USER'S MANUAL

THERMOREGULATOR

TR 500 / TR 501 SERIES

HUNDREDTHS VERSION

ENGLISH V.1.2

TABLE OF CONTENTS

CAUTION: When using the instrument, take care to follow the instructions given in the Manual

Before installing and using the instrument, read the following advice carefully:

-*- Avoid installing the equipment close to high power units, relays, motors etc.

-*- The equipment is NOT supplied with an ON/OFF switch, therefore it is switched on as soon as the power supply is connected.
The power supply must have suitable protection against possible short circuits and faults in the equipment.
Make the connections using cable types with sections that are appropriate for the voltage and current limits specified in the Manual.

-*- Check that the plant has a good earth connection.

-*- Before use, check and verify the settings for the operating parameters, so as to avoid possible damage to persons or objects.

-*- The power supply voltage is shown on the label of the TR501 module.

-*- Use the cable supplied for the connection between the two devices: pay careful attention to the colours of the wires when making connections to the terminal board of the TR501 module.

-*- Do not use the equipment in environments with hazardous atmosphere (inflammable or explosive).

- 1 - INTRODUCTION

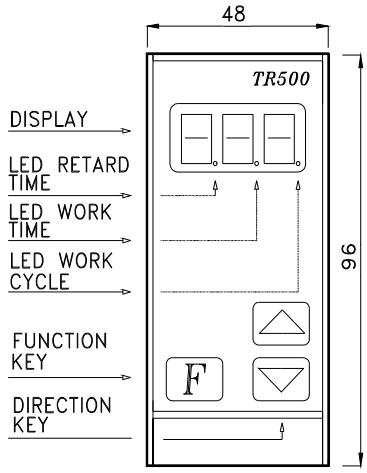
The TR thermoregulators are offered as a valid instrument for regulating heating elements, without the aid of external sensors. By taking advantage of the specific voltage-current of the heating element, the TR are able to regulate and maintain the pre-set temperature, even in conditions of high heat loss, thus achieving considerable advantages over other traditionally used methods.
Reaching the pre-set temperature in the least *possible time* (in the order of 100 ÷ 350 msec.) and *keeping it constant* signifies, above all, a lengthening of the working life of the heating parts and an increase in the operating speed, thus decreasing waiting times due to thermal inertia or losses by the various metallic parts that support the heating element.
Using the TR500 module, which is supplied with a display and keypad, it is possible to insert all the operating parameters, while the TR501 module, to which it is connected, controls the heating parts at all times. *Extremely easy to use*, *high functionality* and *minimal dimensions* make this system the strong point for controlling processes of heat-sealing, thermoregulation, air heating, hot cutting, etc. .

- 2 – TECHNICAL SPECIFICATIONS

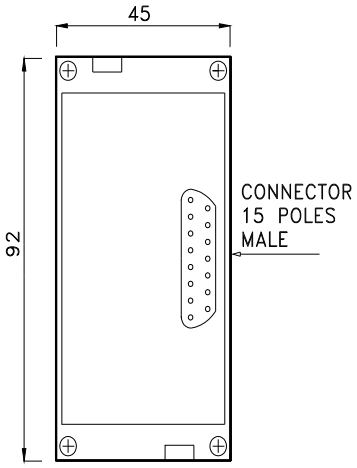
Power supply 230 V AC.
Frequency 50 / 60 Hz.
Power consumed at rest 4 W.
Maximum power output 1300W. (duty cycle at 40%).
Average power output 600W. (duty cycle at 100%).
Range of temperature regulation 30°C ÷ 500°C.
Ambient working temperature from 0 °C to 50 °C.

- 3 - DESCRIPTION OF TR500 CONTROL UNIT E TR501 POWER UNIT

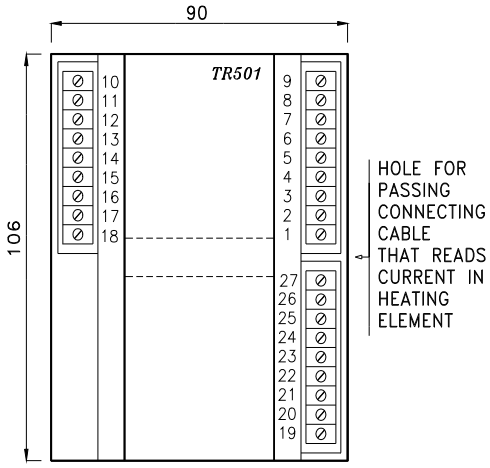
VIEW OF PANEL TR500



REAR VIEW
AND DRILLING POINTS



VIEW FROM ABOVE
POWER UNIT TR501



Control unit TR500 with flush-mounted panel to DIN 43700 standard, material self-extinguishing NORYL UL 94 V-O, size 48 x 96 x 118 mm..

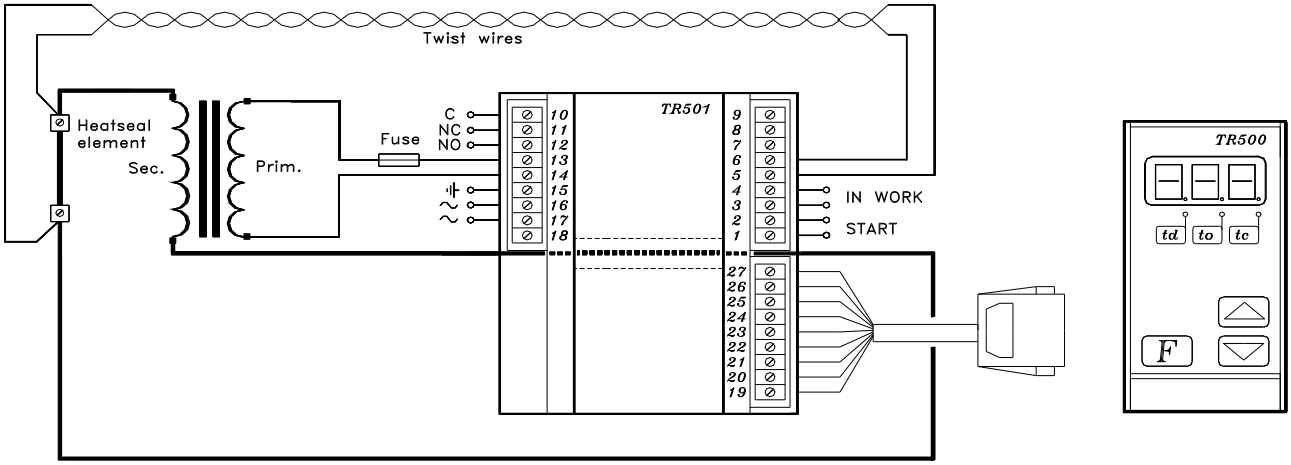
Power unit TR501 on container attachable to Din EN50022 guide, to DIN 43880 standard,
material self-extinguishing NORYL UL 94 V-O, size 106 x 90 x 69 mm. (6 modules).

Connection of control unit to power unit with shielded cable, 9 way x 0.22, with 15 pole female socket connector.

- 4 - SPECIFICATIONS OF HEATING ELEMENT AND ITS MOUNTING

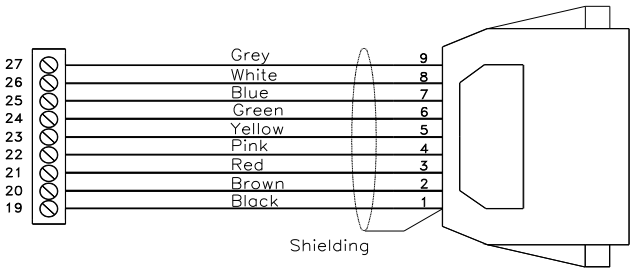
TR thermoregulators are able to control heating elements with a temperature coefficient of $240x10^{-6}$: this choice is of fundamental importance in achieving temperature values that are constant and repetitive over time.
Equally important is the mounting on the mechanical part: it must always be in traction, both at rest (ambient temperature), and at work (operating temperature).
By paying attention to these small details, it is possible to achieve high precision temperatures, thus increasing speed and repeatability in heating and sealing.

- 5 - INSTALLATION PROCEDURE



Insert and fasten, using the two screws, the 15-way female connector to the control unit TR500. Connect the other end of the cable to the terminal board of the power unit TR501 as shown in the diagram below:

To the terminal board of the connector TR501



15 pole female socket

N.B.: Take care not to invert the connections !!

In the TR501unit, to the input terminals 1 and 2, must be applied the signal to start the sealing cycle (START). This signal can have a voltage between 12V AC and 24V AC or from 12V DC to 30V DC attaching the positive to terminal 2 and the negative to terminal 1, with a current consumption of approx. 10 mA.

At terminals 3 e 4, there is an optoisolated outlet that indicates the end of the operating cycle (IN WORK): this photo coupler is closed throughout the whole sealing cycle, to return to the deactivated position at the end of the cycle, and can be configured externally as either NPN or PNP, with a maximum current that must not exceed 50 mA and 24 V DC. When making the connection pay attention to the polarity of the receiver (terminal 3) and the transmitter (terminal 4).

At the ends of the element connect two twist-wires, section 0.22÷0.50 mm².: these two wires must be connected to terminals 5 and 6 respectively.

For any fault indications (see chapter 8), use the contacts N-C or N-O, connected respectively to terminals 10-11 and 10-12 (maximum current 5 amp. at 24 V AC).

To terminal 13 connect a protective fuse of 6.3 amp. Connect the fuse output and terminal 14 to the primary of the power transformer using cables with a minimum section of 1.5 mm².
Using cables with a section that is appropriate for the calculated current Is, connect the output of the secondary to the heating element. For the other output from the transformer: pass it through the central hole in the TR501 unit (see section 7.6) and then connect it to the other end of the heating element.

Connect the earth to terminal 15.

Connect the main power supply to terminals 16 and 17.

- 6 - OPERATION

IMPORTANT: the operation of automatic calibration must be carried out with the temperature of the heating element at approx. 18÷25 °C (ambient temperature). During this procedure the resistance will undergo some heating tests, therefore it is very important that nothing can interfere to alter its temperature. Whenever the heating element is replaced due to accidental breakage or for other reasons, the calibration procedure described below must be repeated. Throughout the initial start-up and calibration phase, the TR thermoregulator may encounter some irregularities and show their error codes on the display. Carefully read the section "Warnings" and, when the problem has been resolved, repeat the procedure from point 6.1 .

-6.1- Initial installation and Calibration

After the TR has been connected to the power supply, the display of the TR500 module will show the message "**Ini**" (Initialisation): after a few seconds, some random codes will be displayed.
At this point press both the key "**F**" and the direction key "▼" simultaneously until, after a few seconds, the display shows the message "**Tar**" (Calibration).

Release the two keys: this begins the phase of automatic calibration between the TR module and the heating element.
After about 2-3 minutes, the display will give the message "**PAE**" (Error Amplification Parameter) and then the value of the setting: the default value is set at 15. Confirm this value by pressing the key "**F**" (this will be followed by analysis of the functionality of this parameter).
The calibration phase is then terminated and the display will show the working temperature, set by default at 250 °C.

-6.2- Definition and use of the parameter PAE

The error amplification parameter PAE has been introduced for when the achievement of more constant precision in working temperature is desired. The pre-set value of 15 has been estimated so as to achieve both a good heating speed and good precision of working temperature. A higher PAE value (maximum 39), will reduce the time needed for heating to the required temperature, but will lead to a slight imprecision, by a few degrees, in maintaining that temperature. Setting a lower value instead, will achieve a slight increase in heating time, but greater precision in the stability of the working temperature.

