Single-use bioreactors

HyPerforma 5:1 250 L Single-Use Bioreactor

Introduction

The Thermo Scientific™ HyPerforma™ Single-Use Bioreactor (S.U.B.) provides state-of-the-art functionality, ease of use, and efficiency. A complete HyPerforma S.U.B. system consists of a bioreactor tank and a HyPerforma S.U.B. BioProcess Container (BPC), which is available in 50, 100, 250, 500, 1,000, and 2,000 L sizes. The redesigned HyPerforma S.U.B. maintains traditional stirred-tank bioreactor design principles, including specific height-to-diameter ratios and an optimized mixer location, that deliver optimum performance, scalability, and cell viability from process development through production. Design is optimized for the 250 L bioreactor tank, which allows for mixing at a 5:1 turndown ratio. Advantages of the 5:1 system include:

- Streamlining bioprocesses by reducing seed vessel requirements and maximizing process vessel usage
- Seeding vessels at 20% volume, then feeding up to full volume
- Reducing cell transfers and associated adaptation
- Reducing the number of single-use BPCs used

This data sheet provides information on the HyPerforma 5:1 250 L S.U.B. system, which includes the tank and standard S.U.B. BPC. The BPC utilizes dual-sparger design for cultures at nominal volume and a cross-flow sparger strategically positioned just above the 20% liquid volume for seed cultures. Both sparge designs have been rigorously tested to provide high k_La values and optimal CO_2 stripping for improved pH control and decreased foaming.

The HyPerforma S.U.B. system consists of the following components:

- S.U.B. hardware unit—available in turnkey format
- Complete mixing system with water jacket
- Drive shaft—inserts into the S.U.B. BPC through the mixing drive motor and locks into the BPC agitator assembly

- S.U.B. BPC (gamma-irradiated and ready to use)—available in Thermo Scientific™ CX5-14 and Aegis™ 5-14 film options
- Agitator assembly—a single-use (polyethylene) impeller with a bearing and seal assembly linked to an external mixer drive
- Dual gas spargers—available with cross-flow and drilled-hole designs
- Vent filter outlet for system exhaust
- Integrally sealed ports in the S.U.B. BPC—allow for additional sensor probes and line sets

System options (adaptable to your needs)

- Optional electrical box (E-Box) for remote agitation control
  - HyPerforma 5:1 S.U.B.s require a separate external temperature control unit
- Exhaust gas vent filter heaters
- Load cells
- Tubing and cable management tree
- Process control system

See the ordering information for auxiliary components for S.U.B. control management. Choose an open architecture approach or a turnkey “ready-to-use” HyPerforma S.U.B. system.

Additional options are listed in Tables 3–7.

Standard HyPerforma 5:1 S.U.B. hardware units

The 250 L standard 5:1 S.U.B. hardware units are available in the configurations below.

- 250 L jacketed S.U.B. with a 5:1 turndown ratio, AC motor, no E-box, and load cells without display
- 250 L jacketed S.U.B. with a 5:1 turndown ratio, AC motor, 120 VAC, E-box, and analog load cells
- 250 L jacketed S.U.B. with a 5:1 turndown ratio, AC motor, 240 VAC, E-box, and analog load cells

Table 1. 250 L standard 5:1 S.U.B. hardware unit with casters (leveling feet).

Description	Cat. No.
250 L jacketed S.U.B. with a 5:1 turndown ratio, AC motor, 120 VAC, no E-box, and analog load cells	SUB0250.8300
250 L jacketed S.U.B. with a 5:1 turndown ratio, AC motor, 120 VAC, E-box, and analog load cells	SUB0250.8301
250 L jacketed S.U.B. with a 5:1 turndown ratio, AC motor, 240 VAC, E-box, and analog load cells	SUB0250.8302

