding this size, the measurement system will not work correctly. Optical density $OD_{850}$ to $OD_{600}$ conversion coefficient of the factory calibration is equal to 1.9.

### FACTORY CALIBRATION GROWTH PHASE INFLUENCE ON MEASUREMENT ACCURACY

During the growth transition of Escherichia coli culture from the exponential growth to the stationary phase, a number of morphological and physiological changes take place, including cell volume decrease and cell shape change. Therefore, if cells taken for referent measurement using spectrophotometer at different stages from stationary phase then the correctness of measurement will be worse than specified.

### CONVERSION RATE COEFFICIENT OF USER CALIBRATION

Optical density $OD_{850}$ to $OD_{600}$ nm conversion rate coefficient depends on the cell size and volume. Therefore, the coefficient will be different for other cell size. The device can be calibrated at desired reference wavelength to meet the needs of the user, e.g. $OD_{600}$.

### DO YOU WANT TO TEST THIS SYSTEM?

We can provide demo units for 50% the price for testing or creating an application note. For such inquiries please contact our R&D department directly at igor@biosan.lv.