

**GENERAL PURPOSE THERMAL CONVERTERS**

**ТПУ 0304**

Operation manual

НКГЖ.411611.001РЭ



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## 1. INTRODUCTION

1.1. The operation manual contains information about the design, principle of operation, characteristics of general-purpose thermal converters ТПЧ 0304 and instructions necessary for correct and safe operation of thermal converters.

## 2. SPECIFICATIONS AND OPERATION

### *2.1. Purpose of the devices*

2.1.1. General-purpose thermal converter ТПЧ 0304 (hereinafter – thermal converters.) are designed for measuring and constant conversion of temperature of hard, liquid, gaseous and loose materials into unified output signal of constant current  $4 \pm 20$  mA.

Thermal converter is used in different technological processes in industry and power engineering.

2.1.2. Thermal converter contain: primary converter (thermal converters of resistance (TC) by State Standards 6651-94 or DIN № 43760 or thermoelectric converters (ТТ) by State Standards P 8.585-2001) and measuring converter of ИП 0304 type (modification ИП 0304/M1 and ИП 0304/M2).

Depending on the used converter, ИП 0304 thermal converters have two modifications - ТПЧ 0304/M1, ТПЧ 0304/M2, every modification has the following versions:

- general-industrial corrosion-proof;
- explosion-proof with the type of explosion protection:
  - «intrinsically safe electric circuit» and marking «ExiaIICT6 X» for ТПЧ 0304Ex/M1, ТПЧ 0304Ex/M2;
  - «explosion-proof casing» and marking «1ExdIICT6» for ТПЧ 0304Exd/M1, ТПЧ 0304Exd/M2;
- advanced reliability for operation in installations of nuclear power stations
  - ТПЧ 0304A/M1, ТПЧ 0304A/M2.

Thermal converters are produced in combination of above-mentioned versions.

Explosionproof thermal converters ТПЧ 0304Ex/M1, ТПЧ 0304Ex/M2 correspond to the requirements of State Standards P 51330.0-99, State Standards P 51330.10-99, possess especially explosion-proof level of implosion protection, provided with the type of explosion protection « intrinsically safe electric circuit » of «ia» level.

Explosionproof thermal converters ТПЧ 0304Ex/M1, ТПЧ 0304Ex/M2 are designed for operation in highly explosive zones of the buildings and external installations in accordance with the implosion protection marking ExiaIICT6 X.

Explosionproof thermal converters ТИУ 0304Ex/M1, ТИУ 0304Ex/M2 with the implosion protection marking may be connected to commercial devices, meeting requirements of the clause 7.3.72 ПУЭ, State Standards P 51330.13-99, determined for explosive zones in buildings and external installations in accordance with the clause 7.3 ПУЭ, clause 3.4 ПТЭЭП and other instruction documents regulating application of electrical equipment in explosion dangerous zones, as well as commercial equipment of general purpose, meeting requirements of the clause 7.3 ПУЭ.

Explosionproof thermal converters ТИУ 0304Exd/M1, ТИУ 0304Exd/M2 meet the requirements of State Standards P 51330.0-99, State Standards P 51330.1-99, possess the implosion protection of «explosionproof casing» type, the level of implosion protection is "explosionproof" for mixtures of gases and vapours with air of IIC category by State Standards P 51330.11-99, 1ExdIICT6 protection marking, and may be used in explosion dangerous zones according to ПЭУ currently in force clause 7.3 or State Standards P 51330.9-99, State Standards P 51330.13-99 and ПН (ПНАЭГ-7-008-89).

ТИУ 0304A/M1, ТИУ 0304A/M2 (of advanced reliability) (hereinafter – ТИУ 0304A) are executed in the version designed for Atomic Power Plants, they are used as components of the control system of engineering procedures of Atomic Power Plants (APP) and they are oriented for their possible operation in «Busher» APP in IRI, APP «Kudankulam» in India and other recently designed APPs.

Thermal converters ТИУ 0304A are earthquake-proof and ensure an advanced protection from electromagnetic fields and a low level of radio-frequency fields.

2.1.3. In accordance to State Standards 25804.1-83 thermal converters ТИУ 0304A belong to:

- the category B - equipment of non-stop use;
- to the I type - equipment, having two quality levels of functioning – nominal level and failure.

2.1.4. In accordance to State Standards ГОСТ 13384-93 thermal converters belong to:

- as to the number of converted input and output signals – single channel instruments;
- as to dependence of output signal on input signal – linear dependence instruments;
- as to interdependence between input and output circuits: ТИУ 0304/M1 – devices with galvanic coupling, ТИУ 0304/M2 – without galvanic coupling and provide galvanic uncoupling of electric circuits when locating explosion-proof thermal converters (ТИУ 0304Ex, ТИУ 0304Exd) in an explosion dangerous zone from electric circuits of the secondary power supply source, circuits of processing, converting and rerecording measured temperatures;
- thermal converters ТИУ 0304/M2 having different variants of embodiment: without indication of current values of measured values (ТИУ 0304/M2, ТИУ 0304A/M2, ТИУ 0304Ex/M2, ТИУ 0304Exd/M2), as well as with indication of current values of measured values and with addition of И1 order indexes for LCD indication into the code or И2 for Light Diodes indication.

2.1.5. In accordance with State Standards 12997-84 TIIY 0304:

- by climatic impact stability when operating TIIY 0304/M1, TIIY 0304/M2 belong to C2 execution group at the temperature of ambient air from minus 50 to plus 70 °C (for an order index t5070);
- by climatic impact stability when operating TIIY 0304/M2 with a LCD indication module or Light Diodes indication belongs to C3 execution group at the temperature of ambient air from minus 10 to plus 60 °C (for an order index t1060).

By climatic impact stability when operating:

- thermal converters TIIY 0304A, TIIY 0304Ex, TIIY 0304Exd belong to
  - C2 or C3 execution groups according to State Standards 12997-84, but at the upper temperature value of ambient air plus 70 °C (for an order index t1070);
  - the type of climatic execution T3 according to State Standards 15150-69 at the temperature of ambient air from minus 25 to plus 80 °C (for an order index t2580);
- thermal converters TIIY 0304Ex – belong to T3 type of climatic execution by State Standards GOCT 15150-69 at the temperature of ambient air from minus 25 to plus 70 °C (for an order index t2570);
- TIIY 0304A, designed for operation in APP «Busher», belongs to climatic execution TB3 by State Standards 15150-69.

2.1.6. According to stability to mechanical effects during operation thermal converters belong to the execution group M6 by State Standard 17516.1-90.

2.1.7. According to State Standard 4254-96 the degree of protection against penetrating of any firm bodies, dust particles, water inside of is - IP54 or IP65 depending on type of the case and cable input.

2.1.8. According to НП-001-97 (ОПБ-88/97) TIIY 0304A concern classes of safety 2, 3, 4:

- by its purpose – to the elements of normal operation;
- by influencing safety - to the elements important for safety;
- on character of carried out functions – to operating elements.

Example of a classification designation 2HY, 3HY, 4HY.

TIIY 0304A intended for work at APP «Kudankulam» with safety class 3H or 4H correspond to climatic type TB4.1 according to State Standard GOCT 15150-69, and according to R01.KK.0.0.AP.TT.WD001, they are serviceable at ambient air from + 5 to + 50 °C, and within 6 hours they are serviceable at ambient air temperature ultimate values, from + 1 to + 60 °C, and air relative humidity to 98 % at temperature 35 °C and lower temperatures without moisture condensation.

2.1.9. On protectability against environmental effects, according to:

- State Standard 15150-69, TIIY 0304A is fabricated in corrosion-proof modification T III;
- State Standard 15150-69 TIIY 0304A, intended for work at APP «Busher», are fabricated in corrosion-proof modification TB3 at the following content corrosion-active agents in atmosphere:
  - chlorides 0,02 mg/(m<sup>2</sup> · day),
  - sulphates 50 mg/(m<sup>2</sup> · day),
  - sulphurous gas 20 mg/(m<sup>2</sup> · day);
- State Standard TIIY 0304A intended for work at APP «Kudankulam» (for atmosphere type III), are resistant against the content of corrosion-active agents in atmosphere in open air, which are characterized by the following parameters:

Agent	Concentration, mg/m <sup>3</sup>	Deposition rate cm/s	Deposition flux, mg/(m <sup>2</sup> · day)
Chlorides	0,0212	0,1	1,83
Sulphates	0,58	0,1	50
Sulphurous gas	0,006	0,9	4,7
Nitrogen oxides	0,004	-	-

Corrosion-active agents in enclosed space is accepted as equal to 60 % of content in open air.

- TIIY 0304A intended for work at APP «Kudankulam» are resistant against musty fungus influence.

2.1.10. According to seismic stability:

- Thermal converters belong to the I category of seismic stability according to HII-031-01 and to the B group of execution 3 according to PД 25 818-87.
- Thermal converters TIIY 0304A of 3H class, are designed for operation in APP «Busher» belong II category of seismic stability according to HAЭГ-5-006-97 and they are resistant to seismic impact II3.

Testing of TIIY0304A thermal converters of 3H safety class are performed in accordance with requirements of MY 7.4-01.

Thermal converter TIIY 0304A of 3H class should be resistant to dynamic load, caused by blast wave and an impact of a jet crash.

- Thermal converters TIIY 0304A of 4H class, designed for operation in «Busher» APP, belong to III category of seismic stability according to ПНАЭГ-5-006-97 and there are no seismic stability requirements for them.
- TIIY 0304A, intended for work at APP «Kudankulam» with safety class 3H or 4H is within category II of seismic resistance for group «B» according to R01.KK.0.0.AP.PZ.WD001.

Thermal converters are durable, steady and resistant to the impact of earthquakes with the level of seismicity of 8 points on the MSK-64 scale at the setting level up to 40 meters.

2.1.11. According to electromagnetic interference stability::

- thermal converters TIIY 0304, TIIY 0304Ex, TIIY 0304Exd correspond to the execution group III, the criteria of functioning – A by State Standards P50746-2000;
- thermal converters TIIY 0304 A correspond the execution group IV, the criteria of functioning – A by State Standards P50746-2000.
- thermal converters TIIY 0304 A of 3H class, designed for operation in APP «Busher», correspond the execution group IV, the criteria of functioning – A by State Standards P50746-2000;
- thermal converters TIIY 0304 A of 4H class, designed for operation in APP «Busher», correspond the execution group III, by State Standards P50746-2000;

## 2.2. Technical characteristics

2.2.1. The basic metrological characteristics of TIIY 0304 for lengths of an assembly part of the primary converter (III) L ≥ of 320 mm and with allowance for their configurations correspond indicated in table 2.1.

Table 2.1

Basic metrological characteristics			Type of primary converter
Range of measurement	Limits of the tolerable basic reduced error, %, (precision class) for order index		
		A	B
1	2	3	4
minus 50 ÷ plus 200 °C	±0,15 (0,15)	±0,25 (0,25)	100M
minus 50 ÷ plus 600 °C	±0,1 (0,1)	±0,2 (0,2)	100Π
minus 50 ÷ plus 350 °C	±0,1 (0,1)	±0,2 (0,2)	Pt100
minus 50 ÷ plus 1100 °C	±0,15 (0,15)	±0,3 (0,3)	TЖК(J)
minus 50 ÷ plus 600 °C	±0,2 (0,2)	±0,4 (0,4)	TХК(L)
minus 50 ÷ plus 1300 °C	±0,15 (0,15)	±0,5 (0,5)[±0,3 (0,3)]*	ТХА(K)
0 ÷ plus 1700 °C	±0,15 (0,15)	±0,4 (0,4)	TIII(S)
plus 300 ÷ plus 1800 °C	±0,25 (0,25)	±0,5 (0,5)	TIP(B)
0 ÷ plus 2500 °C	±0,3 (0,3)	±0,6 (0,6)	TBP(A-1)
0 ÷ plus 1300 °C	±0,15 (0,3)	±0,3 (0,3)	THH(N)
* Optional			

2.2.1.1. Limits of the supposed basic resulted error with allowance for and various lengths of an assembly part of software calculate change-over of working ranges of measurements under the formula

$$\gamma = \frac{K}{(T_B - T_H)} \times 100 + 0,075, \quad (2.1)$$

где  $\gamma$  – limits of a supposed basic resulted error, %;

$K$  – the rationing factor which significances are resulted in table 2.2;

$T_H, T_B$  – upper and lower limits of measured temperature, °C;

0,075 – additive component of the basic resulted error, %.

Table 2.2

Range measurements	Length of an assembly part, mm								Type of primary converter
	60	80	100	120	160	200	250	320 and more	
	Significances of the rationing factor K*								
-50...100 °C	-	0,6	0,4	0,3	0,25	0,25	0,25	0,25	100M
-50...200 °C	-	1,0	0,6	0,4	0,3	0,25	0,25	0,25	
-50...100 °C	-	0,5	0,40	0,25	0,2	0,2	0,2	0,2	100Π
-50...200 °C	-	0,8	0,6	0,4	0,25	0,2	0,2	0,2	
-50...350 °C	-	-	0,7	0,5	0,25	0,2	0,2	0,2	
-50...600 °C	-	-	1,0	0,7	0,4	0,2	0,2	0,2	
-50...100 °C	0,6	0,4	0,25	0,2	0,2	0,2	0,2	0,2	Pt100
-50...200 °C	-	0,6	0,3	0,25	0,2	0,2	0,2	0,2	
-50...350 °C	-	-	0,8	0,5	0,25	0,2	0,2	0,2	
-50...600 °C	-	-	-	1,0	0,7	0,5	0,5	0,5	ЖК(J)
-50...750 °C	-	-	-	-	-	-	0,7	0,5	
-50...600 °C	-	-	-	1,0	0,7	0,5	0,5	0,5	XK(L)
-50...600 °C	-	-	-	1,5	1,2	1,0	1,0	1,0	XA(K)
-50...1300 °C	-	-	-	-	-	-	2,2	1,5	
0...1700 °C	-	-	-	-	-	-	2,0	1,5	ΠΠ(S)
300...1800 °C	-	-	-	-	-	-	3,0	2,0	ΠP(B)
0...2500 °C	-	-	-	-	-	-	5,0	4,0	BP(A1)
-50...1300 °C	-	-	-	-	-	-	3,8	3,0	HH(N)
Notes:									
1. *For an order index A.									
2. For an order index B significances of the rationing factor K increases twice.									