Hardware dimensions

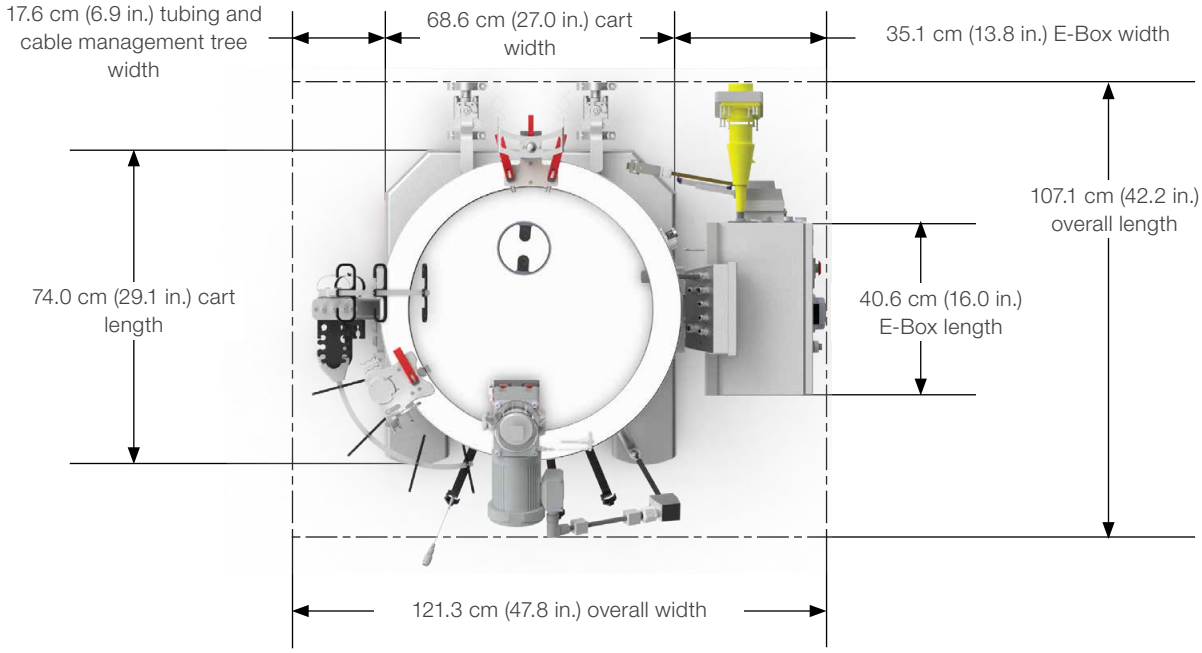

Figure 1. 250 L S.U.B. dimensions (top view).

