



Chapter 4

Reactor Controllers

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[4848 REACTOR CONTROLLER](#)

[4838 TEMPERATURE CONTROLLER](#)

[4871 PROCESS CONTROLLER](#)



4871

PROCESS
CONTROLLER



Parr Reactor Controller Overview

Parr Instrument Company offers a full line of reactor controllers to monitor, control, datalog and archive test data.

The Model 4848 Modular Controller is our general-purpose reactor controller. It can control temperature and stirring speed, and it can be equipped to monitor a redundant temperature and pressure. It can datalog to or be operated remotely from a PC.

The Model 4838 Temperature Controller is offered to control temperature in non-stirred pressure vessels. It can be expanded to include an optional pressure or redundant temperature module.

The Model 4871 Process Controller is a full featured process controller, which can handle either a single reactor with a wide variety of inputs and outputs or multiple reactors running independently. It controls the entire process including gas and liquid flows through a PC interface custom tailored to the application.



4848 4838 4871

Application:	One Stirred Reactor	One Non-Stirred Pressure Vessel (No Motor Control)	Advanced Systems
Features:			
Temperature Control	One	One	Multiple*
Pressure Monitoring	Optional	Optional	Multiple*
Motor Speed Control	One	No	Multiple*
Auxiliary I/O	No	No	Multiple*
Redundant Temperature Monitoring	Optional	Optional	Multiple*
PC User Interface	Included	Included	Included
Data Logging	Process Value	Process Value	Any Variable
Digital Communications	RS485	RS485	Ethernet
Expansion Modules	Three	One	Unlimited*
Number of Reactors Controlled	One	One	Up to eight

*Contact a Parr Customer Service Representative for your Multiple Reactor application needs.



4848 Reactor Controller

The 4848 Reactor Controller brings digital communications to all of the functions of this modular reactor controller. The 4848 offers all of the features expected in a Parr general purpose reactor controller, namely:

- PID programming for precise temperature control and minimum overshoot
- 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
- Optional Solenoid Valve Module for cooling control
- Auto tuning of PID parameters



4848 Reactor Controller shown with MCM, PDM, and HTM Expansion Modules installed.

With the Parr 4848 Reactor 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 readings to a PC, but also to send set points, stirrer speeds, and alarm values from the PC to the 4848 Controller.

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.

The 4848B has a larger chassis to accommodate up to six expansion 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.

2. Pressure Display Module (PDM)

This 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.

3. 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.



4848 Reactor Controller



4848 back panel for 115V model.

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 by-product 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.

4. Motor Torque Module (MTM)

Parr furnishes permanent magnet DC stirrer motors for its magnetic drives in which 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.

5A. 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



The expanded 4848B Reactor Controller is designed for those who need up to six expansion modules for their reactor system.

wired to activate the lock out relay in order to provide safety shutdown should the reactor reach an unsafe temperature.

5B. 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 from 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 an 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.

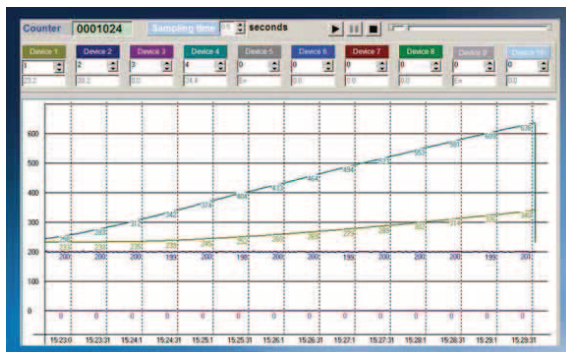
Solenoid Valve Module (SVM)

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

4848 Ordering Guide



Screenshot from remote PC showing logged data from a 4848 Reactor Controller in Data Logging Mode.



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

gathered by the modules of the 4848 is transferred to the PC for display and logging.

SpecView Software

The unified Modbus communications architecture of the 4848 allows us to bring the power and convenience of SpecView to the 4848 Series Controllers. This version of Specview provides support for up to eight individual loo or limit controllers.

Features and Benefits

In comparison to the standard ParrComm software, SpecView software offers:

- Improved real-time plotting including multiple charts each with an unlimited number of pens
- Enhanced data logging — including the ability to log any controller parameter, not just the process variable
- Alarm and event logging
- Superior alarm annunciation
- The ability to easily customize the user interface to a given application
- The user interface can be localized, for example to support a variety of languages.

