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 **ЗЕМЕР**
SCIENCE AND PRODUCTION COMPANY

*RELIABLE DEVICES AND SYSTEMS
OF TECHNOLOGICAL MONITORING*

**TECHNOLOGICAL MEASURING CONTROL
(GENERAL PURPOSE MILLIVOLTMETER)
(Modification IPT 5922A for APP)**

Operation manual

НКГЖ.411618.004-09.02РЭ



for APP

Инь. № подл.	Подп. и дата	Взам инв. №	Инь. № дубл	Подп. и дата

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1. INTRODUCTION

1.1 The operation manual contains information on design, principle of operation, specifications of technological measuring –controls (multipurpose millivoltmeters) ИРТ 5922А (hereinafter – ИРТ), provided in the table 1.1, and instructions required for their correct and safe operation.

Table 1.1– Versions of ИРТ

Modification code	Designation	Installation variants	Design features
ИРТ 5922А	НКГЖ.411618.004-09.02	Panel	four-digit indicator of green glow with symbols 14 mm high
ИРТ 5922А/Д	НКГЖ.411618.004-09.03		four-digit indicator of green/red/yellow glow with symbols 14 mm high
ИРТ 5922А/М	НКГЖ.411618.004-09.04		four-digit indicator of green glow with symbols 14 mm high

2. DESCRIPTION AND OPERATION

2.1 Purpose of the device

2.1. ИРТ 5922А is designed for measuring and control of temperature and other non-electric values, transformed into electrical signals of current strength and voltage and active resistance to continuous current.

2.1.2. ИРТ 5922А (with increased reliability) is used as a component of control system of operational processes of atomic power plants (APP), and are oriented to possibility of their use at APP «Busher» in Islamic Republic of Iran, APP «Kudankulam» in India and at the other newly developed APPs.

2.1.3. ИРТ is used in different technological processes of industry.

2.1.4. ИРТ is a microprocessor device, that can be rearranged by a user with a display of a current value of converted values and it is designed for functioning in autonomous mode, as well as in combination with other instruments, combined into a local computer network. Review and changing of parameters of ИРТ configuration is performed with the aid of a keyboard as well as with the aid of software “Tuning of instruments of ИРТ 5900 and ИПИМ 0399 series” when connecting instruments to a computer. Connection of the instrument and a computer is performed with the aid of interface RS 232C or RS 485, the type of interface is indicated when ordering an instrument.

Indication of measured values in ИРТ is performed on the main LED display. On the additional four-digit LED indicator one from three possible settings is displayed. Indication of setting operation is performed with the aid of single LED indicators. ИРТ performs the control function of reliability of input signals.

2.1.5. IPT is designed for operation with unified input electrical signals in the form of constant current 0...5, 0...20 or 4...20 mA, with thermo-converters of resistance (TC) and thermo-electric converters (TII), as well as for measurement of voltage of direct current up to 100 mV and resistance to direct current up to 320 Ohm.

2.1.6. IPT contains an incorporated power supply source of 24 V, designed for power supply of primary converters with unified input signal of direct current.

2.1.7. IPT contains an incorporated measuring converter (ПВИ), converting a measured value into a unified output signal of direct current of 0...5, 0...20 or 4...20 mA.

2.1.8. IPT has got:

- three settings (a possibility of changing these settings is protected from unauthorized access);
- three channels of electrical circuits management.

2.1.9. IPT performs the signalling function and automatic regulation of controlled parameters.

Individual point relays of signalling channels support commutation:

- of alternating current system frequency:
 - at the voltage of 250 V till 5 A on resistive load,
 - at the voltage of 250 V till 2 A on inductive load ($\cos \varphi \geq 0,4$);
- of direct current:
 - at the voltage of 250 V till 0,1 A on resistive and inductive loads,
 - at the voltage of 30 V till 2 A on resistive and inductive loads.
- minimum value of switched current 10 mA at voltage 5 V.

2.1.10. IPT has the following versions:

- Increased reliability for operation at the objects of Nuclear Power Station with a four – digit basic indicator of green glow with an addition of the letter “A” to the index code;
- Increased reliability for operation at the objects of Nuclear Power Station with a four – digit basic indicator of green/red/yellow glow depending on the actuated signalling channel with an addition of the letter “A/Д” to the index code;
- Increased reliability for operation at the objects of Nuclear Power Station with a five – digit basic indicator of green glow with an addition of the letter “«A/M» to the index code.

2.1.11. According to state standards 9736-91 IPT is:

- By the number of converted input signals
 - By the number of output signal
 - By the number of signaling channels
 - By dependence of output signal from the input one
 - By connection between input and output circuits.
- Single channel;
 - Single channel;
 - Three-channel with an independent adjustment of every channel for operation by any setting ;
 - With linear dependence for input signals from thermoconverters, resistance (TC), thermoelectrical converters (TII) or with linear dependence and with the function square-rooting for unified input signal ;
 - Without galvanic coupling.

2.1.12. As to protection from environmental attack in accordance with :

- All-Union State Standard 15150-69 IPT is produced as the corrosion-resistant version T III;
- State Standard 15150-69 IPT, 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/(m² · day),
 - sulphates 50 mg/(m² · day),
 - sulphurous gas 20 mg/(m² · day);
- State Standard, IPT 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 ³	Deposition rate cm/s	Deposition flux, mg/(m ² · 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.

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

2.1.13. According to state standards 25804.1-83 IPT is :

- By the nature of employment relates to the category Б
- By the number of levels of quality of functioning relates to the type I
- Equipment of continuous operation;
- Nominal level and failure.

2.1.14. According to НП-001-97 (ОПБ – 88/97) IPT belongs to :

- by its purpose – to the elements of normal operation;
- by influencing safety - to the elements important for safety;
- by the nature of performed functions – to the controlling elements.

Example of classification designations 2HY or 3HY.

According to ПНАЭ Г-01-011-97 (ОПБ - 88/97) and management directive R01.KK.0.0.AP.TT.WD001 IPT, intended for work at APP «Kudankulam» and APP «Busher» are within classes 2H, 3H and 4.

2.1.15. According to state standards standard 14254-96 the degree of protection against penetrating of any firm bodies, dust particles, water inside of IPT is as follows:

- for the front panel IP54;
- for the casing IP20.

2.1.16. According to stability to mechanical effects during operation IPT belongs to the execution group M6 by all-Union State Standard 17516.1-90.

2.1.17. In accordance with the State Standard 12997-84 as to climatic impact resistance during operation IPT correspond to production group C3 at the temperature of ambient air from minus 10 up to plus 50 °C (for order index t1050).

2.1.17.1. IPT, intended for work at APP «Busher», APP «Kudankulam» with safety class 2H, 3H or 4 ore 4H correspond to climatic type TB4.1 according to State Standard ГОСТ 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.

2.1.18. According to seismic impact stability

- IPT belongs to the Ist category of the seismic stability according to НП-031-01 and to the Б group of execution 3 according to РД 25 818-87;
- IPT of 4H category is designed for operation at the APP «Busher» and belongs to the IIIst category of the seismic stability according to ПНАЭГ -5-006-97 and no demands as to seismic stability are made to it.
- IPT 5922A, intended for work at APP «Kudankulam» with safety class 3H or 4 is within category II of seismic resistance for group «B» according to R01.KK.0.0.AP.PZ.WD001.

2.1.19. IPT is 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.

2.1.20. According to resistance to electromagnetic interference of IPT relative to State Standards 50746-2000 correspond depending to the version to:

- group of version III, criteria of quality of functioning A,
group of version IV, criteria of quality of functioning B;
(index of order III);
- group of version IV, criteria of quality of functioning A
(index of order IV)

2.2. Technical specifications

2.2.1. The ranges of measurement and conversion, input parameters and limits of the tolerable basic reduced error with respect to configuration of IPT correspond to the given in tables 2.1 and 2.2.

