PendoTECH Bioreactor Control & Data Acquisition System

PENDOTECH
Adding Value To Your Process

OPTIMIZED FOR All Single Use Bioreactors

PendoTECH Bioreactor Control System™

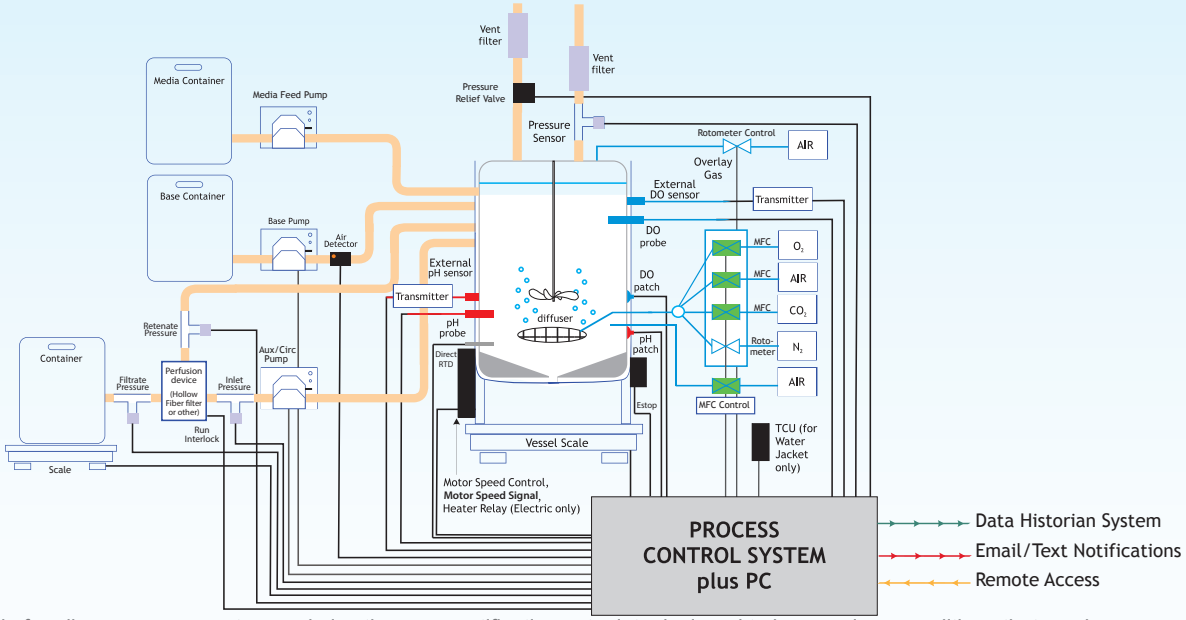
- For use with single use or glass bioreactors
- Complete process control, by PID control of gases, base addition and temperature
- Ability to use traditional pH and dissolved oxygen probes and an option to input additional sensors via external transmitters
- For continuous perfusion processes, vessel weight control feature and the ability to measure 3 pressures from an external perfusion device such as a hollow fiber filter
- Data acquisition & real-time trending with built-in OPC server
- Alarm condition monitoring including pressure monitoring
- Email/text message notifications on out of range process conditions
- Fed-batch addition schedule manager
- Simple wizards for calibration of probes
- Ability to control temperature by electric heater or for jacketed vessels by control of a stand-alone heating / cooling system (TCU)

