THERMOLINE

TEMPERATURE CONTROLLERS

TC410
Installation Manual

RHOMBERG
a Winters company

Guarantee

12 months

Congratulations on the purchase of this new product. Special care with the design, workmanship and choice of materials has been taken to ensure its reliable performance.

Each product is stringently tested before leaving our factory. Therefore, our products are guaranteed for a period of 12 (twelve) months from date of purchase. This guarantee is valid for defects arising from failure during operation under specified conditions. Our company does not accept liability for any consequential damages or losses arising from product malfunction.

Should this product prove to be defective, kindly return it for inspection or repair. For further information, please contact your nearest distributor of Rhomberg products.

RHOMBERG
a Winters company

Contents

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 reapplied to the process. The resulting process temperature oscillates through this hysteresis band (the band between setpoint and recovery levels) as illustrated in Figure 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.

Typical Applications:

Airconditioning
Oil heaters
Bain Marie catering equipment

Simple 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.

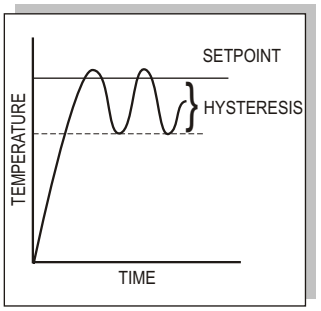


Figure 1 : On/Off Characteristic

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 Figure 3.

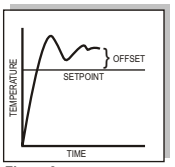


Figure 3 : Proportional Control Characteristic

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. This is achieved by small adjustments in the proportional output.

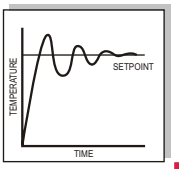


Figure 4 : Proportional and Integral Control Characteristic

The Basics of PID Control (Continued)

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.

Simple 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.

Typical Applications:

Furnaces
Petrochemical processes
Industrial ovens
Refrigeration control
Jacuzzi control
Injection moulding

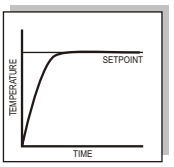


Figure 5 : Proportional, Integral and Derivative Control Characteristic

For optimum PID control, the controller parameters (P, I and D values) should be tuned for each temperature process. In Thermoline, when selecting a setpoint, the proportional band is tuned automatically. This facilitates precision control at the setpoint temperature and 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 auto-tune procedure 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.

Installation

Panel Cut-out

Cut or punch out a panel cut-out. The ideal panel thickness is between 1 and 7 mm.

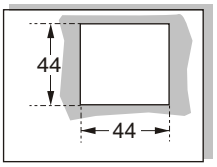


Figure 6 : Panel Cut-out Dimensions (mm)

Mounting

Insert theTC410 into the cut-out. Slide the retaining clip (1) over the housing from the rear until the clip presses firmly against the panel. Secure the clip using the screws (2) provided.

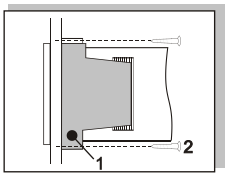
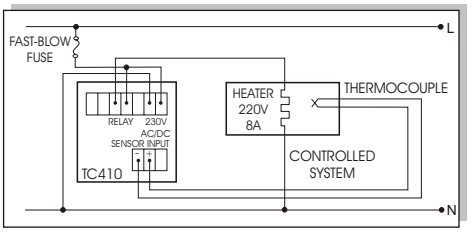


Figure 7 : Mounting Method

Wiring

The following is an example of how to connect the TC 410.



TC410 with Relay Output

RHOMBERG

Installation

Connection

Connect the TC410 to the supply and the temperature sensor to the TC410. Ensure that the correct sensor polarity is observed. **[To prevent noise from entering the sensor input, it is good practice to keep the power and load cables separate from the sensor cable]**.

CAUTION: A sensor without screening must be used when the TC410 has a solid state relay output because there is no isolation between the sensor input and the SSR output.