Table 2.1 – IPT for configurations with input electrical signals from resistance thermo elements (RT) according to all-Union State Standard 8.625-2006, 6651-94 and thermo-electric converters (TC) according to all-Union State Standard 8.585-2001

Type of primary converter	W_{100}^{***} ($\alpha^{\circ}\text{C}^{-1}$)****	Range of measurements $^{\circ}\text{C}$	Input parameters			Limits of the tolerable basic reduced error γ_0 , %						
			of HCX		input resistance kOhm	ИРТ 5922А/М	ИРТ 5922А, 5922А/Д					
			resistance Ohm	Т.Э.Д.С., мВ								
50М	1,4280***	-50...+200	39,23...92,78	-	-	$\pm(0,15 + *)$	$\pm(0,25 + *)$					
53М (Гр. 23)			41,58...98,34									
50М	(0,00428)****		39,23...92,8									
50М	1,4260***		39,35...92,62									
53М (Гр. 23)			41,71...98,17									
50П			1,3910***					40,00...88,53				
50П	(0,00391)****		40,00...88,52					-	-	$\pm(0,1 + *)$	$\pm(0,2 + *)$	
100М	1,4280***		78,45...185,55									
100М	(0,00428)****		78,46...185,60									
100М	1,4260***		78,69...185,23									
100П	1,3910***	80,00...177,05										
100П	(0,00391)****	80,00...177,04										
Pt100	1,3850***	80,31...175,86										
Pt100	(0,00385)****											
50П	1,3910***	-50...+600	40,00...158,59	-	-	$\pm(0,1 + *)^{**}$	$\pm(0,2 + *)^{**}$					
100П			80,00...317,17									
50П	(0,00391)****		40,00...158,56									
100П			80,00...317,11									
Pt100	1,3850***		80,31...313,71									
Pt100	(0,00385)****											
ТЖК(Ж)	-		-50...+1100					-2,431...63,792	-	not less than 100	$\pm(0,25 + *)$	$\pm(0,5 + *)$
ТХК(Л)			-50...+600					-3,005...49,108				
ТХА(К)		-50...+1300	-1,889...52,410									
ТПП(С)		0...+1700	0...17,947									
ТПР(В)		+300...+1800	0,431...13,591									
ТБР(А-1)		0...+2500	0...33,640									
Notes												
1 * One unit of the last digit, presented in percentage of measurement range.												
2 ** Excluding the subrange -50...+200 $^{\circ}\text{C}$.												
3 *** According to State Standards 6651-94.												
4 **** According to State Standards P 8.625-2006.												

Table 2.2. – IPT for configurations with input electrical signals in the form of power direct current voltage and resistance to direct current

Input signal	Range of measurements		Input parameters			Limits of the tolerable basic reduced error $\gamma_0, \%$	
	For dependence of measured value from input signal		Input resistance, kOhm:		Maximum current through measured resistance, mA	ИРТ 5922А/М ИРТ 5922А, 5922А/Д	
	linear	with function of square rooting	Not more	Not less			
Current	0...5 mA	0,1...5 mA	-	0,01	-	$\pm(0,1 + *)$	$\pm(0,2 + *)$
	4...20 mA	4,32...20 mA					
	0...20 mA	0,4...20 mA					
Voltage	0...75 mV	1,5...75 mV	100	-	-	$\pm(0,1 + *)$	$\pm(0,2 + *)$
	0...100 mV	2...100 mV					
	0...10 V	0,2...10 V					
Resistance	0...320 Ohm	-	-	-	0,33 \pm 0,02		

Notes –* One unit of the last digit, presented in percentage of measurement range.

2.2.2. Parameters of configuration of IPT are provided in tables 2.3 and 2.4.

Table 2.3 – Parameters of configuration of IPT

Name of parameter	Conditional designation of parameter			Factory setting
	Principal indicator	Additional indicator		
		Menu	Submenu	
1	2	3	4	5
Permission of settings programming	0 – prohibited	PrUE	-	1
	1 – permitted			
Hysteresis* of setting 1 (in units of parameter measurement)	0...9999	GS 1	-	0
Hysteresis* of setting 2 (in units of parameter measurement)	0...9999	GS 2	-	0
Hysteresis* of setting 3 (in units of parameter measurement)	0...9999	GS 3	-	0
Type of primary converter	in accordance with the table 2.4	dAt	-	U100
Permission of control of short circuiting of input measuring circuit**	0 – prohibited	CutE	-	1
	1 – permitted			
Square-rooting function	0 – off	Sqrt	-	0
	1 – on			
Lower limit of the range of unified input signal conversion	-1999...9999	dPLo	-	0
Upper limit of the range of unified input signal conversion	-1999...9999	dPHi	-	100
TC conversion circuit	0 – double wire	Lc	-	1
	1 – three wire			
Resistance of the connection line at double wire circuit of TC connection TC	0...9999	rL	-	0,7
Resistance of cold end compensator at 0 °C	0...9999	rc0	-	50
Number of digits after comma	0, 1, 2, 3	UF	-	3
Lower limit of INCORPORATE MEASURING CONVERTER conversion range	-1999...9999	IoLo	-	0
Upper limit of INCORPORATE MEASURING CONVERTER conversion range	-1999...9999	IoHi	-	100
Connection of relay 1(K1) with settings and error of measurements (entrance to submenu)	Sub	rL1	-	-
Relay connection 1 with the 1-st setting	0, 1, 2 ***	-	rL1.1	0
Relay connection 1 with the 2-nd setting	0, 1, 2 ***	-	rL1.2	0
Relay connection 1 with the 3 rd setting	0, 1, 2 ***	-	rL1.3	0
Condition of relay 1 at measurement error	0 – off	-	rL1.C	0
	1 – on			
Connection of relay 2(K2) with settings and error of measurements (entrance to submenu)	Sub	rL2	-	-
Connection of relay 2 with the 1-st setting	0, 1, 2 ***	-	rL2.1	0
Connection of relay 2 with the 2-nd setting	0, 1, 2 ***	-	rL2.2	0
Connection of relay 2 with 3-rd setting	0, 1, 2 ***	-	rL2.3	0
Condition of relay 2 at measurement error	0 – off	-	rL2.C	0
	1 – on			
Connection of relay 3(K3) with settings and error of measurements (entrance to submenu)	Sub	rL3	-	-
Connection of relay 3 with the 1-st setting	0, 1, 2 ***	-	rL3.1	0
Connection of relay 3 with the 2-nd setting	0, 1, 2 ***	-	rL3.2	0
Connection of relay 3 with the 3 rd setting	0, 1, 2 ***	-	rL3.3	0
Condition of relay 3 at measurement error	0 – off	-	rL3.C	0
	1 – on			

Notes

1 * Delay of relay actuation relative to setting.

2 ** Only for input signals U75 and U100 in accordance with the table 2.4.

3 *** 0 – condition of relay does not change; 1 – switched on at $U_{H3M} < U_{yct}$, setting is selected «lower»; 2 – switched on at $U_{H3M} > U_{yct}$, setting is selected «upper»; (U_{H3M} – measured signal; U_{yct} – setting).

1	2	3	4	5
Number of measurements for averaging of input signal	1...100	nSU	-	1
Indication of settings on the additional indicator	0, 1, 2, 3*	Ind	-	0
Network address of the instrument	0...255	Addr	-	1
Pass word (first category)	-1999...9999	PSS1	-	0
Pass word (first copy)	-1999...9999	PSS2	-	0
Speed of data transfer in Kbit/sec between instruments and a computer via interface RS 232 / RS 485	0.3, 0.6, 1.2, 2.4, 4.8, 9.6, 19.2	SPd	-	9.6
Range of unified input signal of INCORPORATE MEASURING CONVERTER	1, 2**	IOdP	-	2
Exit form menu (return to the mode of measurement)	-	rEtU	-	-
Notes				
* 0 – no indication; 1 – indication of the 1-st setting; 2 – indication of the 2-nd setting; 3 – indication of the 3-rd setting.				
** 1 – range 0...20 mA is on (0...5 mA); 2 – 4...20 mA is on.				