2.2.2. The range of the unified output signal range is from 4 to 20 mA.

2.2.3. The limit of the tolerable variation of the output signal of TИY 0304 does not exceed 0,2 of the limit of the tolerable basic error.

2.2.4. The time of an operating mode setting (preliminary heating) does not exceed 15 min.

2.2.5. The time of output signal setting (time, during which the output signal of TИY 0304 enters the zone of the limit of tolerable basic error) does nor exceed 30 seconds.



2.2.6. The limit of the additional tolerable error of ТПГУ 0304 caused by a temperature variation of ambient air from the normal (20±5) °C up to any temperature within the range of operational temperatures for every 10 °C of temperature variation does not exceed 0,5 of the limit of the basic tolerable error.

2.2.7. The limit of the additional tolerable error of ТПГУ 0304 for the configuration with ТП caused by a temperature variation of their free ends within the range of operational temperatures, does not exceed the limit of the tolerable basic error.

2.2.8. The limit of the tolerable additional error of ТПГУ 0304, caused by the influence of high dampness up to 95 % at 35°C, does not exceed 0,5 of the limit of the tolerable basic error.

2.2.9. The limit of tolerable additional error of ТПГУ 0304, caused by the effect of constant magnetic fields and (or) variation fields of the circuit frequency of up to 400 A/m voltage, does not exceed 0,5 limit of the tolerable basic error.

2.2.10. The limit of the tolerable additional error of ТПГУ 0304 during exposure to vibration does not exceed the limit of tolerable basic error.

2.2.11. The limit of the tolerable additional error, caused by variation of the power voltage from the nominal  $U_{nom} = 24V$  or from the nominal  $U_{nom} = 36V$  to the minimal tolerable  $U_{min} = 15V$ (for ТПГУ 0304/M1 и ТПГУ 0304/M2 without Light Diodes indication) и 18 В (для ТПГУ 0304/M2 with Light Diodes indication), does not exceed 0,05 %.. Meanwhile, resistance of load  $R_{load}$  should not exceed the value set in clause 2.2.11.1.

2.2.11.1. Resistance of load should not exceed the value, calculated from the formula

$$R_{load} = \frac{U_{volt} - U_{min}}{I_{max}}, \quad (2.1)$$

where:  $R_{load}$  - load resistance, kOhm;  
 $U_{min}$  - the minimum supply voltage specified in item 2.2.11;  
 $U_{volt}$  - supply voltage, V (from 15 to 36 V);  
 $I_{max}$  - load current  $I_{max} = 22,5$  mA.

2.2.12. The limit of the tolerable additional error, caused by deviation of load resistance from the limiting value  $R_{load} = 0,4$  kOhm for  $U_{nom} = 24V$  and  $R_{load} = 1$  kOhm for  $U_{nom} = 36V$  for minus 25 % does not exceed 0,05 %.

2.2.13. The power supply of ТПГУ 0304 is carried out

- from direct current of 15± 36 V
- 18 ... 36 in for ТПГУ 0304/M2 with Light Diodes indication;
- power supply of explosion-proof ТПГУ 0304Ex with explosion-proof marking Exia II CT6X (location in an explosive zone) should be carried out from the power supply equipped by an output spark shielded circuit of “ia” level and electrical parameters corresponding to electrical equipment of the subgroup IIC, with voltage 15± 24 V.

2.2.13.1. Electrical parameters of spark shielded circuit of TIIY 0304 Ex with explosion-proof marking Exia II CT6X:

- Maximum input voltage  $U_i$ : 24 V.
- Maximum input current  $I_i$ : 120 mA.
- Maximum input power  $P_i$ : 0,75 W.
- Maximum internal capacitance  $C_i$ : 22 nF.
- Maximum internal inductance  $L_i$ : 0,1 mGn.

2.2.13.2. Output of TIIY 0304 thermal converters – current loop 4...20mA is combined with the power supply circuit from the direct current source with voltage 15...36 V.

*Notes: When locating in explosion dangerous zone  $U_{max} = 24 V$ .*

2.2.13.3. In case of power supply for TIIY 0304A intended for work at APP «Kudankulam» from the network for own needs, the work is provided:

- in frequency range from 49,0 to 50,5 Hz – for a long period;
- in frequency range (47,5 – 49,0) and (50,5 – 52,5 Hz) – to 5 min once, but not longer than for 750 min during all the period of use;
- in frequency range (46,0 – 47,5 Hz) – to 30 s once, but not longer than for 300 min during the period of use;
- deviation of voltage 220 V of AC  $\pm 10\%$ ;
- total deviation of voltage and frequency not more than  $\pm 10\%$ ;
- maximum acceptable content of harmonics in CH system
  - Systems lower and including 1 kV: 8 %,
  - Systems higher than 1 kV: 5 %.

2.2.14. The power, consumed by the thermal converter from the direct current circuit at nominal voltage of 24V, does not exceed 0,6 W, at nominal voltage of 36V, does not exceed 0,8 W.

2.2.15. The insulation of electric circuits of thermal converter between current-conducting circuits and the casing holds out during 1 minute the effect of testing voltage practically of sinusoidal shape with frequency from 45 up to 65 Hz:

- in normal conditions - 500 V ;
- at the temperature of ambient air  $(35 \pm 3)^\circ\text{C}$  and relative humidity  $(95 \pm 3)\%$  - 300V.

2.2.16. Electric resistance of insulation of input and output current conducting circuits of thermal converters relative to its body is not less than:

- 20 mOhm at the temperature of ambient air  $(20 \pm 5)^\circ\text{C}$  and relative humidity from 30 % up to 80 %;
- 5 mOhm at the temperature of ambient air  $(70 \pm 3)^\circ\text{C}$   $(80 \pm 3)^\circ\text{C}$  and relative humidity from 30 % up to 80 %;
- 1 mOhm at relative humidity  $(95 \pm 3)\%$  and temperature of ambient air  $(35 \pm 3)^\circ\text{C}$ .

2.2.17. Thermal converters withhold a break of load circuit without any harm and damage of spark protection.

2.2.18. Thermo converters withhold a break and short-circuit of input circuits without any damage.

2.2.18.1. At a breakaway of an entry chain thermoconverters instal value of an output current 22.5 mA.

2.2.19. Thermo converters are steady against effect of temperature of air depending on a climatic modification specified in item 2.1.5, in ranges:

- from a minus 50 to plus of 70 °C;
- from a minus 10 to plus of 60 °C;
- from a minus 10 to plus 70 °C;
- from a minus 25 to plus 80 °C;
- from a minus 25 to plus 70 °C.

2.2.19.1. TIIY 0304A intended for work at APP «Busher» and «Kudankulam» are serviceable at ambient air temperature from + 5 to + 50 °C.

2.2.19.2. TIIY 0304A intended for work at APP «Busher» and «Kudankulam» are serviceable for 6 hours at ambient air ultimate temperatures from + 1 to + 60 °C.

2.2.20. Thermo converters is solid to the humidity influence up to 98 % at the temperature 35 °C.

2.2.20.1. TIIY 0304A intended for work at APP «Busher» and «Kudankulam» are serviceable during the effect of air relative humidity to 98 % at temperature 35 °C and lower temperatures without moisture condensation.

2.2.21. Thermo converters is solid to the shock jolting influence with the number of impacts equal to 80 a minute, with an average quadratic speeding value of 98 m/sec<sup>2</sup> and the influence duration equal to 1 hour.

2.2.22. Thermo converters is solid and steady against the influence of a sine wave vibration in a range of frequencies from 1 up to 100 Hz at the vibrating acceleration amplitude 20 m/sec<sup>2</sup>.

2.2.22.1. TIIY 0304A intended for work at APP «Busher» and «Kudankulam» are resistant against effect of sinusoidal vibration in frequency range from 1 to 120 Hz with acceleration 1g.

2.2.23. Thermo converters has no constructive elements and units with resonant frequencies from 5 up to 25 Hz.

2.2.24. Thermo converters is solid and steady against influencing of any mechanical impacts of the single action having a peak shock acceleration of 20 m/sec<sup>2</sup> with duration of a shock pulse from 2 up to 20 ms. The total of impacts is 30.

2.2.25. Thermo converters is solid and steady against influencing of any mechanical impacts of the repeated action having a peak shock acceleration of  $30 \text{ m/sec}^2$ , with preferable action duration of shock acceleration 10 ms (the admitted duration is from 2 up to 20 ms. The number of impacts in each direction makes 20.

2.2.26. Thermo converters is resistant to seismic effects equivalent to effect of vibration with parameters specified in table 2.3.

Table 2.3

Frequency, Hz	1,0	2,0	3,0	4,0	5,0	6,0	8,0	10,0	15,0	20,0	30,0
Acceleration, $\text{m/sec}^2$	6,0	15,0	29,0	51,0	48,0	43,0	38,0	31,0	20,0	19,0	14,0

2.2.26.1. Requirements on resistance to seismic effects to TIIY 0304A intended for work at AP «Kudankulam»

Seismic effects on equipment are normalized by spectra of response in the places on equipment installation, by maximum acceleration of effect and by acceleration of effect depending on frequency and duration.

Duration of accelerogram intensive part where accelerations exceed 50 % of maximum value should be not less than 10 s.

As for requirements to resistance to design earthquake (II3), TIIY 0304A should stand five effects with level II3.

Acceleration due to seismic effect of II3 level should be accepted with coefficient 0,42 of maximum destruction after earthquake (MP3).

Generalized spectra of response on building structures for seismic effects (MP3), depending on fluctuation decrement and acceleration dependence on frequency for group «B» equipment testingB (built-in elements installed on intermediate structures, i.e. cabinets, boards, panels and the other technological equipment) at relative dampings of intermediate structures 1, 2, 5, and 10 %, are given in Table 2.4.

Table 2.4

Relative damping, %	Acceleration, $\text{m/s}^2$ (at height mark above plus 20)								
	Frequency, Hz								
	2...5	5...7	7...10	10...15	15...20	20...25	25...30	30...35	35
1	50	70	70	87	87	87	87	80	30
2	40	52	52	55	55	55	55	35	30
5	30	37	37	46	46	46	38	30	30
10	20	22	22	38	38	38	20	15	10

2.2.27. Overall dimensions, connecting and mounting dimensions of thermal converters correspond to dimensions in appendixes B and C.

2.2.28. The mass of the thermal converters is from 0,3 to 2,4 kgs. Depending on overall dimensions.

2.2.28.1. The length of mounting and submersible parts of thermal converters from 60 to 3550 mm in accordance to State Standards 6651 and State Standards 6616.

2.2.28.2. The material of protective armature of a mounting part of the thermoconverter contacting to the measured environment corresponds resulted in tables Б.1 and Б.2 Applications for primary converters of type of the TC and ТП accordingly.

2.2.29. Provision of electromagnetic compatibility and interference immunity.

2.2.29.1. According to electromagnetic interference stability:

- thermal converters ТПY 0304, ТПY 0304Ex, ТПY 0304Exd correspond to the execution group III, the criteria of functioning – A by State Standards P50746-2000;
- thermal converters ТПY 0304 A correspond the execution group IV, the criteria of functioning – A by State Standards P50746-2000.
- thermal converters ТПY 0304 A of 3H class, designed for operation in APP «Busher», correspond the execution group IV, the criteria of functioning – A by State Standards P50746-2000;
- thermal converters ТПY 0304 A of 4H class, designed for operation in APP «Busher», correspond the execution group III, by State Standards P50746-2000;

2.2.29.2. Thermal converters function normally and do not create any disturbances in conditions of joint operation with equipment of systems and components, for which they are designed, as well as with equipment for other functions, that may be used in combination with this thermal converters in a typical disturbance situation.

2.2.30. ТПY 0304A intended for work at APP «Kudankulam» are resistant to musty fungus effect.

### **2.3. Design and operation.**

2.3.1. Thermal converters consist of a primary temperature converter (ПП) and a measuring converter (ИП), tanks of a head, cable input and an indication module for ТИУ 0304/М2.

2.3.1.1. Resistance converters or thermo-electrical converters, provided in table 2.2 are used as primary temperature converters.

2.3.2. Components of thermal converters are designed for:

- resistance converter is designed for – conversion of temperature into electrical resistance;
- thermal-electrical converter is designed for – conversion of temperature into thermo-electromotive force (т.э.д.с);
- indication module (for ТИУ 0304/М2) – for indication of current values of measured temperatures;
- measuring converter – for conversion of a signal coming from a resistance thermal converter or from a thermo-electrical converter into a unified signal  $4 \div 20$  mA.

2.3.3. Measuring converter ИП contains a temperature compensator of cold end (only for operation with ТП).

2.3.4. ИП is fixed in the head of the thermal converter by two screws М4.

2.3.5. On the front panel ИП 0304 (under cover) the following items:

- clamping joint for connection of TC, ТП and a compensator of cold end for ТП;
- clamping joint for connection of the output current loop  $4 \div 20$  mA;
- key «MIN» - key of correction of additive error (zero shift);
- key «MAX» - key of correction of additive error (scale parameter of conversion of measured value into the output current value);
- split interface RS 232;
- connector for indication module connection ( for ТИУ 0304/М2).