Process System

Lab System

Product Overview

The PendoTECH Bioreactor Control System is loaded with features including an easy to use graphical user interface (GUI). The system offers the ability to monitor and control the pH, dissolved oxygen (DO), and temperature with PID control. Using an embedded transmitter from Mettler-Toledo, an industry standard, for monitoring pH and DO with standard probes, it delivers the advanced features and confidence required for measurement and control of the bioreactor. There is also the ability to use in parallel, for strictly monitoring or for process control, external pH and DO sensors. Alarm setpoints are available for all process parameters and also there are notification setpoints designed to be pre-alarm conditions that can be setup to send email/text message alerts so proper adjustments can be made before a critical alarm occurs. Over-pressure of the bioreactor may occur due to a vent filter clogging or other reason and to prevent a vessel failure, pressure monitoring critical. The highly accurate PendoTECH Pressure Sensor™ or other full-bridge type sensor provides monitoring of the pressure in the headspace and if a high pressure alarm is triggered, the system will actuate the optional valve signal to relieve pressure and if no change occurs it will go to an alarm mode or there is an option to go to a Standby Mode and heating and mixing remain active. The Run Interlock feature can be used to shut off an integrated perfusion system to automatically prevent the perfusion system from running when the bioreactor is not running. For continuous perfusion processes, there is a vessel weight control feature and the ability to measure 3 pressures from an external perfusion device such as a hollow fiber filter. Also, there is a non-invasive air detector on the base pump tubing that can indicate is the base container is empty. The system can also be configured to run in a fermentation mode where the upper pH limit is controlled by the AUX pump which is PID controlled for acid addition.

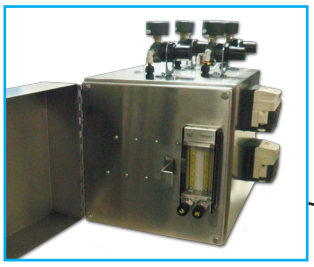


Product Overview

At the heart of the system is the PendoTECH Process Control System platform which is the embedded microcontroller along with its range of input and output cards that can handle the wide range of signals required for monitoring and control of all the features in the bioreactor control system. This same control platform has been used by leading companies in the industry since 2005 for critical bioprocess operations.

Some of the features of the PendoTECH Bioreactor Control System are shown below.

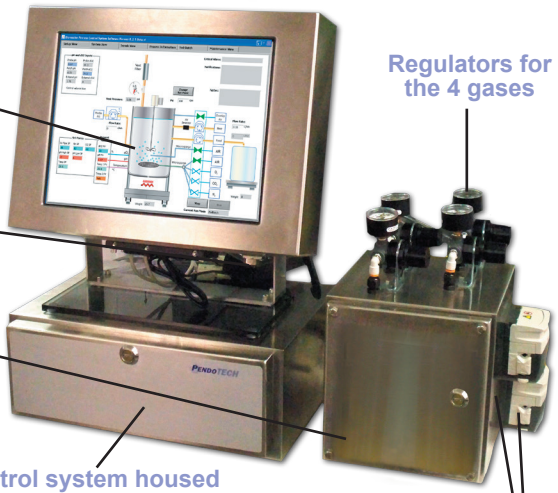
Process System



There are 4 MFCs for PID control and 2 rotometers (for air overlay and nitrogen sparge) which are only controlled by ON/OFF control. These are housed behind a door which can keep the setpoints secure and also gives easy access to the MFC mounting panel for potential service. The 3 gas outlets are on the rear. The max MFC value can be scaled back to 20% of maximum to give the flexibility to handle a range of vessels with the same MFC.

Optional Touch Screen IP66 water-tight PC with Windows 7 GUI software

Panel mount USB & Ethernet connectors



Regulators for the 4 gases

Entire control system housed inside of compact enclosure with optional mounting brackets for bottom

Base and Feed Pump

Lab System

Heater/Motor Control Box

Connects to Bioreactor Motor/ Temperature Control connector and receives signals to control the mixer servo motor and signal to turn the heater on/off

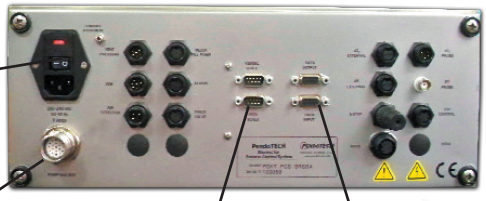
Lab Gas/ Pump Box

Front access to pumps (reversible), regulators, overlay and sparge fittings outlets, and rotometers (4 inlet gases connect to rear)

Control System Hardware Details

Connection of all inputs and outputs are on the back panel. They are keyed to prevent wrong connections. The Bioreactor Motor/Temperature Control connector carries signals for motor speed control and monitoring and the temperature control relay. The Gas/Pump Box connector carries the Base and Feed pump speed control signal along with the MFC and rotometer control signals along with power to the Gas/Pump Box.