Table 2.4 – Type of primary converter IPT

Indication of primary converter type or input signal	Symbolic designation of HCX	W_{100}	Range of measured values
1	2	3	4
Cu85	50M	1,4280	(-50...+200)°C
Cu65	50M	1,4260	
Cu83	53M	1,4280	
Cu63	53M	1,4260	
Cu81	100M	1,4280	
Cu61	100M	1,4260	
PtH5	50Π	1,3910	(-50...+600)°C
PtH1	100Π		
Ptb1	Pt100	1,3850	
HA	TXA(K)	-	(-50...+1300)°C
FC	TЖК(J)	-	(-50...+1100)°C
HE	TXK (L)	-	(-50...+600)°C
PP	TIII(S)	-	(0...+1700)°C
Pr	TIP(B)	-	(+300...+1800)°C
BP	TBP(A)-1	-	(0...+2500)°C
t05	-	-	(0...5)mA
t020	-	-	(0...20)mA
t420	-	-	(4...20)mA
U100	-	-	(0...100)mV,
U75	-	-	(0...75)mV
rr	-	-	(0...320)Ohm

2.2.3. The time of operational mode setting is not more than 30 minutes.

2.2.4. The limit of tolerable additional error of IPT, caused by variation of the ambient air from normal (20±5) °C till any temperature within the limits of operational temperatures for every 10 °C of temperature variation, does not exceed 0,5 of the limit of tolerable basic error.

2.2.5. The limit of tolerable additional error of IPT for configuration with TII, caused by temperature variation of their free ends within the range of operational temperatures does not exceed 1 °C.

2.2.6. The limit of tolerable additional error, caused by variation of power supply voltage from nominal 220 V in the range from 90 to 249 V, does not exceed 0,2 of the limit of tolerable basic error.

2.2.7. The limit of tolerable additional error of IPT, caused by an impact of constant magnetic fields and (or) variable field of circuit frequency of up to 400 A/m voltage, does not exceed 0,2 of the limit of tolerable basic error.

2.2.8. The limit of tolerable additional error of IPT, caused by an impact of voltage of a transverse disturbance of alternating current with an effective value equal to 50 % of the maximum value of electrical input signal of IPT, operating between input measuring clamps in series with a wanted signal and having any phase angle not exceeding 0,2 of the limit of the basic tolerable error.

2.2.9. The limit of tolerable additional error of IPT, caused by an impact of voltage of a longitudinal disturbance of alternating or direct current with an effective value equal to 100 % of the maximum value of electrical input signal of IPT, operating between any measuring clamp and the grounded housing and having any phase angle not exceeding 0,2 of the limit of the basic tolerable error.

2.2.10. The area of settings adjustments corresponds to the range of measurement.

2.2.11. Hysteresis of IPT operation by settings is symmetrical, is programmable irrespective of any setting and is adjusted within the limits of the whole range of measurements.

2.2.12. The limit of the tolerable basic error of signalling actuation does not exceed the limit of tolerable basic error of measured values.

2.2.13. The limit of the tolerable additional error of signalling actuation, caused by ambient air variation from the normal one to any other within the frame of operation temperatures for every 10 °C of temperature variation, does not exceed 0,5 of the limit of tolerable basic error of signalling actuation.

2.2.14. The limit of the tolerable additional error actuation, caused by power supply voltage variation from nominal to any other within the limits of operational conditions of usage not exceeding 0,2 of the limit of tolerable basic error of signalling actuation.

2.2.15. Maximal resistance of every wire connection of IPT to TC - 15 Ohm.

2.2.16. The limit of the tolerable basic error of incorporated measuring converter is equal to $\pm(k \gamma_0 + 0,2) \%$,

where γ_0 – limit of the basic reduced error from tables 2.1, 2.2;

k – coefficient, equal to ratio of the range of measurement to the conversion range of incorporated measuring converter.

2.2.17. Resistance of the load for incorporated measuring converter is not more than:

- 2 kOhm - for the output signal of 0...5 mA;
- 0,5 kOhm - for the output signal of 0...20, 4...20 mA.

2.2.18. The limit of the tolerable additional error caused by variation of temperature of ambient air from normal to any other one within the limits of operating temperatures for every 10° C of temperature variation does not exceed 0,5 of the limit of tolerable basic error for incorporated measuring converter

2.2.19. The limit of the tolerable additional error for incorporated measuring converter caused by variation of load resistance from 0 to the maximal value, provided in the p. 2.2.17, does not exceed 0,2 of the limit of tolerable basic error for incorporated measuring converter

2.2.20. The time of setting of the output signal for incorporated measuring converter (time, during which the output signal of incorporated measuring converter enters the zone of the limit of tolerable basic error) is not more than 2 sec. during the jump of input signal from 0 to 100% when the parameter «nSU» (number of measurements for averaging of input signal) equal to «1».

2.2.21. Output characteristics of the inbuilt voltage stabilizer:

- rated voltage..... (24±0,48) V;
- maximal load current 30 mA.

2.2.22. Power supply of ИРТ comes from the mains of alternating current with frequency from 40 to 100Hz within the range from 90 to 249 V, at nominal values of frequency of 50 Hz and voltage of 220V.

2.2.22.1. In case of power supply for ИРТ 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 ±10 %;
- total deviation of voltage and frequency not more than ±10 %;
- maximum acceptable content of harmonics in CH system
 - Systems lower and including 1 kV: 8 %,
 - Systems higher than 1 kV: 5 %.

2.2.23. Power consumed by ИРТ from the alternating current source at rated voltage of mains- does not exceed 8 VA.

2.2.24. Insulation of electrical circuits of power supply and electrical circuits of signaling between themselves and relative to all other circuits of input-output and protective grounding

clamp depending on the testing conditions carries during 1 minute an affect of testing voltage of practically sinusoidal form of frequency from 45 to 65 Hz;

- 1500 V at temperature of ambient air (20 ± 5) °C and relative humidity from 30 to 80 %;
- 900 V at relative humidity (90 ± 3) % and at temperature of ambient air (25 ± 3) °C.

2.2.25. Insulation of input and interface electrical circuits between themselves and relative to protective grounding clamp depending on testing conditions carries during 1 minute an affect of testing voltage of practically sinusoidal form of frequency from 45 to 65 Hz;

- 500 V at temperature of ambient air (20 ± 5) °C and relative humidity from 30 to 80 %;
- 300 V at relative humidity (90 ± 3) % and at temperature of ambient air (25 ± 3) °C.

2.2.26. Electric resistance of insulation of current-conducting circuits of IPT as to its housing and between themselves is not less:

- 20 mOhm at the ambient air temperature of (20 ± 5) °C, and at the relative humidity from 30 up to 80 %;
- 5 mOhm at the ambient air temperature of (50 ± 3) °C and at the relative humidity from 30 up to 80 %;
- 1 mOhm at the relative humidity of (90 ± 3) % and at the ambient air temperature (25 ± 3) °C.

2.2.27. Overall dimension, mm, no more:

- front panel 96 x 48;
- assembly depth 180;
- slot in the panel 88 x 46;

2.2.28. Mass, kg, is not more than 0,6.

2.2.29. IPT are durable and resistant to ambient air temperature from minus 10 up to +50 °C.

2.2.29.1. IPT intended for work at APP «Busher» and «Kudankulam» are serviceable at ambient air temperature from + 5 to + 50 °C.

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

2.2.30. IPT are durable and resistant to effect of humidity up to 95 and 98 % at the temperature of 35 °C

2.2.30.1. IPT 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.

2.2.31. IPT are durable and resistant to impact of sinusoidal vibration within the range of frequencies from 1 to 100 Hz at the amplitude of vibro - acceleration of 20 m/s².