2.3.5.1. Power source and registration equipment is connected to ИП 0304 according to the drawings of appendix A.

2.3.6. Thermo converters ТИУ 0304, ТИУ 0304А, ТИУ 0304Ex have a national team a game-struktsiju, allowing to replace software, ИП, the case of a head or cable input is resulted in appendixes Б and В.

ПП is mounted in the case of a head by means of carving connection (Appendix Б see) with use of hermetic and the rubber washer which are in the case of a head.

2.3.7. Thermo converters TIIY 0304Exd have a design not allowing for-menu software, replacement only III and cable input is possible.

2.3.8. Dismantling of the thermo converter for replacement III, III, cases of a head and cable input make in the following sequence:

- head cases uncover, having turned off two screws (for case АГ-08) and otkru-tiv a cover for cases АГ-02, АГ-02Exd, НГ-01;
- remove the indication module (only for TIIY 0304/M2);
- disconnect from a wire connector a current loops, III and grounding;
- remove III, having turned off two screws;
- turn off III by means of wrench S22, using III union;
- turn off cable input.

2.3.9. After replacement of one or several components of the thermo converter assemblage make in return sequence under item 2.3.8.

#### ***2.4. Facilities for explosion protection of thermal converters TIIY 0304Ex***

2.4.1. Explosion protection of thermal converters TIIY 0304Ex is provided during operation in complete set with mains and registration equipment, having spark safe electrical circuit for measuring unified current signal  $4\div 20$  mA and the Certificate of conformance with the requirements of explosion protection, as well as a construction and a schematic version according to State Standards P 51330.0-99, State Standards P 51330.10-99.

2.4.1.1. Spark safety of electrical circuits of thermal converters TIIY 0304Ex is provided by:

- feeding from spark safe power supply source with galvanic decoupling from power supply source;
- limiting of current and voltage to the values corresponding to spark safe circuits of electrical equipment of IIC subgroup;
- absence in the construction of concentrated capacitance and chokes dangerous as to accumulated energy for gaseous mixtures of IIC category;
- protection of the primary converter circuits by current-limiting resistors and variable resistors;
- engaging in the output current loop  $4\div 20$  mA of spark proof diodes and a variable resistor, which electrical load does not exceed  $2/3$  of their nominal parameters;
- galvanic decoupling of the TIIY 0304Ex/M2 current loop circuit from its internal circuits and application of DC/DC conversion with electrical insulation strength of the insulating transformer over 1500 V.

2.4.2. All elements relating to spark protection are sealed by thermosetting insulating compound, stable in service conditions.

2.4.3. Electrical parameters of the spark proof circuit correspond to specified in the clause 2.2.13.1.

2.4.4. When manufacturing the casing of the instrument electrically safe materials were used.

2.4.5. The X symbol, following the explosion protection marking denotes, that during operation of thermal converters TIIY 0304Ex it is necessary to follow the stated below requirements:

- thermal converters TIIY 0304Ex should be used complete with power supply and recording equipment provided with spark proof electrical circuit and a certificate of conformance to requirements of explosion protection;
- during operation it is necessary to use protective measures from exceeding temperature of the surface part of thermal converters TIIY 0304Ex due to heat transmission from the measured media above the tolerable limit for the corresponding category of the surrounding mixture of gases and vapours with air;
- repair and adjustment of thermal converters TIIY 0304Ex at the operation site is not permissible;
- exchange, connection, and disconnection of thermal converters TIIY 0304Ex should be performed only in case of a complete absence of pressure in the main lines.

2.4.6. Used primary converters for thermal converters TIIY 0304Ex are selected with consideration of requirements of State Standards P 51330.0-99 and State Standards P 51330.10-99 to the protection rate of the casing, mechanical strength, resistance to flame impact and provision of spark protection from electrical discharges.

2.4.7. Maximum temperature of constructs of thermal converters TIIY 0304Ex in normal conditions and case of an emergency does not exceed 85 °C, assigned for T6 class.

### ***2.5. Equipment for explosion protection support of thermal converters TIIY 03404 Exd***

2.5.1. Explosion protection of thermal converters TIIY 0304Exd is provided by the type of explosion protection «explosion proof shell» according to State Standards P 51330.1-99 and it is achieved by placing electrical circuits of TIIY 0304Exd into an explosion proof shell, which endures the pressure of an explosion and excludes transfer of an explosion into surrounding explosion dangerous media. Durability of the shell is checked by testing in accordance with State Standards P 51330.0-99 and State Standards P 51330.1-99. At the same time, every shell undergoes testing by static hydraulic pressure of 1,5 MPa, during the time sufficient for inspection but not less than  $(10 \pm 2)$  seconds. Thermal converters TIIY 0304Exd have no sparking components or components prone to heating above 80 °C (for the temperature grade T6).

2.5.2. On the chart of explosion protection equipment there are couplings providing explosion protection of the type “explosion proof shell” demonstrated. These couplings are marked by the word “explosion” with indication of tolerable explosion proof parameters according to State Standards ГOCT P 51330.1-99: minimal axial thread length, pitch of thread, number of complete, continuous undamagable threads in engagement of the explosion proof threaded coupling. All screws are stopped by «Remos» composition having thermal stability.



2.5.3. Explosion proof surfaces of the shell of thermal converters ТПУ 0304Exd are protected from corrosion:

- by paint coat of outer surface and covers;
- by applying on the surfaces of greasing ЦИАТИМ-221 according to State Standards 9433-80.

2.5.4. Temperature of the shell surface does not exceed tolerable value according to state Standards P 51330.0-99 for the equipment of the temperature grade T6 at every permissible mode of operation of thermal converters ТПУ 0304Exd.

2.5.5. All screws, bolts, nuts, fastening components of the shell, as well as current conducting and grounding clamps, connections of cable inputs are protected from self-unfastening by application of counter-nuts. Bolt-heads of the outer fastening bolts are located in guard indents and may be accessed only by a special spanner. For prevention of self-unfastening of ТПУ 0304Exd covers from the casing a stopper-rod device is used. Stopper – rod is fixed with the aid of screws to the casing and its leg gets over the skirting of the cover and prevent its self-unfastening.

Upper part of internal chamber of protective armature 5 mm deep is covered by epoxide compound ЭЗК-6 ОСТ4 ГО.029.206.

## ***2.6. Configuration setting***

2.6.1. Reeding parameters from ИП 0304, changing parameters and recording parameters into ИП 0304 is performed by means of the computer program «Tuning of instruments of ИПМ 0399/МО, ИП 0304» using an interface cable with an interface module with a galvanic decoupling МИГР-01.

2.6.2. Factory setting of parameters corresponds to customer's order. One of the variants of the factory parameters settings is presented in the table 2.5.

Table 2.5

Parameter name	Factory setting
Network address	1
Rate of exchange by interface	9600 kbit/sec
TC connection circuit	three wire
Resistance of the two wire connection flow line with TC	0
Type of the sensor ( in accordance with table 2.4)	Cu 81
Control of input circuit rupture	Permitted
Range of signal conversion: upper lower	-50 200
Subrange of signal conversion: lower upper	-50 200
Number of single measurements for averaging	4
Mode ИАП	4÷20 mA
Manual correction	Switched off
Temperature correction	Switched off

Table 2.6

Designation of the primary converter type or input signal *	Symbolic notation HCX	W <sub>100</sub>	Range of measured values
Cu81	100M	1,4280	(minus 50 ÷ plus 200) °C
Cu61	100M	1,4260	(minus 50 ÷ plus 200) °C
PtH1	100Π	1,3910	(minus 50 ÷ plus 600) °C
Ptb1	Pt100	1,3850	(minus 50 ÷ plus 600) °C
HA	XA(K)	-	(minus 50 ÷ plus 1300) °C
FC	ЖК(J)	-	(minus 50 ÷ plus 1100) °C
HE	XK(L)	-	(minus 50 ÷ plus 600) °C
PP	ΠΠ(S)	-	(0 ÷ plus 1700) °C
Pr	ΠΠ(B)	-	(plus 300 ÷ plus 1800) °C
BB	BP(A-1)	-	(0 ÷ plus 2500) °C
	HH(N)		(0 ÷ plus 1300) °C

\* By request of a client it is possible to manufacture thermal converters, technical parameters of which differ from requirements of the present manual on operation in the part of individual static characteristic, designation of the type of the primary converter or an input signal or other individual features.

Indicated primary converter by agreement with a customer is introduced instead of one indicated in the table 2.5.

## 2.7 Manual correction

2.7.1. Manual correction of output current signal of thermal converters is performed with the aid of keys «MIN» and «MAX» on the front panel ИИИ 0304, located in the head of the thermal converter.

**Attention!** Coefficient of manual correction affects the output signal and may be changed if only during configuration of ИИИ 0304 with the aid of the computer program on the anchor "Parameters of the instrument" the permission flag "Manual correction" is set and recorded.

The key «MIN» is used for switching on of the mode of additive error adjustment (displacement of zero) of output current and for step-by-step decreasing of the regulated parameter, the key «MAX» - for switching on of the mode of adjustment of the multiplicative error (scale parameter of measured value conversion into the output current value) and for step-by-step increase of regulated parameter.

Keys «MIN» and «MAX» makes it possible to discretely (step-by-step) decrease and increase the value of output current with the step of 0,01 % (1,6 mkA) from its range (20 mA-4 mA=16 mA), meanwhile the key «MIN» performs the shifting of the COMPLETE scale, and the key «MAX» changes output current in the area of MAXIMUM VALUES.

**Attention!** *If the temperature, at which the shift adjustment is performed, differs from the preset in the instrument minimum conversion range, then the next adjustment of the scale parameter shall affect the setting of the value of the shift in proportion to these temperatures difference. In such a case it may be needed to perform an additional adjustment of the shift after adjustment of the scale.*

The preset values of corrective coefficients are automatically preserved in the electric reprogrammable memory (EEPROM) of the instrument.

2.7.2. The keys «MIN» and «MAX» make it possible to select one of the three operation modes of ИП 0304:

- basic mode;
- mode of indication of the proper temperature of the instrument (for ТИУ 0304/М2 with the indication module);
- mode of adjustment of the scale shift;
- mode of adjustment of the scale coefficient of conversion.

2.7.2.1. When supplying power to the instrument the basic operation mode is set automatically (for ТИУ 0304/М1) and a mode with an indication display of the measured value of the input magnitude (for ТИУ 0304/М2). Transfer to the basic mode from any other mode is performed also automatically with recording of modified parameters into EEPROM, if the keys are not pressed during 4 seconds.

2.7.2.2. Simultaneous pressing of keys «MIN» and «MAX» from the basic mode switches on the indication mode of the proper temperature of the instrument (for ТИУ 0304/М2 with the indication module) in format «t XX °C» for non-negative temperatures or «t -XX °C» for negative, where XX – temperature of the instrument in Celsius degrees.

2.7.2.3. Pressing of the key «MIN» from the basic mode switches on the mode of regulation of the scale shift. When the key «MIN» is pressed, the inscription «SEtLo» is displayed on the indicator. After releasing the key «MIN» the blinking measured value of the input magnitude is displayed (for ТИУ 0304/М2 with an indication module). A single pressing of the key «MIN» from the basic mode switches on the mode of regulation of the scale shift. Every subsequent single pressing of the key «MIN» in this mode decreases correction coefficient of the shift for one unit, a single pressing of the key «MAX» – increasesувеличивает. Pressing and holding of the key for the

time longer than 0,5 seconds, results in automatic variation of the parameter with the rate of 4 units per second. Simultaneous pressing of the key «MIN» and «MAX» sets a zero value of the correcting shift coefficient сдвига, returning the instrument to the factory shift calibration. If during 4 seconds not a single key is pressed the instrument records changed parameters into EEPROM and converts into the basic mode.

2.7.2.4. Pressing of the key «MAX» from the basic mode switches on the regulation mode of scale conversion parameter. While the key «MAX» is pressed, on the indicator the inscription «SEtHi» is displayed. After releasing the key «MAX» the blinking measured value of the input magnitude is displayed on the indicator (for ТПУ 0304/M2 with a module of indication). A single pressing of the key «MAX» from the basic mode switches on a mode of regulation of the scale conversion parameter. Every subsequent single pressing of the key «MAX» in this mode increases the compensation scale factor per unit, single pressing of the key «MIN» – decreases. Pressing and holding of the key for the time longer than 0,5 seconds results in automatic changing of a parameter with the rate of 4 units per second. Simultaneous pressing of the keys «MIN» and «MAX» sets a zero value of the corrective scale conversion coefficient, returning the instrument to the factory scale calibration. If during 4 seconds not a single key is pressed, the instrument records changed parameters into EEPROM and converts into the basic mode.

***Attention!*** For reliable actuation the duration of pressed and released condition of the key in case of a single pressing should not be shorter than 0,25 seconds.

## **2.8. Error reporting.**

2.8.1. Computer software envisage diagnostic analysis of eventual failures in operation of thermal converters and damage of their components.

In case of malfunctioning and faults during operation of thermal converters on the small panel there appears the error message – “Err”, and the error name. Possible error messages:

2.8.1.1. “EEPr” – PROM error of thermal converter.

It can be due to PROM failure, or because of defective PROM data. Thermal converters should be reclosed. If the error fails to disappear, PROM data can be restored with the help of the computer program involving the backup copy of PROM data of thermal converter on the anchor “Various” of the program.

#### 2.8.1.2. “Cut” – input signal interruption (of input circuit).

This message appears on interruption of TC or TII connections with thermal converter inlets. Connections of primary converters of the thermal converter should be restored.

#### 2.8.1.3. “nrdY” – ADC data are not ready.

This message always appears on switching of thermal converters on. The message stays on during the period of time, which is in proportion to the number of averaging of the magnitude of the measured signal (from unit to tens digit of seconds), and then disappears.

