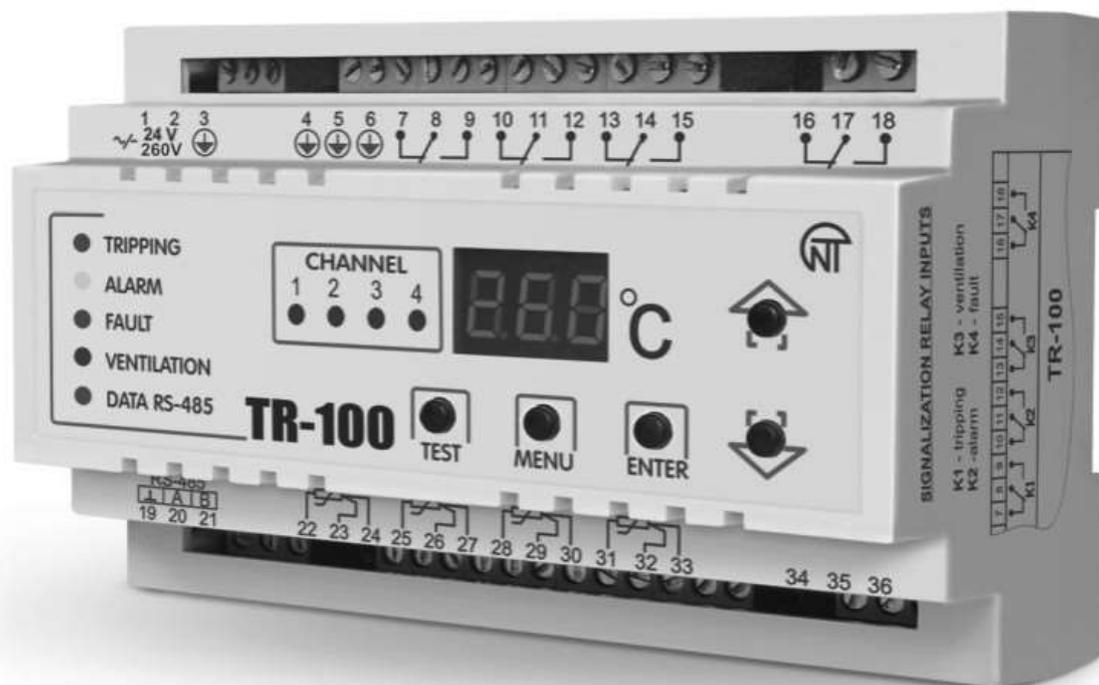


DIGITAL TEMPERATURE RELAY

TR-100



OPERATING MANUAL

UKRAINE, Odessa

www.novatek-electro.com

Service manual is intended for getting acquaints with hardware, operation principals, modes of functioning and sitting rules of digital temperature relay TR-100 (hereinafter TR-100).

1 OPERATION AND DESCRIPTION

1.1 FUNCTION

TR-100 is designed for take measurement and control of temperature of device by 4 sensors which are may connected by two or three wire connection scheme. Temperatures will be indicated on digital display. It is possible to use alarm signals when some of parameters come out of user adjusted ranges. TR-100 can be use for protection of:

- Motors and generators;
- Tree-phase dry-type transformers with additional thermal sensors of core or environment.

TR-100 equipped for universal adapter and therefore it can use power supply from 24 to 260V without reference to polarity.

In the capacity of thermal sensors, TR-100 is able to use next types of transducers:

- PT100 – Platinum transducer with rated resistance is 100 Ohms (0 °C);
- PT1000 – Platinum transducer with rated resistance is 1000 Ohms (0 °C);
- KTY83 – Silicon transducer with rated resistance is 1000 Ohms (25 °C);
- KTY84 – Silicon transducer with rated resistance is 1000 Ohms (100 °C);
- PTC (1, 3, 6 cascade) cold resistance of transducer is 20-250 Ohms;