2.2.31.1. IPT 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.

2.2.32. IPT has no constructive details and units with resonance frequencies from 5 to 25 Hz.

2.2.33. IPT are durable and resistant to impact of single mechanical shocks with a peak shock acceleration of 20 m/s^2 with duration of shock pulse from 2 to 20ms and the total number of shocks equal to 30.

2.2.34 IPT are durable and resistant to impact of multiple mechanical shocks with a peak shock acceleration of 30 m/s^2 and with a preferable operation duration of shock acceleration of 10 ms (permitted duration - from 2 to 20 ms) and the number of shocks in every direction equal to 20.

2.2.35. IPT in transport tare are resistant to effect of vibration shocks with a number of shocks equal to 80 per minute, with quadric value of acceleration shock 98 m/s^2 and exposure duration of 1 hour.

2.2.36. IPT are durable in case of seismic impact, equivalent to impact of vibration with parameters, provided in the table 2.5.

Table 2.5 – Parameters of seismic impact

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, m/s^2	2,4	6,0	11,6	20,4	19,2	17,2	15,2	12,4	8,0	7,6	5,6

2.2.36.1. Requirements on resistance to seismic effects to IPT 5922A 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), IPT 5922A 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 5.1.

Table 5.1

Relative damp- ing, %	Acceleration, 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

2.2.37. Provision of electromagnetic compatibility and noise protection.

2.2.37.1. According to resistance to electromagnetic interference of ИРТ relative to State Standards 50746-2000 correspond depending to the version to:

- version group III, quality criteria A,
version group IV, quality criteria of functioning B,
(order index III);
- version group IV, quality criteria of functioning A,
(order index IV).

2.2.37.2. ИРТ functions effectively and do not generate any interferences in conditions of joint operation with equipment of the systems and components, for which it is designed, as well as with equipment of other designation, which may be used together with present ИРТ in a typical interference situation.

2.2.38. ИРТ intended for work at APP «Kudankulam» are resistant to musty fungus effect.

2.3. Design and operation

2.3.1. ИРТ comprises:

- module of pulse power supply unit (with galvanic uncoupling from the mains) and commutation with three relays of signalling channels;
- indication and control unit with an operation keyboard ;
- unit of analog-digital converter module (ADC)
- incorporated measuring converter module with galvanic uncoupling;
- interface module RS 232 or 485 with galvanic uncoupling;
- block of relays;
- microprocessor control unit.

2.3.1.1 Module of pulse power supply unit converts mains voltage of 220 V with frequency of 50 Hz into constants stabilized voltage for power supply of modules of indication and the keyboard, ADC, incorporated measuring converter, interfaces RS 232/485, relay block, microprocessor control unit. Switch off key is not envisaged, because ИРТ is designed for operation in continuous mode.

2.3.1.2 Module of indication and keyboard is designed for:

- visualization of results of measurement and parameters of ИРТ configuration;
- displaying of digital and symbols information on current condition of the instrument;
- control of instrument operation with the aid of keys, located on the front panel.

2.3.1.3 ADC module is designed for conversion of an input analogous signal from different types of primary converters into a digital code and transfer of it into the microprocessor control unit. On the plate of ADC module there is an incorporated voltage stabilizer of 24 V (with galvanic uncoupling), which provides power supply of measuring converters.

2.3.1.4 Module incorporated measuring converter is designed for conversion of digital code, received from the microcontroller through via photon-coupled decoupling into output current of direct current, the values of which may be set in three ranges:

- from 0 to 5,4 mA for the range - 0...5 mA, at $R_{H\text{ макс}} = 2\text{ кOhm}$;
- from 0 до 21,5 mA for the range - 0...20 mA, at $R_{H\text{ макс}} = 0,5\text{ кOhm}$;
- from 3,5 до 21,5 mA for the range - 4...20 mA, at $R_{H\text{ макс}} = 0,5\text{ кOhm}$;

Switch over of ranges 0...5 and 0...20 mA is performed with the help of the switch, which may be accessed from the rear panel of ИРТ. At that, the parameter «IOdP» of the menu ИРТ should be equal to «1».

The range 4...20 mA is set by positioning the switch at «20 mA» and the value of the parameter «IOdP» is equal to «2».

Attention! It is not permissible to set the switch into the position «5 mA» when the parameter «IOdP» is set to be equal to «2».

2.3.1.5 Interface module RS 232 or RS 485 is designed for communication with the computer and ensures two-way exchange of data with external devices and via standard interfaces RS 232 or RS 485. Diagrams of connection of ИРТ to the computer are provided in the appendix Б.

2.3.1.6 Relay block contains three actuation relays («K1», «K2», «K3») and it is designed for controlling of external actuating devices connected to the instrument.

2.3.1.7 Microprocessor control unit contains a microcontroller, PROM with software, volatile memory and performs the following functions:

- conversion of a digital code into a corresponding value of magnitude (scaling, abiration, square rooting, linearization);

- analysis of the result of the current measurement in the mode of real time;
- management of processes of interaction between modules of ИРТ;
- management of relay condition by results of measurement;
- output of the current value of measured magnitude or values of settings to the indicators;
- keyboard interrogation;
- management of the module of interfaces RS 232 or 485.

2.3.2. On the front panel of ИРТ there are:

- principal CD-seven-segment indicator with 14 mm high symbols:
 - four-digit green glow for ИРТ 5922А;
 - four-digit green /red/yellow for ИРТ 5922А/Д;
 - five-digit green glow for ИРТ 5922А/М;
- additional four-digit seven-segment CD-indicator of red glow, with 8 mm high symbols;
- indicator «K1» – single CD- indicator of condition of the 1st relay;
- indicator «K2» – single CD- indicator of condition of the 2nd relay;
- indicator «K3» – single CD- indicator of condition of the 3rd relay;
- key  - input key;
- key  - forward key;
- key  - backward key.

2.3.2.1 In the measurement mode on the principal indicator the current value of the measured parameter is displayed, on the additional indicator one from the three possible settings are displayed. Numerical values are displayed on the indicator with a mobile decimal point, capacity is switched over automatically. On the principal indicator information on the fault is displayed, exceeding by input signal of the limits of the measurement range, lack of access for changing parameters of the instrument, error reporting. Brightness of indicators shining may be varied with the help of the program «Adjustment of instrument of the series ИРТ 5900 and ИИМ 0399» separately for every indicator.

2.3.2.2 In the programming mode on the principal indicator the following is displayed: values of set parameters, mnemonic designation of which is displayed on the additional indicator.

2.3.2.3 In ИРТ 5922А/Д glowing colour of the main CD-indicator is connected with the relay condition, if neither of relays is actuated the glow of the indicator is green, during operation of the 1st and 3rd relay (indicators «K1» or «K3» are glowing) the colour of glow is red, when the 2nd relay operates (indicator «K2» glows) the colour of glowing is yellow.

2.3.2.4 Indicators «K1», «K2», «K3» reflect the condition of relay of commuted □rogrammi channels. Glowing indicators inform on active relay condition.

2.3.2.5 The key «» is designed for entrance to the mode setting of magnitude values and menu parameters, as well as inputs (recording) renewing of values in memory of IPT. In the mode of changing of the selected parameter the current value of present parameter is blinking after entering (recording) blinking is stopped.

2.3.2.6 The key «» is designed for revue (selection) of settings (towards increment) in the mode of measurement and □rogramming, for entering (exit) the mode of configuring of an instrument together with a key «», for selection of a parameter into the menu (in direction forward) and changing the values of parameters when □rogramming the instrument.

2.3.2.7 The key «» is designed for revue (selection) of settings (towards decrease) in the mode of measurement and □rogramming for entering (exiting) the mode of configuring an instrument together with a key «», for selection of menu parameter (in direction backwards) and changing parameter values when □rogramming an instrument.