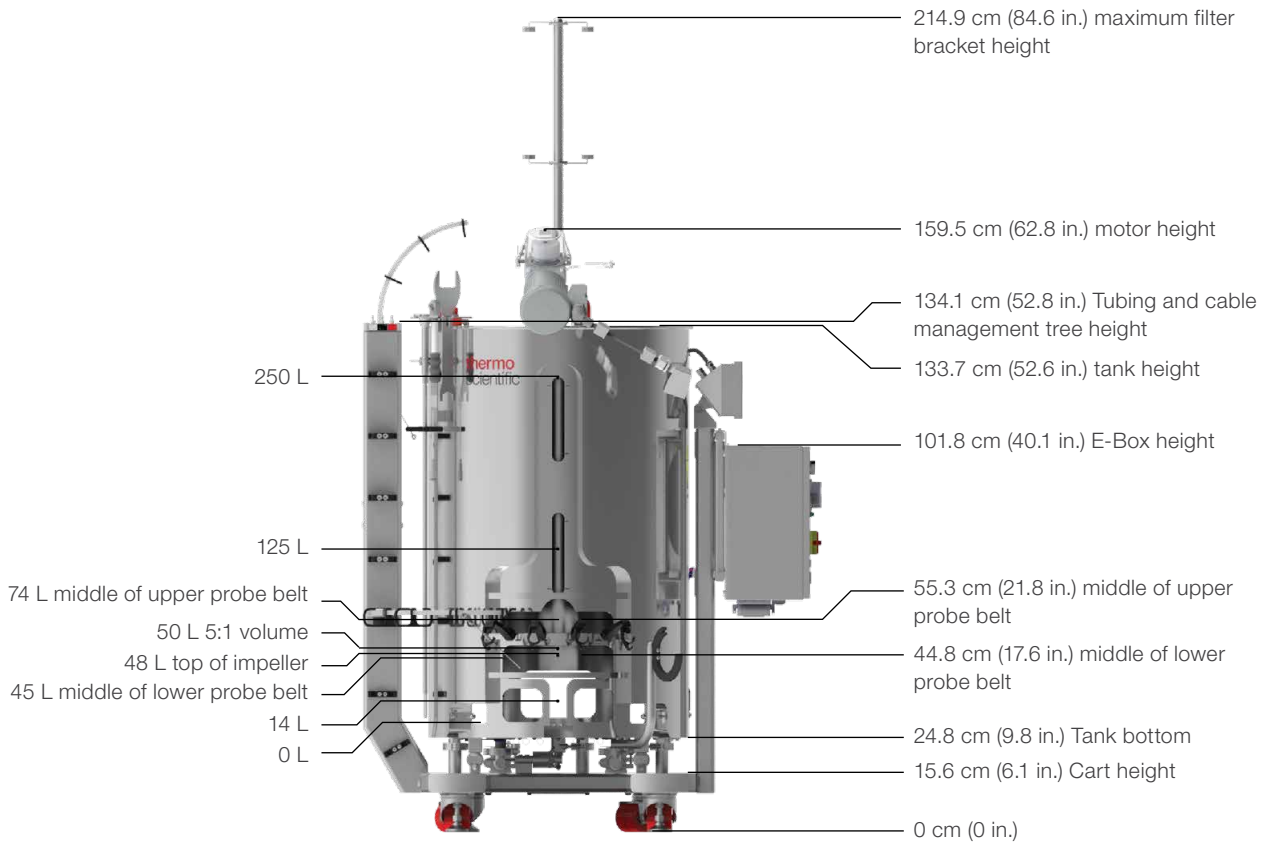

Figure 2. 250 L S.U.B. dimensions (front view).

Design features

1. Exhaust vent filter holder (optional)
2. Mixing assembly with shield
3. Mixer motor
4. Probe access windows
5. Probe hanger bracket
6. Leveling casters
7. Bearing port receiver with clamp
8. Liquid sight windows
9. Electrical control panel (optional)
10. Cart assembly

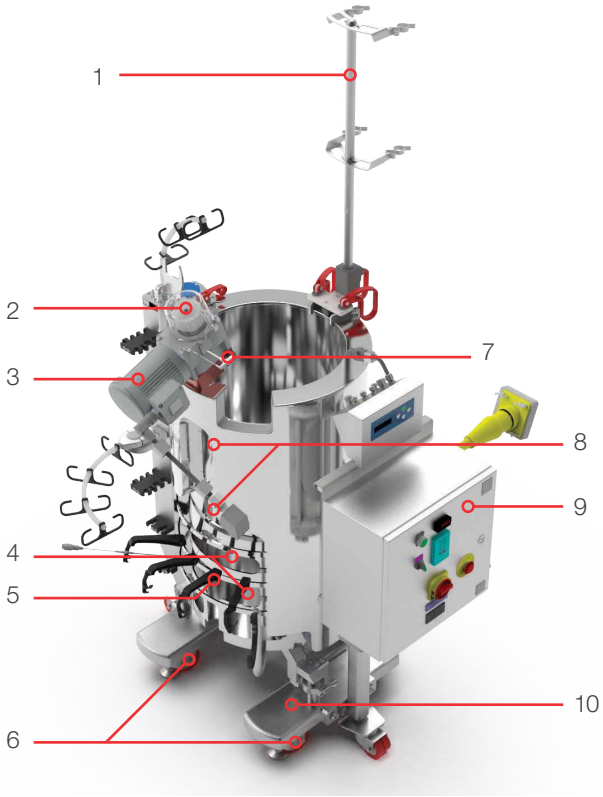

Figure 3. Front-view of the 250 L S.U.B. .

11. Stainless steel (grade 304) outer support container with 0.95 cm (3/8 in.) dimpled jacket (side)
12. Bleed valve
13. Load cells
14. Standard tool set: 10 mm x 16.9 N-m (3/8 in. x 150 in.-lb) square torque wrench; load cell and motor cap lockout wrench
15. Drive shaft (stored)
16. Tubing and cable management tree
17. Bottom cutouts/pins for BPC attachment/alignment
18. Tri-clamp water inlet/outlet ports

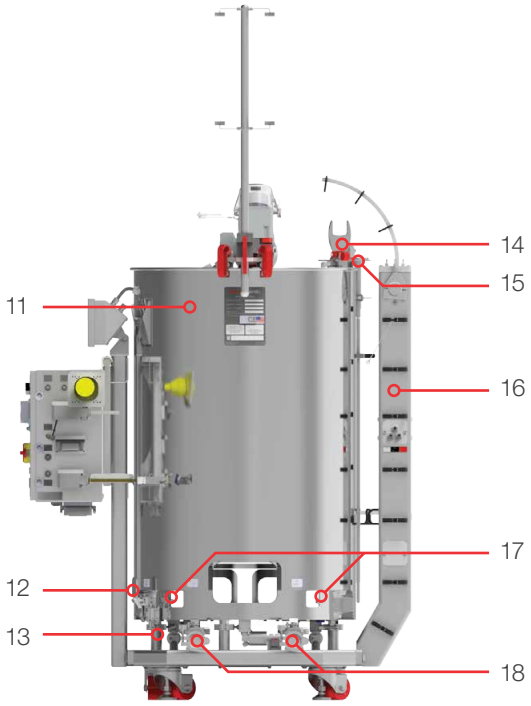

Figure 4. Back-view of the 250 L S.U.B.

Table 2. Standard 250 L S.U.B. system specifications.

