

Single-use bioreactors

HyPerforma 5:1 1,000 L Single-Use Bioreactor

Introduction

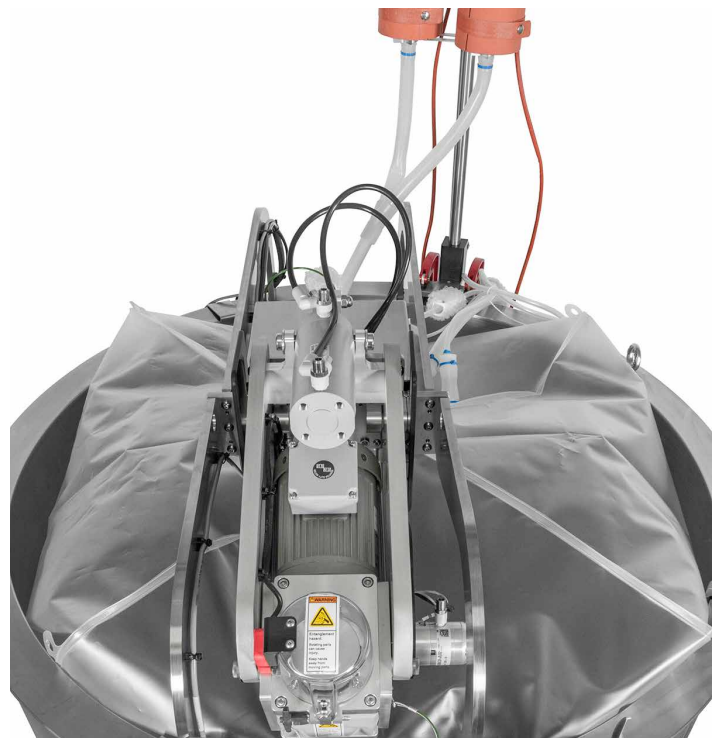
The Thermo Scientific™ HyPerforma™ Single-Use Bioreactor (S.U.B.) provides state-of-the-art functionality, ease of use, and efficiency. A complete HyPerforma S.U.B. system consists of a bioreactor tank and a HyPerforma S.U.B. BioProcess Container (BPC), which is available in 50, 100, 250, 500, 1,000, 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 1,000 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
- Adjustable impeller position for a 2:1 or 5:1 turndown ratio

This data sheet provides information on the HyPerforma 5:1 1,000 L S.U.B. system, which includes the tank and standard S.U.B. BPC. The BPC utilizes a dual-sparger design with a drilled-hole sparger for cultures at nominal volume, and a cross-flow sparger strategically positioned just above the 20% liquid volume for seed cultures. The patented cross-flow sparger supports efficient cell culture at a lower volume. Both sparge designs have been rigorously tested to provide high $k_L a$ values and optimal CO₂ 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 1,000 L standard 5:1 S.U.B. hardware units are available in the configurations below.

- 1,000 L jacketed S.U.B. with a 5:1 turndown ratio, AC motor, no E-box, and load cells without display
- 1,000 L jacketed S.U.B. with a 5:1 turndown ratio, AC motor, 240 VAC, E-box, and analog load cells

Table 1. 1,000 L standard 5:1 S.U.B. hardware unit with casters (leveling feet).

Description	Cat. No.
1,000 L jacketed S.U.B. with a 5:1 turndown ratio, AC motor, no E-box, single 120 in. Bulgin RTD, 3-piece driveshaft, no cable management tree, and no load cell display	SUB1000.9009
1,000 L jacketed S.U.B. with a 5:1 turndown ratio, AC motor, 240 VAC, E-box, single 120 in. Bulgin RTD, 3-piece driveshaft, no cable management tree, and analog load cells	SUB1000.9010