Drop-down hinged door with ¼ turn screw to prevent to access specific admin functions



One power connect for entire system (100-250-VAC)

Control and power to gas/pumpbox

Connection for external scales

Connections to the PC

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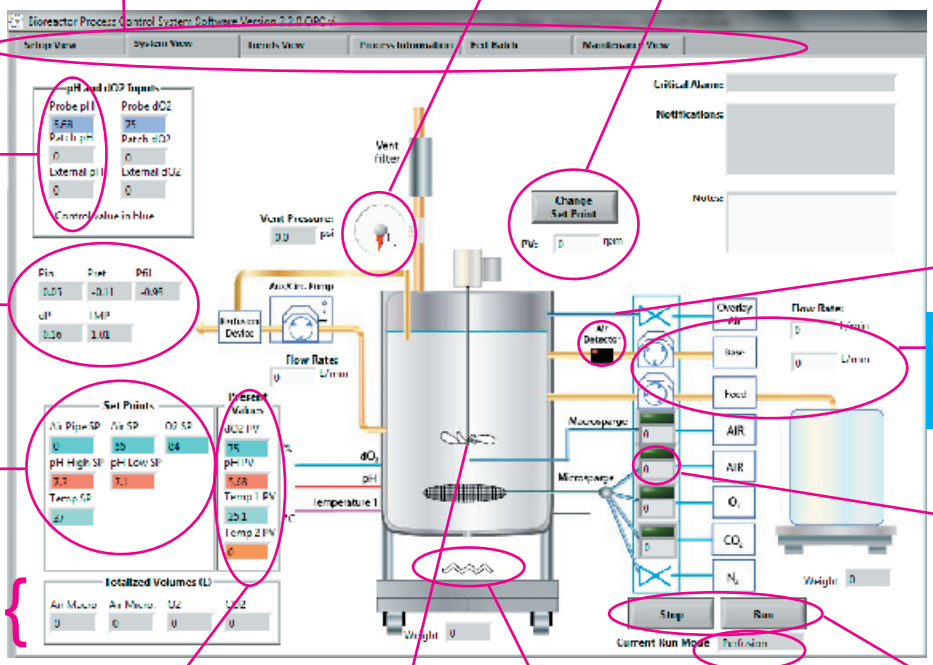
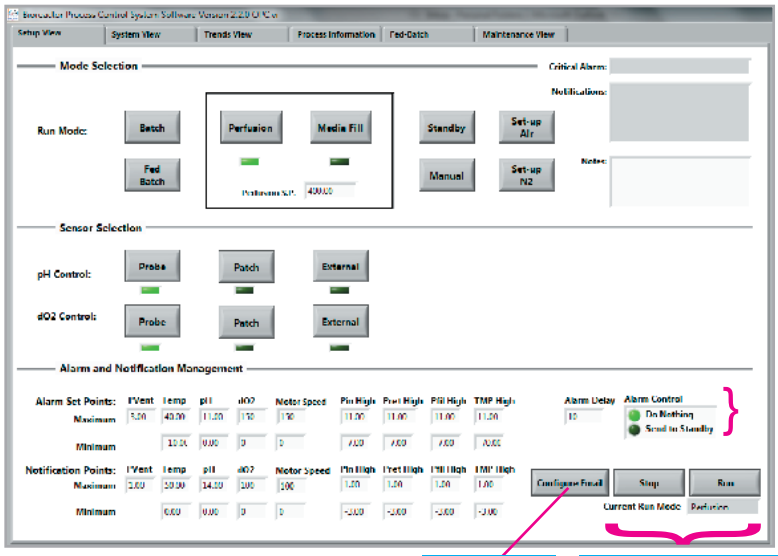
Graphical User Interface

- Designed for a touch-screen PC
- Simple tab-based navigation
- Real-time trending module with advanced features
- Pop-up keypad used to change values
- Writes data to locked file on a real-time basis
- Ability to record time-stamped electronic notes to data file
- Animated indication of process hardware for remote monitoring process visualization
- Manages notification of process conditions out of range