		AC motor	DC motor
Bioreactor geometry	Rated liquid working volume	250 L	
	Minimum liquid working volume	50 L	
	Total reactor volume (liquid and gas)	316 L	
	BPC chamber diameter	59.7 cm (23.5 in.)	
	BPC chamber shoulder height	115.6 cm (45.5 in.)	
	Liquid height at rated working volume	91.4 cm (36 in.)	
	Fluid geometry at working volume (height:diameter ratio)	1.5:1	
	Overall reactor geometry (height:diameter ratio)	1.9:1	
	Tank baffles	No	
General	Ceiling height required for drive shaft loading	267.46 cm (105.3 in.)	
	Electrical power supply requirement (voltage, phase, current)	120/240 VAC, single, 20/10 A	Dependent on controller
	pH and dissolved oxygen (DO) probe, autoclavable type	12 mm diameter x 215-235 mm insertion length x 13.5 PG (pipe) thread	
	Noise level	<70 dB at 1.5 m	
Impeller	Impeller (quantity x blade count)	1 x 3	
	Impeller scaling (impeller diameter/tank diameter)	1/3	
	Impeller blade pitch (angle)	45°	
	Impeller diameter	20 cm (7.88 in.)	
	Impeller, calculated power number (N)	2.1	

Table 2. Standard 250 L S.U.B. system specifications (continued).

		AC motor	DC motor
Agitation	Maximum mixing rate	30-150 rpm	
	Nominal agitation rating, power/volume ratio	20 W/m^3	
	Nominal agitation, 20% working volume	69 rpm	
	Nominal agitation, 50% working volume	93 rpm	
	Nominal agitation, 100% working volume	117 rpm	
	Nominal tip speed	123.6 cm/s (243.3 ft/min)	
	Counterclockwise mixing flow direction	Down-pumping	
	Agitation shaft resolved angle	16.5°	
	Agitation shaft centerline offset	3.3 cm (1.3 in.)	
	Overall drive shaft length	120.9 cm (47.6 in.)	
	Drive shaft diameter	1.27 cm (0.5 in.)	
	Drive shaft poly-sheath outside diameter	2.54 cm (1 in.)	
	Impeller clearance from tank bottom	6.91 cm (2.72 in.)	
Motor	Agitation motor drive (type, voltage, phase)	Induction, 208 VAC, 3-phase	Brushless, 48 VDC, 3-phase
	Motor power rating (AC motor)	186.4 W (0.25 hp)	400 W (0.536 hp)
	Motor torque rating	11.5 N-m (102 in.-lb)	4.86 N-m (43 in.-lb)
	Gear reduction	12.5:1	10:1
	Programmable VFD, remote panel interface, power fault auto restart	Standard	–
	Motor communication methods (for external controller)	0–10 V, 4–20 mA, Modbus	–
Temperature control	Jacket area: full/half volume	1.3 m^2 (13.6 ft2)/0.5 m^2 (5.8 ft^2)	
	Jacket volume	8.6 L	
	Jacket flow rate at 3.4 bar (50 psi)	136 L/min	
	Process connection	1.5 in. sanitary tri-clamp	
	Nominal heating/cooling load	2,500 W	
	Approximate liquid heat-up time (5–37°C), 20% volume	1.1 hr	
	Approximate liquid heat-up time (5–37°C), 100% volume	3.4 hr	
	Resistance temperature detector (RTD) or thermocouple, 3.18 mm (1/8 in.) OD	RTD: Pt-100 (standard)	
Support container	Overall width	121.3 cm (47.8 in.) with E-Box 86.2 cm (33.9 in.) without E-Box	
	Overall length	121.3 cm (47.8 in.)	
	Overall height	214.9 cm (84.6 in.)	
	Dry skid weight	223.6 kg (493 lb.)	
	Wet skid weight at rated working volume	473.6 kg (1044 lb.)	

Table 2. Standard 250 L S.U.B. system specifications (continued).

Recommended operating parameters	Operating temperature range	Ambient to 40 ± 0.5°C (104 ± 0.9°F)
	Motor speed	30–150 rpm
	Volume range	50–250 L
	Maximum bag pressure	0.03 bar (0.5 psi)
	Continuous operating time	21 days mixing time at nominal volume only

System options

- **Bioreactor probe assembly** (Figure 5)—required for each sterile electrochemical probe insertion. New CPC AseptiQuik™ connector is used on probe assembly (Cat. No. SH30720.02) and mating probe belt on S.U.B. BPC for connection
- **Sparge line support** (Figure 6)—keeps gas lines in an upright position for optimal gas transfer
- **Heavy-duty tubing clamp** (Figure 7)—used for each probe port not in use, eliminating process fluid holdup
- **Autoclave tray for probe kits** (Figure 8)—aids in holding the probe assembly during the autoclave process
  - Additional information on autoclave tray:
    - Fabricated from stainless steel
    - Plastic carry handle for easy transport right out of the autoclave
    - Positions probes on 15% incline for greater probe/membrane longevity
    - Will restrain probe bellows from collapsing during sterilization
    - Probe holder accommodates two probes

Figure 5. Bioreactor probe assembly.