A composite identification number to be used when ordering a 4848 Reactor Controller can be developed by combining individual symbols from the separate sections.

Example: A 4848 Reactor Controller, 115V electrical, with Tachometer Display Module, USB Connection Cable and a Solenoid Valve Module and SpecView Package would be listed as:

No. 4848EB-TDM-A1925E4-SVM1-A3504HC

A.	B.	C.	D.	E.
Model	Modules	Cables	Solenoid	Software
4848EB	-TDM	-A1925E4	-SVM1	-A3504HC

A Base Model

PID, Ramp & soak digital communications with motor speed control and software

Model No.	Voltage, AC
4848EB	115
4848EE	230
4848BEB	115
4848BEE	230

B Expansion Modules

-TDM	Tachometer Display Module
-MCM	Tachometer w/Motor Control Module
-PDM	Pressure Display Module
-HTM	High Temperature Cut Off Module
-ETLM	External Temperature Limit Module
-MTM	Motor Torque Module

C Connection Cables

-A1925E4	RS485 to USB Connection Cable, 30 ft.
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D Cooling Control: Solenoid Valve Module

-SVM1	115 VAC
-SVM2	230 VAC

E SpecView Software

-A3504HC	Parr 4848/SpecView Software Package
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PC Requirements

Parr does not furnish the PC as part of this control. 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)
- PC to controller connection cable (A1925E2)
- Serial COM Port or USB Port
- Mouse and keyboard



4838 Temperature Controller

The 4838 Temperature Controller is designed to control the temperature in our 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. A high low heater feature as well as a lock out relay and reset for over temperature protection are also included. The 4838 Controllers can be enhanced with the addition of either a Pressure Display Module or a High Temperature Cut Off Module. An External Temperature Limit Module can be substituted for the High Temperature Cut Off Module.

Features found on the 4838 Temperature Controller are:

- PID programming for precise temperature control and minimum overshoot
- Ramp and soak programming
- Separate heating and cooling control loops
- Full or half power heater option
- Lockout relay and reset for over temperature protection.



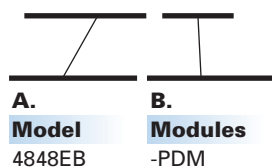
Parr 4838 Temperature Controller shown with optional High Temperature Cut Off Module.

Series 4838 Ordering Guide

A composite identification number to be used when ordering a 4838 Temperature Controller can be developed by combining individual symbols from the separate sections.

Example: A 4838 Temperature Controller, 115V electrical, with optional Pressure Display Module would be listed as:

No. 4838EB-PDM



A Model 4838 Controller

For Non-Stirred Vessels, PID, Ramp and Soak, Digital Communications and Software

Order No.	Voltage A.C.
4838EB	115
4838EE	230

B Expansion Module

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

C Connection Cables

Order No.	Description
A1925E4	RS485 to USB Connection Cable, 30 ft.



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 a single turnkey system containing the following components:

Control Module:

- Honeywell HC-900 Hybrid Controller.

Flexible, Powerful Software:

- SpecView SCADA software.
- System set up with graphical user interface configured to individual requirements.

Power Controller

- Parr 4875 Power Controllers for handling heating, cooling, safety, and motor control devices.

Control Module

The control module of the Parr 4871 Process Controller is a Honeywell HC900 Hybrid Controller. This controller combines analog and logic control into a versatile, cost-effective controller designed specifically for process applications requiring analog measurement combined with programmable control actions.

Input / Output

The controller is adapted to each users requirements by adding to the control chassis input, and output modules. Each module provides for between four and sixteen individual inputs or outputs fully isolated from one another. These modules 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, and similar devices with mV, V, or resistance inputs. Input isolation, cold junction compensation, and burn-out protection are incorporated into the circuitry. Each analog input module provides for eight separate inputs.

The digital inputs can be logic inputs or contact closures. These are typically used for sensing valve positions or conditions of safety devices. Each digital input module provides for sixteen separate inputs.



Function	
Analog Input (AI) Maximum Channels	480
Analog Output (AO) Maximum Channels	200
Digital I/O Maximum Channels	1920
Remote I/O	Yes
Control Loops	Per Memory
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



4871 Process Controller

Output Modules: The analog outputs are 0-20 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. Each analog output is capable of controlling four separate devices or functions.