Hardware dimensions

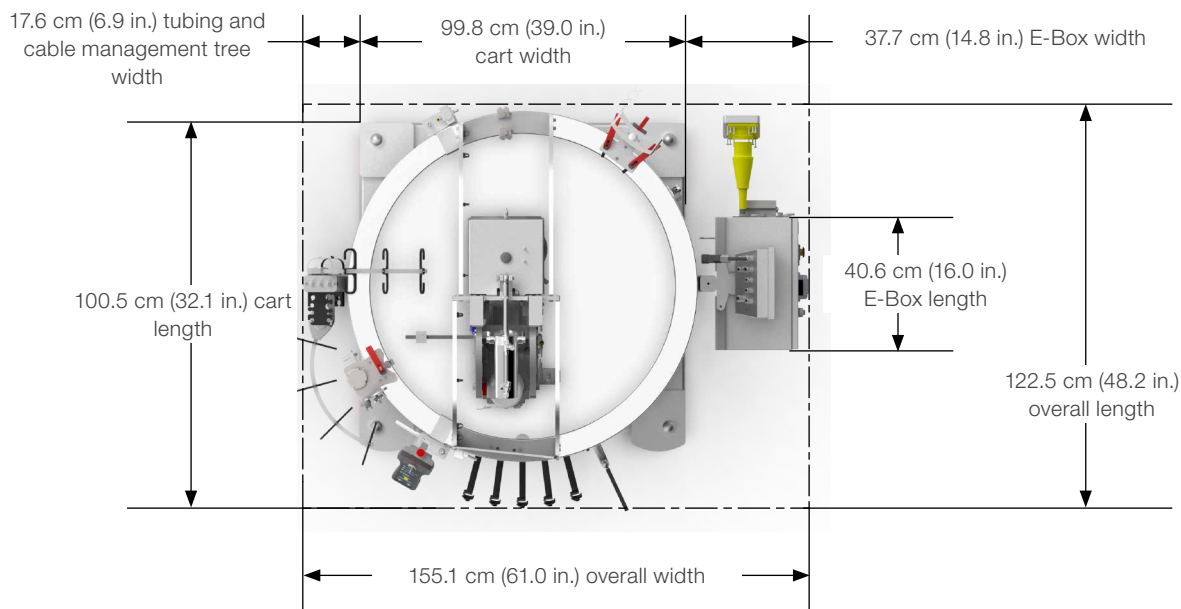


Figure 1. 1,000 L S.U.B. dimensions (top view).