Figure 6. Sparge line support.

Figure 7. Heavy-duty tubing clamp.

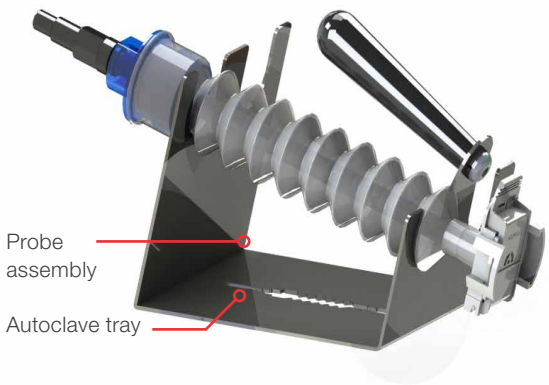

Figure 8. Autoclave tray for probe kits.

- **S.U.B. temperature sample port** (Figure 9)—provides *in situ* temperature monitoring during culture process
- **Load cells** (Figure 10)—Mettler Toledo™ Flexmount™ load cells allow for batch liquid-weight reading; three load cells are mounted with summing box on the S.U.B. hardware unit
- **Tubing and cable management tree** (Figure 11)—allows organization of the S.U.B. BPC tubing lines for operator ease of use
- **Sterile sampling manifolds**—available in 50 and 100 mL sizes for offline sample retention

Figure 9. S.U.B. temperature sample port.

Figure 10. Load cells.

Figure 11. Tubing and cable management tree.

Table 3. 250 L S.U.B. system options.

Description	Cat. No.
Tubing and cable management tree	SV50992.02
Load cell with summation box, without display	SV50988.02
Autoclave tray	SV50177.01
Bioreactor probe assembly with CPC AseptiQuik connector (nonsterile for use in autoclave)	SH30720.02
Sparge line support	SV50177B.19
Heavy-duty tubing clamp (1)	SV20664.01
Heavy-duty tubing clamp (10-pack)	SV20664.04
Sterile sampling manifold with luer lock (1)	SH30845.01
Sterile sampling manifold with luer lock (10-pack)	SH30845.02
S.U.B. temperature/sample port	SV20750.01
PendoTECH™ pressure sensor	SH31134.01
Hamilton™ pressure sensor	SH31134.02

Vent heaters

Vent heaters aid in reducing moisture buildup in exhaust filters from system off-gassing. Vent heaters are factory-preset at 50°C, allowing for condensation to return to the vessel. Recommended gassing strategies of the S.U.B. system are in the S.U.B. Validation Guide (DOC0023). Table 4 lists available vent heaters.

Table 4. Vent heater required for each exhaust filter on S.U.B. BPC.

Description	Cat. No.
120 VAC, 23.8 W, Pall™ Kleenpak™ KA3 series 46 vent filter heater, preset temperature bulb, IEC 320 C14	SV50191.31
240 VAC, 30.3 W, Pall Kleenpak KA3 series 46 vent filter heater, preset temperature bulb, IEC 320 C14	SV50191.32
120 VAC, 23.8 W, Pall Kleenpak KA3 series 46 vent filter heater, integrated, M12–4 pin connector*	SV50191.45
240 VAC, 30.3 W, Pall Kleenpak KA3 series 46 vent filter heater, integrated, M12–4 pin connector*	SV50191.46

* Requires integration to a third party controller, which allows vent heater control through system HMI.

Harsh mount load cell display

Required for remote weight readout from a Mettler Toledo summing box; various signal output options are provided for external control monitoring (Table 5). More information can be found in the Load Cell Data Sheet.

Figure 12. Harsh mount load cell display.

Table 5. Harsh mount load cell display options.

Description	Cat. No.
Mettler Toledo IND331 display, with analog interface (STD), 120 VAC U.S. line cord/plug	SV50177.306
Mettler Toledo IND331 display, with Allen-Bradley™ RIO interface, 120 VAC U.S. line cord/plug	SV50177.307
Mettler Toledo IND331 display, with DeviceNet interface, 120 VAC U.S. line cord/plug	SV50177.308
Mettler Toledo IND331 display, with ethernet/IP and Modbus TCP interface, 120 VAC U.S. line cord/plug	SV50177.309
Mettler Toledo IND331 display, with Profibus interface, 120 VAC U.S. line cord/plug	SV50177.310

Spare parts

Table 6 lists the available spare parts of the 250 L S.U.B. systems. Spare parts are for standard reference only; configured S.U.B. tank drawings will be provided with a spare parts list specific to the S.U.B. tank ordered.