Setup View

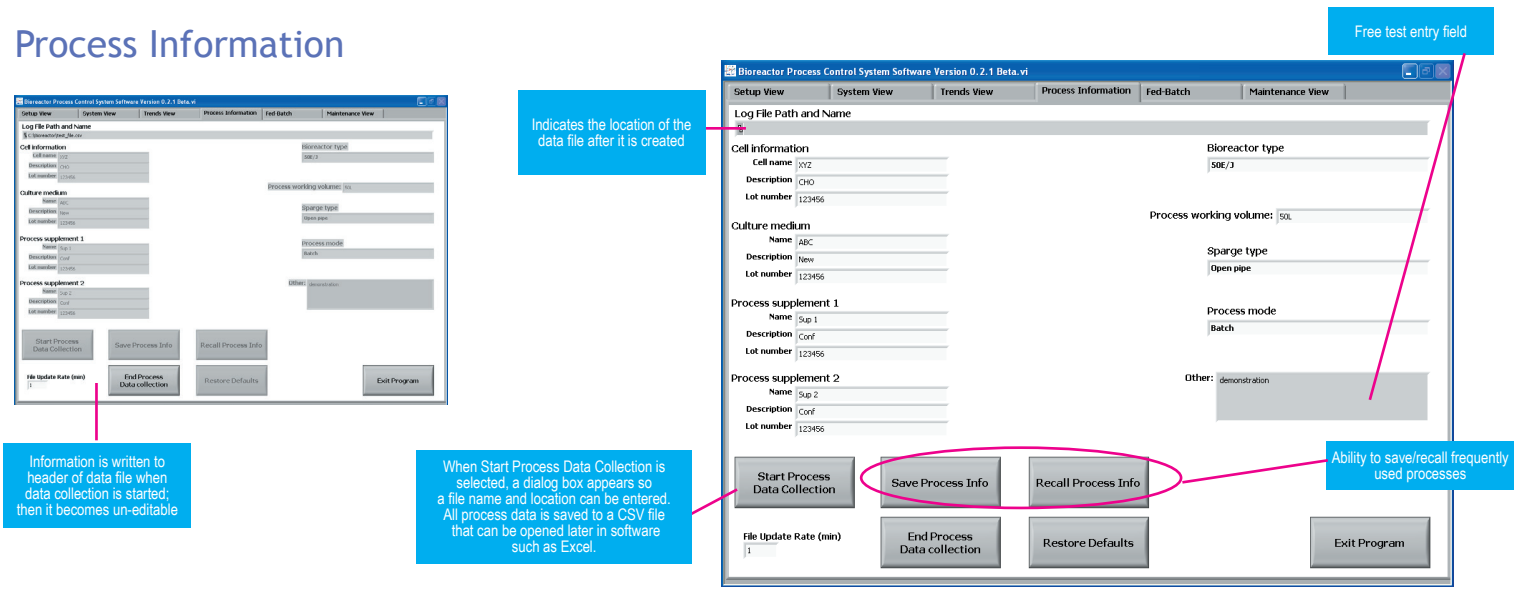
- Change current mode of operation
- Select the present value source for pH and dissolved oxygen control
- Enter critical alarm setpoints
- Enter process notification settings



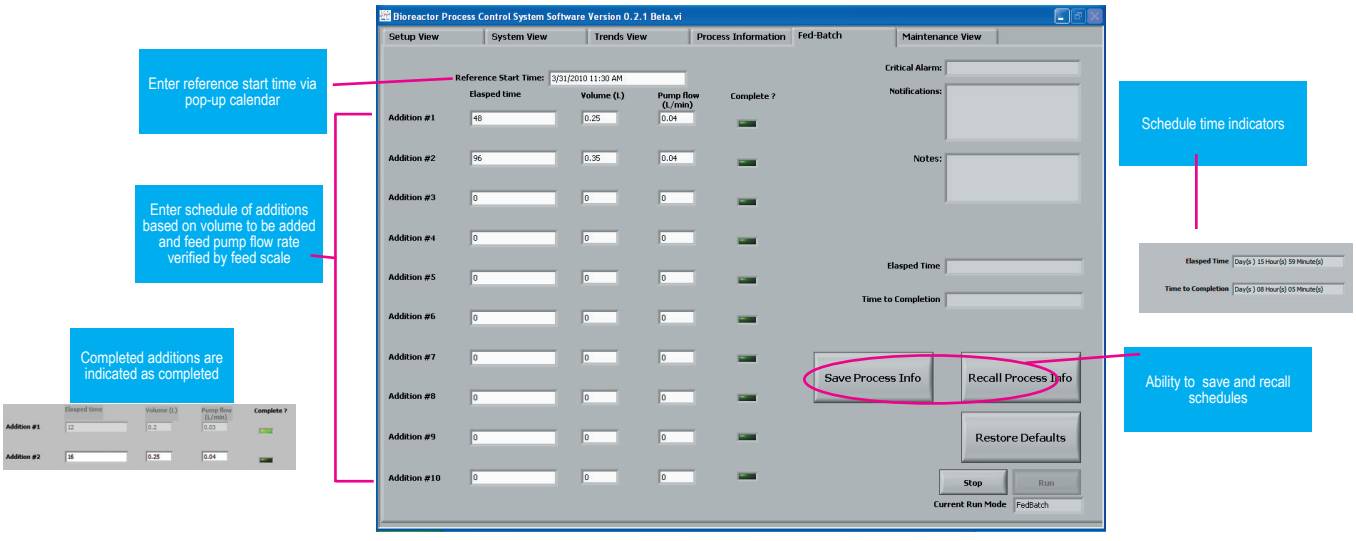
Technical Information

Trends View

Process Information



Fed Batch Manager



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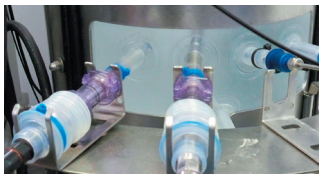
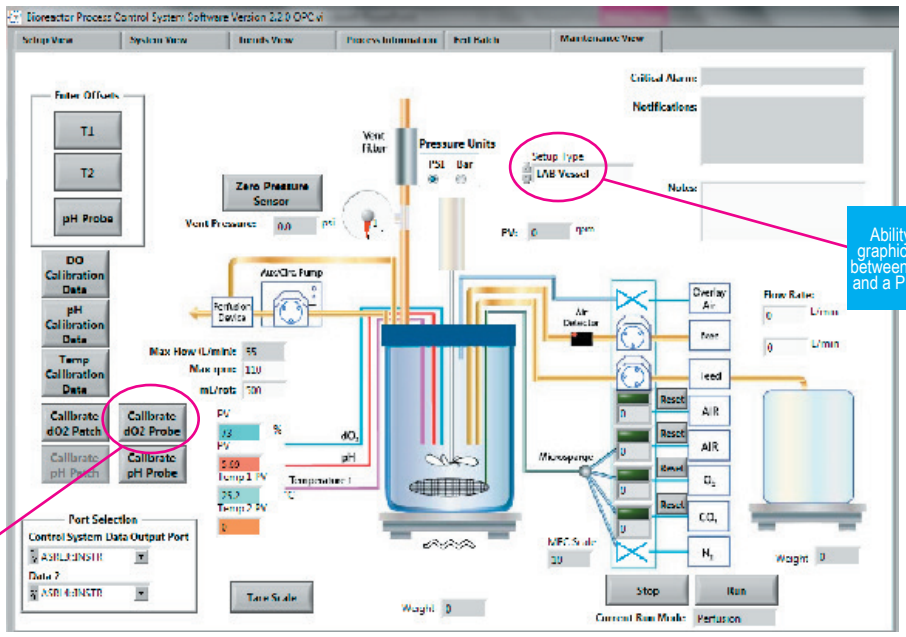
Maintenance View

Functions Include:

- Probe calibration wizards
- Non-invasive Presens patch sensor calibration wizard
- Entry of pH and temperature offsets
- Set-up Aux/Circulation pump calibration
- Reset gas totalizers
- Tare Pressure Sensors
- Exit program



Probes and Patch sensor on a process vessel

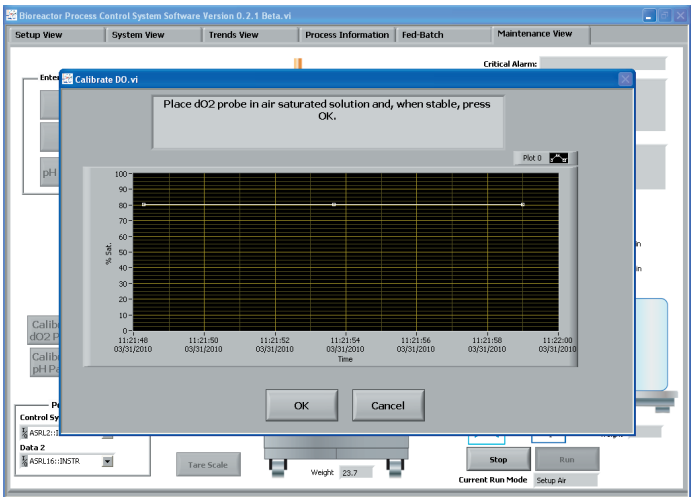


Ability to change graphical interphase between a LAB vessel and a Process Vessel

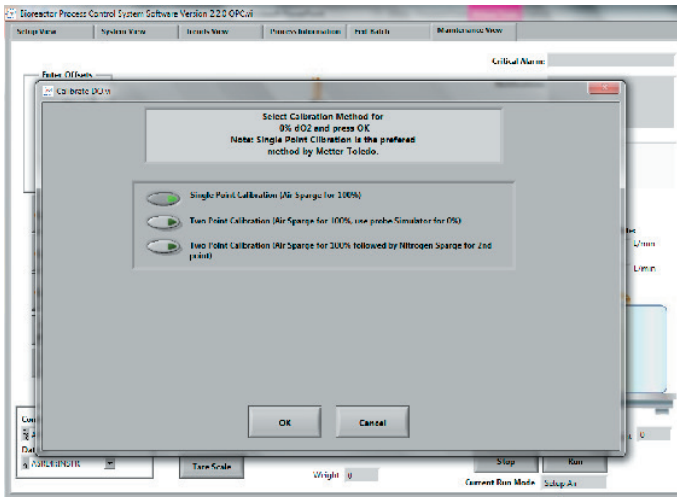
Clicking the button launches the probe calibration wizard

The wizard steps through the calibration process and graphs the probe reading so stabilization can be visualized. It runs the Setup Air and Setup Nitrogen modes as needed and also has a prompt for the option to do the zero calibration by different methods or to skip the zero point calibration

100% POINT CALIBRATION STEP



0% POINT CALIBRATION STEP OPTIONS



Technical Information

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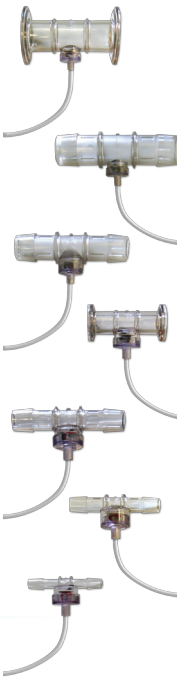
Application Information

The PendoTECH Bioreactor Control System has been used successfully to control process scale bioreactors including the different size Thermo SUBs from 50L to 2000L and also lab scale vessels down to a few liters. In all designs, the control system is the same which gives ultimate flexibility, only the gas/pump box options vary.

Gas Flow Control- Mass Flow Controllers are used to control the gases for pH and DO control. And within each range of each gas/pump box, the MFC maximum flow can be reduced to 20% of the maximum value of the MFC so 100% PID output can be limited so fine tuning can occur for different vessel sizes across one size gas/pump box. The overlay & nitrogen are on/off control with the flow rate set by rotor meters.

Temperature Monitoring and Control- The temperature input signal standard offering is a direct input of a 100ohm Pt RTD which is used for monitoring and control. The PID control is configurable to either control a relay for an electric heater or to control an external temperature control unit (TCU) that circulates liquid through a jacketed vessel. There are a number of communication protocols for communication with major brands such as the preferred brand LAUDA. Control of the TCU is done by manipulation of the jacket setpoint temperature by a cascade PID loop that compares the jacket temperature setpoint to the vessel RTD. This custom configured PID algorithm allows for cooling of the vessel contents if the TCU has the ability to do cooling.