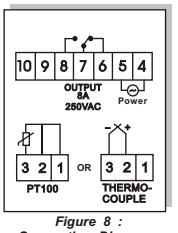
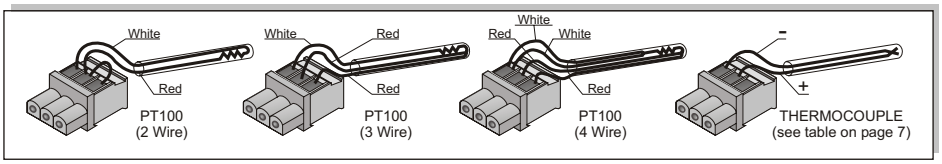


Figure 8 : Connection Diagrams

The following figure illustrates how the thermocouple or PT100 is connected.



THERMOLINE
TEMPERATURE CONTROLLERS

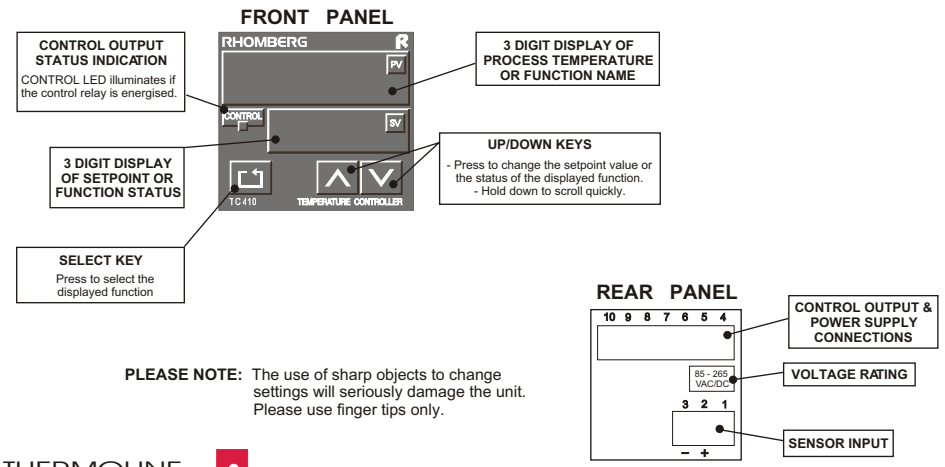
Installation

Thermocouple Reference Table :

	STANDARD									
TYPE	BRITISH BS 1843		AMERICAN ANSI / MCI 96.1		GERMAN DIN 431710-4		FRENCH NFE		DIN IEC 584	
E +	BROWN	BROWN	PURPLE	PURPLE					PURPLE	PURPLE
E -		BLUE		RED						WHITE
T +	BLUE	WHITE	BLUE	BLUE	BROWN	RED	BLUE	YELLOW	BROWN	BROWN
T -		BLUE		RED		BROWN		BLUE		WHITE
V +	RED	WHITE			GREEN	RED	RED	YELLOW		
V -		BLUE				GREEN		BROWN		
K +	RED	BROWN	YELLOW	YELLOW	GREEN	RED	YELLOW	YELLOW	GREEN	GREEN
K -		BLUE		RED		GREEN		PURPLE		WHITE
J +	BLACK	YELLOW	BLACK	WHITE	BLUE	RED	BLACK	YELLOW	BLACK	BLACK
J -		BLUE		RED		BLUE		BLACK		WHITE
R +										
R -										
S +										
S -										
U +	GREEN	WHITE	GREEN	BLACK	WHITE	RED	GREEN	YELLOW		
U -		BLUE		RED		WHITE		GREEN		

RHOMBERG

TC410 - Front and Rear Panels



PLEASE NOTE: The use of sharp objects to change settings will seriously damage the unit. Please use finger tips only.

TC410 - Key Features

Dual display for simultaneous indication of both process temperature and setpoint.

PID control with adjustable relay cycle time for fast or slow processes.

On /Off control with adjustable hysteresis.

Full autotune for PID control.

Keypad lock to prevent accidental tampering.

TC410 - Example of Set-up Procedure Flow Diagram

Example:
Ambient temp. 23°C
Required process temp. 250°C

Apply power. A self test will be performed lasting 5 seconds.

Press the UP or DOWN keys to change the setpoint value.

The temperature controller is ready to function with the factory default settings. If these settings need to be changed use the SELECT, UP and DOWN keys to change the function status.