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. Each digital output module is capable of controlling sixteen separate devices or functions.

Control Loops

The controller can provide any number of PID or ON/OFF control loops, limited solely by the available CPU memory.

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 of the associated digital output.

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

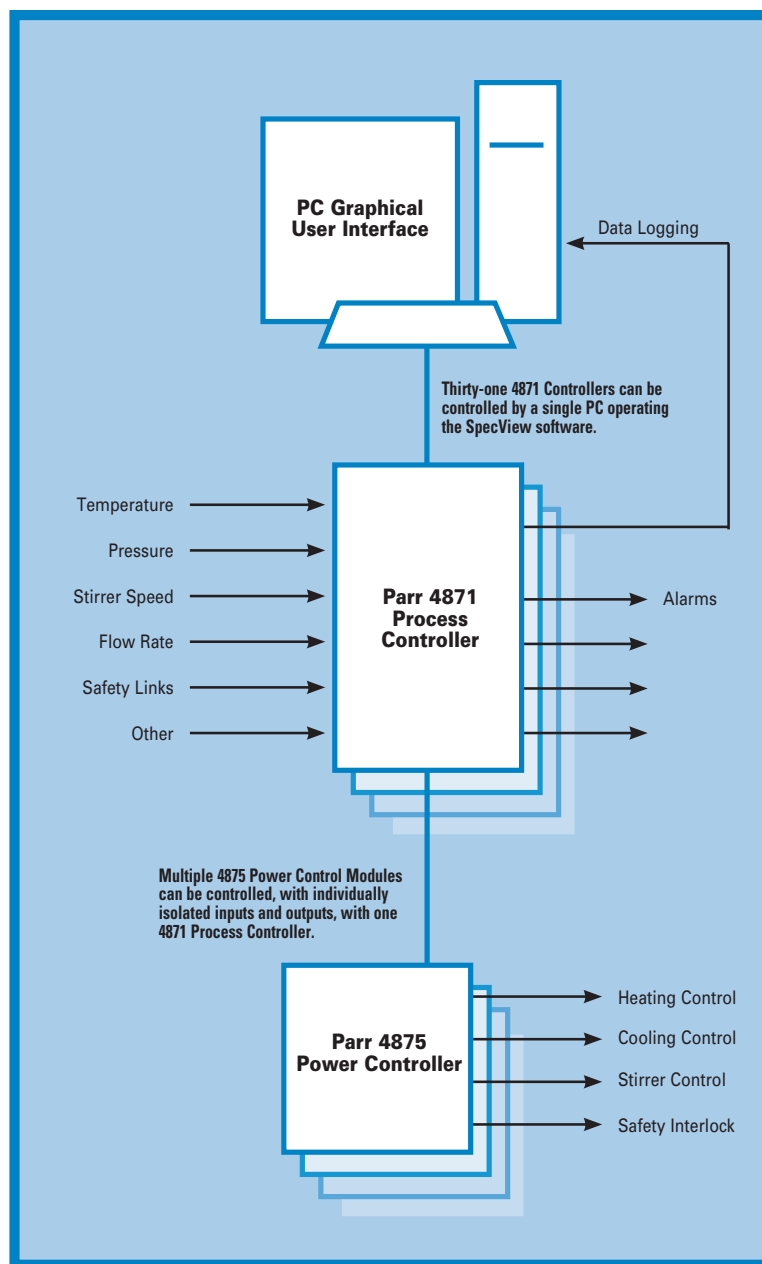
Control loops can be linked together to provide cascade, feed forward or ratio control for difficult or advanced control applications.

