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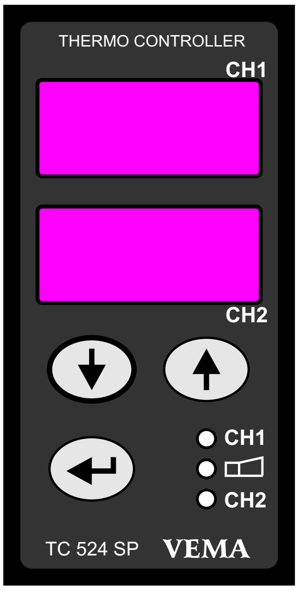
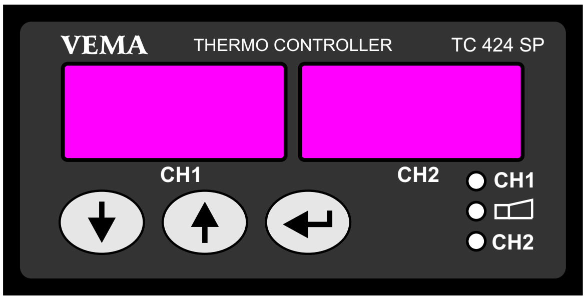
Two-channel temperature controller

TC524SP/TC424SP



- *On/Off or PID control;*
- *Auto- tuning;*
- *Ramp-function;*
- *Wide temperature range: from -199 to 999 °C.*



USER MANUAL

Introduction

The microprocessor Temperature Controllers TC424(524)-J/-K/-P offer optimal comfort of service and visualization of information.

The Temperature Controllers TC424(524)-J/-K are assigned to work with thermocouples of type J or K, the TC424(524)-P Temperature Controllers - with thermistors of type Pt100. Other temperature sensors' compatibility is also available on request.

The output signal is given either as a relay or a direct current output.

The Controller can be set as On/Off, or 2-position PID regulator.

The auto-tuning algorithm explores the parameters of the object to be controlled and sets the corresponding PID-constants of the Controller.

The Controller is supplied with an alarm relay output for preventing the temperature from great detours in the technological mode of the controlled object. The alarm relay output can work in 32 programmable modes, non-latch standby sequence included.

The current temperature PV (Process Value) for each channel are constantly displayed in the Control Mode. The Controller can also display the desired temperature SP (Set Point) in this mode by pressing and holding the (↓) or (↑) button.

The processes of heating (CH1), (CH2) and alarm(▭) are indicated by separate light diodes.

All parameters of the Controller can be set (changed) in Program Mode. In this case the mnemonics of the parameters are shown on the CH1 display and the current values of the parameters are shown on the CH2 display. Using the arrow buttons (↓) and (↑), the parameters' values can be changed by one unit or at a faster rate (when the button is held pressed for a longer time). The values of the parameters are automatically restricted within their possible limits.

Technical specifications

1. Temperature range...- 199 up to 999 °C.
2. Accuracy...0.2% up to 1.0%.
3. Parameters' range:
   - gain factor (P)...0 to 99 %;
   - differential constant time (td)..0 to 250 s;
   - integral constant time (ti)...0 to 999 s;
   - cycle time (tc)...0.1 to 100 s;
   - alarm limits (tAL, tAU)...- 199 to 999 °C;
   - On-Off hysterisis (HY)...0 up to 99.9°C;
   - ramp preheating gradient (r d)..0 to 99.9 °C/min.
4. Indication...seven-segment LED, h=14.2 mm.
5. Control outputs:
   - relay type..max 2A/250V cosΦ=1;
   - open collector (on request)...0/24V to 30 mA.
6. Supply voltage..187 up to 242 V/48-62 Hz.
7. Dimensions................................48x96x100 mm (TC424), 96x48x100 mm (TC524).
8. Ambient temperature...0 to 50 °C.

Mnemonics of the parameters

The parameters can be read and modified by pressing of button (↵) in next sequence:

1. SP1 - Set value for the first channel ch1;
2. SP2 - Set value for the second channel ch2;
3. tAL - lower alarm limit of temperature;
4. tAU - upper alarm limit of temperature;
5. ALn - type of alarm;
6. P 1 - gain factor for channel ch1;
7. td1 - differential constant for channel ch1;
8. tc1 - cycle time (in seconds) for channel ch1;
9. ti1 - integral constant for channel ch1;
10. P 2 - gain factor for channel ch2;
11. td2 - differential constant for channel ch2;
12. tc2 - cycle time (in seconds) for channel ch2;
13. ti2 - integral constant for channel ch2;
14. OPt - auto-tuning start:

"oFF" - no auto-tuning is initiated and the Controller goes off the Program Mode when (↵) is pressed,

"on" - the auto-tuning function is initiated upon pressing the (↵) button in order to find out the best PID parameters.