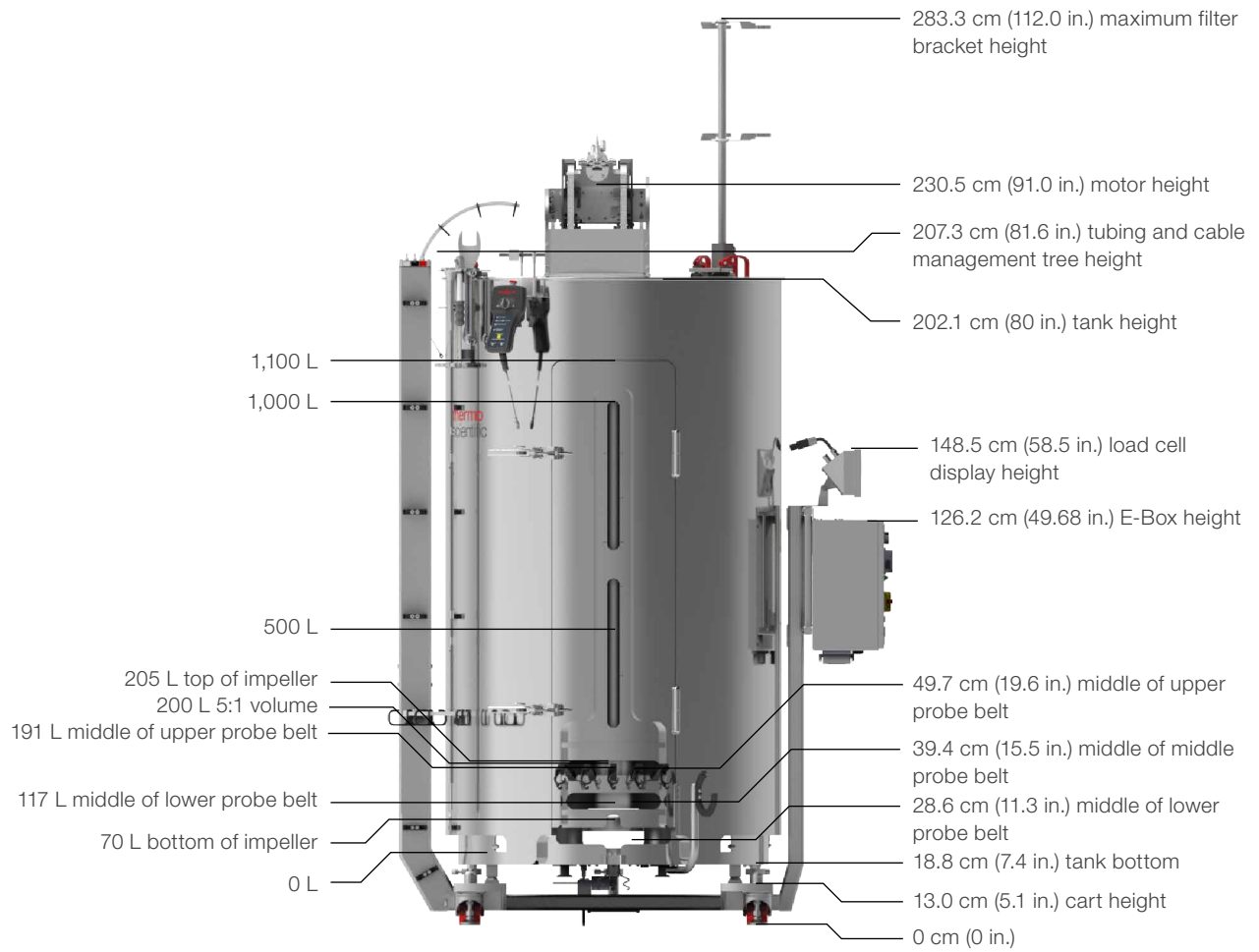


Figure 2. 1,000 L S.U.B. dimensions (front view).

Design features

1. Mixing assembly with motor safety shield
2. Handheld controller for motor adjustment (on bracket)
3. Driveshaft (stored)
4. BPC loading door and liquid sight windows
5. Probe hanger bracket (with probe clips)
6. Probe access windows
7. Exhaust vent filter holder
8. Motor lift
9. Mixer motor
10. Electrical control panel (optional)
11. Cart assembly
12. Stainless steel (304) outer support container with 0.95 cm (3/8 in.) dimpled jacket
13. Bleed valve
14. Load cell (3)
15. Leveling casters
16. 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
17. Tubing and cable management tree
18. Bottom cutouts/pins for BPC attachment/alignment
19. Tri-clamp water inlet/outlet ports