1.2 TECHNICAL CHARACTERISTICS

1.2.1 Main technical characteristic are in the Table 1, which is given below.

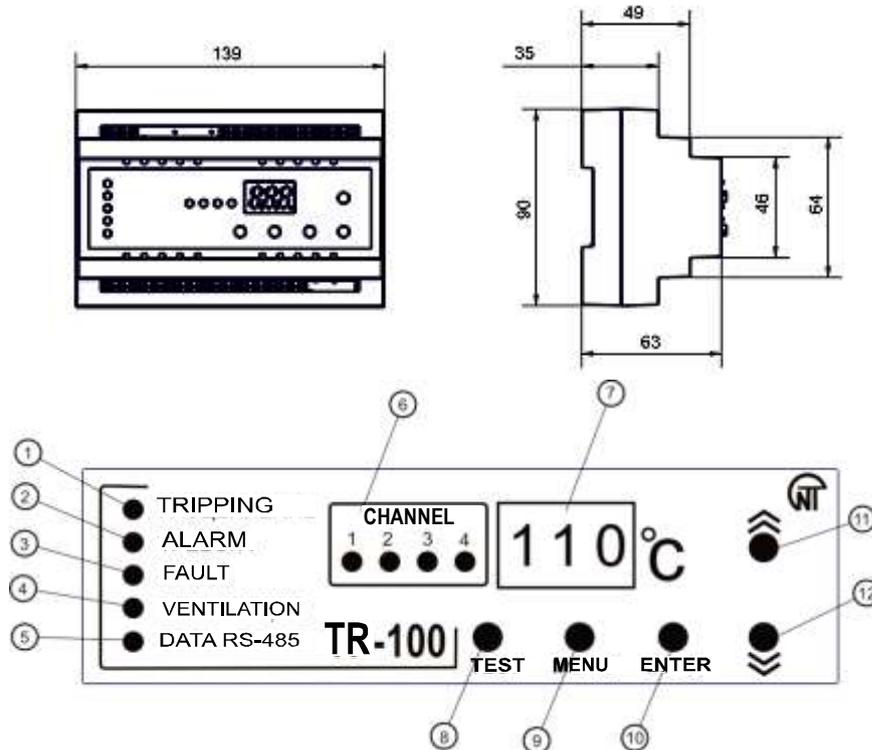
Table 1

Supply power, V	24 – 260 AC/DC
Recommended fuse for equipment protection, A	1-2
Thermal transducers	PT100, PT1000, KTY83, KTY84, PTC
Connectable transducers, pcs.	1 – 4*
Method of hardwire	2 / 3 wired
Wire length of sensor (depending on method of hardwire), m:	2 wired up to 5 3 wired up to 100
Amount of output relay, pcs.	4
Date-hold time, years, not less then	15
Temperature measurement error, °C	± 2
Temperature measurement range, °C	from - 40 to +240
Output relay test	Yes
Indication test	Yes
RS-485 MODBUS RTU	To order
Time measurement, sec.	≤ 2
Degree of protection:	- body - terminal block
	IP30 IP20
Climatic execution	Y3.1
Power input (power load), VA, no more than	4,0
Weight, kg, no more then	0,180
Dimensions, mm	90 x 139 x 63
Operation temperature range, °C	from -40 to +55
Storage temperature, °C	from -50 to +60
Montage to standard 35mm mounting frame	
Free position in space	
* note – PTC transducers can be connected as serial connection (1, 3, 6 pc.)	

Characteristic of output contacts

Cos φ	Max. Current (U~250B)	Max. Power	Max. Voltage.~	Max. Current (U _{DC} =30B)
1,0	10 A	4000 VA	440 B	3 A
Commutation life of the output contacts:				
- under 10A 250V AC, times, not less than				100 mil.
- under 10A 24V DC, times, not less than				100 mil.

1.2.2 Appearance and dimensions are given at picture below.



- 1 – Indication of tripping is ON; 2 – Indicator for ON state of alarm relay or for programmed mode is ON;
 3 – Indicator for failure of device and switching on of bug relay; 4 – Indicator for turning on of ventilation relay;
 5 – Indicator for switching on and actual connection with RS-485; 6 – Indicator for number of current display channel;
 7 – Digital display; 8 – Test indication button; 9 – Button for entering in the view mode or programming mode;
 10 – Use to confirm adjusted settings and to exit from programming mode; 11 – Up button; 12 – Down button.

Picture 1 – Appearance and dimensions

Indicators (4, 5, 6) image corresponded to itself parameters (ON / OFF), (FRN, FSA, ch1, ch2, ch3, ch4, Table 3).