-6.3- Definition of the operating parameters and typical operating cycles

The parameters that can be configured by the user allow modification of the TR operating mode.

Pr= program number
tp = pre-heating temperature.
td = retard time for activation of the heating element after the START signal.
tl = working temperature of the heating element.
to = duration time of maintenance at working temperature of the heating element.

Figure 1 shows a typical operating cycle for the TR: from the pre-heating temperature setting *tp*, following the arrival of the rising front of the START signal, the outlet photo coupler is activated.
After the pre-set retard time *td*, the heating element will be taken to working temperature *tl* and maintained there for the pre-set time *to*. When tihis time has passed, the temperature of the eheating element again falls to the pre-set value for pre-heating temperature, while the optoisolated outlet is still connected for the time set in the parameter *tr*: in this way the heating cycle is then terminated.

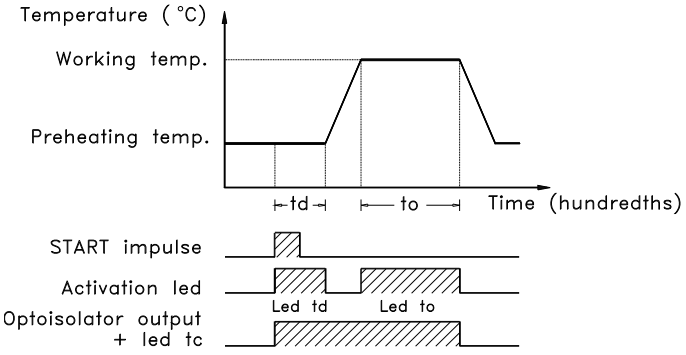


figure 1

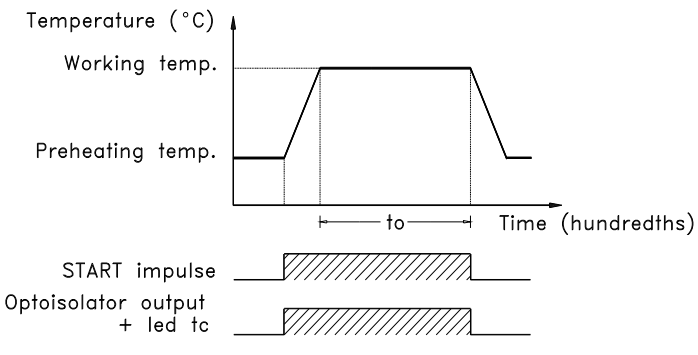


figure 2

In the example in figure 1, the heating cycle depended on the settings for the parameters *td* and *to*. It could be useful to maintain the working temperature for the whole duration of the START signal.
To have a welding cycle as in figure 2, the parameters retard time *td* and duration time *to* must be set at zero during the programming phase (*td*=0 hundredths and *td*=0 hundredths).

-6.4- Inserting the working temperature

Each time the key "**F**" is pressed, the display will show, in sequence, the ambient temperature or the working temperature. Working temperature is defined as the temperature that the heating element has to reach in presence of the "START" signal.

Press the key "**F**" once to view the working temperature.
Using the direction keys "▲" and "▼" modify the value until the desired temperature is reached. If the direction keys are kept pressed down, the value will change more rapidly.

Return to viewing ambient temperature by pressing the key "**F**".

-6.5- Programming the operating parameters (td, to, tp)

In the submenu of the operating parameters, it is possible to set the parameters *td*, *to* e *tp*.
To modify these values, enter programming mode by keeping the function key "**F**" pressed down for 4 seconds.

