TC410

Temperature / Process Controller

THERMOLINE
TEMPERATURE CONTROLLERS

ORDERING CODE

MODEL	INPUT TYPE	POWER SUPPLY	OUTPUT TYPE
TC 410	J0	024E	R-

SEE PAGE 10 FOR ORDERING OPTIONS

Features and Benefits

- User friendly installation and operation.
- Easy configuration via a simple text based function menu.
- Keypad lock to ensure that operational modes and settings are secured once the controller is installed.
- Dual 3 Digit Display for simultaneous indication of both process temperature and setpoint.
- Selectable PID or ON/OFF control.
- PID control with Autotune function ensures precision control.
- Full autotune for PID control, calculating P, I, D and Anti-reset wind-up terms.
- Adjustable PID relay cycle time for precision control of fast or slow processes.
- Adjustable hysteresis allowing greater flexibility.
- An 8 Amp relay output or SSR (Solid State Relay) drive output.
- Analogue and digital input filtering.
- A plug connector system that allows quick and easy installation.
- Multi-voltage (21-53V AC/DC, 85-265V AC/DC).
- Digitally calibrated.
- CE Mark.

Description of Operation

The Basics of ON/OFF Control
In this simple form of control, the controller output switches off when the process temperature reaches the setpoint. The process cools until the recovery level is reached and power is re-applied to the process. The resulting process temperature oscillates through this hysteresis band (the band between setpoint and recovery levels) as illustrated in Fig. 1.
On/Off Control is ideal for large capacity processes (processes that have slow temperature changes and are insensitive to disturbances) because the hysteresis band can be set very narrow, minimising temperature oscillations.
Example: *The thermostat of a household heater uses On/Off control. When the room temperature reaches the setpoint, a switch opens and turns the heater off. The switch remains off until the room temperature drops below the setpoint causing the switch to close, turning the heater on again. The heater is either ON or OFF.*

The Basics of PID Control
In applications where precision control is required, including small capacity processes that react quickly to disturbances, it is necessary to provide a more sophisticated method of temperature regulation than that of ON/OFF control.
For example, ON/OFF control would be ineffective in controlling the temperature of a bathroom shower as the person would be subjected to alternative bursts of HOT and COLD water, neither of which is desirable. It is necessary to establish a proportion of hot to cold water to maintain the required temperature.

Proportional Control (P)
Proportional control provides added temperature stability by eliminating temperature fluctuations by setting the proportion of power supplied to the process depending on the difference between process and setpoint temperatures. Unfortunately, the process temperature only settles at the setpoint if the heat source (heater) matches the heat load of the process EXACTLY. Heaters and processes are rarely matched and therefore the process temperature usually settles at a value offset from the setpoint as shown in Fig. 2.

Proportional and Integral Control (PI)
To compensate for the offset resulting in proportional only control, a second control term known as Integral Action is introduced. Integral Action eliminates the offset by responding to duration of the error signal (through integration) and automatically forcing the process temperature to settle exactly at the setpoint after a period of time (as shown in fig. 3). This is achieved by small adjustments in the proportional output.

Proportional, Integral and Derivative Control (PID)
In many small capacity processes, the controller must respond quickly to large and rapid changes in temperature caused by disturbances. Derivative action provides additional temperature stability by reacting to the rate of change of the process temperature.
Example: *An injection moulding machine benefits from PID control. Proportional control ensures that the plastic temperature is stable and does not oscillate. Integral control maintains accuracy by keeping the temperature exactly at the setpoint over long periods. Derivative action forces the temperature back to the setpoint quickly when the cold plastic pellets enter the melting chamber.*

Autotune Function
For optimum PID control, the controller parameters (P, I and D values) should be tuned for each temperature process. This can be performed manually or automatically by activating the Autotune function. PID control facilitates precision control at the setpoint temperature (as shown in fig. 4) and the Autotune function makes the unit easy to set up.