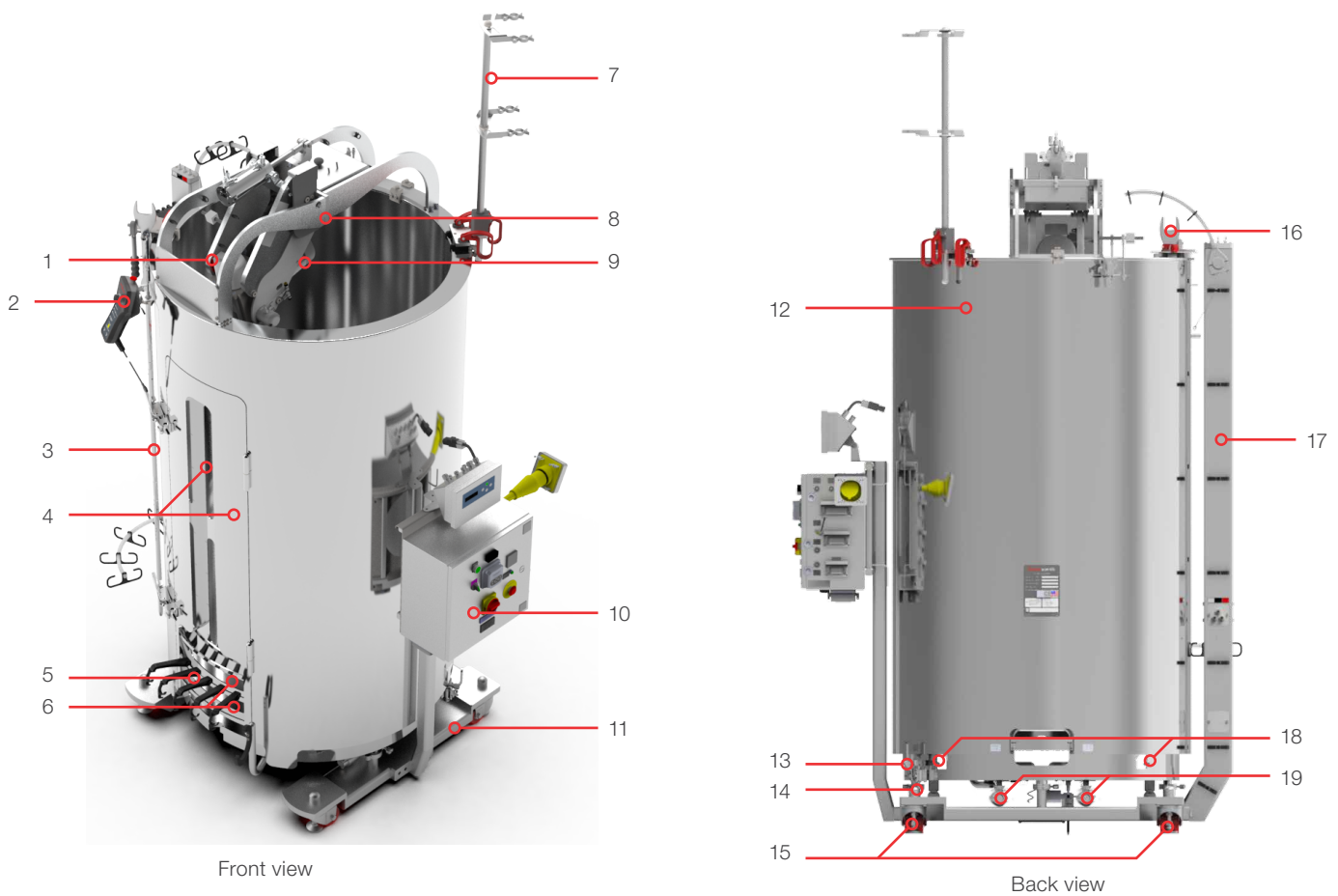


Figure 3. 1,000 L 5:1 S.U.B. hardware unit.

Table 2. Standard 1,000 L S.U.B. system specifications.

		AC Motor	DC Motor
Bioreactor geometry	Rated liquid working volume	1,000 L	
	Minimum liquid working volume (5:1 operation)	200 L	
	Total reactor volume (liquid and gas)	1,320 L	
	BPC chamber diameter	95.9 cm (37.75 in.)	
	BPC chamber shoulder height	200.7 cm (79 in.)	
	Liquid height at rated working volume	142.2 cm (56 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 driveshaft loading	287 cm (113 in.)	
	Electrical power supply requirement (voltage, phase, current)	208–240 VAC, single, 30 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	31.95 cm (12.58 in.)	
	Impeller-calculated power number (N)	2.1	
Agitation	Maximum mixing rate	110 rpm	
	Nominal agitation rating (power/volume)	20 W/m ³	
	Nominal agitation, 20% working volume (5:1 operation)	50 rpm	
	Nominal agitation, 50% working volume	68 rpm	
	Nominal agitation, 100% working volume	86 rpm	
	Nominal tip speed	146.1 cm/s (287.6 ft/min)	
	Counterclockwise mixing flow direction	Down-pumping	
	Agitation shaft resolved angle (5:1 operation)	15.3°	
	Agitation shaft centerline offset	5.08 cm (2 in.)	
	Overall driveshaft length	167.6 cm (66 in.)	
	Driveshaft diameter	1.90 cm (0.75 in.)	
	Driveshaft poly-sheath outside diameter	3.49 cm (1.375 in.)	
Impeller clearance from tank bottom (5:1 operation)	9.73 cm (3.83 in.)		

Table 2. Standard 1,000 L S.U.B. system specifications (continued).

		AC Motor	DC Motor
Motor	Agitation motor drive (type, voltage, phase)	Induction, 208 VAC, 3-phase	Brushless, 48 VDC, 3-phase
	Motor power rating	372.8 W (0.5 hp)	400 W (0.54 hp)
	Motor torque rating	27.7 N-m (245 in.-lb)	22.48 N-m (199 in.-lb)
	Gear reduction	15:1	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	3.31 m ² (35.6 ft ²)/1.38 m ² (14.9 ft ²)	
	Jacket volume	23.5 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	9,000 W	
	Approximate liquid heat-up time (5–37°C), 20% volume	1.2 hr	
	Approximate liquid heat-up time (5–37°C), 100% volume	4.1 hr	
	RTD or thermocouple, 3.18 mm (1/8 in.) OD	RTD: Pt-100 (standard)	
Support container	Overall width	167.1 cm (65.8 in.) with E-Box 129.1 cm (50.9 in.) without E-Box	
	Overall length	136.6 cm (53.8 in.)	
	Overall height	249.4 cm (98.2 in.)	
	Dry skid weight	655 kg (1,444 lb)	
	Wet skid weight at rated working volume	1,655 kg (3,649 lb)	
Recommended operating parameters	Operating temperature range	Ambient to 40 ± 0.5°C (104 ± 0.9°F)	
	Motor speed	20–110 rpm	
	Volume range	200–1,000 L	
	Maximum BPC pressure	0.03 bar (0.5 psi)	
	Continuous operating time	21 days mixing time at nominal volume only	
Motor lift	Power supply requirements	24 VDC, 90 psi of air	
	Weight	115.21 kg (254 lb)	

