Buying a Temperature Controller?

Understand the specification before you order

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I have described some controller features in previous articles in the context of the various processes and applications. Here I will review some of the features and specifications of the commonly used discrete panel-mounted controllers. A review of all makes and features is impossible here, so to supplement this column, my best advice is, extend your reading to catalogs, operation manuals, FAQs and web sites of the top manufacturers. Technology help lines are so overloaded that they become impenetrable and direct you to existing sources of help. Rightly so - but be prepared to quarry your way through some hard to read material.
With product knowledge in your brain and an eye on your process you can make a sound and economical choice of controller.

Thirty second **Sixteenth** **Eighth** **Quarter**

Dimensions. The most common sizes by bezel format are, 96x96mm (called quarter DIN), 96x48mm (one eighth DIN) 48x48mm (one sixteenth DIN) and 48x24mm (one thirty second DIN). DIN means Deutsches Institut für Normung (German Institute for Standardisation). DIN has pioneered many industrial standards and those for rectangular panel instruments have gained worldwide adoption, aiding interchangeability and reducing panel fabrication costs.
While DIN is useful shorthand one DIN (192x192mm) can be sliced many different ways in increments of 12mm and non-square models can be oriented landscape or portrait. I prefer to specify width and height.

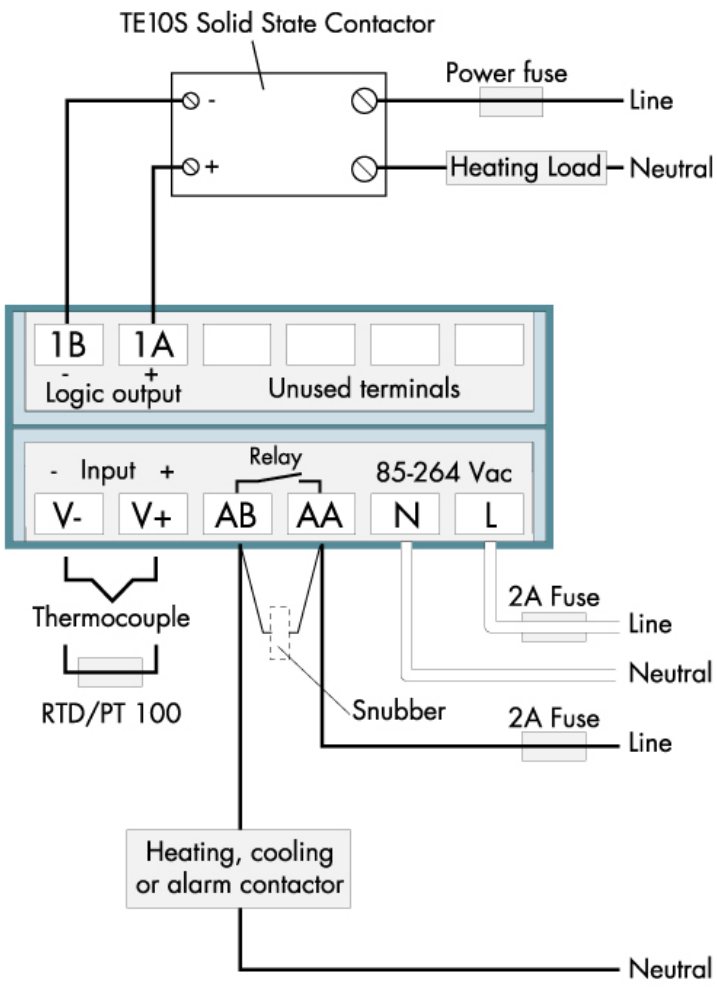
Panel Cut-outs conform to the body width and height dimension (90, 45, 22.5mm etc) plus a small clearance for insertion. The front to back depth dimension depends on the packing density of the internal electronics. Consider depth when you want the most space-saving and cost effective enclosure.

