TC-515

Temperature / Process Controller

THERMOLINE
TEMPERATURE CONTROLLERS

ORDERING CODE

MODEL	INPUT TYPE	POWER SUPPLY	OUTPUT TYPE
TC515	U0	024E	RR

SEE PAGE 10 FOR ORDERING OPTIONS

Features and Benefits

- User friendly installation and operation.
- Easy configuration via a simple text based function menu.
- Dual 3 Digit Display for simultaneous indication of both process temperature and setpoint.
- Selectable PID, ON/OFF or Trip and Recovery Control modes.
- 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 ON/OFF control hysteresis, allowing greater flexibility when controlling non-critical processes.
- Trip and Recovery control mode allows two independently adjustable trip and Recovery levels with separate control outputs.
- Two independently programmable temperature alarm levels can be used in 12 different modes and are selectable as an upper alarm level, a lower alarm level or both. They can also be configured to operate as absolute or deviation standby alarm levels.
- Keypad programmable for use with any one of 9 commonly used temperature sensors.
- Programmable relay action for heating or cooling applications to ensure fail-safe operation.
- Programmable operation in degrees Celsius or degrees Fahrenheit.
- A process protect feature , which when enabled, confines the setpoint to a range determined by the two alarm levels and prevents accidental changes of the setpoint to outside the alarm limits.
- Programmable process temperature offset that can be set to the difference between the process and sensor temperatures. This is used when the sensor cannot be positioned ideally.
- A unique 16 hour timer for batch processing.
- Keypad lock security feature to prevent unauthorised adjustments by providing three levels of security.
- An 8 Amp relay 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 Trip & Recovery Control
Trip and Recovery mode facilitates control of two independent setpoints. In heating, each trip point represents the temperature above which the relay is de-energised and the heating mechanism is de-activated. The recovery points represent a temperature below which the relay is re-energised and the heating mechanism is turned on. This feature can also be used in cooling applications. Each trip point will then represent the temperature below which the relay is de-energised and the cooling mechanism is de-activated. The recovery points represent the temperature above which the relay is re-energised and the cooling mechanism is turned on.
Example: *A typical application where two fans are used to control a process is shown in Fig. 2 above. The first fan is activated at 300° and remains on until the temp. falls below 250°, while the second switches on at 350° and switches off at 280°.*

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. 3.

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. 4). 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. 5) 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.*

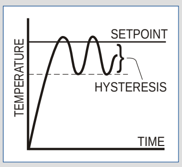


Figure 1

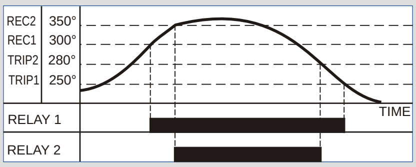


Figure 2

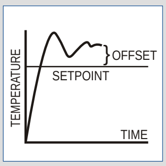


Figure 3

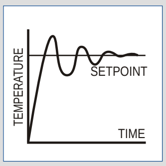


Figure 4

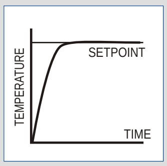
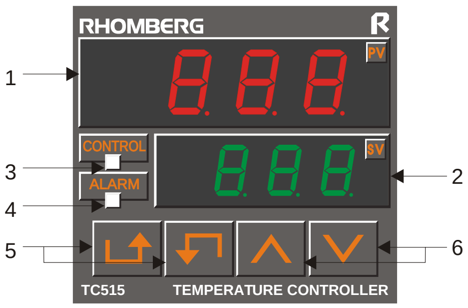


Figure 5

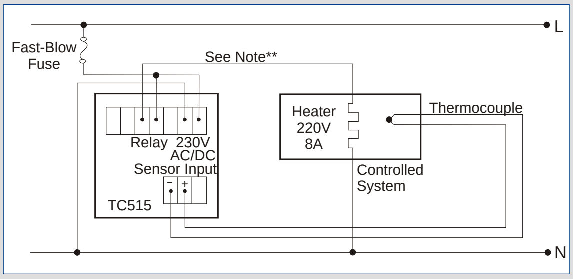
Description of Controls



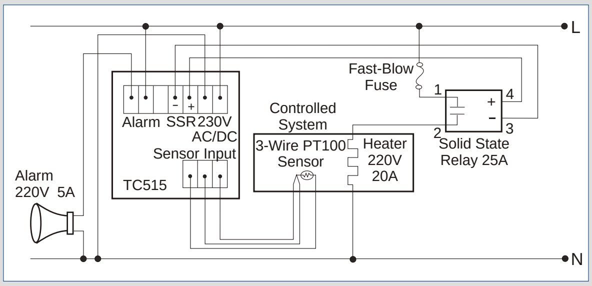
1. **Process Value Display:** 3 digit display of process temperature or function name.
2. **Set Value Display:** 3 digit display of setpoint or function status.
3. **Control LED:** Control output status indication. Control LED illuminates when control output is energised.
4. **Alarm LED:** Alarm output status indication. Alarm LED illuminates when alarm output is energised.
5. **Select Keys:** Press to move up or down the function list.
6. **Up/Down Keys:** Press to change the setpoint value or the status of the displayed function. Hold down to scroll quickly.

Wiring and Connection

Wiring: Examples on how to connect the Controller.



Example 1: *Controller with Relay Output, no alarm required. Input is from a thermocouple.*



Example 2: *Controller with Solid State Relay (SSR) Output and Relay Output for Alarm. Input is from a PT-100 RTD.*

***** 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, On/Off or Trip & Rec.
PID Relay Cycle Period	1-240secs
On/Off Control Hysteresis	0-99.9°
Proportional Band	0,5° - 999º
Integral Time	0-999 seconds
Derivative Time	0-999 seconds
Timer Range	1-999 minutes
Timer Accuracy	0.1% of preset time
Timer Resolution	1 minute

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	
Relay	250V AC, 8A, SPDT
SSR Drive	8-28V DC at 10mA

ALARM OUTPUT OPTIONS	
Relay	250V AC, 8A, SPST (N.O)
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
	ºF	999	999	999	999	999	999	715	999	999
Lower Limit	ºC	-99	-99	-99	-40	-40	-40	-99	50	-99
	ºF	-99	-99	-99	-40	-40	-40	-99	122	-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.*

DISPLAY SPECIFICATIONS	
PV Display Type	3 x 10mm red
SV Display Type	3 x 7mm green
Resolution (PV, SV)	1° (SV 0,1º from -9,9º to 99,9º)
Temp. Display Range	-99º to 999°