#### 2.8.1.4. “brdr” – overrunning the range

The message appears on in case of an overrun by a measured signal from TC and TII of the range of measurement.

#### 2.8.1.5. “AdC” – exchange with ADC failure.

May be caused by ADC malfunction, or by a communication error between the ADC controller and the master controller.

Repair should be performed.

*Notes. Elimination of troubles requiring opening of the thermal converter is performed at the manufacturing company.*

### **2.9. Special features of operations**

2.9.1. Setting (modifications) of numeric values of parameters is performed at the anchor «Parameters of the instrument» of the computer program.

2.9.2. After setting of required parameters in the window of the program it is necessary to record them into a thermal converter by pressing the key «Record parameters into the instrument».

2.8.3. Thermal converter retains parameters of the configuration preset earlier as well as their values in case of power supply failures.

### **2.10. Marking and sealing.**

2.10.1. Marking is fulfilled in accordance with the State Standards 26828-86 E, State Standards 9181-74 E, State Standards 3023-94 and drawing HKГЖ . 411611.001.00СБ.

2.10.2. On the side surface of the head casing of thermal converters the following is indicated:

- trade mark of the producing company
- mark of the measuring devices State Register;
- symbol of the modification and version of a thermal converter;
- date of manufacturing (year);
- symbol of HCX
- range of measured temperatures;
- factory number.

### 2.10.3. Marking of explosion proof thermal converters TIIY 0304Ex

2.10.3.1. On the external surface of the head cover of TIIY 0304Ex there is:

- explosion protection marking «ExiaIICT6 X».

2.10.3.2. On the side surface of the head casing of TIIY 0304Ex there are indicated electrical parameters of the spark safe circuit :

- maximum input voltage  $U_i$ : 24 V.
- maximum input current  $I_i$ : 120 m A.
- maximum input power  $P_i$ : 0,75 W.
- maximum internal capacitance  $C_i$ : 22 nF.
- maximum internal inductance  $L_i$ : 0,1 mGn and
- temperature range of ambient media  $-50\text{ }^\circ\text{C} \leq t_a \leq +70\text{ }^\circ\text{C}$  or  $(-10\text{ }^\circ\text{C} \leq t_a \leq +60\text{ }^\circ\text{C})$ .

### 2.10.4. Marking of explosion proof thermal converters TIIY 0304Exd

2.10.4.1. On the external side of the head cover of TIIY 0304Exd there is a following marking:

- marking of explosion protection «1ExdIICT6»;
- warning inscription «Open only after switching of the circuit».

2.10.5. The method of marking application – sticking (with the aid of 2 side adhesive tape) tables are inscribed on the tape by the method of serigraphy, ensuring undamaged state of marking within the complete operation period.

2.10.6. Sealing is not performed by the producing company.

The customer performs sealing after mounting in the operation location.

### 2.10.7. Packaging

2.10.7.1. Packaging is performed in accordance with State Standards 23170-78 E, State Standards 9181-74 E and drawing HKГЖ.411611.001УЧ.

2.10.7.2. Packing of TIIY 0304A intended for work at APP “Busher” and “Kudankulam” is carried out in enclosed ventilated space with ambient air temperature from + 15 °C to + 40 °C and relative humidity up to 80 % at temperature + 25 °C and with corrosion agents content in air, which does not exceed the values set for atmosphere of type I according to the State Standard 15150-69.

### 3. USE OF DEVICES ACCORDING TO THEIR PURPOSE.

#### 3.1. Preparation of devices for usage

##### 3.1.1. Safety regulations

3.1.1.1. ТИУ 0304А, according to НП-001-97 [ПНАЭ Г-01-011-97] (ОПБ - 88/97) belong to safety classes 2, 3, 4:

- on purpose – to elements of normal use;
- on effect on safety – to elements important for safety;
- on executed functions character – to control elements.

Example of classifications designations of 2HY, 3HY or 4HY.

3.1.1.2. Considering the system of the electrical shock protection for people MRT corresponds to class III according to State Standards 12.2.007.0-75.

3.1.1.3. Thermal converters ТИУ 0304 Exd are provided with threaded grounding elements with a diameter not less than 4 mm. Grounding elements are produced from corrosion proof steel relevant to environment and should not be covered by paint. It is prohibited to use for grounding purposes screw-bolts, screws, pins that are the fastening elements of the device or of its components. There should be a contact ground around the grounding element without any painting not less than 8 mm in diameter.

The value of resistance between the grounding element (grounding place) and every accessible for contact metal non-current-carrying part of the device, that may be alive, should not exceed 0,1 Ohm.

3.1.1.4. Safety requirements when testing insulation and measuring its resistance – according to State Standards 129997-84 and State Standards 12.3.019-80.

3.1.1.5. Thermal converters ТИУ 0304А (of high reliability) in accordance with НП –001-97 (ОПБ – 88/97)) belong to:

- according to purpose – to elements of normal operation;
- according to influence on safety – to elements important for safety.

Example of recording of classification designation 2H or 3H.

3.1.1.6. During use of thermal converters it is necessary that the requirements of GOST 12.3.019-80, “Rules of technical operation of consumer electric installations”, “Safety standards during use of consumer electric installations”, approved by Gosenergonadzor, be observed.

3.1.1.7. Thermal converters are to be connected to the electric circuit when supply voltage is switched off.

3.1.1.8. During use of thermal converters it is necessary that the requirements of safety regulations should be adhered to, which are provided in the documentation for measuring devices, with which they operate complete with.

3.1.1.9. Elimination of defects, exchange, connection of external cables, mounting and disconnection of primary converters should be performed when supply voltage is switched off.

### 3.1.2. External examination.

3.1.2.1. During the external examination the absence of mechanical damages, accuracy of marking and completeness of the set should be checked.

In case of surface defects, which may influence working capacity of thermal converters, or inadequacy of completeness, or of marking are found, the possibility of further use of thermal converters is to be determined on an individual basis.

3.1.2.2. Every thermal converter device should be supplied with an inspection checklist.

### 3.1.3. Installation of the device.

3.1.3.1. The electrical connection chart of thermal converters is provided at the pictures of the appendix A. Connection is performed by connection of a cable of a current loop to the terminal blocks.

Laying and termination of cable should meet requirements of current “Regulations of electrical devices design” (ИУЭ).

3.1.3.2. Power supply source should provide load current not less than 30 mA. (For example БП 96/24-1(2)/120DIN).

3.1.3.3. During assembly it is necessary to make certain that the length of the outer part  $L_H$  should be not more than 120 mm at the temperature of measured medium not less than 350 °C,  $L_H$  from 40 to 120 mm at the temperature of measured media not more than 350 °C.

3.1.3.4. Thermal converters should be grounded with the aid of outer grounding clamp in accordance with State Standards 21130-75.

3.1.3.5. Mounting of explosion proof thermal converters ТИУ 0304Ex, ТИУ 0304EXd should be performed with consideration of requirements “Regulations of electrical devices design” (ИУЭ clause 7.3), «Regulations of technical operations of electrical devices by customers » (ИТЭЭП), State Standards P 51330.13-99 «Electrical devices in dangerously explosive zones».

3.1.3.6. During mounting of explosion proof thermal converters ТИУ 0304Exd it is necessary to verify:

- condition of explosion proof surfaces, fastening elements (all fastening elements should be tightened, removable parts should fit the shell casing very closely, as it is permissible by the structure of thermal converters).



#### 3.1.4. Testing of factory setting

3.1.4.1. Thermal converter is switched on to measuring – calibrator of uniform signals of ИКСУ-2000 (hereinafter – ИКСУ) (or to the power supply source of constant current БП 96/36 and ИКСУ) according to the chart, resulted on pictures 4.1 or 4.2.

3.1.4.2. Thermal converters are placed in ice–water mixture and they are held at the temperature of 0 °C during not less than 30 minutes.

3.1.4.3. ИКСУ measure output current  $I_{\text{вых.}i}$ .

3.1.4.4. The basic reduced error is calculated by the formula

$$\gamma = \frac{(I_{\text{вых.}i} - I_{\text{расч.}})}{(I_B - I_H)} \times 100 \%, \quad (3.1)$$

where :  $I_{\text{вых.}i}$  - measured value of unified output signal mA;

$I_{\text{расч.}}$  - calculated value of unified output signal,  
corresponding to temperature 0 °C, mA;

$I_H, I_B$  - lower and upper limits of unified output signal mA.

Calculated by the formula (3.1) values of the basic reduced error  $\gamma$  should not exceed 0,5 of the limit of tolerable basic error.

### 3.2. *Employment of devices*

3.2.1. All required connections of thermal converters are performed in accordance with the pictures of appendix A.

3.2.2. The power supply source of direct current is switched on. After 15 minutes a thermal converter is ready for operation.

3.2.3. The measured temperature is determined by the formula

$$T = \frac{(I - I_H)}{(I_B - I_H)} \times (T_B - T_H) + T_H, \quad (3.2)$$

where:  $I$  - measured value of an output signal, corresponding to measured temperature mA;

$I_H, I_B$  - lower and upper limits of unified output signal, mA;

$T_H, T_B$  - upper and lower limits of measured temperature, °C;

$T$  - the value of measured temperature, °C.

### ***3.3. Adjustment TИY 0304 on a range of measurements of temperature distinct from «factory installation»***

3.3.1. Adjust communication with the converter measuring ИП 0304 (device) according to subitem 2.6.

3.3.2. Read out parameters from the device.

3.3.3. Change a range of an entrance signal (the bottom and top limit of measurement of temperature) and range ПВИ always equal to a range of an entrance signal.

3.3.4. Write down new parameters in the device.

3.3.5. Place the thermo converter in a ice-water mix and maintain it at temperature 0 °C during not less than 30 minutes or place the thermo converter in the calibrator at the temperature, corresponding  $T_n$  if it differs from 0°C.

3.3.6. By means of button "MIN" located on top panel ИП 0304 make manual correction of a target signal. Establish a target signal corresponding  $I_H (4 \pm 0,008)$  mA.

***Attention! Adjustment TИY 0304 on other range of measurements of temperature is possible only in the limits specified on the primary converter.***

### ***3.4. Tuning of thermal converters with other primary converters and selected range of measured temperature.***

3.4.1. Connect the jack cold end to ИП (only for work with ТП).

3.4.2. Install demanded parameters according to item 2.6, unset correcting coefficients of shift of a scale of  $K_a$  and scale coefficient  $K_b$  according to subitem 2.7.2.3, 2.7.2.4 and write parameters in the instrument.

3.4.3. The temperature corresponding to lower (upper) limit of measurement of temperature is set in the calibrator КТ-500 (КТ-1100, КТ-650, КТ-110, thermostat or oven)\*

3.4.4. Thermal converter is connected to ИКСУ (or to the power supply source of direct current БП 96/36 and ИКСУ) according to the chart, provided at the corresponding pictures of appendix A.

3.4.5. Thermal converter КТ-500 (КТ-650, КТ-1100, КТ-110, thermostat and oven) is placed at the depth corresponding to the length of submerged part (for calibrator – at the depth of 160 mm, from the thermostat – at the depth of submerged part of a thermal converter or, if the length of submerged part is over 250 mm – at the depth not less than 250 mm), and it is held at this temperature during the interval of time not less than 30 minutes.

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\* КТ-500 (КТ-650, КТ-1100, КТ-110, thermostat or oven) in accordance with the table 4.1

3.4.6. ИКСУ measure output current  $I_{6bx.i}$ .

3.4.7. For the lower limit of measurement of thermal converters with the aid of the key «MIN», located at the upper panel ИП 0304 of the thermal converter, output current is set corresponding to  $(4\pm 0,008)$  mA.

3.4.8. For upper limit of measurements of thermal converters with the aid of the key «MAX», located at the upper panel ИП 0404 of a thermal converter, output current is set corresponding to  $(20\pm 0,008)$  mA.

3.4.9. Repeat measurements of an output current of the thermo converter for a limit inferior of measurements and are convinced that the value of an output current is in a range  $(4\pm 0,008)$  mA, otherwise repeat clause 3.4.3 –3.4.8.

3.4.10. Instal in the calibrator temperature corresponding to average value of a range of measurement of temperature, after a calibrator output on the set temperature, maintain the thermo converter within 30 minutes

3.4.11. Measure value of output current  $I_{6bx.i}$ .

3.4.12. Calculate the main resulted error under the formula (3.1). The calculated value of the main resulted error should not exceed value of a limit of the admitted main resulted error specified in table 2.2.

#### 4. VERIFICATION TECHNIQUE

4.1. Verification of thermal converters is carried out by State Standardising Authorities or by the authorised Metrological Service, authorized to carry out such a verification. Verification requirements, its procedure and main phases are defined by ПП 50.2.006-94 “ТСИ. Measuring devices verification. Organization and procedure”.

4.2. The recalibration interval makes two years.

When using thermal converters with primary converters of TII type in the temperature range from 1100 to 2500 °C the recalibration interval is – 6 months.