15. POS - type of the Controller

"ALL" - control of the two channels;
"ch1" - control only on the first channel;
"ch2" - control only on the second channel;
"oFF" - no control.

16. rEP - end-point temperature for preheating on a ramp;

17. r d - gradient of the ramp preheating (in deg/min);

18. HY 1 - heating hysteresis for On/Off regulator, i.e the heating output will go “on” when PV is under SP 1-HY 1, and will go “off” when PV is above SP 1 for channel ch 1;

19. HY2 -heating hysteresis for On/Off regulator for channel ch2;

20. ctr - type of the Controller:

”oFF” - the Controller will only measure the temperature, no regulation;

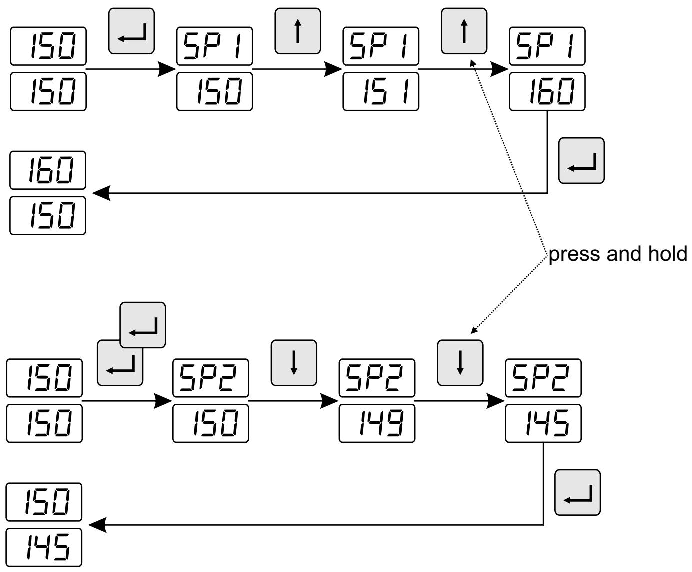
“onF” - the Controller will work as an On/Off regulator (s. HY 1 and HY2);

“P id” - the Controller will work as a 2-PID regulator.

PROGRAM AND MONITOR MODES

In MONITOR mode with pressing (↵) button the display for CH1 reads “SP 1” and arrow keys can be used to modify the set temperature for CH1. Pressing the (↵) two times displays “SP2” and arrow keys are used to modify the set temperature for CH2 and so on for all other parameters. After all parameters of the selected mode have been passed, the Controller will go back to MONITOR mode. In order to set the auto-tuning mode, “ch 1” or “ch2” must be entered as value of the parameter “OPt”. After the end of optimization the Controller will go back automatically in MONITOR mode. The auto-tuning mode can be cancelled with simultaneously pressing of two arrow keys.

Changing the values of SP 1 and SP2 is sketched below:



SPECIFIC CHARACTERISTICS

The normal deviation of the current temperature (PV) from the set temperature is about 1°C or less. Greater deviations of 2-3°C are sign of incorrect PID-parameters, unacceptable outer influences, intense electrical noises, incorrect placement of the temperature sensors or damages.

The **auto-tuning** algorithm enables the Controller to adjust its PID- parameters to the characteristics of the controlled object for a more precise temperature regulation. The only parameters needed are the SP 1 and SP2. The auto-tuning can be started in Program Mode by setting the “OPt” parameter to “ch 1” or “ch2”. The "CH1" display reads a blinking "OPt", indicating that the (self-)optimization routine is still going on. It is recommended to give a tolerance of at least 30 degrees Celsius between the starting and the set temperature before starting the auto-tuning algorithm, since the self-optimization uses the **step-response method**.

If the gain factor after auto-tuning is greater than 80%, it will mean that the heater is not powerful enough for this object. If this parameter is less than 10%, then the heater has an exceeding power for the controlled object.

RECOMMENDATIONS

A better control of the temperature is achieved by a smaller cycle times. However, this leads to a more frequent commutation of the relay and to a faster wear-out. A compromised value in this respect is tc= 10 sec.

The **differential time constant** influences the forecasting action of the Controller, so to a great extend the initial oscillations of the temperature depend on this constant. When no auto-tuning is used, the recommended values for td 1/2 to start with are 40 sec.

The fast and smooth reaching of the set temperature depends greatly on the **integral time constant**. The temperature controllers TCx24SP are fuzzy-optimized with respect to the PID integral action, so that values ti=200 give a sufficient result for a huge class of objects.

The **gain factor** depends entirely on the location of the set temperature on the characteristic of the heaters, so it is not possible to give any recommended values. However, if the heaters are optimally designed for the controlled object, P=25 will suffice.