2.3.3. On the rear panel of IPT the following is located:

- terminal blocks for connection of mains power supply , commutation circuits, primary converters of current loads and interface cable;
- switch of the range of input signal of incorporated measuring converter;
- protective grounding clamps.

2.4. Configuring of IPT

ATTENTION! It is not permissible when configuring an instrument with the aid of a keyboard to operate simultaneously the instrument using computer interface be means of the adjustment program.

2.4.1 Revision and changing parameters values determining operation of the instrument is performed in the menu mode. Changed value of a parameter is retained in nonvolatile memory of an instrument and it is activated immediately after ending of editing. After entering the menu mode the process of measuring , regulation and controlling of incorporated measuring converter does not stop.

Parameters of configuration of IPT with possible values in the order of their display on indicators are presented in the table 2.3.

2.4.1.1. The list of configuration parameters has got a double level structure. Upper level – menu, and lower level - submenu. Submenu has got the following parameters: «rL1», «rL2», «rL3», determining the logics of relay operation.

2.4.2 In order to enter the configuration mode press simultaneously the keys «» and «». On the additional indicator will appear one from two names of the current parameter, that is: «PrUE» - permission of settings programming or «PASS» - input of the password.

2.4.3 When a request for the pass input appears - «PASS», on the main indicator there will be a blinking zero. Using the key «» or «» set the password and press the key «». On the small display the parameter «PrUE» will appear.

Notes – In case of an incorrect password input all attempts to change configuration of IPT will be blocked and an error message – «Acde» will be displayed (access denied).

2.4.4 When the value of the parameter «PrUE»(permission of settings programming) is equal to «0», it should be set in «1». For this purpose press the key «», the value of the parameter will start blinking. Using the keys «» or «» select «1» and press the key «».

2.4.5 When configuring IPT using keys «» or «» select the required parameter from the menu on the additional indicator. On the principal indicator the value of the selected parameter will appear.

2.4.6 Press the key «».

2.4.6.1 The value of the parameter will start blinking (besides the value «Sub»).

Using the keys «» or «» set the required value of a parameter and press the key «».

2.4.6.2 Parameter «Sub» denotes entrance to submenu of parameters «rL1», «rL2» and «rL3».

Using the keys «» or «» select the required parameter of submenu (besides «rEtU»), press the key «». The value of the parameter will start blinking.

Using the keys «» or «» set the required value of the parameter and press the key «».

2.4.6.3 To exit from submenu select the parameter «rEtU» and press the key «». On the additional indicator there appears the value «Sub». After that it is possible to continue programming parameters of menu (item 2.4.5).

2.4.7 Exit from menu of configuration of IPT is performed by two methods – either by simultaneous pressing the keys «» and «», or by input of the command «rEtU» (on the additional indicator) be pressing the key «».

Notes – Factory (initial) setting of parameters of IPT corresponds to the table 2.3.

2.5. Setting of incorporated measuring converter parameters

2.5.1 Setting of parameters of output unified signal incorporated measuring converter is performed in accordance with the table 2.6 and item 2.3.1.4.

2.5.2 The range of the output unified signal should be less or equal to the range of measurement of the instrument, and the error of current output is determined in accordance with the item 2.2.16.

2.5.3 In order to set the reverse characteristic of current output the parameter «IoLo» should be more than parameter «IoHi».

Table 2.6 – Parameters of incorporated measuring converter configuration

Range of incorporated measuring converter	Menu parameter «IOdP»	Position of range switch
0...5 mA	1	5 mA
0...20 mA	1	20 mA
4...20 mA	2	20 mA

2.6. Assigning of setting values

2.6.1 Press the key . On the additional indicator the designation of the first setting will be displayed - «US_1», and on the main indicator its numerical value will be displayed. Press the key , the value of the setting will start blinking. Using keys  and  set the required value of the setting and press the key .

2.6.2 Using the key  select the second setting – «US_2». Set the required value in accordance with item 2.6.1.

2.6.3 Using the key  select the third setting – «US_3». Set the required value in accordance with item 2.6.1.

2.6.4 Press the key , IPT will enter measuring mode.

2.6.5 Transfer of the setting «US_3» to settings «US_2» and «US_1» may be performed by pressing the key . Next pressing of the key  will also return IPT to the mode of measuring.

Notes: 1 Factory (initial) value of setting – zero.
2 For programming of setting «PrUE» - permission to program settings, should be set to«1».

2.7. Internal calibration

2.7.1 Internal calibration of IPT may be performed in autonomous mode may be as follows:

- calibration of resistance of communication line in case of double-wire circuit of TC connection;
- calibration of the compensator of cold end when using TII (besides TII of the type ПП(В) with the range of measurement 300...1800 °C).

2.7.1.1 Calibration resistance of communication line in case of double-wire circuit of TC:

- connect TC to clamps K1(10), K3(12). Between clamps K2(11) and K4(13) install the bridge (see picture A.1 of appendix A);
- switch on IPT. Enter the mode of configuration and set the corresponding type of primary thermo-converter (item 2.4);
- set the bridge on clamps of TC;
- select parameter «Lc» and determine its value equal to «0» - double-wire circuit of TC connection;
- select parameter «rL» and press the key . On the main indicator there will be lighted «CLbr» - calibration. After completion of calibration (on the main indicator there will be displayed the value of resistance of double-wire communication line of TC with IPT) exit configuration mode.

Notes – If the parameter «Lc» in the configuration menu are absent, it is necessary to check the type of preset primary converter.

2.7.1.2 Calibration of the compensator of the cold end using TII:

- connect TII to clamps K1(10), K2(11) and locate it into ice-water mixture;
- connect compensator to clamps K3(12), K4(13);
- switch on IPT. Enter configuration mode and set the corresponding type of primary converter;
- select parameter «rc0» and press the key . On the main indicator «CLbr» - gradation will be displayed;
- after a few seconds on the principal indicator there will be displayed a preliminary (thermal equilibrium is not yet achieved) не наступило) value of compensator resistance R_c, which will be automatically considered during measurements;
- exit from the configuration mode into measurement mode and wait for thermal equilibrium – temperature gradient should not exceed 0,3 °C/min;

- enter configuration mode again, select parameter «rc0» and press the key »;
- after graduation ending (on the main indicator there will appear the value Rc in condition of thermal equilibrium) exit configuration mode.

Notes – Graduation mode is required for precise measurement with specific TII, as a compensator of a cold end in complete set with supplied IPT is supplied TC 50M, for which «rc0» is equal to 50 Ohm.

2.8. Error reporting

2.8.1 In case of malfunctioning and faults of IPT on the additional indicator appears a message about an error – «Err», and on the additional indicator – the name of the error. Error reporting and method of their elimination are provided in the table 2.7.

Table 2.7 – Error reporting

№ order	Mnemonic designation	Probable cause	Elimination methods
1	«AcdE»	Password is incorrect	Enter the correct password from the keyboard or using the program «Tuning of the instruments of series IPT 5900 and ИИМ 0399»
2	«Cut»	Open-circuit fault of input measuring circuit or an error of connection	Check the correctness of connection of primary converter TC or TII
3	«nrдY»	Data of ADC are not ready	Message appears when an instrument is switched on, duration of reporting is proportional to the selected number of measurements for averaging of an input signal, after that a message disappears.
4	«brdr»	Overflow of the magnitude of measured value beyond the borders of measurement range	Message appears when a measured signal from TC and TII overruns the borders of measurement range, provided in the table 2.1, when overflowing of the measured signal in the form of resistance of value of 320 Ohm, when the measured signal in the form of direct current overruns the measurement borders: (-0,2...6) mA - for signal 0..5 mA; (-0,2...22) mA - for signal 0...20 mA; (2,5...22) mA – for signal 4...20 mA. Message disappears in 10 seconds after returning of the signal back to measurement range.
6	«AdC»	ADC out of order	Elimination of the error is possible only by the manufacturer.
7	«EEPr»	Error in volatile memory of IPT	Switch on once again IPT, if the error does not disappear, data may be rehabilitated with the help of software «Tuning of instrument of the series IPT 5900 and ИИМ 0399» in case of availability of a reserve copy of data of volatile memory. Further elimination of the error may be performed only by manufacturer.