4.3. During verification procedure the operations are performed and verification devices are employed that are provided in the table 4.1

Таблица 4.1

Name of the operation	Number of the clause	Recommendation of verification means and equipment	Obligation of operation performance by	
			Initial verification	Periodic verification
1	2	3	4	5
1. External inspection	4.6.1		Yes	Yes
2. Testing	4.6.2	Duare vessel for presentation of the temperature of ice melting with an error not more than $\pm 0,02$ °C. Measuring-calibrator of unified signals reference ИКСУ-2000 ТУ 4381-031-13282997-00: Range of current measurement from 0 to 25 mA, limits of the tolerable basic absolute error $\pm 0,003$ mA, output voltage of integrated stabilizer of voltage $(24 \pm 0,48)$ V. Direct current power supply source БП 96/36 ТУ 4229-018-13282997-99: output voltage $(36 \pm 0,72)$ V, load voltage is not more than 45 mA	Yes	Yes
3. Testing of electric resistance of insulation	4.6.3	High-resistance ohmmeter Ф 4102/1-1М ТУ 25-7534.005-87: range of measurement from 0 to 20000 MOhm	Yes	Yes
4. Testing of electrical durability of insulation	4.6.4	Device for testing electrical safety  GPI-745A: range of output voltages 500 V, range of measured resistances at voltage of 500 V from 1 to 9999 MOhm	Yes	No

Continuation of the table 4.1

1	2	3	4	5
5. Determination of the basic reduced error	4.6.5	<p>Verification devices and equipment in accordance with the clause 2 of the present table and also :</p> <p>Standard temperature calibrator KT-500 TY 4381-030-13282997-00: range of temperatures presentation (from +50 to +500) °C, basic error not more than <math>\pm(0,05+0,0006 \cdot t)</math> °C, instability of temperature maintenance during 5 minutes, °C, in the ranges: (from +50 to +200) °C <math>\pm 0,015</math>, (from +200 to +500) °C <math>\pm 0,05</math>.</p> <p>Standard temperature calibrator KT-650 TY 4381-056-13282997-04: range of temperatures presentation (from +50 to +650) °C, basic error not more than <math>\pm(0,05+0,0006 \cdot t)</math> °C, instability of temperature maintenance during 30 minutes, °C <math>\pm 0,0002 \cdot t</math>.</p> <p>Standard temperature calibrator KT-110 TY 4381-049-13282997-03: range of temperatures presentation (from minus 40 to +110) °C, basic error <math>\pm 0,15</math> °C, instability of temperature maintenance during 30 minutes <math>\pm 0,03</math> °C.</p> <p>Standard temperature calibrator KT-1100 TY 4381-053-13282997-03 range of temperatures presentation (from +300 to +1100) °C, basic error <math>\pm 1,5</math> °C, instability of temperature maintenance during 5 minutes <math>\pm 0,3</math> °C.</p> <p>Hydraulic thermostat U15C ТГЛ 32386: range (from minus 60 to +260) °C, thermostatting error not more than <math>\pm 0,02</math> °C.</p> <p>Standard thermometer (образцовый) of the 1-st category ПТС-10. ПИЗ.879.001 ТУ: range (from minus 183 to +630) °C, basic error not more than 0,01 °C.</p> <p>Standard platinum-rhodium thermocouple (model) of the 2-nd category of the type ППО ТУ 50-104-83 range (from +300 to +1200 °C), basic error not more than 0,9 °C.</p> <p>Oven МТП-2М ТУ 50-239-84 temperature (from +300 to +1300 °C), temperature gradient in the hot face not more than 0,8 °C/sant.</p>	Yes	Yes

Continuation of the table 4.1

1	2	3	4	5
6. Registration of the verification results	4.6.6		Yes	Yes
Notes: 1. Producing company of ИКСУ-2000, КТ-1100, КТ-650, КТ-500, КТ-110, БП 96/36 is SRC «Elemer». 2. It is admissible to employ separate, newly developed or used verification means and equipment as to its characteristics not inferior to the ones provided in the present regulation.				

#### 4.4. Safety requirements

4.4.1. During verification procedure safety requirements are complied with, that are presented in documentation for applied verification instruments and equipment.

#### 4.5. Conditions of verification and preparation for it.

4.5.1. During verification procedure the following conditions are observed:

- temperature of ambient air, °C 20±5;
- relative air humidity, % 30-80;
- atmosphere pressure, kPa (mm merc. Column) 84,0-106,7  
(630-800);
- supply voltage, V 24±0,48;  
or 36±0,72.

External electric and magnetic fields should be absent or should be within the limits not affecting instruments operation.

Verified thermal converters and employed verification instruments and equipment should be protected from shocks, vibration, jolting, affecting their operation.

4.5.2. Operations performed with verification instruments and verified by thermal converters should correspond to instructions provided in the in-line documentation and the present operation manual.

4.5.3. Before the verification procedure the following preparation operations are performed:

4.5.3.1. Thermal converters sustain in conditions determined according to clause 4.5.1, during 4 hours.

4.5.3.2. Verification instruments are prepared for operation in accordance with operation manuals.

#### 4.6. Verification operation.

4.6.1. External examination of verified thermal converters is performed in accordance with clause 3.1.2 of the present operation manual.

4.6.2. Testing of verified thermal converters lies in testing of the factory preset or testing of thermal converters tunings on other primary converters and preset range of temperatures according to clause 3.1.4 or clause 3.1.5 of the present operation manual.

4.6.3. Testing of electrical resistance of insulation.

4.6.3.1. Testing of electrical resistance of insulation of thermal converter circuits is performed with the aid of high-resistance ohmmeter  $\Phi$  4102/1-1M (GPI-745A) or with the aid of another instrument measuring electrical resistance with working voltage over 500 V and an error not more than 20 %.

Readout is performed after 1 minute after application of voltage between contacts of the supply circuit and the casing.

Insulation resistance should not exceed 20 MOhm.

4.6.4. Testing of electrical insulation strength

4.6.4.1. Testing of electrical insulation strength is performed using the plant GPI-745A, allowing increasing voltage smoothly or uniformly by steps, and not exceeding 10 % of testing voltage.

Testing voltage should be increased smoothly, starting from zero or from the value, Testing of electrical insulation strength not exceeding nominal voltage till 5 – 10 sec., but not more than 30 seconds.

Measurement error of testing voltage should not exceed  $\pm 5$  %.

Testing voltage is applied between contacts of the feed circuit and the casing.

Thermal converters are matured under influence of testing voltage of 500V during 1 minute. Next, voltage is smoothly reduced to zero or the value not exceeding nominal after that the testing plant is switched off.

Insulation of thermal converters circuits should withstand combined testing voltage without any disruptions and surface overlapping.

4.6.5. Determination of basic reduced errors.

4.6.5.1. Verification is performed for the following measurement ranges:

- from minus 50 to plus 200 °C for thermal converter with TC of 100M type;
- from minus 50 to plus 600 °C for thermal converter with TC of 100II type;
- from minus 50 to plus 600 °C for thermal converter with TC of Pt100 type;
- from minus 50 to plus 1300 °C for thermal converters with TII of TXA(K) type;
- from minus 50 to plus 600 °C for thermal converter with TII of TXK(L) type.

4.6.5.2. Lower and upper limits of measurements are determined in accordance with clause 3.1.5.

4.6.5.3. The basic reduced error of thermal converters is determined according to procedure from clauses 3.1.5.2 – 3.1.5.5 in the points corresponding 25, 50 and 75 % of measurement range.

4.6.5.4. The readings from indicators KT-500 (KT-1100, KT-650 or KT-110) are taken, and when using a thermostat (or an oven), a reference (standard) thermometer (or thermocouple) is placed into a thermostat (or an oven) and temperature is measured by a reference (standard) thermometer (or thermocouple)  $T_0$  as well as an output signal of thermal converter – ИКСУ .

4.6.5.5. The value of the basic reduced error  $\gamma_i$  is calculated from the formula

$$\gamma_i = \frac{(T_i - T_0)}{(T_B - T_H)} \times 100\%, \quad (4.1)$$

where  $T_i$  - temperature in verified point, calculated from the formula (3.2);  
 $T_H, T_B$  - lower and upper limits of measured temperature $^{\circ}\text{C}$ .

The larger of the calculated value of the basic reduced error should not exceed the corresponding value indicated in the table 2.1.

Notes. It is allowed to determine the basic reduced error of thermal converters in two points corresponding to 5 and 95 % of the measurement range for ТПУ 0304 with primary converters of TC type and in three points corresponding to 5,50,95% of the temperature measurement range for ТПУ 0304 with primary converters with primary converters of ТП type, during preliminary testing of linearity of ИП 0304 with the aid of ИКСУ with tolerable variation not more then 0,5 of the basic reduced error of thermal converters .

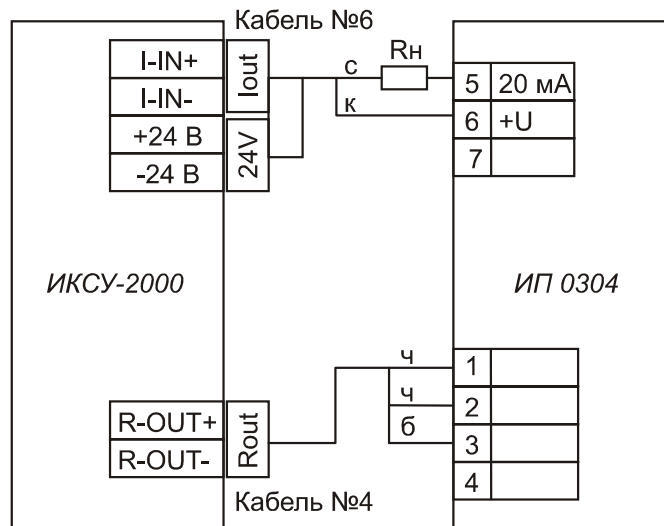
Non-linearity of ИП 0304 is tested when determining the basic reduced error according to procedure outlined by clause 4.6.5.6.

4.6.5.6. For determination of an error ИП 0304 when operating with TC the following operations are performed:

1) ИКСУ-2000 is prepared for operation in compatibility mode of temperatures, corresponding to input signals from TC and it is connected to inputs of ИП 0304 according to three-wire circuit, provided in the picture 4.1.



### Connection layout for verification of ИП 0304



Проверка ИП 0304 в режиме ТС

с, к, ч, б – blue, red, black, white wires of cables;  
 $R_n$  – resistor C2-23-0,25-390 Ом-5 5-A-B-B.

Picture 4.1

2) With the aid of ИКСУ-2000 the emulated value of temperature minus 50,0 °C (actual  $T_\delta$ ) is preset and measurement of output current signal of thermal converters is performed with the aid of ИКСУ-2000.

3) Temperature  $T_i$  is determined at the verified point by formula (3.2).

4) Absolute error value  $\Delta T$  is computed as a difference of measured  $T_i$  and actual  $T_\delta$  temperature values in a verified point by formula

$$\Delta T = T_i - T_\delta, \quad (4.2)$$

where  $T_i$  - the temperature value in a verified point, computed by the formula (3.2).

5) The value of the basic reduced error  $\gamma_i$  is computed by the formula (4.1).

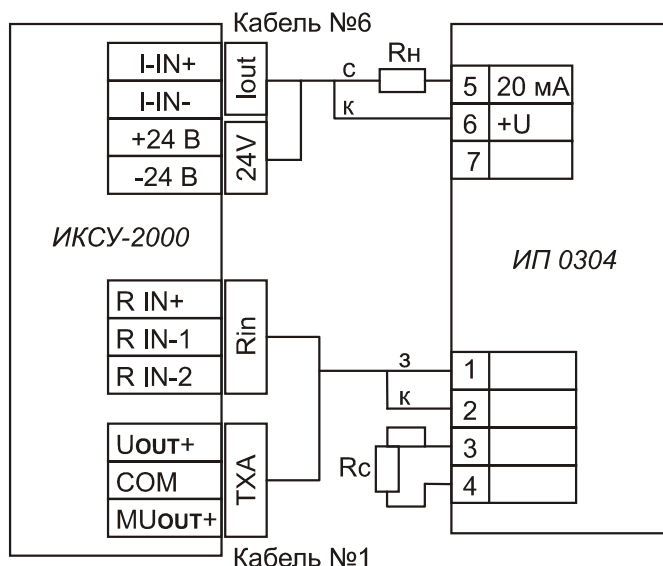
6) Operations are repeated according to clauses 4.6.5.6.2), ...4.6.5.6.5), determining consequently with the aid of ИКСУ-2000 emulated (actual) temperature values, equal to 10, 25, 50 and 75 % of the measurement range and appropriate measurements of output current signal of ИП 0304 is performed. .

4.6.5.7. For determination of the error of ИП 0304 during operations with input signals from ТП the following operations are performed:

1) Compensator of cold end is connected to ИП 0304.

2) ИКСУ-2000 is connected to ИП 0304 in the mode of ТП signals emulation, for example, of the type XA(K) by the corresponding cable according to the chart, presented in the picture 4.2 and thermal converters are held in such a condition during 15 minutes.

### Connection layout for verification of ИП 0304



Проверка ИП 0304 в режиме ТП

с, к, з – blue, red, green wires of cables;  
 $R_n$  – resistor C2-23-0,25-390 Ohm-5 %-A-B-B;  
 $R_c$  – compensator Pt 100.

Picture 4.2

- 3) With the aid of ИКСУ-2000 the value of emulated (actual) temperature is set equal to 0 °C.
- 4) Calibration of the resistance of cold end calibration is performed for which purpose in the window of the computer program:
  - the key is pressed «Calibrate  $RC_0$ »;
  - beginning of calibration is confirmed and recording of parameters into the instrument is confirmed, after appearance of the message «Start measurement» a pause of 180 seconds is made and the key «Yes» is pressed for the calibration beginning;
  - during the calibration process an average value of temperature of ТП and a compensator is displayed in the window «Measured parameter»;
  - after calibration is accomplished new coefficients are recorded into the instrument by pressing the key «Record calibrations into the instrument».
- 5) Serially establish by means of ИКСУ-2000 the values of the emulated temperature equal of 0, 100, 25, 50, 75 % from a range of measurements.
- 6) Make measurement target токового signal ИП 0304 in each of verified points and under the formula (3.2) count corresponding value of the measured temperature.

7) Define value of an absolute error of the measured temperature in each of verified points under the formula (4.2).

8) Count value of the basic resulted error in each of verified points  $\gamma_i$  under the formula (4.1).

