

Helium Controller for Particle Therapy Systems



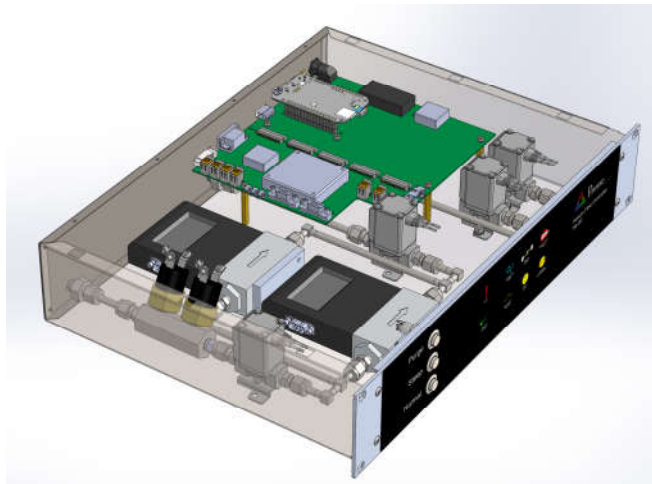
Features

- Controls and monitors helium concentration, pressure and flow to maintain a known and stable helium-filled beamline segment.
- Mass flow control of flow and purge
- Fully automated startup, purge and flow sequences
- Front panel control or remote control via Ethernet with browser interface
- Integrates with Pyramid nozzle systems
- Detection of residual oxygen
- Logging of helium consumption
- Detection of fault conditions including over and under-pressure
- Interlock relay
- Parameters adjustable under software control to suit different system configurations
- Pressure servo alternative operating mode

Applications

- Particle therapy nozzle automated helium beampath control.

- Dual mass-flow controllers.
- All stainless-steel internal pipework
- Compact 2U chassis
- Full access via remote control using simple browser interface
- Unit can be located on a gantry
- Remote sensor head monitors pressure, orientation, temperature and residual oxygen close to the helium chamber



Specifications

Sustain flow control	Helium, regulated by 0 to 30 sccm mass flow controller
Purge control	Helium, regulated by 0 to 5000 sccm mass flow controller
Helium supply	N2.0 grade (99%) helium gas at 15 psi. Typical sustain flow rate 10 sccm (depending on chamber size and integrity). L size cylinder (9 m ³) duration approx. one year including purge cycles.
Inlet pressure sensing	Pressure switches set at 10 psi (low pressure limit) and 30 psi (high pressure limit)
Helium chamber pressure sensing	+/- 1 psi pressure relative to atmosphere sensed by differential sensor in remote sensor head, resolution better than 0.1 psi.
Residual air detection	Oxygen sensor (optical fluorescence quenching) located in remote sensor head, measuring exhaust gas.
Chamber orientation sensing	Dual axis accelerometer located in remote sensor head detects gantry rotation.
Temperature measurement	IC temperature sensor device in remote sensor head.
HC80 internal pipework	Stainless steel pipes and fittings in helium supply path.
Controls	Three illuminated front panel buttons for Vent / Sleep / Operate functions.
Displays	Illuminated front panel indications for operational states and error conditions <ul style="list-style-type: none"> - System overall state ready / not ready - Excess oxygen detected - Remote sensor not present - Helium supply fault - Power was interrupted - Chamber is vented - Chamber pressure error
Processor	Sitara AM3358 (BeagleBone) ARM Cortex A8
Mass Flow Controllers	Two Sierra SmartTrack 50, calibrated for helium
Interlock relay	SR4 safety-rated relay, two poles in series. Detection of welded contact failure mode by built-in processor.