All of these recommendations are only given for basic orientation, so the best recommendation is to run the auto-tuning algorithm and after that dynamically correct the evaluated parameters, if need may be.

The **alarm output** is logical OR of the internal alarm outputs for each channel. The table below represents the state of the internal alarm outputs depending on ALn, tAL and tAU. Alarm zones 16 to 31 haves the same behavior like those from 0 to 15, only that tAL and tAU are **referential values** according to SP1 and SP2. It means that the **absolute alarm values** for channel ***x*** will be SP***x***+tAL and SP***x***+tAU.

The alarm mode must be selected according to the technological assignment of the controlled object. For extruder machines, it is very hazardous to run the main motor before the temperatures have not been stabilized and the material along the screw has not melted. In this case, ALn must have the value of 1 or 3 (5 and 7 for normally closed output). If an alarm siren is used outside the **alarm strip** (**AS**) after the initial heat-up, then the **standby sequence** is recommended with values for ALn 9 or 11 (14 or 15 when normally closed):

ALn*	**under Alarm Strip** PV<tAL*	**inside Alarm Strip** tAL*<PV<tAU*	**above Alarm Strip** PV>tAU*
ALn= 0, 16			
ALn= 1, 17	X		
ALn= 2, 18			X
ALn= 3, 19	X		X
ALn= 4,20	X	X	X
ALn= 5,21		X	X
ALn= 6,22	X	X	
ALn= 7,23		X	
ALn= 8,24			
ALn= 9,25	X		
ALn= 10,26			X
ALn= 11,27	X		X
ALn= 12,28	X	X	X
ALn= 13,29		X	X
ALn= 14,30	X	X	
ALn= 15,31		X	

☐ alarm output for this channel is off, the corresponding indicator not blinking.

[X] alarm output for this channel is on, the corresponding indicator not blinking.

standby sequence. If PV on powerup is in this zone, then alarm output for this channel is on with the corresponding indicator blinking until this zone is left. Entering this zone from AS will clear the alarm output and stop the blinking of the indicator.

[X] **standby sequence.** If PV on powerup is in this zone, then alarm output for this channel is off with the corresponding indicator blinking until this zone is left. Entering this zone from AS will set the alarm output and stop the blinking of the indicator.

The end-point temperature for **ramp preheating** rEP should be set carefully according to the object to be controlled, having in mind the set point SP. In the hot runner systems for instance, this value is around half of the set temperature SP so that the nozzle heater is not overloaded during the starting phase. The gradient r d for the ascent of the set temperature should be a value much greater than the actual speed ability of the heating elements.

The ramp preheating feature can be disabled by clearing the parameter r d.

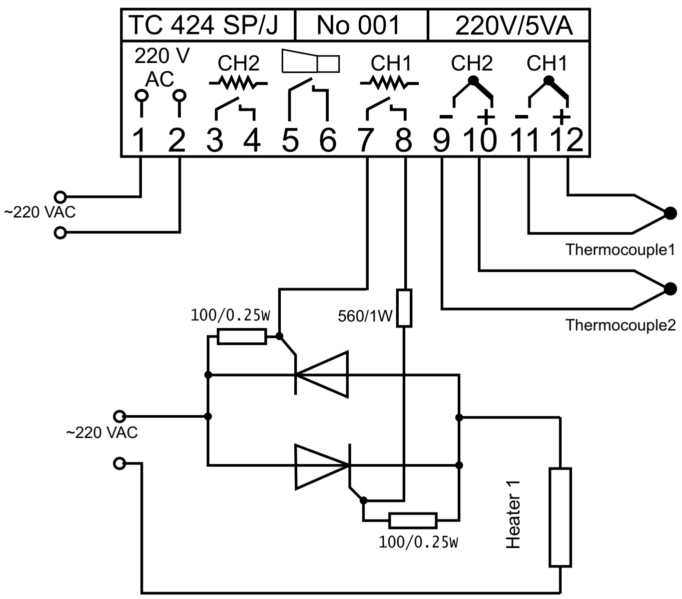
MECHANICAL CONNECTION AND MOUNTING

The Controller is assigned for mounting on facet panels of electrical units. The slot for mounting should have a shape of (45+0.8)x(92+0.6) mm. To secure the Controller on the panel, use the attaching screws.

The connector pin attachment of the Controller is pictured on its rear panel. The connecting wires must be isolated and have minimal diameter of 0.5 mm^2. Direct control of powerful heating elements should be avoided. Use of thyristor elements is recommended, since they are not exposed to frequent commutations and fast wear-out.

The figures below shows an example of how the Controller is to be connected using thyristor elements or solid state relays:

Control with thyristors:



Control with Solid state relay: