Controller Overview

Parr offers a full line of controllers to monitor, control, datalog and archive various parameters. The new model 4848 Modular Controller is our general-purpose reactor controller. It can control temperature, stirring speed, redundant temperature, and monitor pressure. It can datalog to a PC.

The model 4857 Reactor Controller can control up to two reactors, as well as monitor additional auxiliary inputs. It features an advanced PC interface with full charting and datalogging capability.

The model 4871 Process Controller is a full featured controller, which can handle a wide variety of inputs and outputs to control an entire process including gas and liquid flows as well as up to eight reactors simultaneously. It has a PC interface custom tailored to the application.

The model 4838 Temperature Controller is offered to control the temperature in nonstirred pressure vessels. It can be expanded to include an optional pressure or redundant temperature module.

	4848	**4857**	**4871**	**4838**
Application:	One stirred reactor	One or two reactors with full datalogging	Advanced systems	Non-stirred Pressure Vessels (no motor control)
Features:				
I/O and Control				
Temperature Control	One	Up to Two	Up to Eight	One
Pressure Monitoring	One	Up to Two	Up to Eight	Option (1)
Motor Speed Control	One	Up to Two	Up to Eight	No
Auxiliary I/O	No	Up to Seven	Up to Forty	No
Redundant Temperature Monitoring	One	Up to Two	Up to Eight	Option
PC User Interface	Yes	Yes	Yes	Yes
Ethernet Communications	No	No	Yes	No
Expansion Modules	Three	Seven	Eleven*	One
# of Reactors Controlled	One	Up to two	Up to eight	One

* Each 4871 Expansion Module can accept up to sixteen inputs and outputs.

Controller Selection Guide

Models:
4848 Modular Controller
4857 Reactor Controller
4871 Process Controller
4838 Temperature Controller

4848 Reactor Controller

4848 Controller with MCM, PDM and HTM expansion modules installed.

The Parr 4843 and 4836 Controllers have been replaced with the new 4848 Controller. This new controller brings digital communications to all of the functions of these modular reactor controllers.

The 4848 Controller continues to offer all of the features previously included in the 4843 Controller; namely:

- PID control
- Ramp and soak programming
- Separate heating and cooling control loops
- Motor speed control
- Full or half power heater option
- Lockout relay and reset for over temperature protection
- Expansion modules for tachometer, pressure, and high temperature alarm
- Auto tuning of PID parameters

In recent versions of the 4843 and 4836 Controllers, the primary controller was equipped with an RS232C digital communications port and software for two-way communications

with a PC. The expansion modules for stirrer speed display, vessel pressure readout, high temperature protection, and motor current readout could be ordered with analog outputs that required an analog to digital conversion board to log these readings into a PC.

With the 4848 Controller, all of the expansion modules as well as the primary temperature controller are equipped with bidirectional digital communications [RS-485] that enable the user to not only log all current reading to a PC, but also to send set points, stirrer speeds, and alarm values from the PC to the 4848 Controller.

4848 back panel for 115V model.

Modular Design

A total of seven different modules are offered for the 4848 Controller. A maximum of three expansion modules in addition to the primary temperature control can be installed in the 4848 Controller. The user can select either the Tachometer Display Module or the Motor Control Module. This either/ or option also applies to the High Temperature Cut Off and External Temperature Limit Modules.

1. Temperature Control Module (TCM)
The temperature control module can accept either thermocouples or RTD temperature sensors. It has three outputs that are used for heating and cooling control and for alarm actuated heater cut off. The control function is a full proportional, integral and derivative (PID) control with auto-tune capabilities.
The controller provides ramp and soak programming with up to 64 segments.
The temperature in the reactor is transmitted to and displayed on the PC on a continual basis.

Screenshot from remote PC showing Set Point and Process values for up to four variables.
Lower section showing operating parameters of active module.

2. Pressure Display Module (PDM)

The pressure monitoring module is set up to accept its input from a pressure transducer mounted on the reactor or attached accessory. It can be set to accept a wide variety of operating ranges. Operating pressures are transmitted continuously to the PC. These modules are available calibrated in either psi or bar. In most applications, pressures are controlled by either a forward or back pressure regulator. The output from the pressure monitoring module is connected to the alarm relay to shut off power to the heater if the high pressure limit set by the operator is reached during operation.

3A. Tachometer Display Module (TDM)

In this configuration, the module will display the stirrer speed and will continuously transmit it to the PC for display and logging. The stirrer speed is set manually using a potentiometer on the face of the 4848 Controller.

3B. Motor Control Module (MCM)

In this configuration, the module provides true closed loop feedback control of the reactor stirring speed. The primary output of this module is wired to dynamically adjust the motor voltage in response to changes in motor loading. This provides better reactor stirring speed regulation than the standard open loop speed control, especially with reactions that involve changing viscosities. Additionally, the use of this module allows the stirring speed set point to be adjusted remotely from the host PC. A byproduct of this closed loop speed control scheme is that the value of the primary controller output directly reflects the degree of loading on the motor in order to maintain a constant stirring speed. While not a direct torque measurement, this is a useful option for those who want to, for example, monitor the progress of polymerization reactions in which there is a change in viscosity as the reaction proceeds. The output to the motor can be displayed on the PC, but to log this value requires the addition of the Motor Torque Module.

4A. High Temperature Cut Off Module (HTM)

The high temperature cut off module or limit controller augments the operation of the

main control module. Its redundant sensor can be mounted either internally or externally to the reactor. The primary output of the module is wired to activate the lock out relay in order to provide safety shutdown should the reactor reach an unsafe temperature.

4B. External Temperature Limit Module (ETLM)
This configuration uses the same aforementioned HTM Module with its sensor mounted in such a way to monitor the reactor's outside wall temperature. The primary output of this module is used to limit the external temperature of the reactor. This is done by interrupting the control signal form the main temperature controller when the external temperature exceeds a predetermined value.

The secondary output of this module is used to activate the lock out relay if the outside wall temperature exceeds a preset unsafe temperature. The use of this module provides and effective alternative to cascade control, offering improved temperature regulation in systems with large thermal lags, such as those found in non-stirred reactors or systems that use PTFE liners, as well as systems where the reactants have low heat capacities, such as gas phase reactions.

5. Motor Torque Module (MTM)
For the permanent magnet DC motors Parr furnishes, there is a linear relationship between torque and applied voltage for a fixed RPM. This module provides a means for continuously displaying and logging the voltage supplied to the stirrer motor. This voltage is displayed as a percent of full span. This module must be installed in conjunction with the Motor Control Module.

Solenoid Valve Module (SVM)

This package includes a solenoid valve and a flow adjustment valve with all of the parts required to assemble an automatic system to control the flow of coolant thru a cooling coil in any reactor. It plugs into the cooling output socket on the 4848. It is designed for use with tap water as the cooling media.

Communications Software

Software is provided with each 4848 Controller to provide bidirectional communications between the controller and an attached PC. All operating set points and control parameters can be sent from the PC to all of the operating modules installed in the 4848 Controller. All data gathered by the modules of the 4848 is transferred to the PC for display and logging.
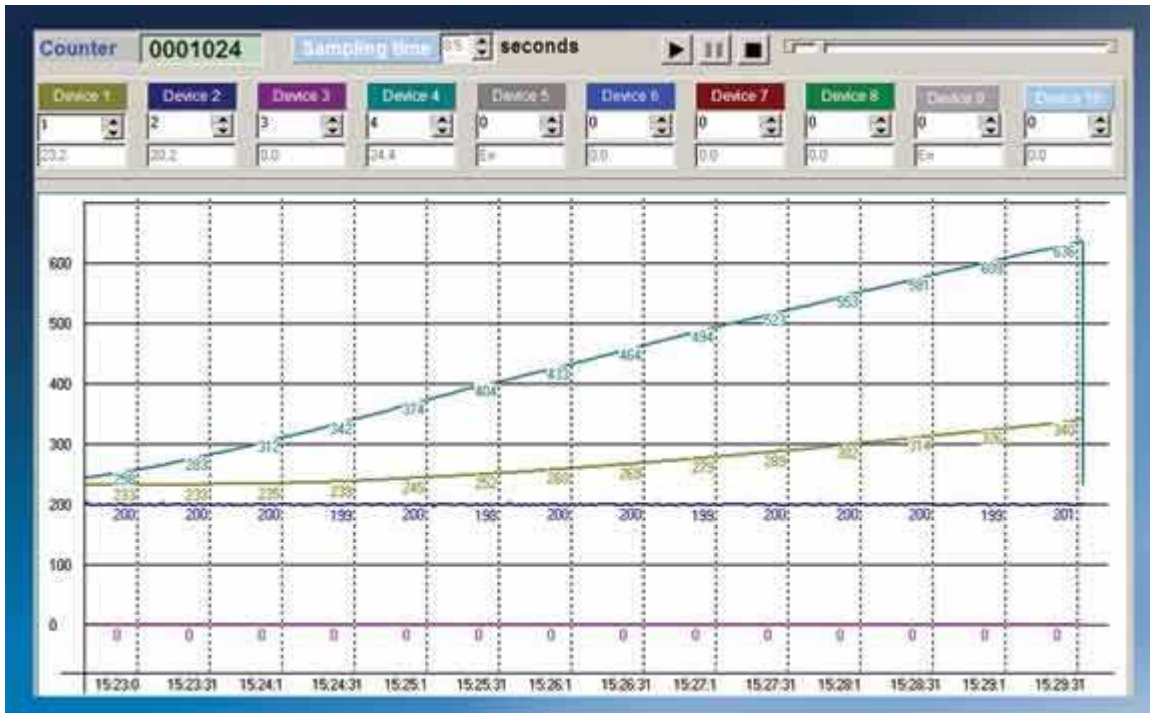
Screenshot from remote PC showing logged data in Data Logging Mode

PC Requirements

Parr does not furnish the PC as part of this control. The minimum requirements for the PC are:

- Pentium III processor with a minimum of 256 MB of RAM
- Windows 2000 or XP Operating System
- Minimum of 40 MB free hard disk space
- CD ROM Drive
- Graphics display capable of at least 256 colors and 1024 x 768 screen resolution (SVGA)
- Serial COM Port or USB Port
- Mouse and keyboard
- PC to Controller connection cable (A1925E2 RS485 to USB Connection Cable)

Ordering Information

	Order No.	Voltage
Model 4848 Reactor Controller	4848EB	115 v.a.c.
	4848EE	230 v.a.c.
PID, Ramp and soak digital communications with motor speed control and software.		

Expansion Modules	
TDM	Tachometer Display Module
MCM	Tachometer with Motor Control Module
PDM	Pressure Display Module

HTM	High Temperature Cut Off Module
ETLM	External Temperature Limit Module
MTM	Motor Torque Module

Connection Cables:	
Order No.	**Description**
A1925E2	RS485 to USB Connection Cable, 30 ft

Cooling Control:		
SVM	Solenoid Valve Module	
	Order No.	**Description**
	SVM1	115V AC
	SVM2	230V AC

Series 4857 Reactor Controller

The 4857 Reactor Controller with with two reactors.

The Model 4857 Reactor Controller offers fully integrated control, monitoring and data handling of temperature, pressure, stirring speed, and other parameters, for up to two reactors from a single controller. The operating software provides a graphical interface to fully configure and operate the controller from a PC. All reaction parameters are digitally transferred to the PC for real time displays as well as logging reaction data.
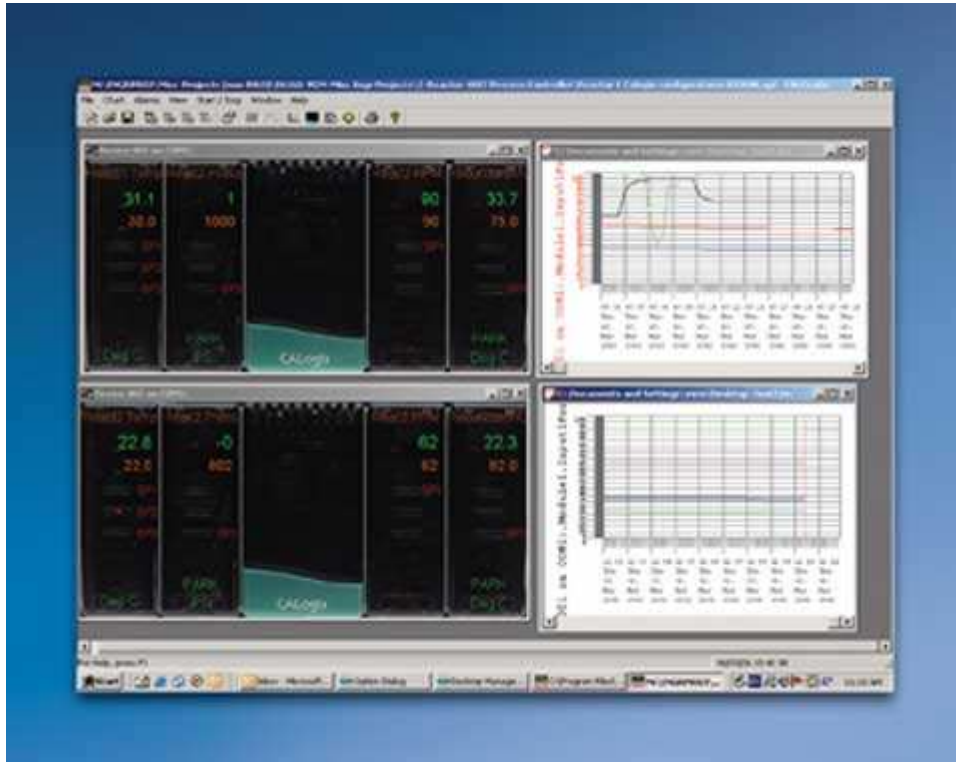
A 4875 Power Controller is included for handling the switching and control of high current heater and stirrer motor circuits. A logic control module offers three physical digital input channels and three digital outputs along with virtual inputs and outputs. It can be used to run, stop or hold set point programs, link associated inputs and outputs (using logic, timer, counter and comparator functions) and to control valves or meters.

Operating Modules:

1. Temperature Control
2. Pressure Monitoring
3. Stirrer Speed, Control, and Display
4. Redundant Temperature Monitoring and Control
5. Auxiliary Pressure Monitoring
6. Logic Control

- Changing set-point
- Manual Power
- Autotune
- Program

The Model 4857 Reactor Controller is available in three configurations. The standard configuration (4857A) includes a single control rail with up to four individual modules. The dual reactor configuration (4857B) includes two control rails set up to control two separate reactors. The expanded configuration (4857C) includes two control rails with up to eight PID control modules. This provides the capability to control or monitor multiple temperatures, pressures or other operating parameters.

Ordering Information

Model 4857A Reactor Controller for one reactor	Order No.	Voltage
	4857AEA	115 v.a.c.
	4857AEF	230 v.a.c.

Includes one control CPU, Temperature Control Module with Thermocouple, Pressure Monitoring Module with Transducer, Tachometer and Motor Current Display Module, Operating and Configuration Software, one 4875 Power Controller and all required connecting cables.

Model 4857B Reactor Controller for one reactor	Order No.	Voltage
	4857BEA	115 v.a.c.
	4857BEF	230 v.a.c.

Includes two control CPU's, two Temperature Control Modules with Thermocouples, two Pressure Monitoring Modules with Transducers, two Tachometer and Motor Current Display Modules, Operating and Configuration Software, two 4875 Power Controllers and all required connecting cables.

Model 4857C Reactor Controller for one reactor	Order No.	Voltage
	4857CEA	115 v.a.c.
	4857CEF	230 v.a.c.

This model of the 4857 is reserved for custom modification. It can be equipped with up to 8 control / monitoring modules that can be mixed and matched to control multiple heaters or add additional instrumentation as required.

4857E Dual Control Expansion Module	Order No.	Voltage
	4857EEA	115 v.a.c.
	4857EEF	230 v.a.c.

The 4857E Expansion Module includes a second CPU and rail, with Temperature Control Module, Pressure Monitoring Module, Tachometer and Motor Current Display Module and 4875 Power Controller, **to convert a 4857A Single Control to a 4857B Dual Controller**.

Expansion Modules	
The 4857A Controller can accept one additional expansion module. The 4857B can accept two. The 4857C can accept any configuration of modules up to a total of eight.	
TCM	Temperature Control Module with thermocouple
PMM	Pressure Monitoring Module with Transducer
TMM	Tachometer and Motor current display Module (4857C only)
LCM	Logic Control Module

For Cooling Control	
A160HW3EB	Solenoid Valve Package 115V
A160HW3EE	Solenoid Valve Package 230V

Series 4871 Process Controller

4871 Process Controller

The Parr model **4871 Process Controller** has been developed to provide an integrated stand alone control system for controlling either a single reactor with multiple feed and product controls or multiple reactors operating independently or in parallel.

The Parr 4871 Process Controller combines into a single turnkey system the following component parts:

1. Honeywell HC-900 Hybrid Controller.
2. SpecView Plus SCADA software.
3. Power controllers for handling heating, cooling, safety and motor control devices.
4. System set up with graphical user interface configured to individual requirements.

I. Control Module

The control module of the Parr 4871 Process Controller is a Honeywell HC- 900 Hybrid Controller. The HC900 Controller comes with 4, 8 and 12 card capacities. We are offering the 4 card controller as our model 4871A Controller and the larger ones as our model 4871B and 4871C Controller respectively. Detail of the controller functions is provided in the following table:

Function	4871
Analog Input (AI)	128
Analog Output (AO)	64
Digital I/O	256

Total I/O	256
Remote I/O	Yes
Control Loops	32
Logic Scan	25-50 ms
Loop Scan	500 ms
Ethernet Communications	Yes
Peer to Peer Communications	Yes
Modbus Master	Yes
Modbus Slave	Yes
On-line Programming	Yes
Function Blocks	2000
Sequential Functions	Yes
e-mail Alarms	Yes

A. Input / Output

The control chassis has been designed to accept up to 4 input or output modules. Depending upon the type, each module contains between 4 and 16 individual inputs or outputs, fully isolated from one another. The modules available to tailor the controller to the users application include:

Input Modules

The analog inputs are of universal type and are most commonly used for thermocouple or RTD temperature sensors, strain gage type pressure transducers, motor current monitoring and similar devices with mV, V, or resistance inputs. Input isolation, cold junction compensation, and burnout protection are incorporated into the circuitry.

The digital inputs can be logic inputs or contact closures. These are typically used for sensing valve positions or conditions of safety devices.

Output Modules

The analog outputs are 0/4-20 mA. A suitable dropping resistor can be used to convert this to 0-5 or 0-10 VDC. Analog outputs are commonly used to set stirrer motor operating speeds, position control valves, or drive mass flow controllers or pumps.

The digital outputs are open collector type capable of sinking up to 300 mA . They are commonly used to control heaters, solenoid valves for cooling or other flow control, system safety shut down, visual and/or audible alarms, and similar devices.

B. Control Loops

The controller can provide 8 PID or ON/OFF control loops in its standard configuration. These can be expanded to 32 function blocks in the extended control version.

The PID control algorithm includes auto-tuning and fuzzy logic overshoot suppression for each control loop. For heating and cooling control, the PID control loops provide time proportioning output of the associated digital output.

Many temperature control applications utilize two separate time proportioning outlets with one PID controller; one for heating and one for cooling.

Control loops can be linked together to provide cascade, feed forward or ratio control for difficult or advanced control applications.

Both high and low limit values can be entered for each control loop to sound alarms or initiate safety control schemes.

C. Set Point Programming
Recipes for controlling the entire process of a reactor can be written using the setpoint profiler incorporated into the control firmware. A single profile may be from 2 to 50 segments in length. A typical profile might be a ramp and soak of the reactor temperature but, in addition, the analog and digital outputs can be tied to the basic profile to start and stop flows, activate stirrers or accessories, or change alarms. Any of the setpoints within the profile can be protected with the setpoint guarantee function that assures that the process variable will be within the entered limits before the profile can proceed.

Up to eight separate profiles can be running independently (8 reactors each on their own program, for example) at one time.

While a maximum of 70 profiles can be stored in the controller itself, an unlimited number can be stored in the operator's PC for rapid transfer to the controller.

In addition to the setpoint profiling capability, the controller is also equipped with a setpoint scheduling function. This feature can operate up to 8 profiles operating on a common time base. Under this scheduler, up to 4 reactors can be operated in parallel on a single program.

D. Communications Channels
Each 4871 controller is equipped with a RS-232 and Ethernet communication port. The RS-232 port is used to establish fundamental control logic. The Ethernet port provides communication with the host PC when using the SpecView GUI program. Multiple controllers, each with a unique address, can be networked on the Ethernet interface with a single connection to the PC.

The principal advantage of the Ethernet interface is that it allows the user to use an existing network infrastructure to connect the controller to the PC. As a result, one can operate the controller over the network from anywhere within your facility. Additionally, Internet access from remote locations becomes possible. This type of connectivity offers unique possibilities, for example, related to remote diagnostics and system troubleshooting.

E. PC Requirements
Windows 95/98/NT/2k/XP PC with at least 100 MB free hard disk space to allow for data logging and the configuration files.

The display resolution should be set up for 1024x768 pixels and at least 16-bit color.

A CD-ROM drive for program installation, at least one RS-232 COM port and an Ethernet port are required to communicate with the controller.

Screenshot of typical 4871 Controller user interface main screen.

II. Operator Interface

In most laboratory and pilot plant applications, a PC will be used for the operator interface. For plant or production applications, an industrial type user interface box with a color graphic LCD is available.

A. User Interface Software

SpecView describes their product as "Software for people with other jobs". That seems to be an excellent description of this software package used with the 4871 controller to:

- Configure the control package
- Develop the graphical screen layout
- Establish the data logging profiles
- Prepare custom reports
- Create bar graphs
- Generate time trend graphs
- Monitor alarms
- Create flexible recipes
- Retrieve and replace logged data
- Operate the reactor system(s)

The full software package, not just a run-time version, is supplied with 4871 controller so operators can enhance their system as they get familiar with it or expand / change their applications.

Demonstration versions of the SpecView software can be downloaded at www.specview.com.

B. Configuration

An integral part of the Honeywell Controller is the control builder software. This is the "Drag and Drop" software that enables Parr to rapidly establish the controller's internal logic and adapt it to individual systems requirements.

The user can employ this same software to change or enhance the fundamental logic of the controller as additional components are added to the system or as functions need to change.

4875 Power Controller

III. Power Controllers

Parr designs, builds and furnishes power controllers to adapt the analog and digital outputs from the 4871 controllers to the reactors or systems being controlled. These power controllers handle all of the high current power circuits so that the control circuitry is isolated from these loads. This also makes it possible to install the controller in a control room some distance from the system being controlled. The power controller or controllers will be designed for each individual system, but as an example, a 4875 power controller includes:

1. A solid-state relay sized to handle the current drawn by the vessel heater. This is commonly a 25-amp relay with its protective fuses.
2. A solid-state relay sized to drive a solenoid valve to control the flow of cooling water to the vessel.
3. A motor speed controller that converts the analog output signal from the controller to the electrical signal required to drive the specific stirrer motor. A circuit breaker for the motor is also provided.
4. A lockout relay to shut down the heater circuit should an alarm condition be detected.
5. Status lights for the principal functions.
6. Connections of appropriate style for the power input and device outputs.

   Note: One model 4875 Power controller is required for each reactor in a parallel system.

The 4875 Power Controller module is flexible and can be used in remote locations from the system being controlled.

IV. System set up with graphical user interface

The software and the Operating Instructions for the 4871 come on a CD furnished with the Controller.

Expansion Capabilities

This custom order is set up to run sixteen reactors, two 4871 Process Controllers, with sixteen 4875 Power Controllers all through one PC.

If any of the input, output, control or programming limits described here for a single controller are a limitation in building a control system, a limitless number of controllers can be linked together in a network to a single host PC.

Third Generation Technology
The 4871 Controller is the third generation of process control Parr has offered to its customers for integrated process control. Starting with the terminal based 4850

introduced in 1989 and the graphical based 4860 introduced in 1998 we have developed a good appreciation of the requirements for integrated process controllers.

The combination of the Honeywell 900 HC controller with the SpecView software system provides a major step forward in the capabilities, flexibility, ease of programming and adaptability of these controllers for small to moderate size systems.

Current Industrial Standards
Modbus, Ethernet, auto-tuning, fuzzy logic, auto-configuring man machine interface (MMI), supervisory control and data acquisition (SCADA), multi- loop control; these are a few of the terms and capabilities designed into the hardware and software incorporated into the Parr 4871 controller.

This is a very modern and powerful package that enables us to offer turnkey systems ready to run within weeks of order at very attractive prices compared with custom programmed systems previously available.

The photo above illustrates a six station multi-reactor system. Each reactor is equipped with it's own constant pressure gas delivery system. The 4871 Controller maintains all of the important system parameters, including temperature and stirring speed, and records the gas consumption of each of the reactors.

4871 Controller for use with Series 5000 Multiple Reactor System

The 4871 Controller provides two options for controlling the temperature Ramp and Soak programming of the individual reactors.

1. **Set Point Scheduler**

   Using the Set Point Scheduler, different temperature profiles could be programmed for each reactor, but the length of time for each segment of the profile was fixed for all reactors. For example, each reactor could be heated to an individual temperature set point, but the time allowed to reach this set point was the same for all reactors as would be the time they were held at this set point.

2. **Set Point Programmer**

   Using the Set Point Programmer, completely independent temperature profiles could be established which vary not only in the set point, but also in the length of the segment.

The 4871 Controller includes Operational Sequence Control

The sequence control function offered by the 4871 Controller greatly expands the capabilities of this control for users who wish to control reactor systems. The operation of valves, pumps and meters can be programmed on either a time or an event basis. Sequences can be very simple timed events or they can be very complex with multiple nested default sequences programmed to occur only if process feedback indicates a need to take alternative actions.

Ordering Information

4871 Base Model consisting of
Control Panel **Case** **Power Supply** **Connection Cable to PC** **Operating and Configuration Software and Hardware** **Ethernet Connection**

4871 AI Analog Input Module	
8 – Inputs / module	
4871 DO Digital Output Module	
16 Outputs / module	
4871 DI Digital Input Module	
16 Inputs / module	
4871 AO Analog Output Module	
16 Outputs / module	
Power Controller	
4875 Power Controller Includes Heating control relay, Cooling control relay, Motor speed control for computer control of motor	
4871A	Equipped for up to 4 modules
4871B	Equipped for up to 8 modules
4871C	Equipped for up to 12 modules

External Connection Harnesses & Accessories	
Order No.	*Description*
A1906EP20	Transducer, 0-2000 psi
A1906EP30	Transducer, 0-3000 psi
A1906EP50	Transducer, 0-5000 psi
A2599HC2	Transducer Mounting Body with cooling sleeve
A1905E	Transducer Cable 10 ft
A1905E3	Transducer Cable 20 ft
A1905E7	Transducer Cable 30 ft
A1177E	Tachometer Cable, 10 ft
A1177E2	Tachometer Cable, 20 ft
A1177E3	Tachometer Cable, 30 ft
A160HW3EB	Solenoid Valve Package, 115V
A160HW3EE	Solenoid Valve Package, 230V

A470E4	Thermocouple Extension Wire, 10 ft
A470E5	Thermocouple Extension Wire, 20 ft
A470E6	Thermocouple Extension Wire, 30 ft
External Connection Cables	
Additional External Harness with connections for peripheral accessories	

4838 Temperature Controller

4838 Temperature Controller

The 4838 Controller has been added to the line of Parr Controllers. This compact controller is intended to control the temperature in our extensive line of non-stirred pressure vessels. No provision is made for the current or future expansion to control motor stirring speeds.

The controller contains the same Temperature Control Module used in the 4848 Controller and provides identical control and communications capabilities. The high low heater feature (full or half power) as well as the lock out relay and reset for over temperature protection are also included.

The 4838 Controller can be enhanced with the addition of either a Pressure Display Module or a High Temperature Cut Off Module or an External Temperature Limit Module.

Ordering Information

Model 4838 Controller	Order No.	Voltage
	4838EB	115 v.a.c.
	4838EE	230 v.a.c.
For Non-Stirred Vessels, PID, Ramp and Soak digital communications and software.		

Expansion Modules	
PDM	Pressure Display Module
HTM	High Temperature Cut Off Module
ETLM	External Temperature Limit Module

Connection Cables:	
Order No.	Description
A1925E2	RS485 to USB Connection Cable, 30 ft