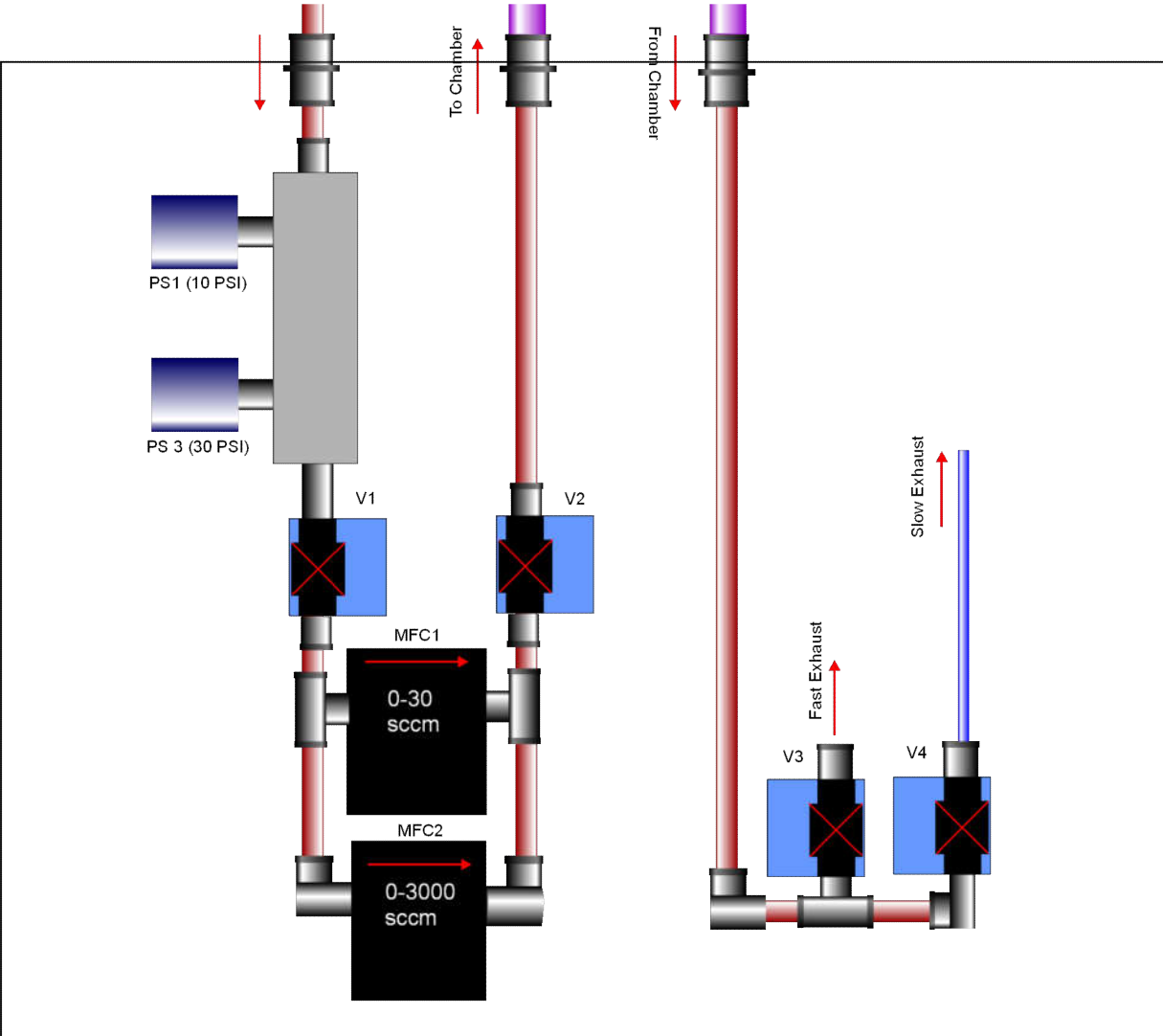


Specifications (continued)

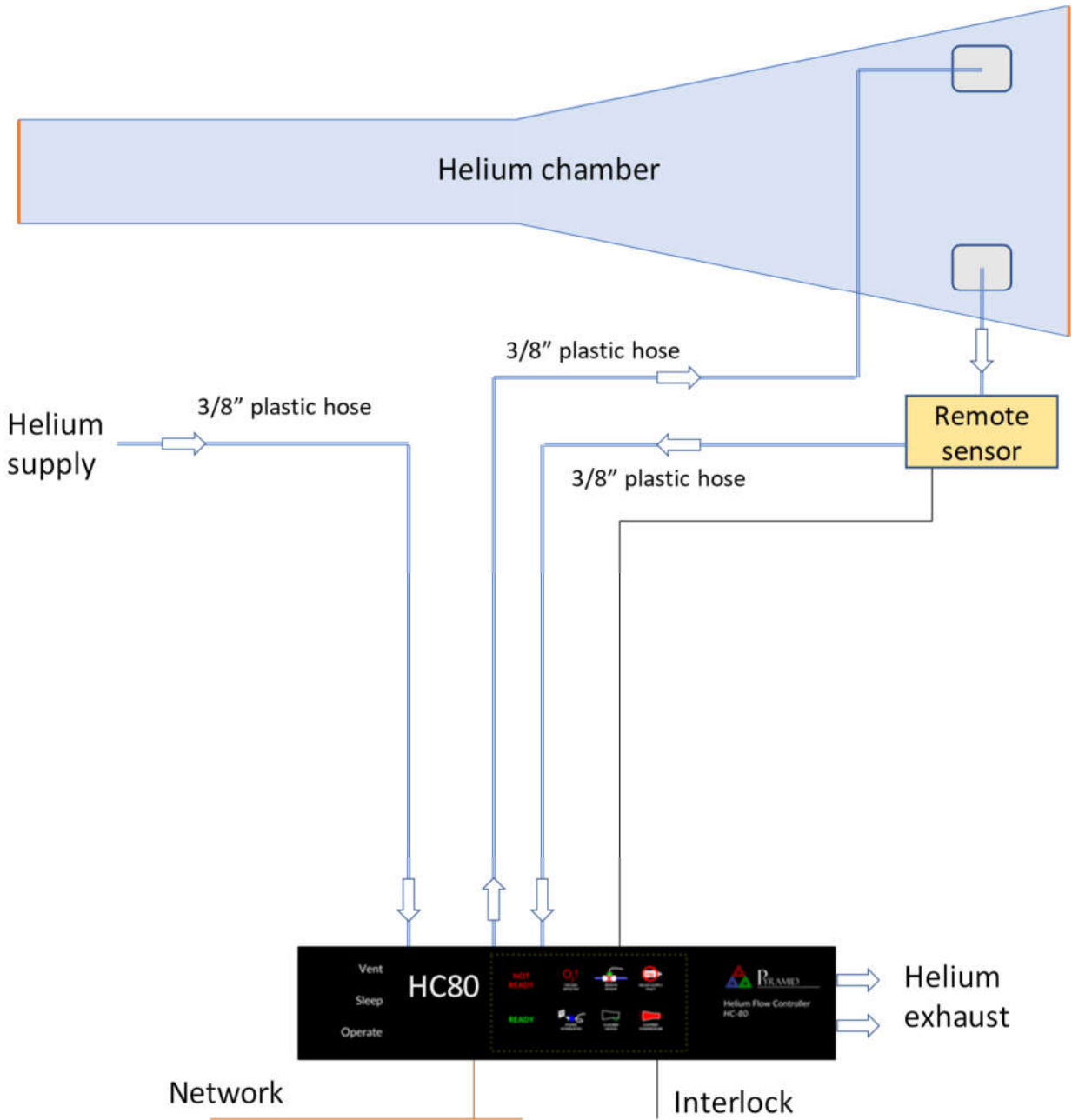
Power input	+24 V (+/- 2V) DC, 2000 mA typ, 2500 mA max. Diode polarity protection. 30 V transorb overvoltage protection across input.
Fuses	Self-resetting PTC fuses: 24 V input 1100 mA on logic board 24 V out (interlock circuit) 200 mA Solenoid coil drive 6 x 200 mA Cooling fan 200 mA
HC80 case	2U by 341 mm deep 19" rack mounting steel chassis with Al alloy front panel Filtered cooling fan fitted to rear panel.
Remote sensor case	Aluminium box 97 mm x 56 mm x 30 mm excluding pipe connections. Under-side of PCB forms one face of the case.
Weights	HC80 unit 7.6 kg (16.8 lb) Remote sensor 0.3 kg (0.7 lb)
Remote sensor unit location	Close to helium chamber exhaust in series in pipeline. Case should be mounted oriented with gantry rotation and such that descriptive decal is up-permost and parallel to the floor when gantry is at 90 degrees.
Operating environment	15 to 30 C (18 to 25 C recommended for optimum performance) , < 70% humidity, non-condensing, vibration < 0.1g all axes (1 to 100 Hz) Note: Due to its weight, the HC80 main unit must be supported by full depth angle brackets in a 19" cabinet installation, not only from the front panel. Note: In a gantry installation, the unit must be supported to prevent strain to the front panel also for the inverted position.
Shipping and storage environment	-10 to 50 C, < 80% humidity, non-condensing, vibration < 0.5 g all axes, 1 to 100 Hz



HC80 flow schematic



System configuration



Gas connectors

Helium connections to HC80 unit	Three 1/4" NPT female threaded ports for helium supply in, chamber flow out, chamber flow return. Unit is supplied with push-fit adaptors to for 3/8" od plastic tubing.
Helium connections to remote sensor unit	Two 1/4" NPT female threaded ports for gas in and gas out. Fitted with brass push-fit adaptors for 3/8" plastic hose as standard.

Electrical connectors

Remote connection to sensor unit	HD15 male (HC80), HD15 female (remote sensor). <table border="1"> <tr> <td>1</td> <td>X acceleration</td> <td>6</td> <td>Gnd</td> <td>11</td> <td>Y acceleration</td> </tr> <tr> <td>2</td> <td>Gnd</td> <td>7</td> <td>Pressure</td> <td>12</td> <td>Gnd</td> </tr> <tr> <td>3</td> <td>O2 sensor xmit</td> <td>8</td> <td>O2 sensor rcv</td> <td>13</td> <td>Gnd</td> </tr> <tr> <td>4</td> <td>Temperature</td> <td>9</td> <td>Gnd</td> <td>14</td> <td>5 V ref</td> </tr> <tr> <td>5</td> <td>+15 V</td> <td>10</td> <td>Gnd</td> <td>15</td> <td>-15 V</td> </tr> </table>	1	X acceleration	6	Gnd	11	Y acceleration	2	Gnd	7	Pressure	12	Gnd	3	O2 sensor xmit	8	O2 sensor rcv	13	Gnd	4	Temperature	9	Gnd	14	5 V ref	5	+15 V	10	Gnd	15	-15 V
1	X acceleration	6	Gnd	11	Y acceleration																										
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4	Temperature	9	Gnd	14	5 V ref																										
5	+15 V	10	Gnd	15	-15 V																										
Interlock	Four pin 3.81 mm header TE Connectivity 284541-4. Mating connector 284511-4 is included. <table border="1"> <tr> <td>1</td> <td>+24 V out, 200 mA fused</td> </tr> <tr> <td>2</td> <td>Relay contact</td> </tr> <tr> <td>3</td> <td>Relay contact</td> </tr> <tr> <td>4</td> <td>24 V return</td> </tr> </table>	1	+24 V out, 200 mA fused	2	Relay contact	3	Relay contact	4	24 V return																						
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2	Relay contact																														
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Diagnostics port	Six-pin 2.54 mm header TE Connectivity 826468-6. Processor serial debug - factory use only.																														
Ethernet	RJ-45 socket.																														
Power	Lemo Redel PXG.M0.2GG.NG. To suit mating connector PAG.M0.2GL type as fitted to Pyramid power supply PSU24-100M-1R. <table border="1"> <tr> <td>1</td> <td>+24 VDC in</td> </tr> <tr> <td>2</td> <td>24 V rtn</td> </tr> </table>	1	+24 VDC in	2	24 V rtn																										
1	+24 VDC in																														
2	24 V rtn																														
Ground lug	M4 threaded stud.																														



Operation - primary states

Vent	Long-term non-operating state. MFCs set to zero flow, vent valves open.
Sleep	Normal shut down state. System not vented to atmosphere, HC80 actively maintains a small positive pressure in the chamber.
Operate	Normal running state. The HC80 attempts to go to Operate mode directly at power-up. On enabling this mode, the system automatically performs a helium chamber flush to obtain the target low oxygen reading, for not less than five minutes. If the chamber orientation is not level (gantry not at 90 degrees), the HC80 will continue but will alert the user via the remote interface that the purge could be less efficient. If the purge exceeds the timeout limit, it will terminate to prevent unnecessary helium use and an error is reported. Once the flush is complete the system switches to a controlled low maintenance flow rate. The front panel "Ready" indication shows green to indicated that the system is operating normally with no errors. The system monitors and alerts errors: <ul style="list-style-type: none"> • residual oxygen too high • Sensor disconnected • Helium supply line less than 10 psi or unable to achieve flow target • Power was interrupted • Helium chamber pressure outside allowed band

Operation - host software functions

Helium supply log	The HC80 will monitor helium usage and report estimated helium remaining from the initial amount. The host software can provide graphical logs of usage.
Chamber integrity test	Automated function to check the helium chamber and connecting piping for leaks. A small helium overpressure is applied, and the pressure and temperature is monitored over a 15 minute period and compared to a reference response curve. Deviations beyond the allowed tolerance band indicate that the system has a leak.
Pressure PID mode	Normal operating mode maintains a specified flow rate of helium to the chamber. An alternative mode can be selected in which a servo controller maintains the pressure measured by the remote sensor by controlling the flow.
System setup	Access to system setup parameters for authorized users.



Browser interface

Gasket

Helium controller

0.0% Oxygen 21

0.49psi Pressure 0.5

86% Tank 100

-1.3e+2° Angle 180

Vent

Sleep

Operate

Status display

NOT READY

READY

O₂! OXYGEN DETECTED

He HELIUM SUPPLY FAULT

CHAMBER VENTED

CHAMBER OVERPRESSURE

REMOTE SENSOR

POWER INTERRUPTED

Configuration

0.5 % Oxygen threshold

0.05 psi Target pressure

0.07 psi Sleep pressure

0.3 psi Interlock pressure

60 sec Minimum purge time

3500000 cm3 Tank size

1000000 cm3 Tank volume

Refill tank

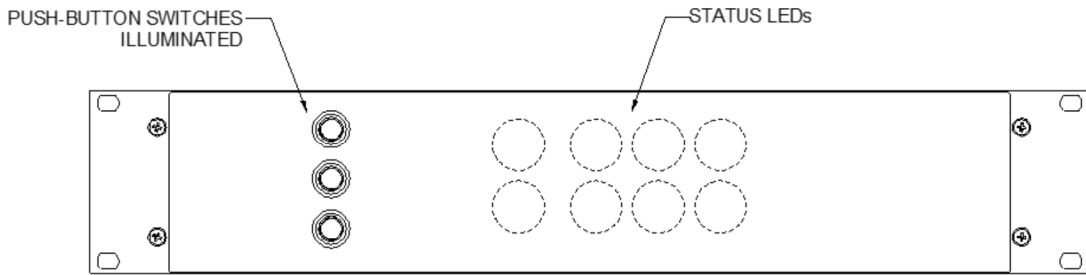
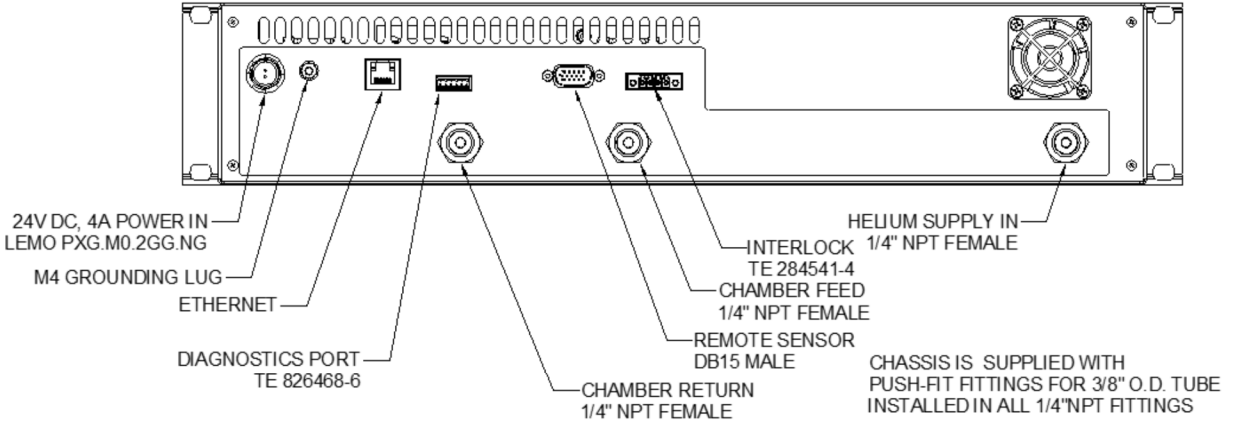
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Interfacing

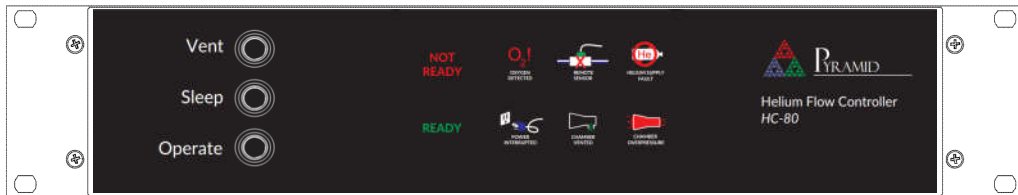
Interfaces	Ethernet 10/100 Mbps. UDP and TCP/IP. Auto MDIX.
	Diagnostic port for factory use only.



HC80 rear and front panels



Front panel showing controls and indicators

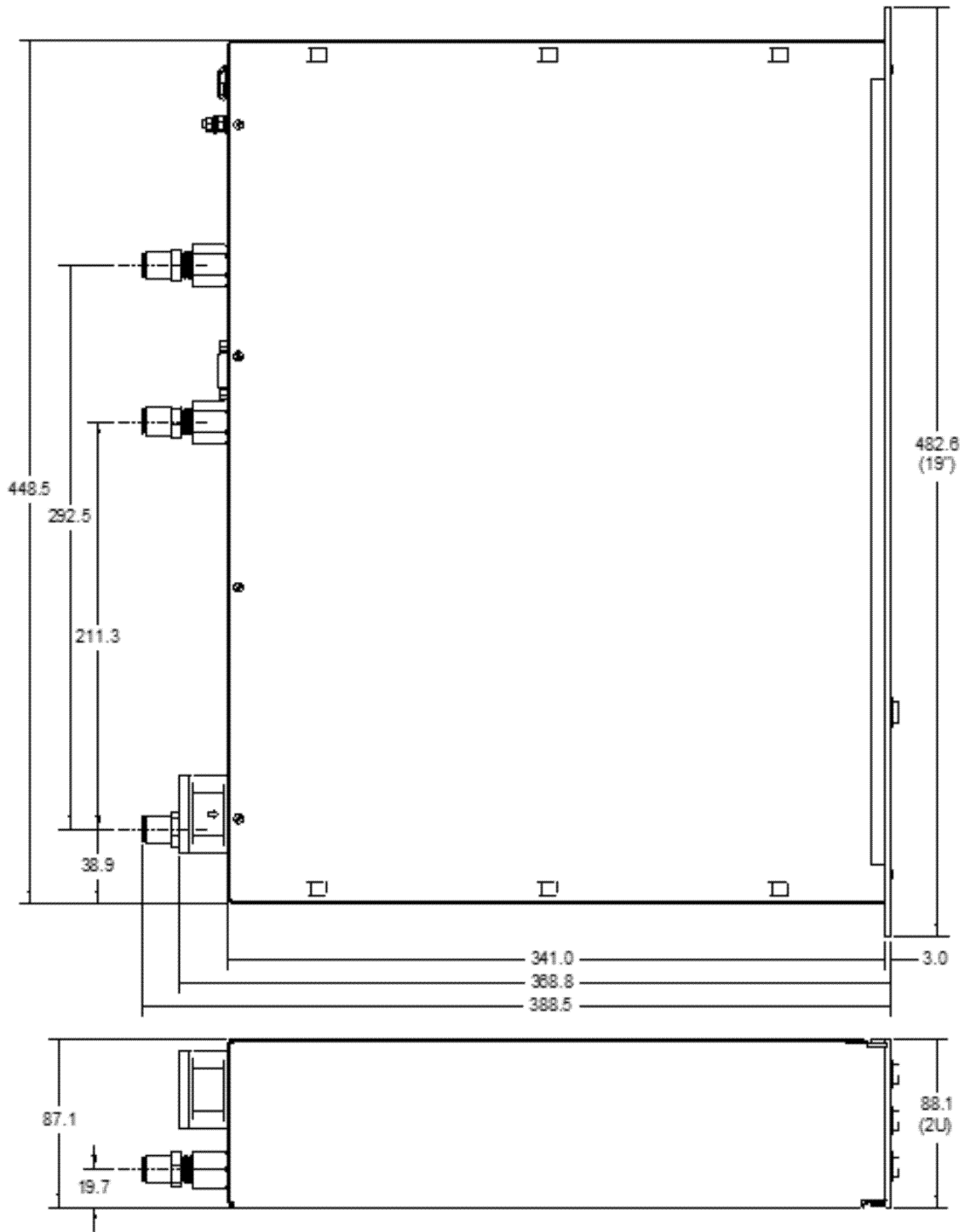


Ordering information

HC80	Helium controller including remote sensor unit.