Typical Specifications

Year 2001 entry-level models would have the typical specification below:

Size	1/32 DIN (W48mm H24mm)
Control Modes	On/Off or PID with auto-tune and overshoot inhibition
Outputs	Relay 250V 2A for heat, cool or alarm. Logic 9V 18mA dc for heat or cool.
Cycle-times	0.2 – 100 sec Time-proportioning
Thermocouple Inputs	J K T L N Platinel II R S B C
RTD Inputs	DIN Pt 100 2-wire
Linear mV inputs	-12 to 80mV
Linear mA inputs	4 – 20mA
Display Ranges	-999 to 9999: up to 2 decimal places for linear inputs. º C or º F: Full useable range of temperature sensors
Input Offset	User adjustable over the whole input range
Input Filter	1.0 to 99.9sec
Power supply	85 – 264V ac 2.5W 48 – 62 Hz
Set point range	High and low limits adjustable within full range of input.
Set point rate limit	0.01 to 99.99 º/ min or units/min
Display	Single 4-digit green LED 10mm high
Indicators	Output 1 and Output 2 Legends. Flashing display indicates alarm active
Sample rate	5Hz (5 A/D conversions /sec)
Calibration Accuracy	0.25% of reading ± 1LSD or ± 1º F or C
Cold Junction Compensation	> 15:1 rejection of ambient temperature change
Common Mode Rejection	140dB (10^7) Sensor tolerates 250V elevation to ground
Process Alarms	High, Low, Deviation or Deviation Band
Load Diagnostics	Alarms for heater circuit open, loss of heater supply and short circuit of solid state contactor (over temperature hazard)
Panel Sealing	**IP65 NEMA 4X**

Fig 2 shows the wiring of a simple entry level 48x24mm controller.
Its sensor, (thermocouple or RTD) is shown connected to the input terminals. Line voltage can be any value from 85 to 264V. The controller's switching power supply self-adjusts to accommodate this range. This design avoids the winding burnouts often suffered by misconnections on dual tapped transformer power supplies.



The logic output is shown triggering a solid-state contactor with fast-cycling dc pulses. The contactor has internal diagnostics for load malfunction. A fault condition can be transmitted back on the logic wires to operate the relay provided that it has not been configured for cooling or some other alarm duty.
It is common practice to wire the relay for shutdown or audible or visible alarm.

With a 2-wire RTD connection the temperature will read high by about 1 º C per 0.4 ohm of cable resistance. You can trim this out by using the offset adjustment. This is just one of the many uses of the offset feature.

Fig 2. Rear Terminal Connections

The internal input filter cuts down noise on input signals. Its effect is equivalent to a single RC low pass filter with the RC product expressed in seconds.
On entry-level instruments it is usual to have only one display and bump the process temperature temporarily in order to display the parameters one by one as you are setting or observing them

A Few Steps Upmarket

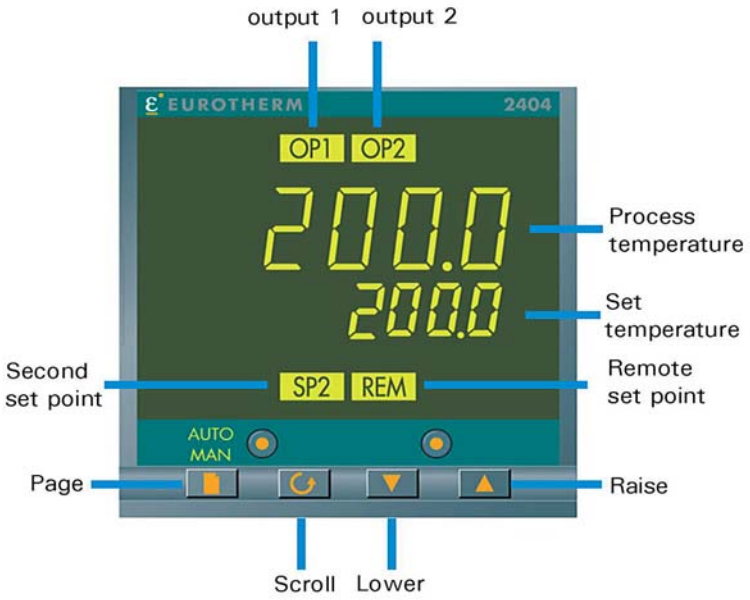


Fig 3. Mid Range Controller

Fig 3 shows the front of a mid range 1/4 DIN model with the controls and displays identified.
An 1/8 DIN model could provide about the same range of features with better space usage for multiple loop panels such as extruders.

Displays and Controls

The 7-bar digital LED display in red or green is the most common for process temperature (upper display) and set temperature (lower display). In the **operation mode** touching the up/down buttons will, change the main set point without the need to touch any other control. The lower display can be toggled between set temperature and controller output, e.g. percentage, amps, valve position etc. Here it is important to distinguish between the output signal at the controller terminals and the actual state of the final control device that is supposed to obey the controller. You can be misled if this link is defective.