2 TR-100 OPERATION AND APPLICATION

2.1 TR-100 START-UP

2.1.1 Safety

All connection must be completed only BEFORE TR-100 gets power supply.

2.1.2 Connection TR-100 must be according to picture 2.

Note: All measurement transmission cables from temperature sensors should be corresponded with next requirements:

- Made of shielded twisted-pair cable (triplet);
- Cable cross must be at least 0,5mm²;
- Hard connection to device clamps;
- Connection route must be separated from high voltage cables and from cables make inductive load;

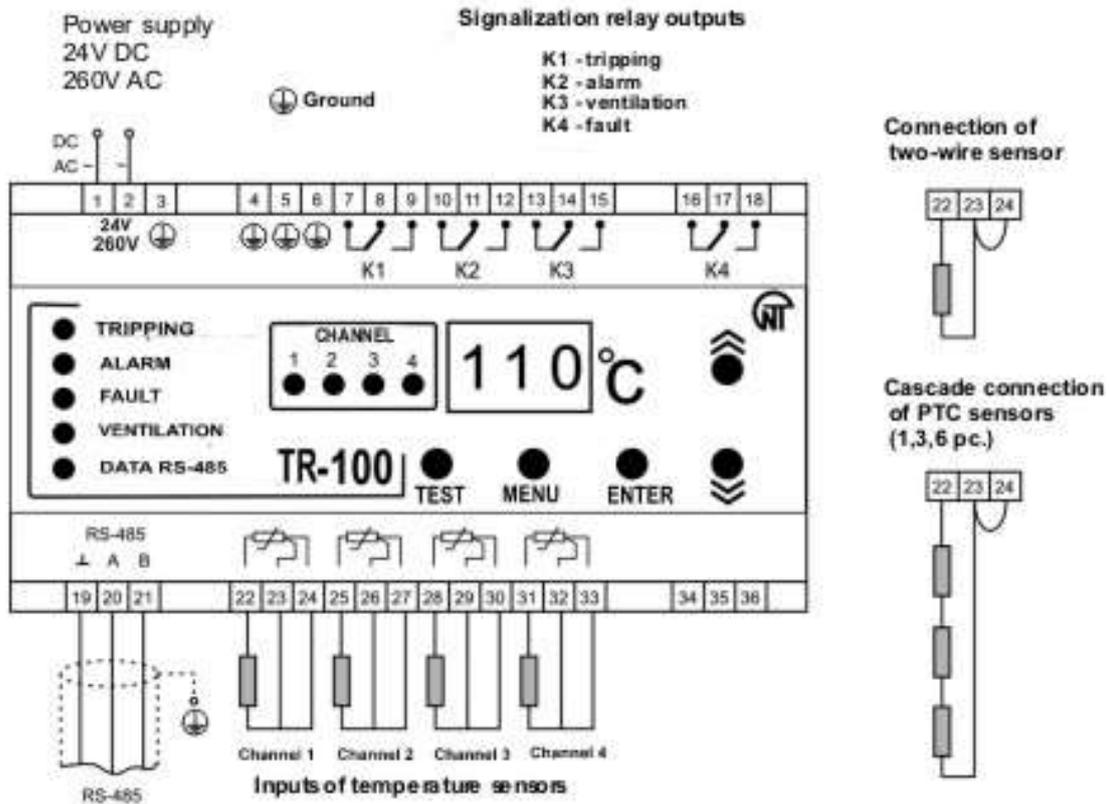
All cables must be in equal length.

2.1.3 Turn the power supply on and adjust, if it necessary, modes of operation in according to Table 3.

2.2 APPLICATION TR-100

- When temperature of one of four sensors exceeds the alarm threshold temperature value (parameter RLr , see Table 3), then with user defined time dLR the Alarm relay will close its output contact and the appropriate indication will be shown on the front panel of the device.

- The same sequence of events will happen in case tripping threshold temperature value will be detected (trP): tripping relay will close its contacts and appropriate indication will appear on the front panel.



Picture 2 – Electrical connections of TR-100

- Turn Off for Alarm and Tripping detected faults will happen after the temperature detected by all sensors will become lower than $R L r - d F R$ (for Alarm fault) and $t r P - d F t$ (for tripping Fault). Both these relay will return to it's initial cold state with simultaneous front panel indication turn Off.