On/Off Control Setup

Press the SELECT key until Ctr is reached. Press the UP or DOWN keys so that OnF appears in the lower display.

Press the SELECT key until HYS is displayed. Press the UP or DOWN keys to adjust the ON/OFF control hysteresis in degrees.

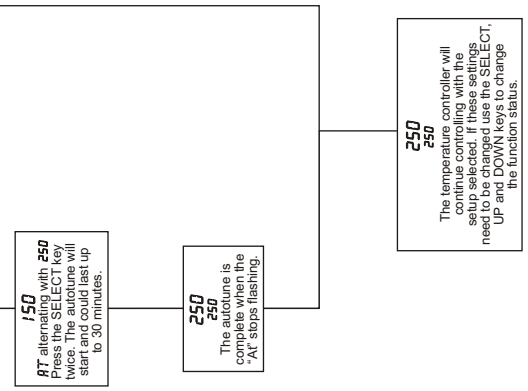
PID Control Setup

Press the SELECT key until Ctr is reached. Press the UP or DOWN keys so that Pid appears in the lower display.

Press the SELECT key until CYC is displayed. Press the UP or DOWN keys to adjust the PID relay cycle time to match the dynamics of the system (Note 2).

Press the SELECT key until the Process Value and Set Value are displayed. Check that the set value is correct before starting Autotune. Adjust if necessary.

Press the SELECT key until AtL is displayed. Press UP or DOWN keys to toggle Autotune on. Autotune is performed at the setpoint and calculates P,I,D and Anti-reset terms.



NOTE 1:
If the desired functionality differs from the factory default settings shown on page 12, an error message may appear. Complete this set-up procedure to configure the unit correctly.

NOTE 2:
Adjust the PID relay cycle time to < 10 seconds for a system with fast dynamics and > 10 seconds for a slow system.

TC 410 - Function Description Table

FUNCTION READING	FUNCTION	STATUS OPTIONS	FACTORY SETTINGS	NOTES
Ctr	CONTROL MODE (PID/On-Off)	STATUS / CONTROL MODE / APPLICATIONS Pid / PID Control / Precision Control OnF / ON/OFF Control / Non-critical Applications	OnF	See page 13 for a more detailed description.
CYC	PID RELAY CYCLE TIME	CYC / CONTROL / LIMITS / FUNCTION CYC / PID / 1-240sec / CYCLE TIME	10 sec	See page 13 for a more detailed description.
HYS	ON/OFF CONTROL HYSTERESIS	HYS / CONTROL / LIMITS / FUNCTION HYS / ON/OFF / 0 - 99.9° / HYSTERESIS IN DEGREES	10°C	See page 13 for a more detailed description.
At	PID AUTOTUNE	STATUS / PID AUTOTUNE OFF / Disabled On / Enabled	OFF	See page 14 for a more detailed description.
LOC	KEYPAD LOCK	STATUS / KEYPAD LOCK OFF / Disabled On / Enabled	OFF	See page 14 for a more detailed description.

TC 410 - Detailed Function Description

Ctr CONTROL MODE

- Set Ctr to Pid for PID control. Adjust PID relay cycle time in CYC function. This control mode should be used where precise control is required. When selected for the first time the Autotune function should be initiated (See At).
- Set Ctr to OnF for ON/OFF control. Adjust ON/OFF control hysteresis in HYS function. This control mode should be used for non critical applications.

CYC PID RELAY CYCLE TIME

The CYC value represents the PID relay cycle time in seconds and is only used when the control mode is set to PID. It can be adjusted from 1-240 seconds. The faster the process the smaller the cycle time will have to be for the controller to maintain control. For best results this value should be set as low as can be tolerated by the load and switching element.

HYS HYSTERESIS

The HYS value represents the ON/OFF control hysteresis in degrees and is only used when the control mode is set to ON/OFF. It can be adjusted from 0-99 degrees, defining the recovery point for ON/OFF control. ON/OFF control takes place in the hysteresis band between the setpoint and the recovery point.