Two other buttons give auto/manual access and run/hold control for ramp and soak programs.

In the **configuration mode** the lower display is used to display the short name (mnemonic) of any one of the many control, alarm or configuration parameters that you might be adjusting. Their values will be shown in the upper display.
The **Page** button takes you through various headings. **Scroll** takes you down a list of parameters under those headings. At this point you can configure or adjust the parameters using the UP/DOWN buttons. PASSWORDS??

The above is just one example of the user interface. Apart from the UP/DOWN buttons there is no consensus on the names, functions and keystroke sequences of the other controls or buttons. This applies between manufacturers and even between different models from the same

manufacturer.
Understanding a controller and applying it to the process demands deep study of the manual and practice at the displays and controls. Process disasters, often put down to operator error are more likely to be attributable to documentation and a non-intuitive HMI (human-machine interface).

Wiring to the Process

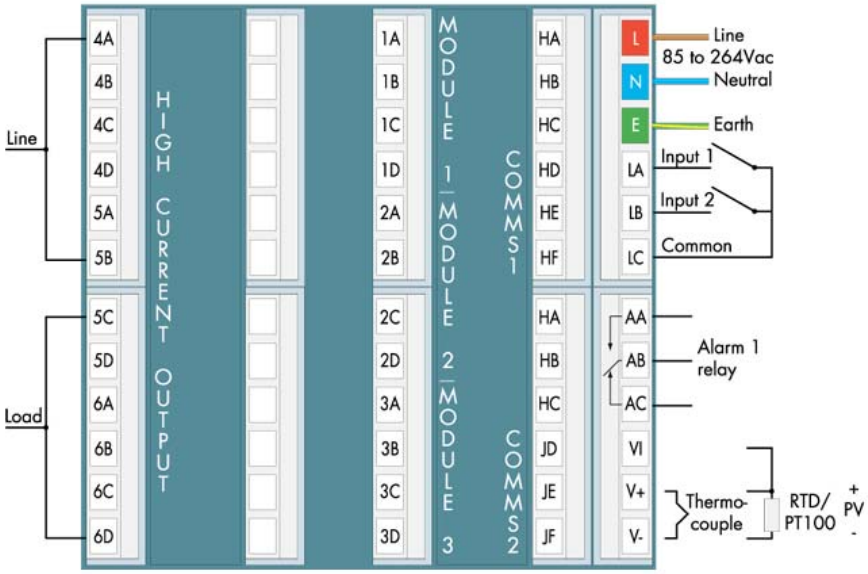


Fig 4. Rear Terminals of a Mid-range Controller

Additional features when you move up from entry level:

Control Modes.

- Reverse or direct-acting
- Self and adaptive tune.
- Dual heat/cool outputs
- Auto/manual
- Ramp/soak programming
- Feed forward control

Process Inputs.

- Higher calibrated accuracy, stability and cold junction compensation speed.

- More sensor types. User defined non-linear inputs.
- 10 Hz sampling rate.
- 3-wire RTD connection.

Other Analog Inputs

- Input voltage or current for remote set-point, external power limit, valve position feedback, heater current, set point trim and load diagnostics

Logic Inputs

- Up to 11 available inputs can control any 11 out of some 30 commands

Control Outputs, one Heat one Cool

- Analog current or voltage
- Form C relay for heat, cool or valve position motor
- 10A relay
- 2A triac for heat, cool or valve position motor

Function Outputs. Several relay triac or logic type. Allocatable to:

- Alarms, Manual, sensor break, Out of range, Load fail, Tuning in progress, DC output open circuit, New alarm, End of program.

Digital Communications

- EIA485, Modbus Protocol

Ramp and Soak Programming.

- 16 segment program
- Multiple recipes

Further yet upmarket.

- Multiloop controller/programmers for cascade, ratio and, temperature/humidity
- Profibus and Modbus communications
- Real time clock
- Toolkit blocks for internally wiring analog and digital functions together without taking up external terminals.
- PC configuration software
- Dot matrix displays to enable scaleable and versatile alphanumeric and graphical displays to be shown.
- Bargraphs used to show for example load current, valve position, deviation from set point and controller output signals.
- Zirconia oxygen probe inputs