4.6.5.8. Values of the resulted errors calculated under the formula (4.2) in each of verified points, 0,5 limits of the supposed resulted errors specified in item 2.2.1, table 2.1 should not exceed.

4.6.5.9. Determination of the basic errors of thermal converters configured to match a specific type of input signal.

4.6.5.9.1. The basic error of thermal converters for configurations with TC and TII (clause 2.2.1, table 2.1) is determined in the points, corresponding to 5, 25, 50, 75, and 95 % of the measurements range.

Nominal static characteristics of TC conversion should correspond to State Standards 6651-94, nominal static characteristics of TII conversion should correspond to State Standards P 8.585-2001.

Measurements for determination of basic errors with specified configurations of thermal converters are performed in accordance with the procedure set forth in the clause 4.6.5.2 - clause 4.6.5.4.

The basic reduced error  $\gamma_i$  is computed by the formula (4.1) in every verified point.

The maximum computed value of the basic error should not exceed the corresponding value provided in the table 2.1.

4.7. Registration of verification results.

4.7.1. Positive results of thermal converters verification are validated by the certificate on state verification of a set form IIP 50.2.006-94.

4.7.1.1. Results of thermal converters verification, configured for a specific type of the primary converter and for the specific range of measurements are validated by the certificate on state verification of a set form IIP 50.2.006-94 with presentation of verification results on its reverse side (or by the report in derived form).

***Attention!*** *Int his case it is not allowed to reconfigure thermal converters into other types of primary converters and measurement ranges.*

4.7.2. In case of negative results of thermal converters verification they are not permitted to operate until the failure cause is determined and eliminated.

4.7.3. After elimination of a failure one more verification is performed.

The results of the second verification is considered to be final.

## 5. MAINTENANCE SERVICE

5.1. Servicing of thermal converters comes to observing operation, storage and transportation regulations, given in the present manual on maintenance inspections, periodic verification and repairs.

5.2. Maintenance inspections are carried out according to the rules, established by the organization, using thermal converters, but not less than twice a year, and they include:

- a) external examination in accordance with the sect. 3.1.2;
- b) checking safety of connection of thermal converters communication circuits with the primary converter, power supply and load in accordance with the sect. 3.1.3.2;
- c) performance check in accordance with the sect. 3.1.4 or 3.1.5;
- d) verification of measurements precision of thermal converters in the points, corresponding to 5, 50, 95% of the range of measured values with Sec.4 of the present manual.

If the performance check is carried out in the circumstances, when there is no possibility of using accessory instruments, thermal converters cannot be tested for precision of measurements. In that case only an operability test of thermal converters may be carried out. Thermal converters are considered operable if their indications approximately coincide with the measured value.

5.3. Periodic verification of thermal converters is carried out once in a two-year period, according to the instructions, given in the sec. 4 of the present manual.

5.4. Thermal converters with defects, which cannot be eliminated during the maintenance inspection, or the ones, which have not passed a periodic verification, are liable to a current repair.

Repair of thermal converters is carried out by a manufacturer subject to a separate contract in accordance with State Standards P 51330.18-99.

5.5. Provision of explosion proof during mounting.

Explosion proof thermal converters may be used in explosion dangerous zones of premises and external fastening element instruments in accordance with established marking of explosion protection with consideration of requirements of current «Regulations of electrical appliances design» (ИУЭ clause.7.3), «Regulations of technical maintenance of consumer electrical appliances» (ИТЭЭП, clause.3.4), of the present operation manual, instruction on mounting of electrical equipment, as a component of which - a pressure converter – is installed.

Prior to mounting, explosion proof thermal converters should be inspected. At the same time it is necessary to pay attention to:

- warning placards, explosion proof marking and its correspondence to the class of explosion dangerous zone;
- absence of casing damages of explosion proof thermal converters and components of cable input;
- condition and reliability of screwing of electrical contact connections, availability of all fastening elements ( bolts, nuts, washers etc);
- condition of grounding.

Mounting of explosion proof thermal converters is performed in accordance with the connection layout. Reliable connection of cable wiring to current conducting connector contacts is provided excluding a possibility of cable wiring short-circuiting.

After mounting it is necessary to test operation ability of explosion proof thermal converters..

All fastening elements should be tightened; detachable elements should fit as closely to the housing as the design of the thermal converters may permit.

The housing of explosion proof thermal converters should be grounded. The place of attachment of outside grounding should be thoroughly cleaned and after connection of grounding conductor it should be safeguarded from corrosion by applying of grease lubricant.

#### 5.6. Provision of explosion proof during operation.

Acceptance of thermal converters for operation after their mounting and organization of operation and repair should be performed in accordance with the clause 3.4 «Electrical installations in explosion proof zones» ПТЭЭП, as well as actual instructions for electrical equipment in which TC is installed.

Operation of thermal converters should be done in such a way that all requirements provided in subsections «Provision of explosion proof quality» and «Provision of explosion proof quality during mounting and operation».

During operation it is necessary to supervise normal operation of explosion proof thermal converters and make systematic outside and cyclic inspection of them.

During external examination it is necessary to test the following:

- absence of ruptures and damages of insulation of outer connecting cable ;
- absence of apparent mechanical damages in the casing of explosion proof thermal converters.

During routine testing all outer inspection operations should be performed, as well as the condition of contact connections inside the casing of explosion proof thermal converters should be checked and sealing of cable in cable termination. Periodicity of cyclic inspection is determined in accordance with conditions of operation of explosion proof thermal converters.

Operation of explosion proof thermal converters with damages and faults is prohibited.

When installing in the explosion dangerous zone explosion proof thermal converters with heads АГ-01 and АГ-02 it is expedient to avoid convection currents of environment around the head to exclude appearance on its surface of electrostatic discharges.

Operation and technical maintenance of explosion proof thermal converters should be performed in accordance with requirements of State Standards P 51330.13-99.

## **6. STORAGE.**

6.1. Storage conditions for thermal converters packed in shipping container at the manufacturer's storage facilities should meet requirements of I State Standards 15150-69. The air should not contain active agents.

6.2. Stowage of thermal converters in storage facilities should ensure easy access to them.

6.3. Thermal converters should be stored on the racks.

6.4. The space between the walls, the floor of the storage facility and thermal converters should not be less than 100mm.

## **7. TRANSPORTATION**

7.1. Thermal converters are transportable by all kinds of transport in covered transport facilities. Strapping of package in a transport facility should be carried out according to the current regulations of the corresponding transport facilities.

7.2. Thermal converters transportation conditions should meet requirements 5 according to State Standards 15150-69 at the ambient temperature from minus 50 to +50°C, and should comply with anti-shock and anti-vibration measures.

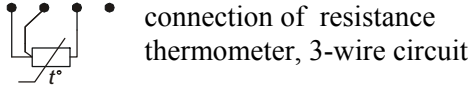
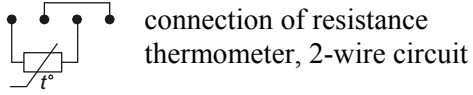
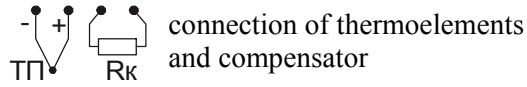
7.3. Thermal converters should be transported parceled or separately.

7.4. If transported in boxes, requirements of State Standards 21929-76 should be observed.

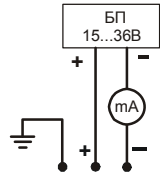
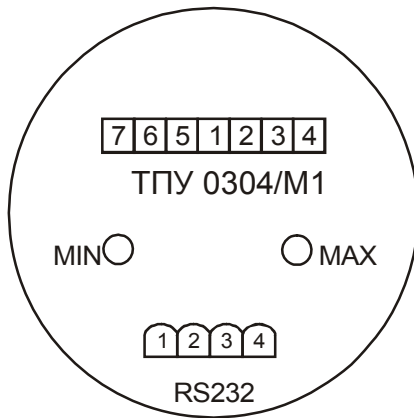
# APPENDIX A

## ELECTRICAL CONNECTION CHARTS

ТПУ 0304/М1

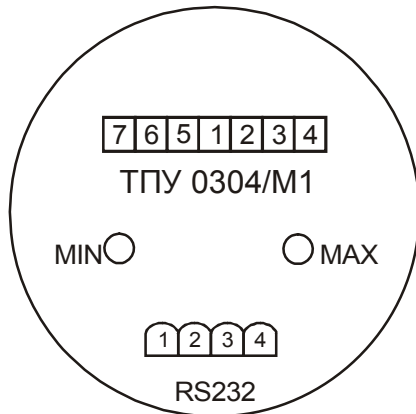


7 6 5 1 2 3 4  
• • • • • • •



connection of current output

7 6 5 1 2 3 4  
• • • • • • •

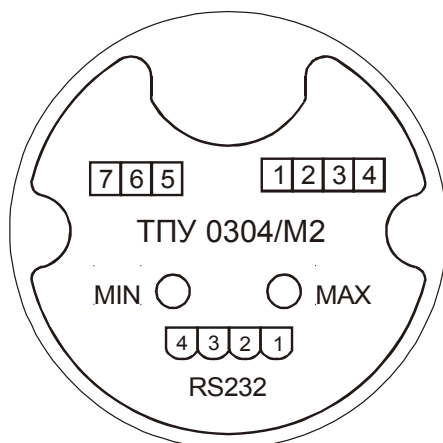
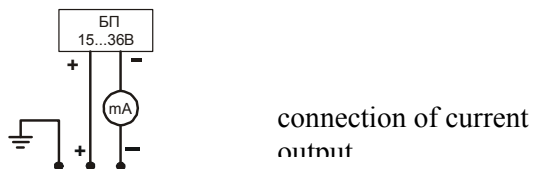
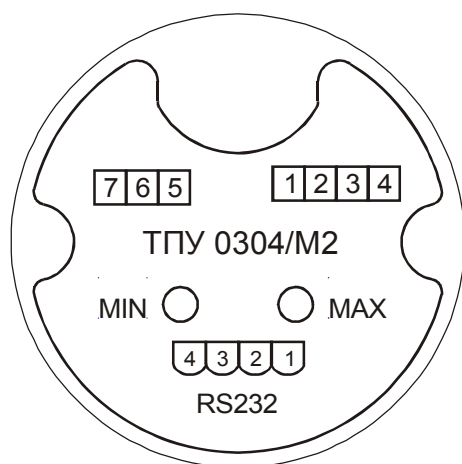
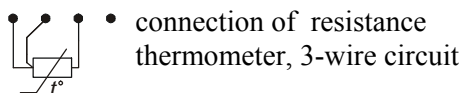
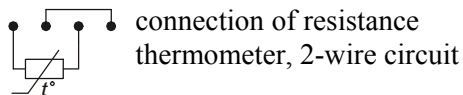
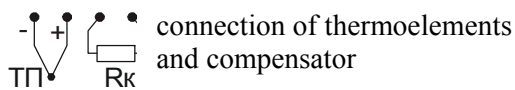


Picture A.1



**Continuation of Appendix A**  
**ELECTRICAL CONNECTION CHARTS**

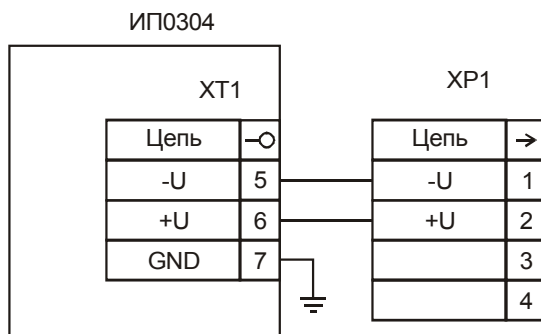
ТПУ 0304/M2



**Picture A.2**

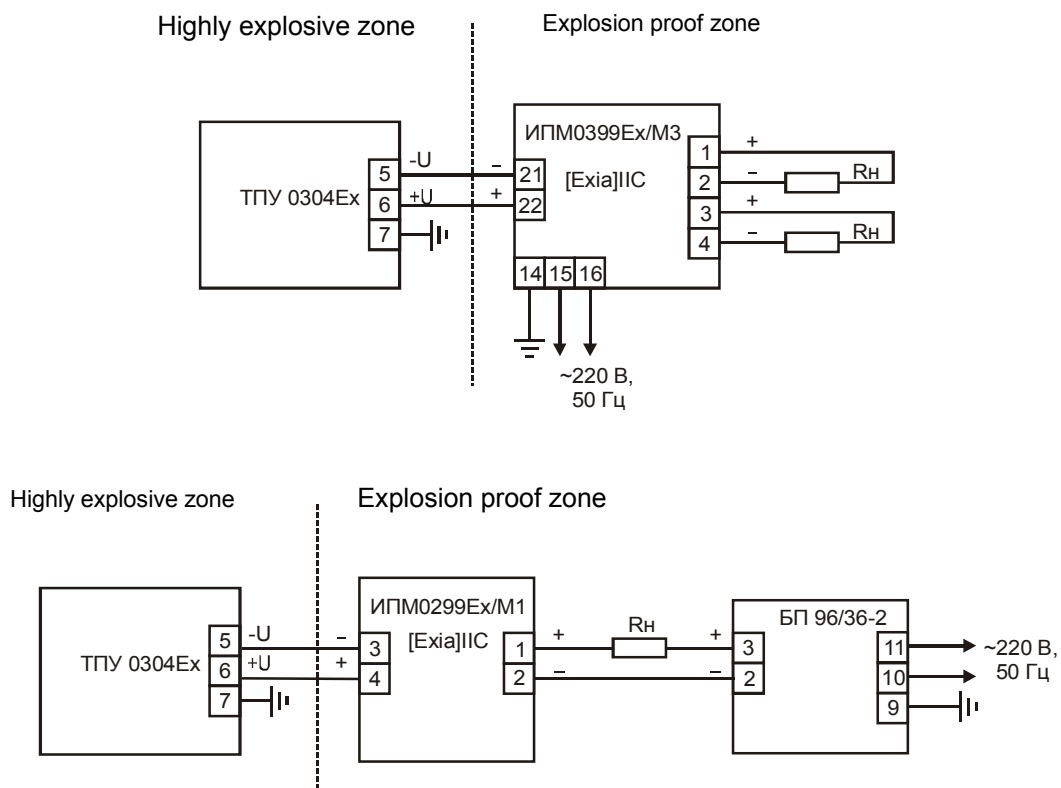
### Continuation of Appendix A

Circuit of internal connection of the terminal block (ХТ 2) ИП 0304 with the plug of the external connector (ХР 1) of thermal converters