TC 410 - Detailed Function Description cont:

AT PID AUTOTUNE

- Set AT to On to start the Autotune function. **Note:** The controller must first be in PID control mode (CTr, previous page). While the Autotune function is active, AT will flash on the lower display. The Autotune function calculates P,I,D and Anti-reset terms by cycling the process 3 times. The time it takes to complete an Autotune will therefore depend on the speed of the process.
- Once completed AT will automatically return to OFF. The controller will revert to PID control using the new P,I,D and Anti-reset terms. These terms are also saved for future use whenever PID control is selected.
- Set AT to OFF to abort the Autotune function and revert to PID control with previously saved P,I,D and Anti-reset terms.

LOC KEYPAD LOCK

- Set LOC to On to avoid any tampering with the controller's settings. The controller will display the process value and set value and no adjustments will be possible.
- To set LOC to OFF press and hold the up and down keys simultaneously. Once LOC, OFF is displayed the function key can be used to access any of the above functions.

TC 410 - Error Messages & Troubleshooting Table

Message	Condition	Remedy
Err 1	Measured temperature is below specified sensor minimum	Select more appropriate sensor type.
	TC 410 input failure	Factory Repair
Err 2	Measured temperature is above specified sensor minimum	Select more appropriate sensor type.
	Sensor cable open circuit (burn out)	Replace sensor
	Sensor incorrectly connected	Check connections
	TC 410 Input failure	Factory Repair
Err 3	Ambient temperature >50°C	Reduce the TC 410's operating temperature
	Cold junction failure	Factory repair

TC 410 - 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
PID Relay Cycle Period	1 - 240secs
On/Off Control Hysteresis	0 - 99.9°C
Proportional Band	50°
Integral Time	36s
Derivative Time	5s

Power Supply:

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

Display Specifications:

PV Display Type	3 x 10mm red
SV Display Type	3 x 7mm red
Resolution (PV, SV)	1°C
Temperature Display Range	-99 to 999°C

General Specifications:

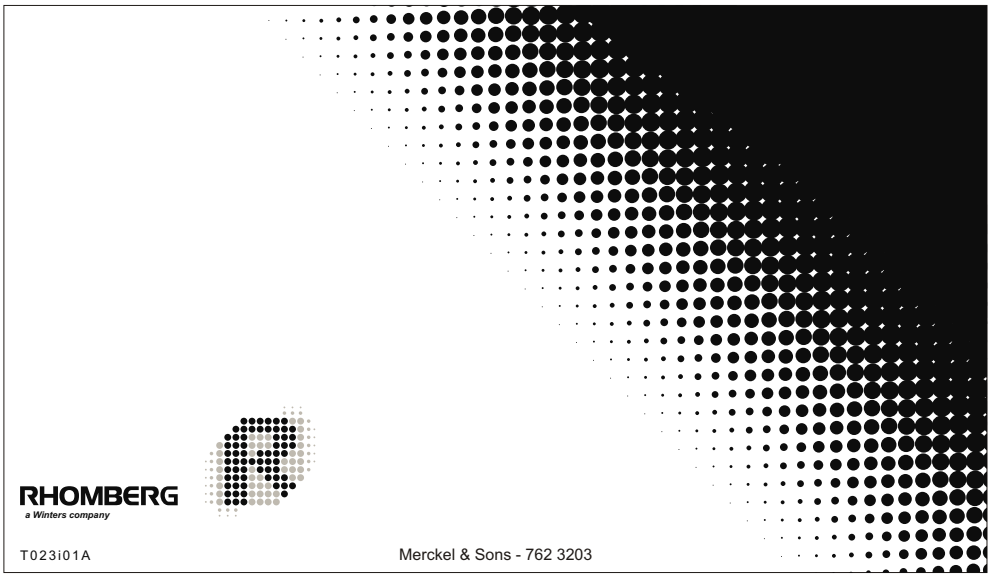
Operating Temperature	0 - 50°C
Humidity	5 - 85% non-condensing
Storage Temperature	-20°C to 70°C
Protection Class (Front Panel)	IP54
Protection Class (Rear)	IP30
Connection	Plug-connector
Weight	250g
Standards	CE Mark
Creepage Distance	VDE 0110 (Group C 250V) IEC 664/664A VDE 0435

Output Specifications:

Control Output (Relay)	250V AC, 8A, SPDT
Control Output (SSR Drive)	10mA at 8V

Notes

RHOMBERG
a Winters company



RHOMBERG
a Winters company