Table 6. Available spare parts.

Description	Cat. No.
DC motor	SV50237.07
AC motor	SV50237.16
Drive shaft	SV50959.11
RTD 304.8 cm (120 in.) with Bulgin connector	SV50177.363
Standard probe holders	SV50177.23
Improved, adjustable probe holders	SV51274.01
Autoclave tray for probe kit (Stainless steel with plastic carry handle)	SV50177.01
Adjustable filter bracket	SV50177.313

250 L standard 5:1 S.U.B. BPC systems

Table 7 shows the available standard 250 L S.U.B. BPC system options with drilled-hole, cross-flow, and overlay spargers. Standard S.U.B. BPC packaging is shown in Table 8.

Table 7. 250 L standard 5:1 S.U.B. BPCs.

Film	Cat. No.
CX5-14 film	SH31102.01
Aegis5-14 film	SH31075.01

Table 8. 250 L standard 5:1 S.U.B. BPC packaging.

	Description
Outer packaging	Supplied flat-packed Two polyethylene outer layers
Label	Description Product code Lot number Expiration date on outer packaging and shipping container
Sterilization	Irradiation (25–40 kGy) inside outer packaging
Shipping container	Durable cardboard carton
Documentation	Certificate of Analysis provided with each lot for delivery

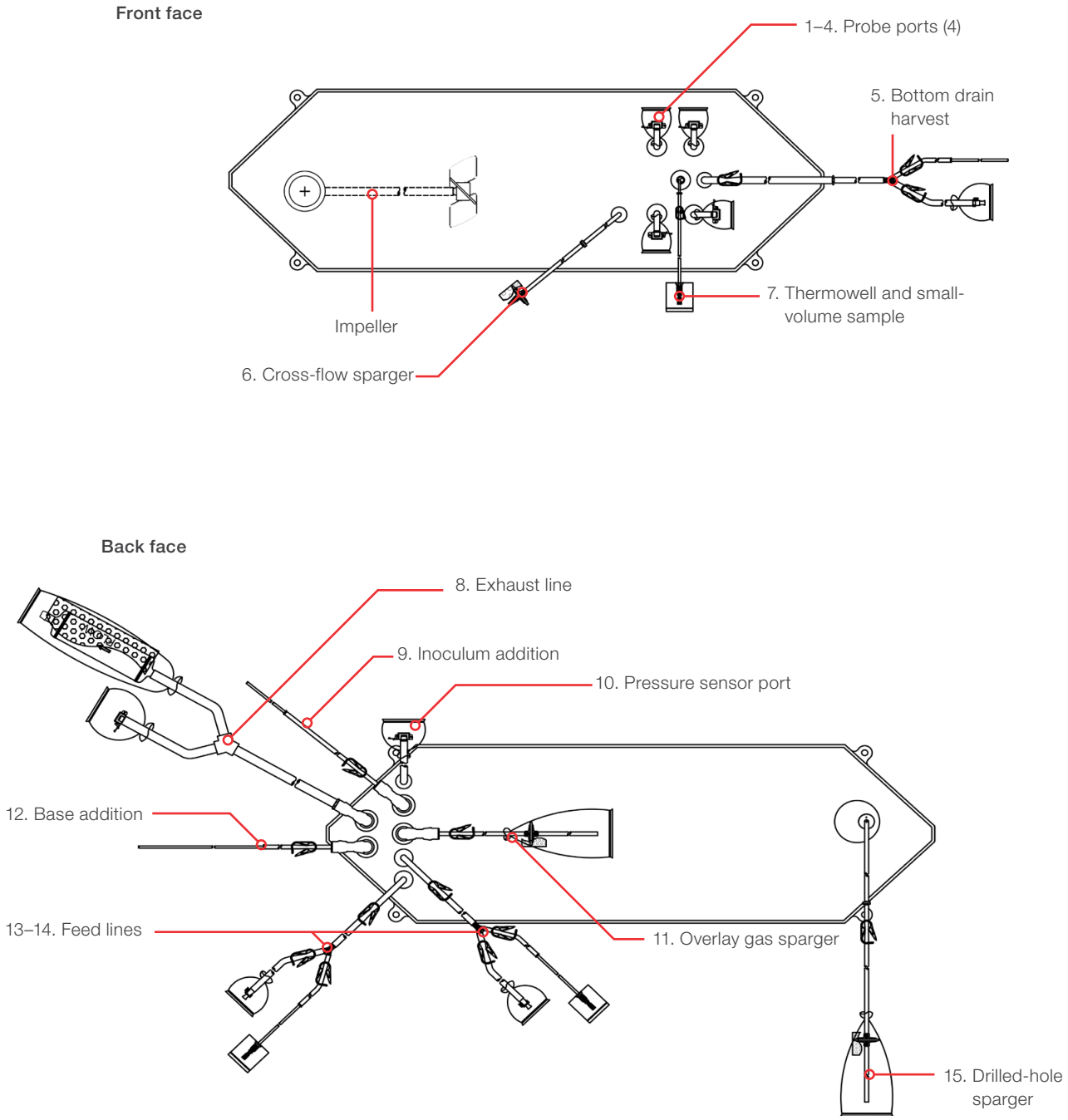

Figure 13. Standard 250 L 5:1 S.U.B. BPC.

Table 9. 250 L standard 5:1 S.U.B. BPC specifications.

Item	Description	Tubing set (inner diameter x outer diameter x length)	End treatment
1–4.	Probe ports (4)	12.7 mm (1/2 in.) tube ports	CPC AseptiQuik aseptic connectors
5.	Bottom drain harvest	12.7 mm x 19.1 mm x 152 cm (1/2 in. x 3/4 in. x 60 in.) C-Flex tubing reduced to 9.5 mm x 15.9 mm x 30 cm (3/8 in. x 5/8 in. x 12 in.) C-Flex tubing; splits to 6.4mm x 11.1 mm x 30 cm(1/4 in. x 7/16 in. x 12 in.) C-Flex tubing reduced to 3.2 mm x 6.4 mm x 30 cm (1/8 in. x 1/4 in. x 12 in.) C-Flex tubing and 9.5 mm x 15.9 mm x 30 cm (3/8 in. x 5/8 in. x 12 in.) C-Flex tubing	Plugged 9.5 mm (3/8 in.) MPC insert
6.	Cross-flow sparger	6.4 mm x 11.1 mm x 8 cm (1/4 in. x 7/16 in. x 3 in.) C-Flex tubing connected to check valve and 6.4 mm x 11.1 mm x 183 cm (1/4 in. x 7/16 in. x 72 in.) C-Flex tubing	Meissner Steridyne™ 50 mm filter
7.	Thermowell and small-volume sample	Thermowell adapter for 6.4 mm (1/4 in.) diameter 3.2 mm x 6.4 mm x 46 cm (1/8 in. x 1/4 in. x 18 in.) C-Flex tubing	SterilEnz™ pouch with injection site assembly
8.	Exhaust line	19.1 mm x 25.4 mm x 30 cm (3/4 in. x 1 in. x 12 in.) C-Flex tubing; splits to 19.1 mm x 25.4 mm x 15 cm (3/4 in. x 1 in. x 6 in.) and 19.1 mm x 25.4 mm x 15 cm (3/4 in. x 1 in. x 6 in.) C-Flex tubing	CPC AseptiQuik G connector (genderless), (2) Meissner Ultracap 0.2 µm hydrophobic filters
9.	Inoculum addition	6.4 mm x 11.1 mm x 152 cm (1/4 in. x 7/16 in. x 60 in.) C-Flex tubing reduced to 3.2 mm x 6.4 mm x 30 cm (1/8 in. x 1/4 in. x 12 in.) C-Flex tubing	Plugged
10.	Pressure sensor port	12.7 mm x 19.1 mm x 8 cm (1/2 in. x 3/4 in. x 3 in.) C-Flex tubing	CPC AseptiQuik aseptic connector
11.	Overlay gas sparger	6.4 mm x 11.1 mm x 15 cm (1/4 in. x 7/16 in. x 6 in.) C-Flex tubing	Meissner Steridyne 0.2 micron hydrophobic filter connected to 15 cm (6 in.) C-Flex tubing
12.	Base addition	6.4 mm x 11.1 mm x 15 cm (1/4 in. x 7/16 in. x 6 in.) C-Flex tubing reduced to 3.2 mm x 6.4 mm x 152 cm (1/8 in. x 1/4 in. x 60 in.) C-Flex tubing	Plugged
13–14.	Feed lines	9.5 mm x 15.9 mm x 152 cm (3/8 in. x 5/8 in. x 60 in.) C-Flex tubing; splits to 6.4 mm x 11.1 mm x 30 cm (1/4 in. x 7/16 in. x 12 in.) C-Flex tubing reduced to 3.2 mm x 6.4 mm x 30 cm (1/8 in. x 1/4 in. x 12 in.) C-Flex tubing and 9.5 mm x 15.9 mm x 30 cm (3/8 in. x 5/8 in. x 12 in.) C-Flex tubing	SteriEnz pouch with injection site assembly and 9.5 mm (3/8 in.) MPC body
15.	Drilled-hole sparger 12.2 cm (4.8 in.) disk with 760 x 0.233 mm (0.009 in.) holes	6.4 mm x 11.1 mm x 8 cm (1/4 in. x 7/16 in. x 3 in.) C-Flex tubing connected to check valve and 6.4 mm x 11.1 mm x 150 cm (1/4 in. x 7/16 in. x 59 in.) C-Flex tubing	Meissner Steridyne 0.2 µm hydrophobic filter connected to 15 cm (6 in.) C-Flex tubing