Picture A.3

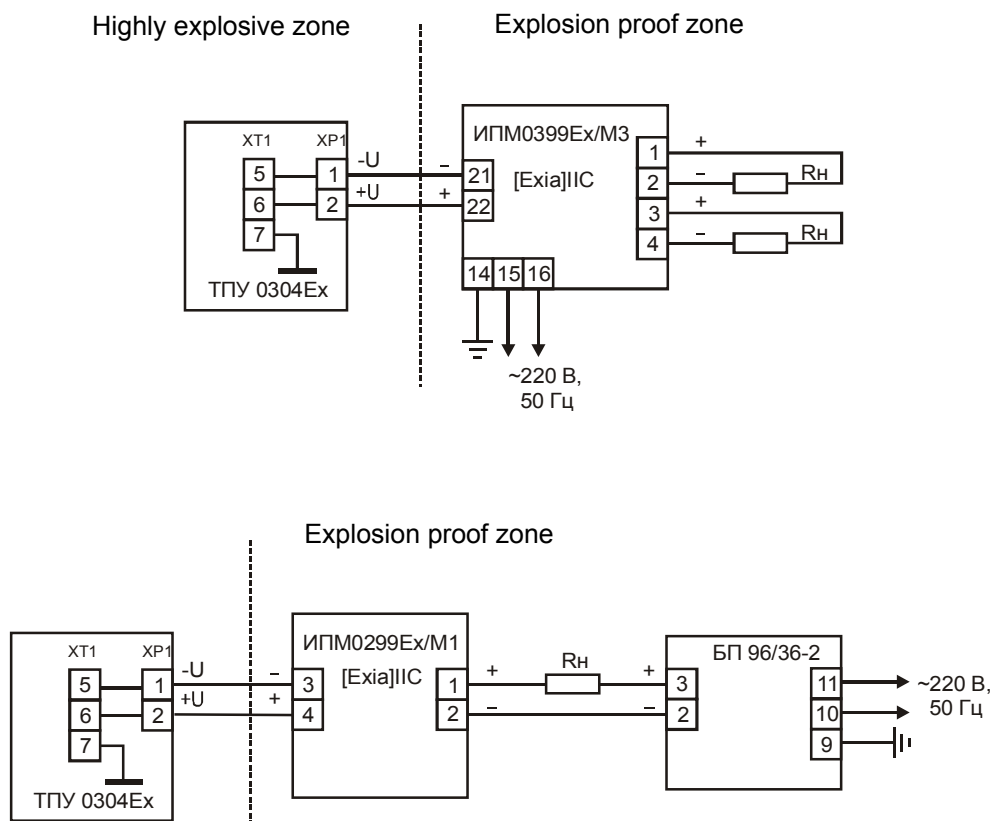
Circuit of connection of ТПУ 0304Ex to cable terminations and gland terminations in case of its location in an explosion dangerous zone ExiaIIC T6 X



Picture A.4

## Continuation of Appendix A

Circuit of connection of ТПУ 0304Ex with connectors  
in case of its location in an explosion dangerous zone  
ExiaICT6 X



**ИПМ 0299Ex/М1,**

**ИПМ 0399Ex/М3** – modular measuring converters manufactured by SPC «ELEMER»

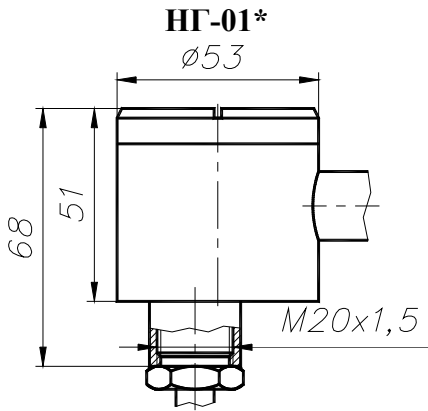
**R<sub>н</sub>** – load resistance;

**БП96/36-2** – power supply source of direct current manufactured by SPC «ELEMER».

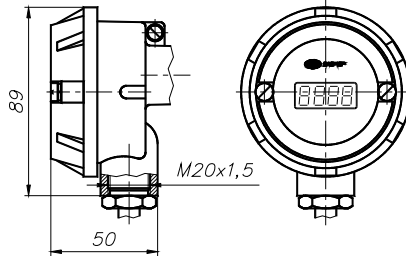
**Picture A.5**

## APPENDIX B

Multi – purpose thermal converters ТПЧ 0304.  
Head casings

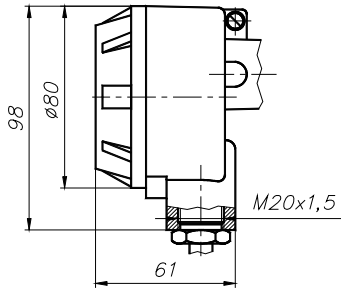


**АГ-01 vertical with indication**

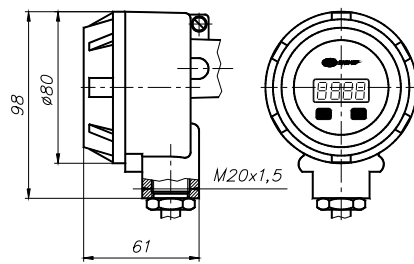


\* Only for ТПЧ 0304/М1

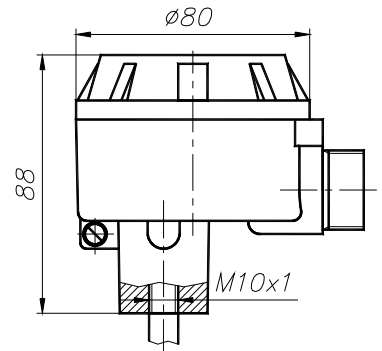
**АГ-02 vertical. with out indication**



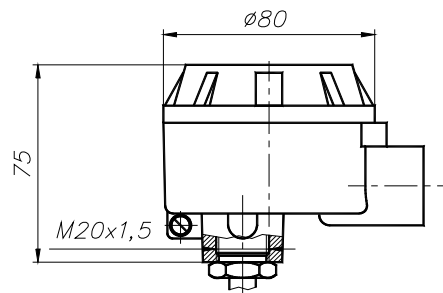
**АГ-02 vertical with indication**



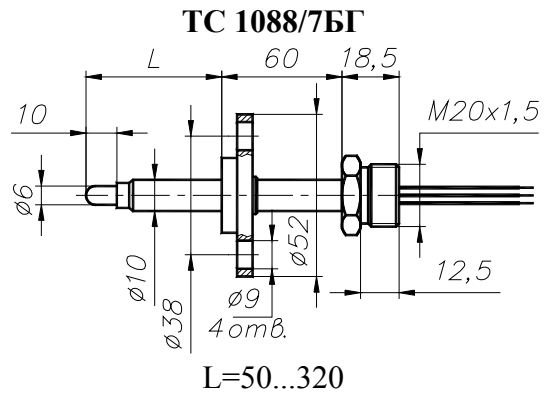
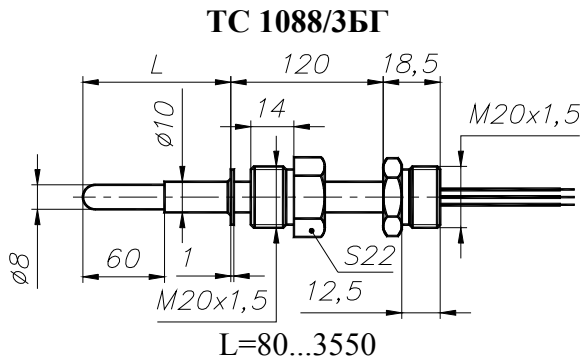
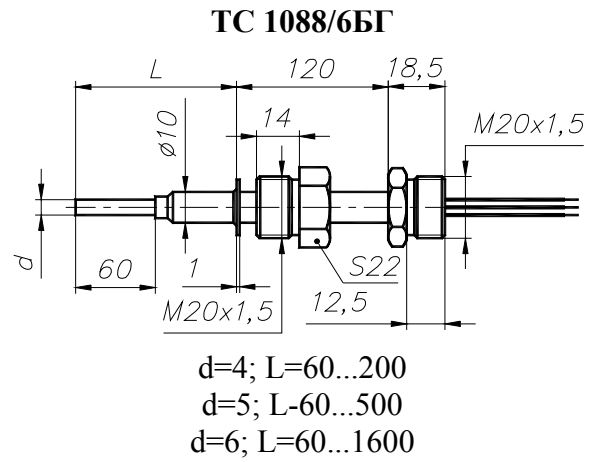
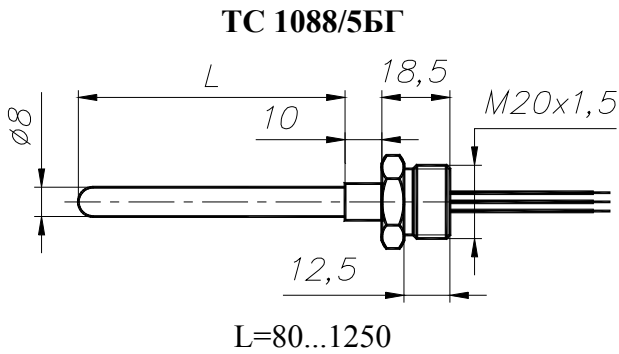
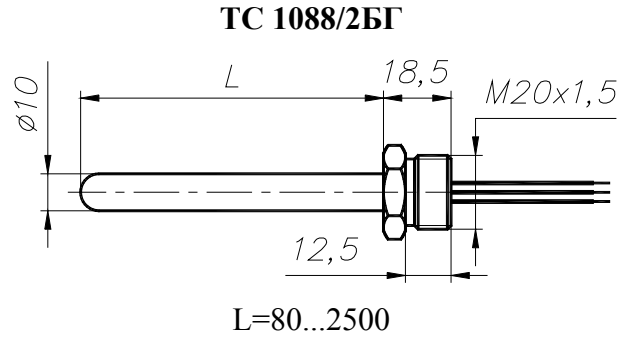
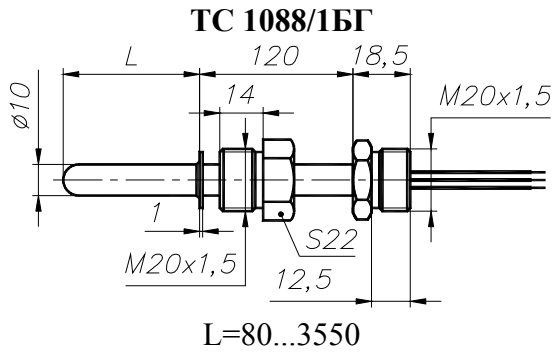
**АГ-02Exd**



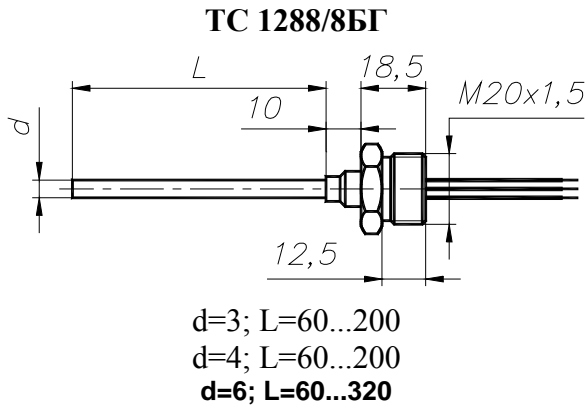
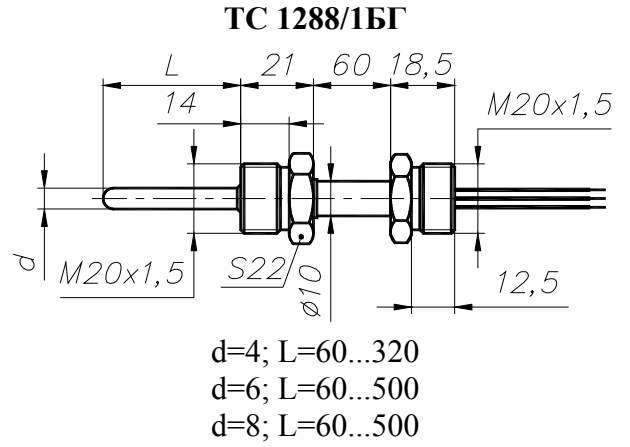
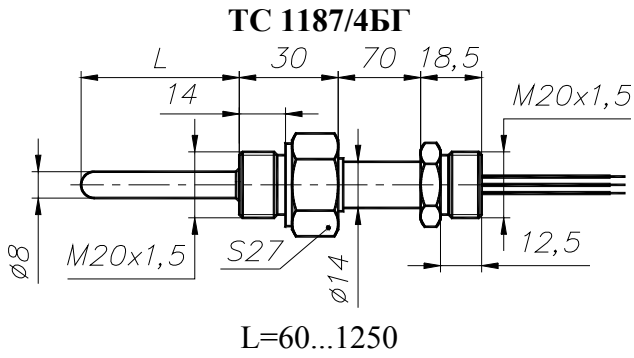
**АГ-02 horizontal.**