Pressure Measurement for a Continuous Perfusion Process or Cell Harvest- The system has the ability to input 4 PendoTECH Single Use Pressure Sensor (shown on right)- one for the vent pressure that is integrated to alarm control and three to monitor the performance of an external perfusion device such as a hollow fiber filter. These three pressures (Pin, Pret, and Pfil) are used to calculate delta-P and TMP which are required to measure filter performance. This data is logged to the file and can be trended to measure performance over a lengthy run.



Specifications and Standard Accessories

Detail	Specifications
Enclosure Dimensions (HxWxD)	System: 6.125" x 16" x 11.5" (15.5cm x 40.64cm x 29.21cm) plus front hinged door PROCESS Gas / Pump Box: 11.25" x 11" x 15.5" (28.6cm x 27.9 cm x 39.37cm) LAB Gas / Pump Box: 19" x 12.25" x 12.25"
Enclosure Weight	System: 15 lbs. Gas / Pump Box: 17 lbs.
Enclosure Material	304 stainless steel
Power Requirements	100 - 240 Volts, 50 - 60 Hertz, 6 amp max
Pressure Sensor Input	PendoTECH Pressure Sensors +/- 2% of value from 0 - 6 psi, +/- 3% of value from 6 - 30 psi ; Other full-bridge type sensors optional
Aux/Circulation Pump Control	Speed Control: 4 - 20mA, 12 bit (4,096 counts)
E-Stop Interlock	5V Digital input controlled by external relay (normally closed)
Motor Speed Signal Input	0-10VDC, Input impedance of 376 KΩ, 16-bit
Motor Speed Control	0-10VDC, 12-bit, allowed resistance of ≥1KΩ, op-amp output sources and sinks up to 10 mA, sink current limited at Vo=0 by 39Ω output resistance,
Temperature Input	Standard: 100 ohm Pt RTD 3-wire
BR Temperature Control	For Electric On/Off: Relay 3 - 48 VDC, up to 3A continuous TCU: RS232 or RS485
External pH and DO inputs	4 -20 mA input, 16-bit (65,536 counts)
Max Flow (SLPM) [with gas regulator for each gas with maximum pressure of 10psi] *MFC	Overlay / Air Sprg* / O2 Sprg* / CO2 Sprg* / N2 Sprg / Air Pipe* SM: 10 / 5 / 2 / 1 / 12 / 10 LG: 20 / 10 / 5 / 2 / 12 / 20 Lab: 0.5 / 1.5 / 0.2 / 0.1 / 0.2 / NA
Run Interlock and Valve Signal	Relay 3 - 48 VDC, up to 3A continuous, NO/NC selectable
Scale Inputs	RS232 with user selectable scale profiles
External pH and DO monitor	4-20mA input, 16-bit (65,536 counts)
PC Requirements	Windows 7, 2 GHz or faster, 2 GB or more of RAM

Additional Accessories Details:

1) Non-invasive air detector for base tube
2) NEMA4 / IP66 Stainless Steel Design All in One PC:
   - Completely sealed, no external fan
   - Display- 15" TFT XGA (1024x768)Touch
   - Resistive touch screen
   - Windows 7 OEM, multilingual
3) PendoTECH Single Use Pressure Sensors:
   For full range of sizes see: http://www.pendotech.com/pressure
4) Optional mounting brackets for Thermo SUB Handle
   (as shown in picture below)
5) Optional Presens measurement sensing board and
   Fiber Optic Probes for Non-Invasive Patch Sensors
5) Optional Heater/Motor Control Box for control of motor & temperature to for Lab Benchtop vessels

Example of AUX/Circulation Pump

Base tube air detector

Ordering Information

Part Number	Description
PDKT-PCS-BRSMF	PendoTECH Bioreactor Control System in standard enclosure with front panel cover with PROCESS scale gas/pump box with MFCs for Air, CO2, O2 (vessel size <500L)
PDKT-PCS-BRLMF	PendoTECH Bioreactor Control System in standard enclosure with front panel cover with PROCESS scale gas/pump box with MFCs for Air, CO2, O2- ranges (vessel size up to 2000L)
PDKT-PCS-BRBMF	PendoTECH Bioreactor Control System in standard enclosure with front panel cover with LAB scale gas/pump box with MFCs for Air, CO2, O2 ranges

Warranty/Disclaimer