System options

- **Bioreactor probe assembly** (Figure 4)—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
- **Sparg line support** (Figure 5)—keeps gas lines in an upright position for optimal gas transfer
- **Heavy-duty tubing clamp** (Figure 6)—used for each probe port not in use, eliminating process fluid holdup
- **Autoclave tray for probe kits** (Figure 7)—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 4. Bioreactor probe assembly.



Figure 5. Sparg line support.



Figure 6. Heavy-duty tubing clamp.

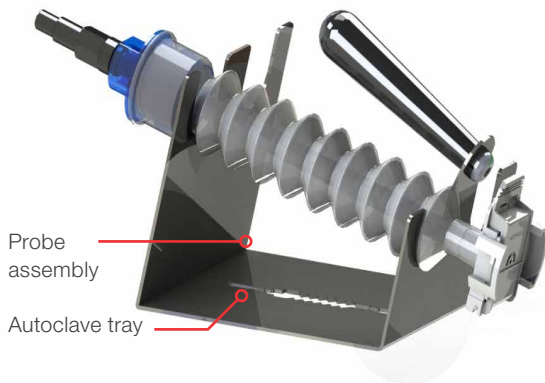


Figure 7. Autoclave tray for probe kits.

- **S.U.B. temperature sample port** (Figure 8)—provides *in situ* temperature monitoring during culture process
- **Load cells** (Figure 9)—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 10)—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 8. S.U.B. temperature sample port.



Figure 9. Load cells.



Figure 10. Tubing and cable management tree.

Table 3. 1,000 L S.U.B. system options.

Description	Cat. No.
Tubing and cable management tree	SV50992.04
Autoclave tray	SV50177.01
Bioreactor probe assembly with CPC AseptiQuik connector (nonsterile for use in autoclave)	SH30720.02
Sparge line support	SV50177.65
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, 99.6 W, Meissner™ 10 in. series 46 vent filter heater, preset temperature bulb, IEC 320 C14	SV50191.33
240 VAC, 99.6 W, Meissner 10 in. series 46 vent filter heater, preset temperature bulb, IEC 320 C14	SV50191.34
120 VAC, 99.6 W, Meissner 10 in. series 46 vent filter heater, integrated, M12–4 pin connector*	SV50191.47
240 VAC, 99.6 W, Meissner 10 in. series 46 vent filter heater, integrated, M12–4 pin connector*	SV50191.48
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 11. 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 1,000 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	SV50237.22
AC motor	SV50237.19
Drive shaft	SV50177.155
RTD 304.8 cm (120 in.) with Bulgín 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

1,000 L standard 5:1 S.U.B. BPC systems

Table 7 shows the available standard 1,000 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. 1,000 L standard 5:1 S.U.B. BPCs.

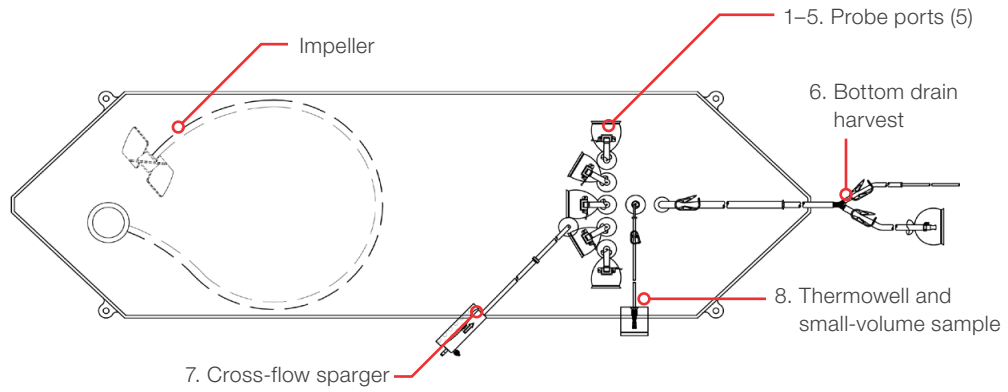
Film	Cat. No.
CX5-14 film	SH31132.01
Aegis5-14 film	SH31133.01