BPC options

Table 10 lists available custom 250 L S.U.B. BPC system options. Not all options are available for all ports. For additional information, please see the selection guides in the S.U.B. BPC catalog.

Table 10. Custom 250 L S.U.B. BPC options.

Category	Options/capability	Notes
Tubing type	Thermoplastic elastomers: C-Flex™, PharMed™, PharmaPure™ platinum-cured silicone PVC	More information is available in the component selection guide
Tubing size	Ranging from 0.318–2.54 cm (1/8–1 in.) ID, in customer-specified lengths	More information is available in the component selection guide
Connectors	Luers, quick connects, SIP connectors, tri-clamp, aseptic connectors, sterile connectors, steam-to, steam-through, sample ports, plugs, etc.	More information is available in the component selection guide
Probe ports	Additional ports: second row of four	The reusable probe port connection uses a Kleenpak connector only
Disposable sensors	Pressure sensor: PendoTECH™ DO and pH: Hamilton™ and PreSens™ pH: Mettler Toledo™	Choice of qualified sensors available
Additional probe ports	Limited engineer-to-order customization only	Qualified location on second row of probe ports only
Port sizes	Limited engineer-to-order customization only	Dependent on location in BPC and fit with hardware (e.g., 2.54 cm (1 in.) port on harvest line)
Rearrangement of lines on existing ports	Limited customization possible, e.g., moving sample/thermowell port to a probe tube port, or swapping overlay inlet line with supplement line	Dependent on location in BPC and fit with hardware
Sparger	Drilled-hole, cross-flow, and overlay spargers standard	Sparger locations are fixed
Diptube lines	Limited customization possible	Length cannot interfere with impeller and shaft
Overlay and sparger line filters	Filter options available from standard component library	Choice of qualified filters available
Vent filters	Standard is Pall or Meissner 0.2 µm exhaust vent filter	Filters must be compatible with available vent filter heater configurations
Vent filter tubing length	Extended filter height above the S.U.B. BPC is made-to-order	Must be compatible with a vent filter bracket option
Filters on media and supplement inlets	Limited engineer-to-order customization only; choice of filters used to sterilize incoming media or supplements is available	Choice of qualified filters available

External controller options

The HyPerforma S.U.B. offers an open architecture or turnkey system. An open architecture system allows you to use any control system of your choice. The capital investment can be reduced by using a control system already utilized in your facility. A turnkey system is a ready-to-use, out-of-the-box system with a choice of dedicated controls from Thermo Fisher Scientific or Applikon. These systems work on DeltaV™, Allen Bradley™, or Siemens™ formats. Contact your local sales representative for more information.

Ordering information

Product	Quantity	Cat. No
S.U.B. hardware unit	1 unit	SUB0250.8300
S.U.B. BPC CX5-14 film	1 unit	SH31074.01
S.U.B. BPC Aegis5-14 film	1 unit	SH31075.01
Bioreactor probe assembly with CPC AseptiQuik connector (nonsterile for use in autoclave)	12 units	SH30720.02
Heavy-duty tubing clamp	12 units	SV20664.01
Autoclave tray for autoclaving probe accessories	1 unit	SV50177.01

Auxiliary components supporting the HyPerforma S.U.B. (supplied by end user or requested turnkey)

Product	Quantity	Purpose
Bioreactor control system	1	Necessary for feed strategies, gas flow, DO, and pH control
DO probe	*	Autoclavable probe (13 mm x 13.5 PG thread with 195–235 mm insertion length)
pH probe	*	Autoclavable probe (13 mm x 13.5 PG thread with 195–235 mm insertion length)
Sterile/aseptic connection	*	Tubing welder, steam-in-place, sterilizer, or laminar flow hood
Stand-alone peristaltic pump	*	Used for fluid transfer between line sets on the containers
Temperature control unit (TCU)	*	Necessary for temperature controls (not provided)

* Quantity based on needs.

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