2.2.1 Control and Operation

In initial state TR-100 indicates temperatures of sensors which are ON, in turns with 4 sec interval (if parameter $d S P$ is adjusted as 2).

Equipment control is carried out as follows:

- To changing between channels press \downarrow \uparrow buttons;
- To check all LED indicators press **TEST** button;
- To entering in view mode press **MENU** button;
- To entering in adjusting of parameter mode press and hold **MENU** button for 7 seconds.
- TR-100 display $E H E$ (for 1 sec.) and return to initial state, unless any button has pressed for 20 seconds.

2.2.1.1 Viewing of parameters.

To viewing of parameters, press **MENU** once, LED indicator “**FAULT**” (pic.1 pt.3) will **ON** and first parameter of Table 3 will appear on the digital display.

Use \downarrow \uparrow buttons for scrolling. To enter in menu item, press **MENU** button, to return to previous item, press **MENU** once again. If any buttons are in inaction for more than 20 seconds, TR-100 will return to initial mode. In viewing mode, changing of parameters is impossible.

2.2.1.2 Changing of parameters.

To changing of parameters, press and hold **MENU** button for 7 seconds, and:

- If password has set, type it. Changing of current value digit due \downarrow \uparrow buttons, changeover to next item by **MENU** button. To confirm password press **ENTER** button. Cancel of password - if any buttons are inaction for more than 20 seconds, TR-100 will return to initial mode.

- If entered password is correct, then LED indicator “ALARM” (pic.1 pt.2) will ON and first parameter of Table 3 will appear on the digital display.
- If entered password is NOT correct, then TR-100 will return to initial mode.
- If **PAS** is set as “000”, then password checking will NOT affected, LED indicator “ALARM” (pic.1 pt.2) will ON and first parameter of Table 3 will appear on digital display.

Scrolling of parameters due   buttons, to enter in menu item, press  button, to change value use   button, to confirm adjusted parameters and to return to menu press  button. Exit from menu without saving due  button. If any buttons are in inaction for more than 20 seconds, TR-100 will return to initial mode.

2.2.2 Restore factory defaults.

There are two ways to restore factory defaults:

- Set **rSt** parameter as 1 when device is in change parameters mode, and press  button whereupon TR-100 will be restarted with factory defaults. In this case, password WON'T be restored.
- Hold both   buttons as pressed and Turn the supply power **ON**. Keep button holding for more than 2 s, whereupon **nRU** will appear on the digital display, release buttons. Cut off power. Factory defaults will be restored as well as password (password disable).

2.2.3 Testing TR-100.

2.2.3.1 Testing of LED indication.

Press  button, all LED indicators will ON for 2 sec. If at least one of them does NOT light, TR-100 is considered faulty and requires under repair. During test of LED indication TR-100 continue normal operation.

2.2.3.2 Testing of output relays.

In TR-100 testing all relays together is provided and each relay separately, for this it is necessary:

- In change parameters mode, set value of **ESL** parameter according with Table 3 and press  button, thus on the digital display **OFF** will be showed (it means testing relay stays in normally open (OFF) conditional) and all LED indicators will be OFF.
- Condition of testing relay change due single press  button:
 - OFF** - Relay stays in normally open (OFF) condition;
 - ON** - Relay stays in normally close (ON) condition.

Press  button to return in menu. If any buttons are in inaction for more than 20 seconds, TR-100 will return to initial mode.

2.2.4 Usage ventilation.

TR-100 is able to control of switching on and cutting off of cooling fan, for this it is necessary to set value of **FAn** parameter as different from 0 (see Table 3):

- *Mode 1* – In this mode, temperature is detected due THREE sensors 1, 2 and 3. As soon as temperature of one of sensors exceed of temperature of adjusted threshold of switching on of ventilation **FOn**, ventilation relay will ON with corresponding indication (flashing of LED indicator 4 pic.1). Cutting off of ventilation relay will occur, if temperatures of all sensors drop below than **FOn** - **dFF**.
- *Mode 2* – The same as Mode 1, but temperature is detected due FOUR sensors 1, 2, 3 and 4.
- *Mode 3* – If channel 4 is ON (**ch4** = 1, see Table 3). In this mode temperature is detected due 4th sensor.

As soon as temperature of sensor exceeds temperature of adjusted threshold of switching on of ventilation **FOn**, relay will ON with corresponding indication (flashing of LED indication 4 pic.1). Cutting off of ventilation relay will occur, if temperature of sensor drops below than **FOn** - **dFF**.

NOTE: LED 4 (pic.1) is ON, when control of ventilation is ON and LED 4 is flashing, when temperature of one of sensors exceeds temperature of adjusted threshold **FOn** (see Table 3).

2.2.5 Viewing of maximal reached temperature.

In TR-100 storage of maximal reached temperature of channel is provided. To display of maximal temperature it is necessary:

Come into menu of viewing or changing of parameters (pt.2.2.1.1 or pt.2.2.1.2), scroll to desired parameter (Cn1/Cn2/Cn3/Cn4, channels 1 to 4 accordingly) due   buttons, press  button (enter in parameter), to restore maximal temperature press  button. Return to menu -  button. To restore temperature device should stays in change parameter mode.

NOTICE: in case there is sensor malfunction than the parameter may contain not valid values.

2.2.6 System of alert conditionals

Alert and tripping relays are ON only if threshold of adjusted temperatures is reached.

Fault relay operates in normally close conditional. It is ON, when device is turned ON, and it is OFF when there are faults of sensors or power is cut off, indication of faults is ON if there are faults of TR-100 or sensors. In case damage of one of connected thermal sensors indicators “TRIPPING”, “ALARM”, “FAULT” (1, 2, 3 pic.1) will be flashing, code of fault (/) will be showed on the digital display and subsequent operation depends on adjusted parameter  (see Table 3).

Kinds of faults are given in Table 2.

Table 2

CODE	Fault	Note
1	Error of parameter	TR-100 will load factory default instead of invalid parameter, thus  will be showed on the digital display and TR-100 will continue normal operation.
2	Fault EEPROM	All relay will OFF, and  will be showed on the digital display.
3	Closing of any sensor	FAULT relay will OFF with corresponding indication, ALARM and TRIPPING indicators will be flashing.  will be showed on the digital display.
4	Break of any sensor (except PTC)	FAULT relay will OFF with corresponding indication, alarm and tripping indicators will be flashing.  will be showed on the digital display.
5	Exceed of tripping temperature	Tripping relay will ON with corresponding indication on the channel.
6	Exceed of alarm temperature	Alarm relay will ON with corresponding indication.
7	Exceed of ventilation temperature	Ventilation relay will ON with corresponding indication.
8	Loss of connection with RS-485	“DATA RS-485” indicator will blink with 0,5 sec interval.

2.2.7 Programming and using parameters of TR-100.

Programming and using parameters are given in Table 3.

Table 3

Address	Parameter	Mnemonics	Min./Max.	Factory Default	Action
<i>hex</i>	General				
0x100	Alarm		50/240 °C	140	Temperature of tripping alarm relay
0x102	Diff. alarm		1/200 °C	10	Differential of cutting off of alarm
0x104	Tripping		50/240 °C	160	Temperature of tripping relay activation
0x106	Diff. Tripping		1/200 °C	10	Differential of cutoff tripping
0x108	Ventilation relay		0/3	1	Ventilation relay operation modes: 0 – Always OFF; 1 – works on channel1, 2, 3; 2 – works on channel 1, 2, 3, 4; 3 – works on 4 th channel (if channel is ON).
0x10A	Ventilation is ON		30/240 °C	90	Temperature of turning on of ventilation
0x10C	Diff. Ventilation		1/200 °C	20	Differential of cutoff ventilation

Address	Parameter	Mnemonics	Min./Max.	Factory Default	Action
0x10E	Delay	DLA	0/300sec	4	Delay of turning on when there is failure by temperature
0x110	Sensor malfunction	Act	0/2	0	Device action at sensor fault: 0 – indication with fault relay activation; 1 – pt.0 + switching on of alarm relay; 2 – pt.1 + switching on of tripping relay.
RS-485					
0x112	Switching ON	rsa	0/2	0	Switching ON/Cutoff RS-485: 0 – OFF; 1 – ON. 2 – ON (remote operation by power relays)
0x114	Identifier	rsn	1/247	1	Device number (Net address)
0x116	Rate	rss	0/3	2	Data transfer rate: 0 – 2400 (bit/sec); 1 – 4800 (bit/sec). 2 – 9600 (bit/sec); 3 – 19200 (bit/sec)
0x118	Parity	rsp	0/3	0	Parity check and stop bits: 0 – No : 2 stop bits 1 – Yes : even 2 – Yes : odd
0x11A	Timeout	rsl	0/300	0	Detection of connection loss (sec.): 0 – forbid (any other value activates current mode)
0x11C	Connection loss	ACL	0/1	0	Carrying out an action after connection loss: 0 – Only indication; 1 – Indication with switching on of fault relay
System					
0x11E	Indication mode	dsp	0/2	2	Device indication mode of operation: 0 – the highest temperature is displayed with channel number; 1 – user checks temperature manually; 2 – TR-100 displays temperature of sensors, which are ON, alternately with 4 s interval.
0x120	Test relays	est	0/4*	0	Output relays testing: 0 – To test the tripping relay; 1 – To test the alarm relay; 2 – To test the ventilation relay; 3 – To test the fault relay; 4 – To test ALL relays.
0x122	Password	PAS	000/999*	000	000 – password disable, any other value activates password
0x124	Reset to default settings	rst	0/1	0	Reset to factory default. 0 – DON'T restore; 1 – To restore all adjusted settings to factory default.
0x126	Version	ver	*	25	Device version
Channel 1					
0x128	Channel is ON	chl	0/1	1	Usage of channel1: 0 – Channel is OFF; 1 – Channel is ON;
0x12A	Calibration	cal	-9/9 °C	0	Scale shift on CA1 relatively measured by thermal sensor

Address	Parameter	Mnemonics	Min./Max.	Factory Default	Action
0x12C	Type	ct.1	0/4	0	Type of used sensor: 0 – PT100 (100 Ohms); 1 – PT1000 (1000 Ohms); 2 – KTY83 (1000 Ohms); 3 – KTY84 (1000 Ohms); 4 – PTC (1, 3, 6).
0x12E	Maximal value for channel 1	cn.1	*	-40	Maximal detected value for Channel 1 since the moment of last settings reset.
Channel 2					
0x130	Channel is ON	ch.2	0/1	1	Usage of channel 2: 0 – Channel is OFF; 1 – Channel is ON;
0x132	Calibration	CA2	-9/9 °C	0	Scale shift on CA2 relatively measured by thermal sensor
0x134	Type	ct.2	0/4	0	Type of used sensor: 0 – PT100 (100 Ohms); 1 – PT1000 (1000 Ohms); 2 – KTY83 (1000 Ohms); 3 – KTY84 (1000 Ohms); 4 – PTC (1, 3, 6);
0x136	Maximal value for channel 2	cn.2	*	-40	Maximal detected value for Channel 2 since the moment of last settings reset.
Channel 3					
0x138	Channel is ON	ch.3	0/1	1	Usage of channel 3: 0 – Channel is OFF; 1 – Channel is ON;
0x13A	Calibration	CA3	-9/9 °C	0	Scale shift on CA3 relatively measured by thermal sensor
0x13C	Type	ct.3	0/3	0	Type of used sensor: 0 – PT100 (100 Ohms); 1 – PT1000 (1000 Ohms); 2 – KTY83 (1000 Ohms); 3 – KTY84 (1000 Ohms);
0x13E	Maximal value for channel 3	cn.3	*	-40	Maximal detected value for Channel 3 since the moment of last settings reset.
Channel 4					
0x140	Channel is ON	ch.4	0/1	0	Usage of channel 4: 0 – Channel is OFF; 1 – Channel is ON;
0x142	Calibration	CA4	-9/9 °C	0	Scale shift on CA4 relatively measured by thermal sensor
0x144	Type	ct.4	0/4	0	Type of used sensor: 0 – PT100 (100 Ohms); 1 – PT1000 (1000 Ohms); 2 – KTY83 (1000 Ohms); 3 – KTY84 (1000 Ohms); 4 – PTC (1, 3, 6);
0x146	Maximal value for channel 4	cn.4	*	-40	Maximal detected value for Channel 4 since the moment of last settings reset.
* Parameters is read only.					

2.2.8 Sensors.

2.2.8.1 Sensors of PT100 type.

Platinum sensor with 100 Ohms rated resistance at 0 °C. In using this type of sensor, measurement inaccuracy presents ± 2 °C, all sensors are connected to 1, 2, 3, 4 channels by 2- or 3-hardwiring (see pic.2) with subsequent adjusting of value "0" of parameters as per Table 3.

Measurement range of temperature is -40 to +240 °C.

TR-100 detects break and shorting of measuring lines.

2.2.8.2 Sensors of PT1000 type.

Platinum sensor with 1000 Ohms rated resistance at 0 °C. In using this type of sensor, measurement inaccuracy presents ± 2 °C, all sensors are connected to 1, 2, 3, 4 channels by 2- or 3-hardwiring (see pic.2) with subsequent adjusting of value "1" of parameters as per Table 3.

Measurement range of temperature is -40 to +240 °C.

TR-100 detects break and shorting of measuring lines.

2.2.8.3 Sensors of KTY83 type.

Silicon sensor with rated resistance range is 990 Ohms to 1010 Ohms at 25 °C. In using this type of sensor, measurement inaccuracy presents:

- ± 3 °C at - 40°C
- ± 2 °C at 0°C
- ± 7 °C at 175°C

Sensors are connected to 1, 2, 3, 4 channels by 2- or 3-hardwiring (see pic.2) with subsequent adjusting of value "2" of parameters as per Table 3.

Measurement range of temperature is -40 to +175 °C.

TP-100 detects break and shorting of measuring lines

2.2.8.4 Sensors of KTY84 type.

Silicon sensor with rated resistance range is 970 Ohms to 1030 Ohms at 100 °C. In using this type of sensor, measurement inaccuracy presents:

- ± 7 °C at - 40°C
- ± 6 °C at 0°C
- ± 12 °C at 240°C

Sensors are connected to 1, 2, 3, 4 channels by 2- or 3-hardwiring (see pic.2) with subsequent adjusting of value "3" of parameters as per Table 3.

Measurement range of temperature is -40 to +140 °C. TR-100 detects break and shorting of measuring lines.

2.2.8.5 Sensors of PTC type.

Semiconductor resistors which are able to sharply change electrical resistance under temperature changing on the body surface in range of sensitivity limit. Cold resistance of sensors is 20 Ohms to 250 Ohms. Sensors could be serial connected up to 6 (1-3-6) pcs. to one channel.

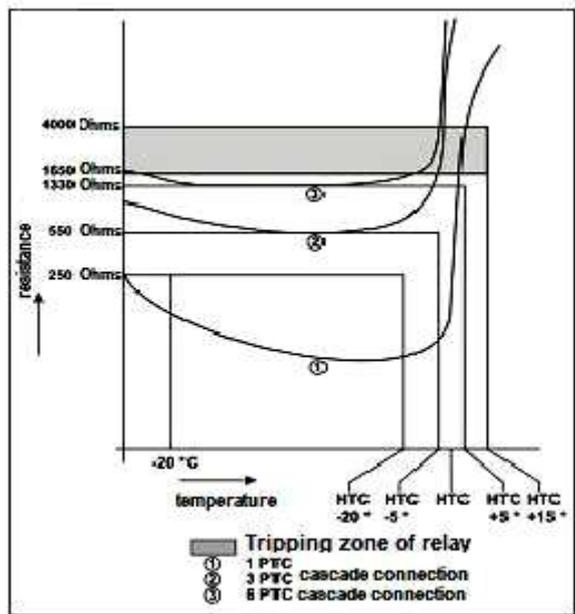
Sensors are classified on different NTC* (60°C to 180°C) with 10°C increment.

PTC sensors connection is possible ONLY to 1, 2, 4 channels by 2- or 3-hardwiring with subsequent adjusting of parameters as "4" as per Table 3.

Temperature value corresponding with sensor NTC* is adjusted in parameters (1, 2, 4 channels accordingly).

TR-100 detects only shorting of measuring lines. If there is sensor breakage, then temperature accident corresponding to this sensor will be triggered.

In temperature zone is up to NTC*, will be showed on the digital display. Value of NTC* sensor will be displayed if NTC* is reached or exceeded.



Picture 3 – Resistance-Temperature diagram of PTC sensors

2.2.9 Using RS-485 interface by MODBUS RTU protocol.

TR-100 allows carry out data exchange with external device by serial interface (MODBUS protocol, see Programming Manual of TR100-MODBUS).

The software, allowing to print a current state on the display of the personal computer, it is possible to download from a site www.novatek-electro.com in part “Production”.

Addresses of registers of programming parameters in decimal style are given in Table 3.

Additional registers and their meaning are given in Table 4.

*NTC (rated temperature of tripping) is temperature at which sensor sharply changes own electrical resistance.

Table 4

Address	Item	Description	Note
0x150	Status register of TR-100	bit 0 0 – NO failure; 1 – Failure (Code in failure register).	bit 5 – bit 15 are reserved
		bit 1 0 – Tripping relay is OFF; 1 – Tripping relay is ON.	
		bit 2 0 – Alarm relay is OFF; 1 – Alarm relay is ON.	
		bit 3 0 – Ventilation relay is OFF; 1 – Ventilation relay is ON.	
		bit 4 0 – Fault relay is OFF; 1 – Fault relay is ON.	
0x152	Failure register	bit 0 0 – NO failure; 1 – Failure of EEPROM. EEP	bit 7 – bit 15 are reserved
		bit 1 0 – NO failure; 1 – Sensor(s) shorting. FCC	
		bit 2 0 – NO failure; 1 – Sensor(s) break. FOC	
		bit 3 0 – NO failure; 1 – Tripping threshold excess. TRP	
		bit 4 0 – NO failure; 1 – Alarm threshold excess. ALr	
		bit 5 0 – NO failure; 1 – Ventilation threshold excess. FOn	
		bit 6 0 – NO failure; 1 – Loss of RS-485 connection. rSL	
0x154	Register of sensor 1 condition	bit 0 0 – NO failure 1 – Sensor shorting FCC	bit 5 – bit 15 are reserved

		bit 1	0 – NO failure 1 – Sensor breakage F_{OC}	
		bit 2	0 – NO failure 1 – Tripping temperature excess. T_{TP}	
		bit 3	0 – NO failure 1 – Alarm temperature excess. AL_r	
		bit 4	0 – NO failure 1 – Ventilation temperature excess. F_{ON}	
0x156	Register of sensor 2 condition	Similarly to register of sensor 1 condition.		
0x158	Register of sensor 3 condition	Similarly to register of sensor 1 condition.		
0x15A	Register of sensor 4 condition	Similarly to register of sensor 1 condition.		
0x15C	Temperature of the 1 st sensor			
0x15E	Temperature of the 2 nd sensor			
0x160	Temperature of the 3 rd sensor			
0x162	Temperature of the 4 th sensor			
0x200	Register to operate by Tripping relay	0x0000 – relay OFF; 0x0001 – relay ON.		Integer
0x202	Register to operate by Alarm relay	0x0000 – relay OFF; 0x0001 – relay ON.		Integer
0x204	Register to operate by Ventillation relay	0x0000 – relay OFF; 0x0001 – relay ON.		Integer
0x206	Register to operate by Fault relay	0x0000 – relay OFF; 0x0001 – relay ON.		Integer

3 MAINTENANCE

3.1 Safety precautions

ATTANTION!!! During maintenance Supply power MUST BE CUT OFF.

3.2 Order of maintenance

Recommended interval of maintenance is each 6 months.

Maintenance consists of visual examination, during which reliability of wires to TR-100 clamps connections and absence of spalls and crack on the TR-100 case must be check.

4 PERIOD OF SERVICE AND STORAGE, AND MANUFACTURER’S WARRANTY

The TR-100 has 15-year life period. Upon expiration of the service period, please, contact the manufacturer.

Warranty period is 36 month upon the day of sale.

The manufacturer shall repair the unit, in the compliance with the operating manual by the user, within the warranty period.

TR-100 is not subject to the warranty service in the following cases: expiry of the warranty period;

availability of mechanical damages;

attempts to open and repair;

traces of moisture attack or in the presence of foreign items inside the unit:

damage is caused by electric current or voltage in excess to the permissible values as indicated in the Operating manual

Warranty service is provided in the place of purchase Post-warranty service shall be provided by the manufacturer.

The manufacturer's warranty does not cover compensation for direct or indirect losses associated with the unit transportation to the place of purchase or manufacturer’s plant.

5 TRANSPORTATION

Transportation of TR-100 in package may be performed by any type of transport according to the transportation rules and regulations valid for such mode transportation.

During transportation, shipping and storing in a warehouse TR-100 must be protected form blows, shocks and moisture.