2.9. Special features of operations with IPT

2.9.1 Setting (changing) of numerical values of parameters is performed with the help of the keys «» and «» in two modes: stepwise and scanning .

Stepwise mode – single pressing and release of a key, as a result of that the value of a parameter is changed for one unit of lower order.

Scanning mode – changing of a value of a parameter by pressing and holding the key in the pressed condition. When holding the key pressed changing of the value is performed bitwise, starting from the lower order and finishing by the high order. At the same time the value of every order varies for ten units, starting from the current value. After changing of the value of the current order for ten units, the next higher order is being scanned.

Scanning is stopped:

- when the keys are released;
- when reaching the upper (9999) or lower (-1999) limiting value of the numerical range;
- when passing the decimal point.

Notes – For acceleration of setting of the required value of a parameter it is recommended to decrease the number of digits after comma, by changing the value of the parameter «UF».

After scanning is stopped a new value of the parameter is blinking. Press the key «» to record a renewed value into IPT memory.

2.9.2 Number of measurements for averaging of input signal «nSU» - it is a parameter, making it possible to reduce noises of a measured signal. When setting this parameter it is necessary to take into consideration that, the time of setting of measured value is equal to $nSU \times 1 \text{ s}$. Besides, when power supply of IPT is switched on or after elimination of short-circuit of input circuits, the process of measurement and control of relay will start after $nSU \times 1 \text{ s}$. In IPT 5922A/M in order to decrease noise it is recommended to set the parameter «nSU» equal to 3.

2.9.3. IPT retains all current parameters of configuration and their values in case of failure of power supply voltage. For example, if power supply is out at the time of parameter programming, the renewed values will be retained without exiting programming mode. In case of voltage interruption during programming, after reappearance of power supply voltage it is necessary to exit programming mode correctly with the help of the keyboard using menu «rEtU», or by simultaneously pressing the keys «» and «».

2.9.4. When setting a password the value of the password preset in menu «PSS2» should coincide with the preset in menu «PSS1».

2.10. Marking and sealing

2.10.1. Marking is fulfilled in accordance with the all-Union State Standards 26828-86 E, all-Union State Standards 9181-74 E, and НКГЖ.411618.004-09 СБ layout.

2.10.2. IPT is sealed by a production control department representative of the manufacturer.

2.11. Packaging

2.11.1. Packaging is fulfilled in accordance with the all-Union State Standards 23170-78 E, all-Union State Standards 9181-74 E and it secures absolute safety of IPT 5922A.

2.11.2. Packing of IPT 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.

2.12.3. General requirements to packaging of IPT intended for work at APP «Busher» and «Kudankulam» should correspond to the State Standard 23170 of category KY-2 or KY-3. Inner package should correspond to requirements of the State Standard 9.014 for group III, protection variant B3-10, package variant BY-5. Period of protection without preservation is 3 years.

3. USING THE DEVICE ACCORDING TO ITS PURPOSE

3.1. Preparation of the device for use

3.1.1. Safety regulations

3.1.1.1 ИРТ 5922А, ИРТ 5922А/Д, ИРТ 5922А/М in accordance with НП-001-97 (ОПБ-88/97) belong to safety classes 2, 3:

- by purpose – to instruments of normal operation;
- by influence on safety– to elements important for safety;
- by the nature of functions performed – to controlling elements.

An example of classification designation 2НУ, 3НУ or 3Н, 4.

3.1.1.2 Considering the way of the electrical shock protection for people ИРТ corresponds to class I according to State Standards 12.2.007.0-75 and meet the safety requirements of State Standards П 51330-99.

3.1.1.2.1. Design of ИРТ 5922А intended for work at APP «Busher» and «Kudankulam» provides safety during maintenance and use, and satisfies requirements of class 01 according to the State Standard ГОСТ 12.2.007.0-75.

3.1.1.3 ИРТ has protective grounding according to State Standards 12.2.007.0-75.

3.1.1.4 Primary converters, input discreet circuits, interface circuits, signalling circuits and power supply circuits should be connected according to marking, supply voltage switched off.

3.1.1.5. ИРТ is a fire-safe device, a possibility of fire in ИРТ is equal to 10^{-6} during a year period of time according to State Standards 12.1.004-85, that is in case of any malfunctions in ИРТ itself as well as in outside electrical circuits, connected to it, the device is not the cause of fire.

3.1.1.6. During use of ИРТ it is necessary that the requirements should be observed of State Standards 12.3.019-80, “Rules of technical operation of consumer electric installations”, “Safety standards during use of consumer electric installations”, “Rules of electric installations setup”, approved by State energy inspection.

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 surface defects, which may influence working capacity of ИРТ, or inadequacy of completeness, or of marking are found, the possibility of further use of ИРТ is to be determined.

3.1.2.2. Every ИРТ device should be supplied with a certificate with an inspection mark and seals intactness should be checked.

3.1.3. Device assembly

3.1.3.1. For installation of ИРТ, there should be access to it from the rear side of the panel.

Dimensions of the recess in the panel should agree with p.2.2.27.

Installation order:

- put ИРТ into the recess in the panel;
- insert brackets into the inlets on the lateral sides of the case;
- attract the front side of ИРТ to the panel by screws.

Connecting ИРТ to power supply, primary converters, switched channels and computer is effected through the terminal blocks, located on the rear panel, in accordance with Appendix A. Connection should be performed using a single-wire or stranded cable with a soldered tip. Cable laying and termination should be in accordance with the requirements of the current “Rules of electric installations setup”

3.1.4. Testing

3.1.4.1. For naught checks of ИРТ with input signals from TC and ТП connect ИКСУ-2000 (ИКСУ-260) or place the thermoelectric converter into an ice-water mixture.

Set the zero value of temperature for corresponding type TC or ТП

3.1.4.2. For ИРТ configuration with input electric signals in the form of current strength and direct current voltage connect calibrated current and voltage supplies ИКСУ-2000 (ИКСУ-260). to inputs.

Set the input signals values, corresponding to the minimal of the conversion range of input unified signal.

3.2. Using the device

3.2.1. Set ИРТ 5920 on the control panel and safely fix it.

3.2.2. Make necessary connections of ИРТ 5920 in accordance with Appendix A.

3.2.3. Make assignment of configuration of ИРТ 5920 and settings according to items 2.4. and 2.6.

3.2.4. To carry out at necessity, internal graduation of ИРТ 5920, according to items 2.7.

Notes – Procedures according to paragraphs 3.2.3 and 3.2.4 may be performed with the help of a computer «Tuning of instruments of series ИРТ 5900 and ИПМ 0399».