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

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



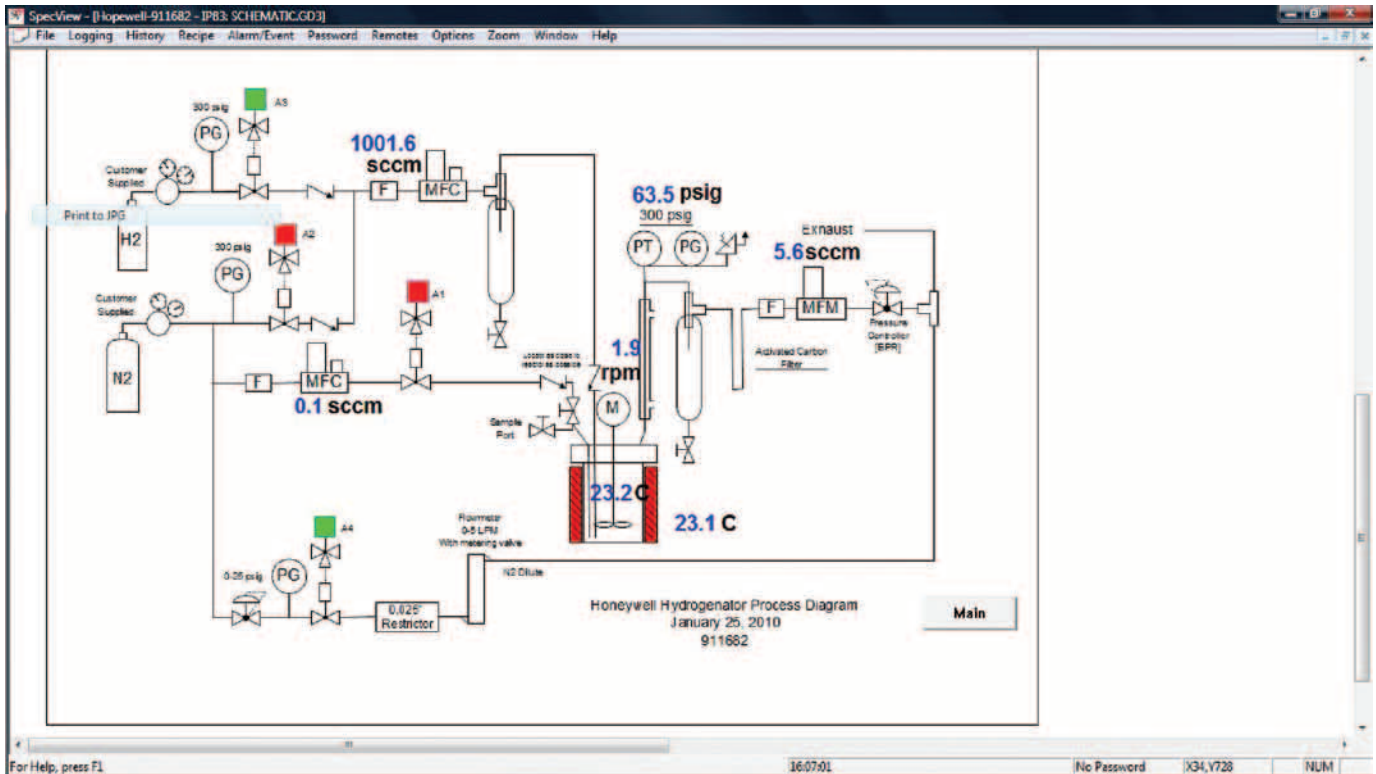
4871 Process Controller Input/Output Diagram.

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.

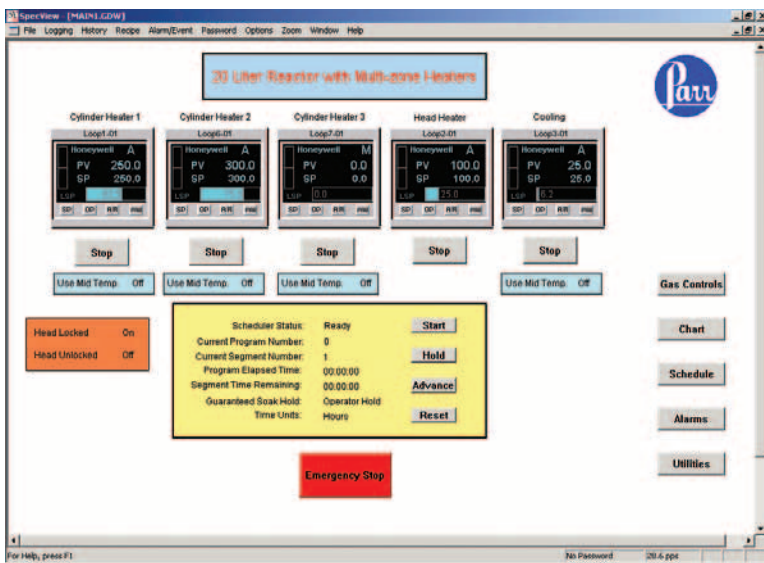
The number of set point programmers is limited by the amount of available memory in the controller CPU. Typically, at least eight separate profiles can be running independently (8 reactors each on their own program, for example) simultaneously.



4871 Process Controller



Process Flow Diagram with real-time process renderings and control capabilities.



Screenshot of typical 4871 Controller user interface main screen.

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 other peripheral devices can be programmed on either a time or an event driven 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.

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.

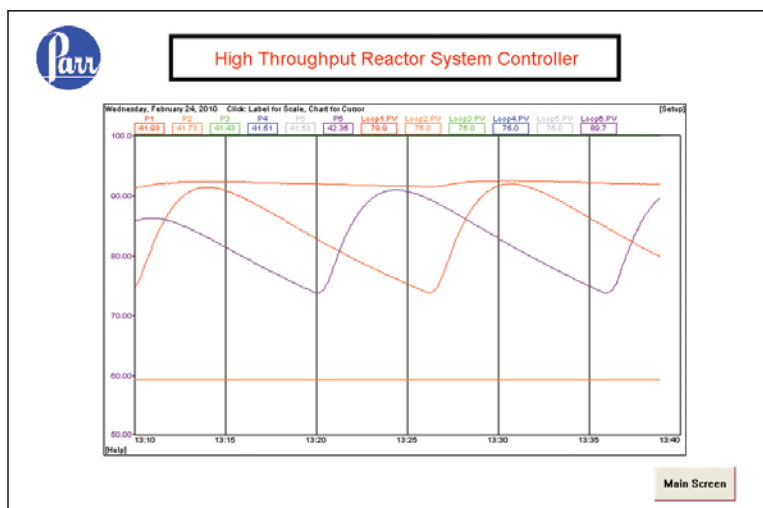
The principal advantage of the Ethernet interface is that it allows the user to use an existing network infrastructure to connect the controller to the PC. As a result, one can operate the controller over the network from anywhere within your facility. Additionally, Internet access

While a maximum of 99 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.



4871 Process Controller



Screenshot from remote PC showing logged data in Data Logging Mode.

from remote locations becomes possible. This type of connectivity offers unique possibilities, for example, related to remote diagnostics and system troubleshooting.

Three Models Available

Parr 4871 Process Controllers are available in three different models to cover a wide range of applications. The 4871A will accept four I/O modules (typically up to 36 inputs and outputs). The 4871B will accept up to eight I/O modules, and the 4871C will accept up to 12 I/O modules. If more than 100 inputs and outputs are required, multiple controllers can be linked.

Flexible, Powerful Software

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.

SpecView SCADA 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 the 4871 Controller so operators can enhance their system as they get familiar with it or expand/change their applications. Download a demo at www.specview.com.

Graphical User Interface

An integral part of the Honeywell Controller is the hybrid control designer 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.

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.

PC Requirements

The PC used with the 4871 serves several functions. It is the operator’s user interface for controlling the process. It also logs all of the operating data generated during a process run. It can also store multiple setups for rapid transfer to the 4871 Process CPU.

Any modern PC with current Windows operating system can be used with these controllers.

It is important to note that the control of the process always resides within the 4871 Controller, and not in the PC itself.

Power Controller

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.



4871 Process Controller



Rear view of the 4871 Process Controller. This 4871 has been set up to run six vessels simultaneously in an MRS 5000 apparatus.

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.



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



4875 Power Controller back panel for 230V model.



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

Each 4871 Controller will be specified and assembled to match the users intended application. These applications can vary from a single reactor with full process control to eight reactors operating in parallel. The 4871 Process Controller connects to a customer-supplied PC with a current Windows Operating System.

Model 4871 Base Model

The 4871 base model consists of the control panel, case, power supply, connection cable to PC, operating and configuration software and hardware, and an 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	4 Outputs / Module
4875 Power Controller	Includes Heating Control Relay, Cooling Control Relay, Motor Speed Control For Computer Control Of Motor

Model No. Number of Modules

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 w/ 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, 115 VAC
A160HW3EE	Solenoid Valve Package, 230 VAC
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



Series 5000 Multi Reactor System (MRS): 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.