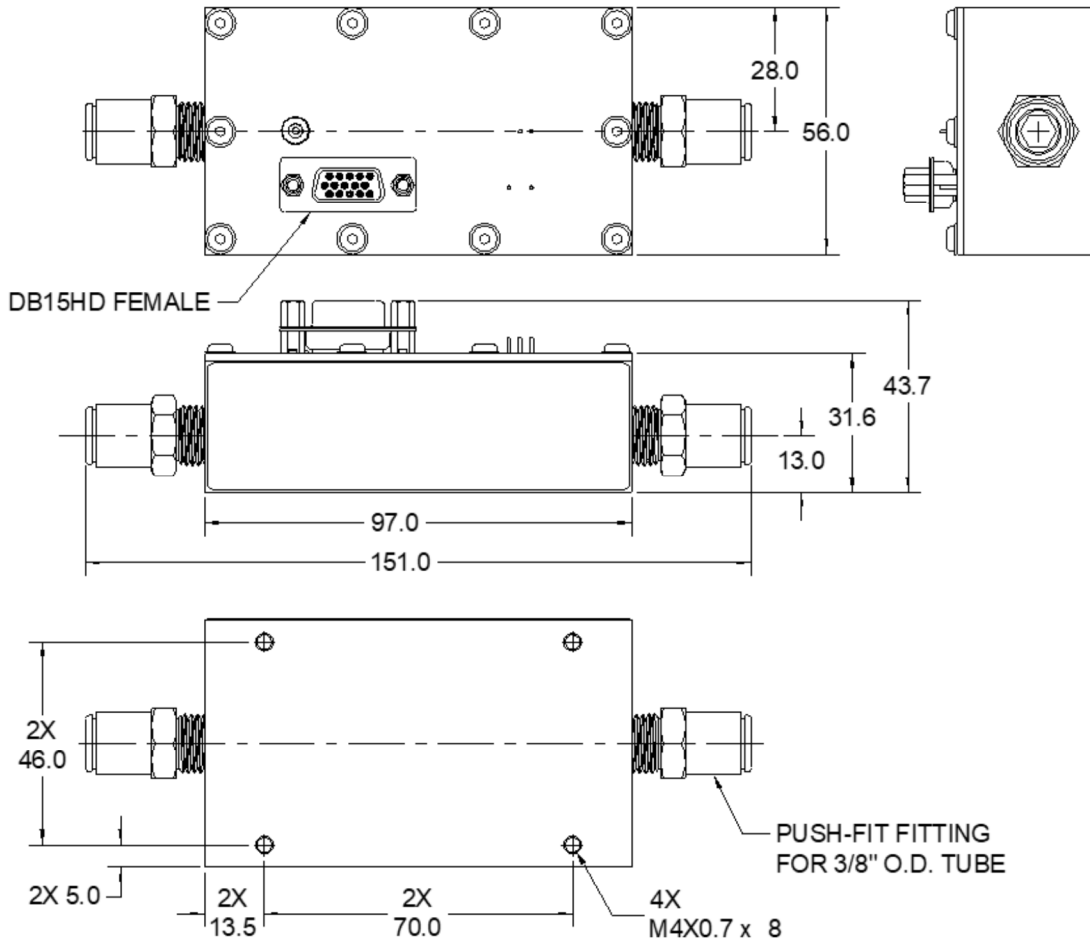
HC80 chassis



Dims mm



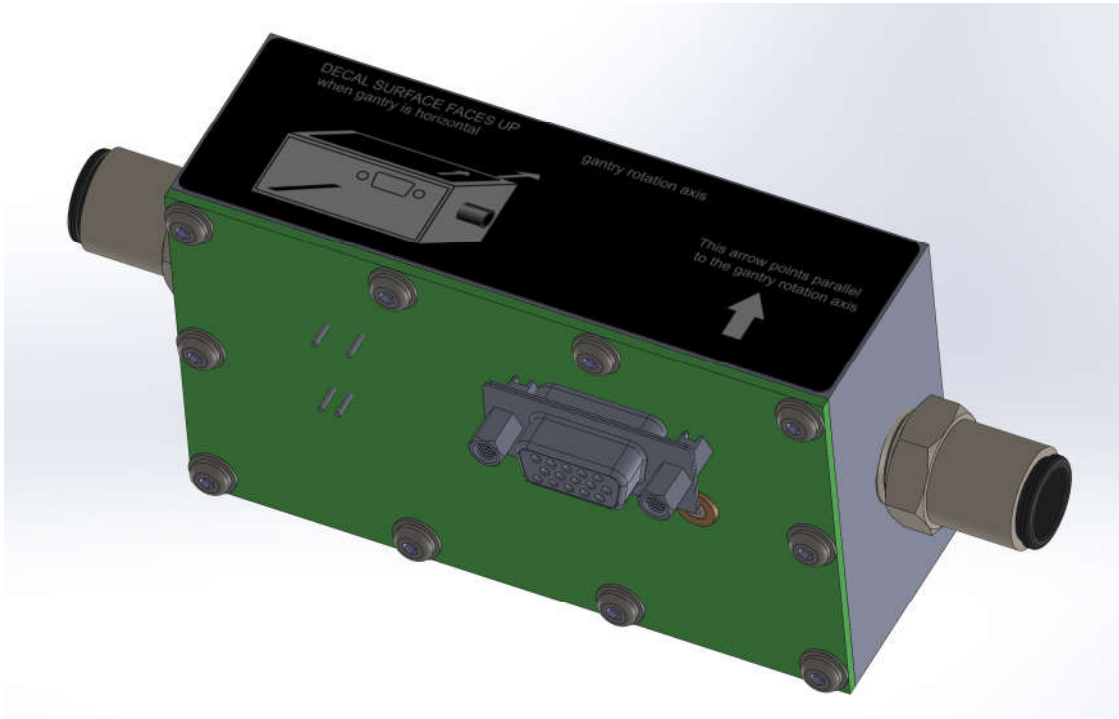
Remote sensor unit



Dims mm



Remote sensor unit



Shown with 1/4" NPT to 3/8" push-fit tube adaptors as supplied.
For gantry systems, top face should be parallel to ground when gantry angle is 90 degrees.
Arrow should be parallel to rotation axis.

Mounting hole pattern on base. Dims mm

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All trademarks and names acknowledged.

HC80_DS_171222