Anti-Reset Wind-Up
Anti-reset wind-up, sometimes referred to as manual reset, is automatically calculated during the Autotune function but can also be manually set, if required. It is used in conjunction with proportional, integral and derivative terms to speed up the time it takes a process to reach its setpoint temperature while minimising overshoot. This term represents the percentage power that a proportional only system would require to maintain its setpoint temperature.
Example: *A user would set the anti-reset term to 30 for a system requiring 30% power to maintain its setpoint temperature.*

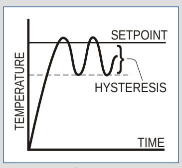


Figure 1

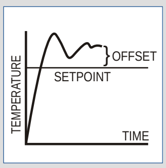


Figure 2

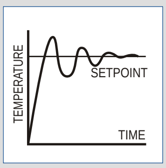


Figure 3

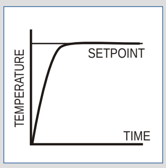
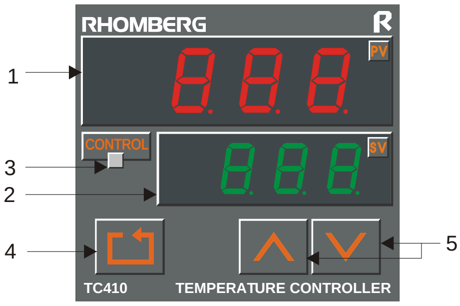


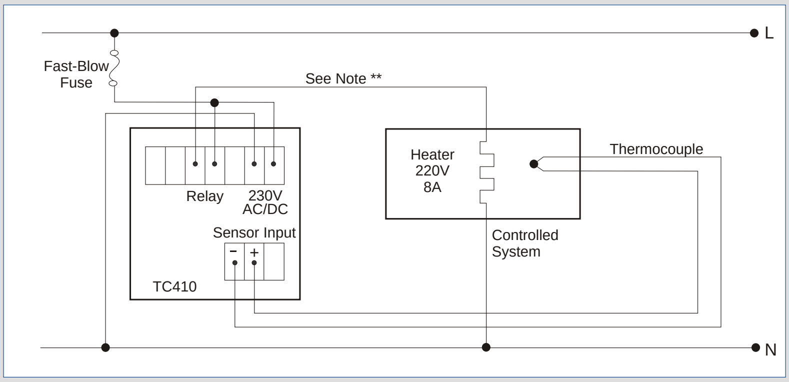
Figure 4

Description of Controls



1. **3 Digit Display:** 3 Digit display of process temperature or function name
2. **3 Digit Display:** 3 Digit display of setpoint or function status
3. **Control LED:** Output status indication. Control LED illuminates when control output is energised.
4. **Select Key:** Press to select the displayed function.
5. **Up/Down Keys:** Press to change the setpoint value or the status of the displayed function. Hold down to scroll quickly.

Wiring and Connection



Example 1:*Controller with Relay Output and thermocouple input.*

*** **Note:** It is recommended that a Slave Relay/Contactor be installed when switching large inductive/ resistive loads*

Technical Specifications

CONTROLLER SPECIFICATIONS	
Setting Accuracy	± 1%
Linearisation Accuracy	± 0.3%
Cold Junction Tracking	0.05°C per °C
Sampling Period	70ms
Control Method	PID or On/Off.
PID Relay Cycle Period	1-240 seconds
On/Off Control Hysteresis	0 to 99.9°C

EMC PROTECTION RATING	
Radiated Susceptibility	IEC 801-3, Class 3
Radiated Emission	CISPR11, Class B
Conducted Susceptibility	IEC 255-22-1, Class II
Conducted Emission	CISPR11, Class B

CONTROL OUTPUT OPTIONS	
Control Output (Relay)	250V AC, 8A, SPDT/SPST(N.O.)
Control Output (SSR Drive)	8-28V DC at 10mA

GENERAL SPECIFICATIONS	
Operating Temperature	0 - 50°C
Humidity	5-85% non-condensing
Storage Temperature	-20°C to 70°C
Protection Class (Front)	IP54
Protection Class (Rear)	IP30
Connection	Plug-connector
Weight	250g
Standards	CE Mark
Creepage Distance	VDE 0110 (Group C 250V) IEC 664/664A VDE 0435

POWER SUPPLY	
Power Supply	21 - 53V AC/DC 85 - 265V AC/DC
Power Consumption	Less than 3VA

INPUT SPECIFICATIONS										
Operating Temperature		SENSOR TYPE								
		PT100	E	J	K	R	S	T	B	N
Upper Limit	ºC	800	950	750	999	999	999	380	999	999
Lower Limit	ºC	-99	-99	-99	-99	-40	-40	-99	50	-99

Note: *In some cases the sensor range is limited by the display range of the controller (-99° to 999°). For operation over a wider temperature range see TC600/ PC100. °F available on request*

DISPLAY SPECIFICATIONS	
PV Display Type	3 x 10mm red
SV Display Type	3 x 7mm green
Resolution (PV, SV)	1°C
Temp. Display Range	-99º to 999°C