4. VERIFICATION TECHNIQUE

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

4.2. The recalibration interval makes two years.

4.3. The present method may be used for calibration of IPT.

4.4. Operations and methods of verification.

4.4.1. When performing verification the following operations are carried out that are presented in the table 4.1.

Table 4.1

№ o/n	Verification operation	Number of item	Obligation of an operation	
			primary veri- fication	periodic veri- fication
1	External examination	4.7.1	Yes	Yes
2	Test-run	4.7.2	Yes	Yes
3	Testing of electrical durability of insulation	4.7.3	Yes	No
4	Testing of electrical resistance of insulation	4.7.4	Yes	No
5	Determination of values of basic errors of IPT, intended for operation with a variable configuration	4.7.5	Yes	Yes
6	Determination of the values of basic errors of IPT configured for a specific type of primary converter	4.7.6	Yes	Yes
7	Determination of output characteristics of the integrated voltage source	4.7.7	Yes	Yes
8	Verification results handling	4.7.8	Yes	Yes
9	Verification results registration	4.8	Yes	Yes

4.4.2. During verification basic and auxiliary means are employed, provided in the table 4.2.

Table 4.2

№ o/n	Name of the verification means and designation of ИТД	Basic metrological and technical characteristics of verification means
1	Measuring calibrator of unified signals reference ИКСУ-2000 ТУ 4381-031-13282997-00	Range of resistance representation: 0...180 Ohm, basic error: $\pm 0,015$ Ohm Range of resistance representation 180...320 Ohm, basic error $\pm 0,025$ Ohm
		Range of temperature representation (TC): minus 200...200 °C. Basic error $\pm 0,03$ °C Range of temperature representation (TC): plus 200...600 °C. Basic error $\pm 0,05$ °C Range of temperature representation (TII): plus 210...1300 °C. Basic error $\pm 0,3$ °C Range of temperature representation (TII): plus 1200...2500 °C. Basic error $\pm 2,5$ °C
		Range of representation and measurement of voltage: minus 10...100 mV Basic error of representation $\pm(7 \cdot 10^{-5} \cdot U + 3)$ mkV. Range of voltage representation: 0...12 V Basic error of representation: ± 3 mV. Range of voltage measurement: 0..120 V. Basic error: ± 20 mV.
		Range of representation and measurement of current: 0...25 mA; Basic error: $\pm(10^{-4} \cdot I + 1)$ mkA
2	Resistor MJIT	MJIT-1-820 Ohm ± 5 %
3	Resistor MJIT	MJIT-0,125-470 Ohm ± 5 %
4	Resistor MJIT	MJIT-0,125-1,8 k Ohm ± 5 %
5	Plant for testing electrical safety GPI-745A	Voltage 1500 V
		Range of output voltages from 100 to 5000 V
6	Plant for testing electrical safety GPI-745A	Range of resistance measurement: 0...20000 MOhm
Notes: 1 Manufacturing company of verification means according to item 1 is SPC «ELEMER». 2. All enumerated in the table 4.2 measurement means should have actual verification certificate. 3. It is possible to use newly developed or already used verification means and equipment by its characteristics not inferior to those indicated in the present methods of verification.		

4.5. Safety requirements

4.5.1. During verification the following requirements of safety means should be followed that are provided in documentation for employed verification means and equipment.

4.6. Conditions of verification and preparation for it

4.6.1. During verification the following conditions are observed:

1) temperature of ambient air, °C	20 ± 5 ;
2) relative air humidity, %	30...80;
3) atmospheric pressure, kPa (mm merc. column)	84,0...106,7 (630 ÷ 800);
4) supply voltage, V	$220 \pm 4,4$;
5) mains supply frequency, Hz	$50 \pm 1,0$.

External electrical and magnetic fields should not exist or be far enough not to influence operation of IPT.

Verified IPT 5920 and employed verification means should be protected from shocks, vibration affecting its operation.

4.6.2. Operations, performed with verification means and verified IPT, should correspond to instructions provided in operation documentation.

4.6.3. Prior to verification the following preparation operations are performed:

4.6.3.1. IPT is kept in conditions provided in items 4.6.1.1), 4.6.1.3) during 4 hours.

4.6.3.2. Verification means are prepared for operation in accordance with operational documentation.

4.7. Verification procedure

4.7.1. External examination of verified IPT is done according to the item 3.1.2 of the present operation manual.

4.7.2. Testing of verified IPT consists of testing of its operation ability in accordance with the item 3.1.4 of the present operation manual.

4.7.3. Testing of electrical durability of insulation

Testing of electrical durability of insulation is carried out using the installation GPI-745A.

Testing voltage should be performed gradually; beginning from zero till the testing one during 5-10 sec. decreasing of voltage till zero should be carried out with the same speed.

Values of testing voltage for different circuits of IPT are provided in the table 4.3.

Table 4.3

Testing voltage, V	Tested circuits	Numbers of contacts in accordance with the pictures A.1 appendix A, united in groups	
		first	second
1500	Power supply circuit of alternate current, of an electrical circuit of signaling <u>relative to</u> : interface circuits output current circuits output circuits of an integrated power supply source output circuits clamp of protective grounding	17, 18 19 - 27	1, 2, 3, 4, 5 6, 7 8, 9 10 - 15 16
	Circuit of power supply of alternate current relative to: electrical signaling circuits	17, 18	19 - 27
500	Clamp of protective grounding relative to: interface circuits output current circuits output circuit of incorporated power supply source of input circuit	16	1, 2, 3, 4, 5 6, 7 8, 9 10 - 15
	Interface circuits relative to: interface circuits output circuit of incorporated power supply source of input circuit	1, 2, 3, 4, 5	6, 7 8, 9 10 - 15
	Output current circuits relative to: output circuit of incorporated power supply source of input circuit	6, 7	8, 9 10 - 15
	Output current circuits relative to: output circuit of incorporated power supply source	10 - 15	8, 9

Insulation is kept under influence of testing voltage within 1 min. After that voltage is gradually reduced till zero, after that the testing installation is switched off.

During verification there should be no disruptions in the surface of flashover insulation. .

4.7.4. Testing of insulation electrical resistance

4.7.4.1. Testing of insulation electrical resistance of ИРТ circuits is carried out using megohmmeter Ф4102/1-1М or any other instrument for measuring of electrical resistance with operational voltage of direct current of not less than 500 V.

Readings counting out is carried out 1 minute after voltage application between contacts joined together of the first circuit under testing and connected together contacts of the second circuit under testing in accordance with the table 4.4.

Insulation resistance should be not more than 20 mOhm.

Table 4.4

Testing of voltage, V	Verified circuits	Numbers of contacts corresponding to pictures A.1 of Appendix A, united in groups	
		first	second
500	Power supply circuit of alternate current, electrical circuits of signaling relative to: interface circuits output current circuits output circuits of incorporated power sources input circuits clamps of protective grounding	17, 18 19 - 27	1, 2, 3, 4, 5 6, 7 8, 9 10 - 15 16
	Power supply circuit of alternate circuit relative to: electrical signaling circuits	17, 18	19 - 27
500	Clamp of protective grounding relative to: interface circuits output current circuits output circuit of incorporated power supply source of input circuits	16	1, 2, 3, 4, 5 6, 7 8, 9 10 - 15
	Interface circuits relative to: input circuits and output circuit of incorporated power supply source input circuits	1, 2, 3, 4, 5	6, 7 8, 9 10 - 15
	Output current circuits relative to: output circuit of incorporated power supply source of input circuits	6, 7	8, 9 10 - 15
	Output circuits relative to: output circuit of incorporated power supply source	10 - 15	8, 9

4.7.5. Determination of values of basic errors of IPT by measured value, designed for operation with variable configuration.

4.7.5.1 Determination of error values of measuring channel of IPT may be carried out either autonomously (using a keyboard of IPT for its configuration and IPT indicator for reading data), as well as with the help of the software «Adjustment of instruments of the series IPT 5900 and ИПМ 0399».

4.7.5.2. Determination of values of basic errors of IPT when operating with TC and with input signals in the form of resistance to constant current is performed at verified points according to State Standards P 8.625-2006 or State Standards 6651-94, provided in tables 4.5, in the following sequence:

Table 4.5

Input parameters					Limits of tolerable basic absolute error by measured value, °C	
Type of primary converter	Measuring range, °C	Verified point,			ИРТ 5922А, ИРТ 5922А/Д	ИРТ 5922А/М
		°C	Ohm, by State Standards			
			P 8.625-2006	6651-94		
50П	minus 50...200	minus 50	40,00	40,00	± 0,7	± 0,39
		150	79,11	79,11	± 0,7	± 0,39
100П	minus 50...200	150	158,22	158,23	± 0,6	± 0,26
	minus 50...600	550	300,63	300,67	± 1,4	± 0,66

4.7.5.2.1. ИРТ is switched on and is kept in switched on condition not less than 30 minutes.