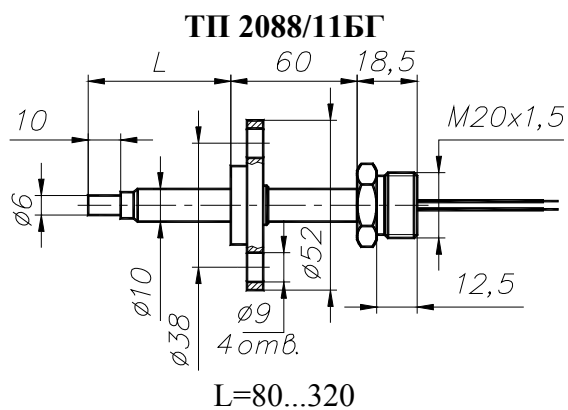
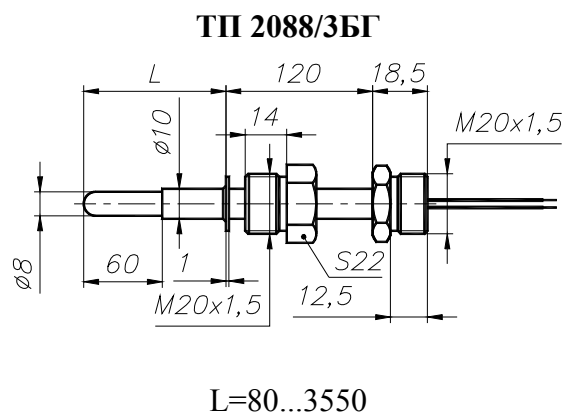
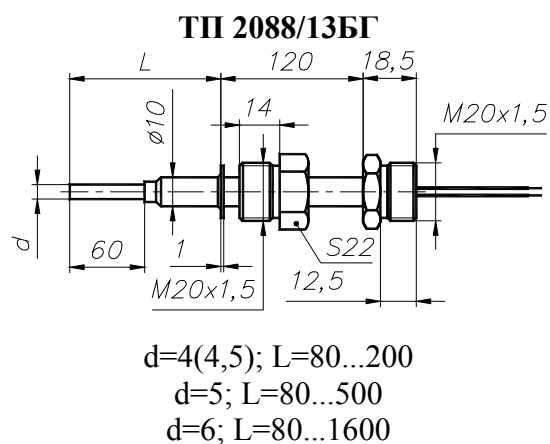
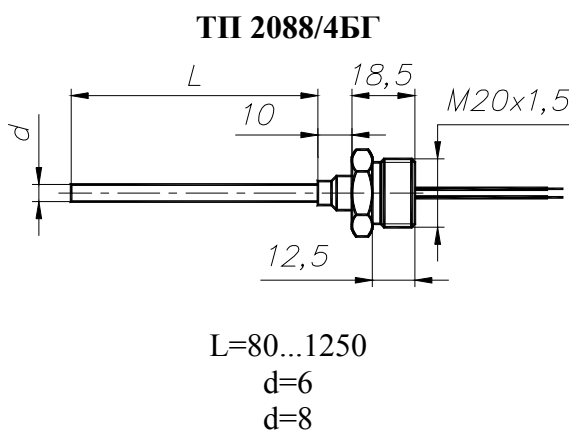
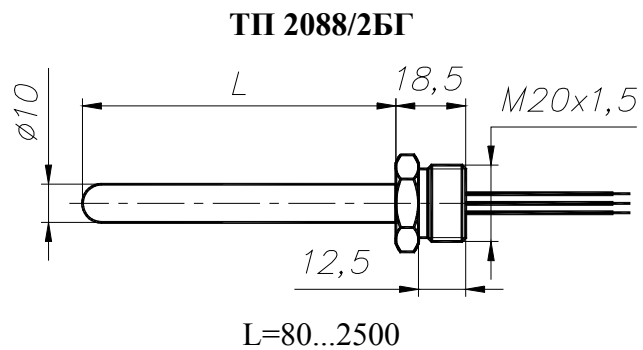
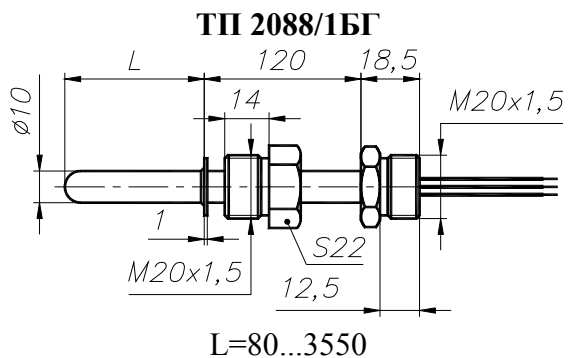
**Continuation of appendix Б**  
 Multi-purpose thermal converters ТПУ 0304.  
 Primary converters of TC type



**Continuation of appendix Б**  
 Multi-purpose thermal converters ТПНУ 0304.  
 Primary converters of TC type

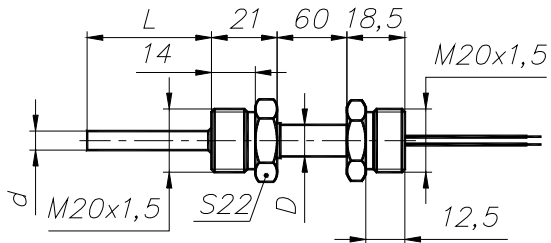


**Continuation of appendix Б**  
 Multi-purpose thermal converters ТПУ 0304.  
 Primary converters of TC type



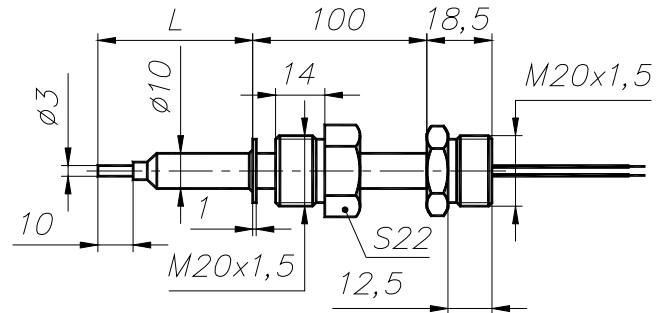
**Continuation of appendix Б**  
 Multi-purpose thermal converters ТПУ 0304.  
 Primary converters of TC type

**ТП 2088/6БГ**



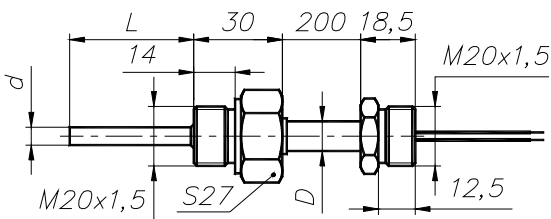
d=4 (4,5); D=10; L=80...320  
 d=6; D=10; L=80...500  
 d=8; D=14; L=80...1000

**ТП 2088/5БГ**



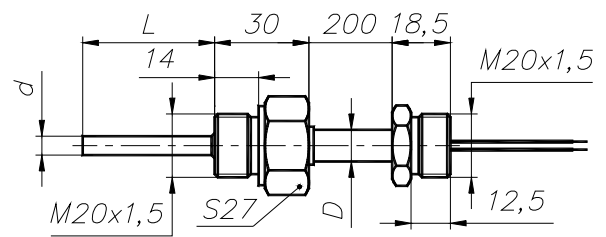
L=80...320

**ТП 0195/1БГ**



L=320...1000  
 d=6; D=10  
 d=8; D=14

**ТП 0195/2БГ**



L=200...1000  
 d=4 (4,5)  
 d=6  
 d=8

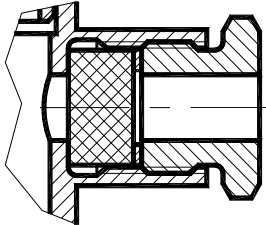
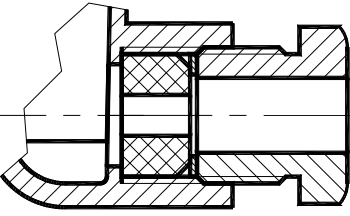
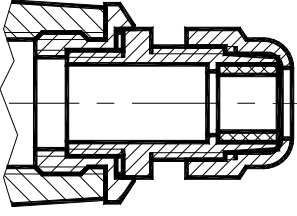
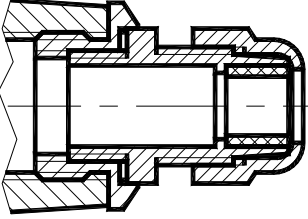
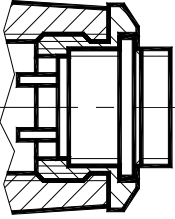
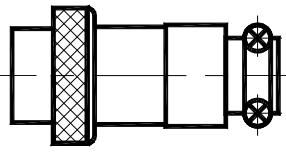
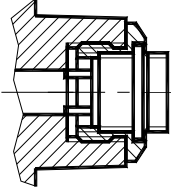
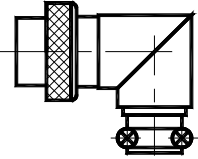
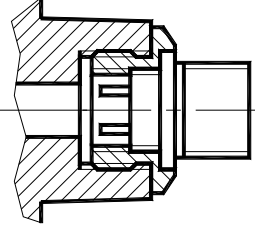
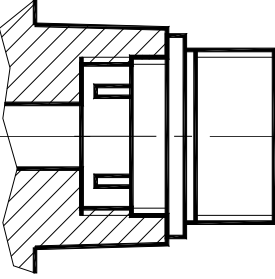
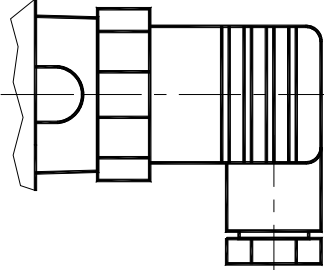




## APPENDIX B

### Multi-purpose thermal converters TIIY 0304. Cable entries

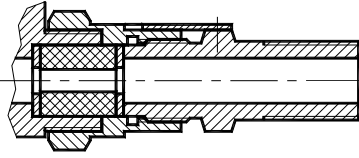
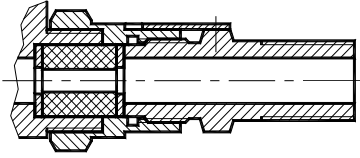
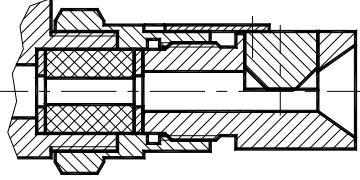
Table B.1

<p>Gasket M16x1,5</p>  <p><b>1</b></p>	<p>Gasket M20x1,5</p>  <p><b>2</b></p>	<p>VG9-K68 (plastic)</p>  <p><b>3</b></p>
<p>VG9-MS68 (metal)</p>  <p><b>4</b></p>	<p>Plug PLT-164-R</p>   <p>Socket PLT-164-P</p> <p><b>5</b></p>	<p>Plug PLT-164-R</p>   <p>Socket PLT-164-LP</p> <p><b>6</b></p>
<p>Plug 2PM14</p>  <p><b>7</b></p>	<p>Plug 2PM22</p>  <p><b>8</b></p>	<p>Plug GSP 311</p>  <p>Socket GDM 3009 Gasket GDM 3-16</p> <p><b>9</b></p>

## APPENDIX B

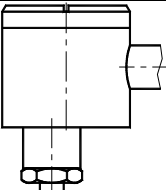
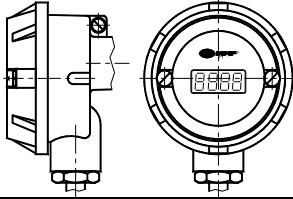
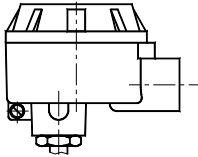
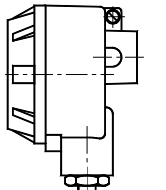
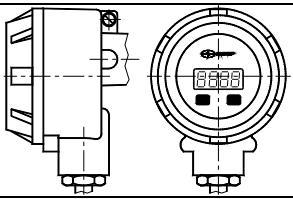
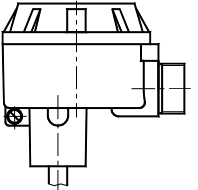
Multi-purpose thermal converters TIIY 0304.  
Cable entries

Continuation of the table B.1

<p>Installation kit Exd tube. 1/2"</p>  <p>10</p>	<p>Installation kit Exd tube. 3/4"</p>  <p>11</p>	<p>Installation kit for armored cable .</p>  <p>12</p>
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## Continuation of appendix B

Table B.2 – Possible embodiments of casings of heads and cable entries

Designation of a head casing	Casings of heads	Number of cable entries by table B.1							
		1	2	3	4	5	6	7	8
		Gasket M16x1,5	Gasket M20x1,5	VG9-MS68 (metal)	VG9-K68 (plastic)	Plug PLT-164-R	Plug GSP 311	Installation kit Exd G1/2 or G3/4	Installation kit for armored cable .
<b>HF-01</b>		+	-	+	-	+	-	-	-
<b>AF-01</b> vertical with indication		-	-	+	+	+	-	-	-
<b>AF-02</b> horizontal.		-	+	+	+	+	+	-	-
<b>AF-02</b> vertical. with out indication		-	-	+	+	+	+	-	-
<b>AF-02</b> vertical with indication		-	-	+	+	+	+	-	-
<b>AF-02Exd</b>		-	-	-	-	-	-	+	+
Sign “+” designates a possibility of an embodiment. Sign “-“ designates that an embodiment is impossible.									