-6.6- Inserting the operating program Pr

The Tr 500 is able to store 9 operating programs: for each program it is possible to store the time parameters td, to, tr, the value of the pre-heating temperature tp and the value of the sealing temperature.
Using the arrow direction keys, select the program to be used, from Pr 0 to Pr 9.

Confirm the program selected by pressing the function key **"F"**.

-6.7- Inserting activation retard time td

The display will show the message "**td**" for one second, and then will show the pre-set value (by default 0 hundredths of a second).
Using the direction keys "▲" and "▼" modify the activation retard time for the heating element. This must take a value between a minimum of 0 and a maximum of 239 hundredths of a second.

Confirm the value inserted by pressing the function key "**F**".

-6.8- Inserting duration time of temperature maintenance to

The display will now show the message "**to**", followed by the pre-set value (by default 0 hundredths of a second).
Using the direction keys "▲" and "▼" modify the duration time of maintenance at working temperature of the heating element. This must take a value between a minimum of 0 hundredths and a maximum of 239 hundredths.

Confirm the value inserted by pressing the function key "**F**".

-6.9- Inserting activation time for optoisolator outlet tr

The display will now show the letters "**tr**", followed by the pre-set value (by default, 0 hundredths of a second).
Using the direction keys "▲" e "▼" modify the activation time for the optoisolator outlet at the end of temperature maintenance time *to*.
This value must be between a minimum of 0 hundredths and a maximum of 239 hundredths.

Confirm the value of the setting by pressing the function key "**F**".

-6.10- Inserting pre-heating temperature tp

The display will now show the message "**tp**", followed by the pre-set value (by default 30 °C.).
Using the direction keys "▲" e "▼" modify the value of the pre-heating temperature for the heating element. This must take a value between a minimum of 15 °C. and a maximum of 499°C.

Confirm the value inserted by pressing the function key "**F**".

The parameter programming phase is thus completed: the display will return to showing the setting for the working temperature.

-6.11- Verifying the operating parameters with a manual heating cycle.

To verify the correct functioning of the parameter settings, it is possible to activate a manual heating cycle: from the mode for viewing working temperature, press the key "**F**" and pass to viewing bar temperature.
At this point, when the direction key "▲" is pressed, the manual heating cycle will be started (a simulation of the "START" signal). The display will show, with the lighting up of 3 LED's, the activation phases for the times *td*, *to* and for the whole heating cycle *tc* (LED on = cycle running/ LED off = cycle completed).

When correct operation has been verified, the TR thermoregulator is ready to be set in operation.

- 7 –DETERMINING THE DIMENSIONS OF THE TRANSFORMER

Bearing in mind that the voltage of the primary must be the same as the power supply voltage Tr, two other parameters remain to be defined: power and voltage of the secondary.

-7.1- To calculate the power of the heating element, use the following formula:

Pr = Power of heating element $_{(watt)}$ = (La + Sp) x 2 x Lu x Cs

where **La** = width of heating element (cm.).
Sp = thickness of heating element (cm.).
Lu = length of resistance (cm.). If the technique of using more than one heating element in series is adopted, **Lu** must be taken as the sum of the lengths of each individual bar.
Cs = surface load (W/cm^2). This parameter is normally considered equal to 30 W/cm^2 . It must be remembered that this value for surface load achieves good heating speed (100÷250 msec.) and good temperature stability. In the event of going beyond the control properties (voltage of secondary-current of secondary), possibly because of a need to reduce the size/weight of the transformer or because of particular characteristics of the heating element, the value of this parameter can be reduced at the expense of an increase in heating time.

The graph in figure 3 has been made, at the theoretical level, for a 2.5 x 0.2 bar in air, with an ambient temperature of 25 °C and a working temperature of 200 °C. The values in practice depend, however, on the method used for installing the heating element.