Table 8. 1,000 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

BPC features

Front face



Back face

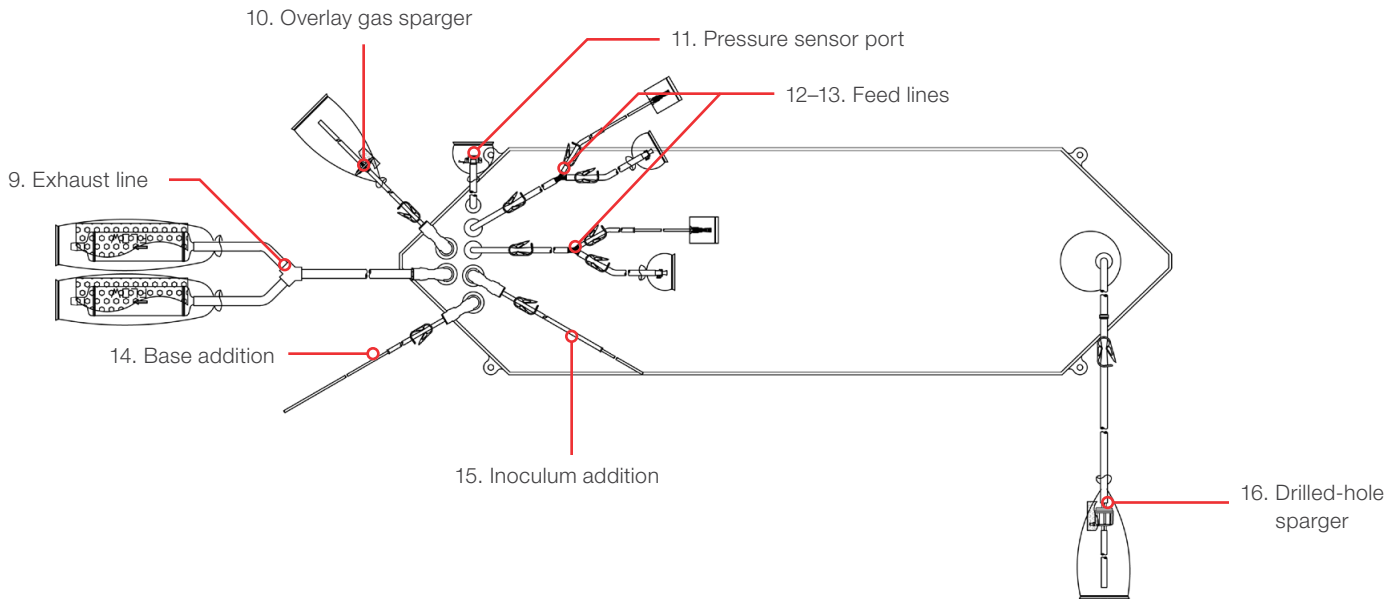


Figure 12. Standard 1,000 L 5:1 S.U.B. BPC.

Table 9. 1,000 L standard 5:1 S.U.B. BPC specifications.

Description		Tubing set (inner diameter x outer diameter x length)	End treatment
1–5.	Probe ports (5)	12.7 mm (1/2 in.) tube ports	CPC AseptiQuik aseptic connectors
6.	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 6.4 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	Plugged 9.5 mm (3/8 in.) MPC insert
7.	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
8.	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
9.	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	Meissner Ultra Cap 0.2 µm exhaust filters
10.	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	Hydrophobic vent filter with Emflon™ II membrane, connected to 15 cm (6 in.) C-Flex tubing
11.	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
12–13.	Feed lines	9.5 mm x 15.9 mm x 213 cm (3/8 in. x 5/8 in. x 84 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
14.	Base addition	6.4 mm x 11.1 mm x 213 cm (1/4 in. x 7/16 in. x 84 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
15.	Inoculum 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 213 cm (1/8 in. x 1/4 in. x 84 in.) C-Flex tubing	Plugged
16.	Drilled-hole sparger, 8.9 cm (3.5 in.) disk with 360 0.178 mm (0.007 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 97 cm (1/4 in. x 7/16 in. x 38 in.) C-Flex tubing	Kleenpak™ with Emflon™ II 0.2 µm membrane hydrophobic filter connected to 15 cm (6 in.) C-Flex tubing

BPC options

Table 10 lists available custom 1,000 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 1,000 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	SUB1000.9009
S.U.B. BPC CX5-14 film	1 unit	SH31132.01
S.U.B. BPC Aegis5-14 film	1 unit	SH31133.01
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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