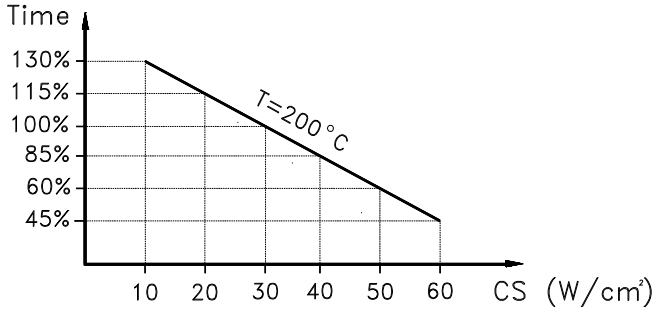


figure 3

-7.2- To calculate the power of the transformer, use the following formula:

Pt = Power of transformer $_{(watt)}$ = Pr + 10%

where **Pr** = power of heating element (Watt)
10 % = percentage compensation for transformer losses

-7.3- To calculate the resistance of the heating element:

Re = Resistance of element $_{(\Omega)}$ = Rs x Lu

where **Rs** = specific resistance of heating element (Ohm/meter)
Lu = length of heating element (meters)

-7.4- To calculate the voltage of the secondary of the transformer use the following formula:

Vs = Volt secondary $_{(volt)}$ = $\sqrt{\text{Pr x Re}}$

where **Pr** = power of heating element (Watt)
Re = resistance of heating element (Ohm)

-7.5- To calculate the size of the cables used, it is necessary to calculate the quantity of current output by the secondary of the transformer:

Is = Current of secondary $_{(amp)}$ = Vs : Re

where **Vs** = voltage of secondary (Volt)
Re = resistance of element (Ohm)

The values of **Vs** and **Is** that have been calculated as above must fall within a specific field of values for the TR500, more precisely :
-voltage of secondary Vs between 12 and 72 Volt
-current Is between 50 and 10 amp.

If they do not fall between these values, repeat the calculations, varying the value of surface load or using a model of heating element with a different specific resistance.

N.B.: Should the calculated value of Is lie between 10 amp and 20 amp, the cable that is used to detect the current in the heating element must be passed twice through the hole in the TR501 module.

- 8 - WARNINGS

The TR thermoregulator is able to identify a whole series of faults that could occur in the electric and electronic circuits, and will signal the error both by commutation of the warning relay and by the showing an error code on the display of the TR500 unit.

Important : Ensure that the main power supply has been disconnected before intervening !

The following is a list of the possible error codes, with some suggestions for their solution, during the installation and operating phases.

--- During the calibration phase ---

On the display Fault

Er1 = Mains supply frequency outside range.
Solution: the mains supply frequency is not 50/60 Hertz. Check voltage and frequency of power supply.

Er2 = Voltage on heating element not sufficient.
Solution: the dimensions of the transformer properties are incorrect. Check the connections.

Er3 = Current in heating element not sufficient.
Solution: check the circuit connections and the continuity of the heating element. Check whether, with the calculated value of Is, it is necessary to make a double turn on the TR500 module. Finally, if all checks are found to be correct, invert the connection from terminal 5 to terminal 6 and vice versa and then repeat the calibration phase.

--- During normal operation---

Er4 = Impossible to regulate the temperature on the heating element.
Solution: check the correctness of the dimensions of the transformer or whether the inserted value of the parameter PAE is too low.

Er5 = No voltage on heating element.
Solution: check the circuit connections, fuse and functioning of the transformer.

Er6 = Current in heating element not sufficient.
Solution: check the circuit connections and the continuity of the heating element.

Er7 = Current in heating element too high (possible that the heating element is in short circuit).
Solution: repeat the calibration phase making sure that the heating element is at ambient temperature; check the connecting cables (possible earth contacts) or that the heating element is not in short circuit. Check the presence of the correct voltage on the secondary of the transformer.

--- During the start-up phase ---

Er8 = Fault.
Solution: return the equipment to the manufacturer.

Er9 = Fault.
Solution: return the equipment to the manufacturer.