4.7.5.2.2 ИРТ is connected to PC, power supply is switched on and the software «Adjustment of instruments of ИРТ 5900 and ИПМ 0399 series » is started

4.7.5.2.3 The following parameters of configuration of measuring channel of ИРТ are set, which are provided in the table 4.6 (configuration parameters and their designation correspond to item 2.2.2 of the present operation manual):

Table 4.6

Name of the parameter	Designation of the parameter	Parameter value
Type of the primary converter	«dAt»	PtH5 (50П, W=1,391)
Number of symbols after comma	«UF»	2
Number of measurements for averaging	«nSU»	1
Permission of the control of short circuit of input measuring circuit	«CutE»	1
Diagram of connection to TC	«Lc»	1 (three-wired)

The values of the rest of parameters may be any other.

4.7.5.2.4. ИКСУ 2000 (hereinafter ИКСУ) is switched on, it is prepared for operation in the mode of temperature emulation, corresponding to output signals from TC of 50П type, and it is connected to the input of ИРТ by a 3-wired circuit.

4.7.5.2.5. With the aid of ИКСУ emulated (actual A_0) temperature value is set minus 50 °C (corresponding to ИРТ signal, supplied to the input 40,00 Ohm according to State Standards 6651-94 or State Standards P 8.625-2006) and perform measurements by the verified ИРТ.

4.7.5.2.6. The value of an absolute error ΔA is determined, as a difference of the measured and actual values of the measured value from the formula

$$\Delta A = A_{u3M} - A_0, \quad (4.1)$$

where A_{u3M} - the measured magnitude of the value (of temperature) in the verified point, read from IPT indicator or at the bookmark of the program «Adjustment of IPT 5900 и ИПМ 0399».

4.7.5.2.7. With the aid of ИКСУ emulated (actual) temperature value equal to 150 °C (79,11 Ohm) is set, and operations from the items 4.7.5.2.5, 4.7.5.2.6, are repeated.

4.7.5.2.8. Configuration of measuring channel of IPT is set for an input signal from TC of the type 100П, provided in the table 4.7 (configuration parameters and their designation correspond to the item 2.2.2 of the present operation manual):

Table 4.7

Parameter name	Symbol designation of the parameter	Parameter value
Type of primary converter	«dAt»	PtH1 (100П, W=1,391)

The values of the remaining parameters should correspond to items. 4.7.5.2.3 and the table 4.6.

4.7.5.2.9. ИКСУ is prepared for operation in the mode of temperature emulation, corresponding to input signals from TC of the type 100П

4.7.5.2.10. The operations from items 4.7.5.2.5, 4.7.5.2.6 are repeated in turn IPT. with the aid of ИКСУ emulated temperature values are set equal to 150 °C [158,23 Ohm (158,22 Ohm)] and 550 °C [300,67 Ohm (300, 63 Ohm)], and making measurements by the verified IPT.

4.7.5.2.11. To control the breaking of an input circuit of primary converter - ИКСУ is disconnected from IPT on the indicator of IPT there should appear the message «CUt».

4.7.5.3. Determination of values of basic errors of IPT with input signals in the form of direct current voltage in the range of 0...100 mV is carried out in the verified points provided in the table 4.8, in the following order:

Table 4.8

Input parameters			Limits of tolerable basic absolute error by converted value		
Input signal	Range of conversion	Verified point		ИПТ 5922А, ИПТ 5922А/Д	ИПТ 5922А/М
		mV	A_0		
0...100 mV	plus 5...105	0	5	±0,023	±0,012
	minus 10...90	15	5	±0,06	±0,03
	minus 45...55	50	5	±0,089	±0,045
	minus 90...10	95	5	±0,15	±0,076

4.7.5.3.1. The configuration parameters of measuring channel of IPT, provided in the table 4.9 (parameters of configuration and their designation correspond to item 2.2.2 of the present operation manual).

Table 4.9

Name of the parameter	Symbol designation of the parameter	Parameter value
Type of primary converter	«dAt»	U100 (voltage 0...100 mV)
Number of digits after comma	«UF»	3
Number of measurements for averaging of an input signal	«nSU»	1
Permission of control of short-circuit of input measuring circuit	«CutE»	1 (permitted)
Function of square rooting	«Sqrt»	0 (disconnected)
Lower limit of the range of conversion of unified input signal	«dPLo»	5.000
Upper limit of the range of conversion of unified input signal	«dPHi»	105.0

The values of the remaining parameters may be any other.

4.7.5.3.2. ИКСУ-2000 is prepared for operation in the mode of generation of constant voltage of millivolt range and it is connected to the measuring channel of IPT.

4.7.5.3.3. With the aid of ИКСУ the emulated (actual) voltage is set to be 0 mV.

4.7.5.3.4. The settled readings are read by measuring value form the verified IPT.

4.7.5.3.5. The value of the absolute error is determined by measured value, as a difference of measured and actual magnitude of measured value from the formula (4.1).

4.7.5.3.6. Configuration parameters of IPT are set, that are provided in the table 4.10 (parameters of configuration and their designation correspond to item 2.2.2 of the present operation manual).

Таблица 4.10

Name of the parameter	Symbol designation of the parameter	Parameter value
Lower limit of the range of conversion of unified input signal	«dPLo»	-10.0
Upper limit of the range of conversion of unified input signal	«dPHi»	90.00

The values of the remaining parameters should correspond to item. 4.7.5.3.1, table 4.9.

4.7.5.3.7. With the aid of ИКСУ is determined the value of emulated (actual) voltage, equal to 15 mV.

4.7.5.3.8. Operations from items 4.7.5.3.4, 4.7.5.3.5. are repeated.

4.7.5.3.9. The configuration parameters of IPT are set, that are provided in the table 4.11 (configuration parameters and their designations correspond to the item 2.2.2 of the present operation manual):

Table 4.11

Name of the parameter	Symbol designation of the parameter	Parameter value
Lower limit of the range of conversion of unified input signal	«dPLo»	-45.0
Upper limit of the range of conversion of unified input signal	«dPHi»	55.00

The values of the remaining parameters should correspond to item. 4.7.5.3.1, table 4.9.

4.7.5.3.10. With the aid of ИКСУ is determined the value of emulated (actual) voltage, equal to 50 mV.

4.7.5.3.11. Operations from items 4.7.5.3.4, 4.7.5.3.5. are repeated.

4.7.5.3.12. The configuration parameters of IPT are set, that are provided in the table 4.12 (configuration parameters and their designations correspond to the item 2.2.2 of the present operation manual):

Table 4.12

Name of the parameter	Symbol designation of the parameter	Parameter value
Lower limit of the range of conversion of unified input signal	«dPLo»	-90.0
Upper limit of the range of conversion of unified input signal	«dPHi»	10.00

The values of the remaining parameters should correspond to item. 4.7.5.3.1, table 4.9.

4.7.5.3.13. With the aid of ИКСУ is determined the value of emulated (actual) voltage, equal to 95 mV.

4.7.5.3.14. Operations from items 4.7.5.3.4, 4.7.5.3.5. are repeated.

4.7.5.4. Determination of the values of the basic errors of IPT with input signals in the form of direct current voltage in the range of 0...10 V is performed in verified points, provided in the table 4.13, in the following order:

Table 4.13

Input parameters				Limits of the tolerable basic absolute error by the converted value	
Input signal	Conversion range	Verified point		ИРТ 5922А, ИРТ 5922А/Д	ИРТ 5922А/М
		B	A_0		
0...10 В	0...10	9,5	9,5	±0,2	±0,1

4.7.5.4.1. Configuration parameters of the measuring channel of IPT are set, that are provided in the table 4.14 (configuration parameters and their designations correspond to item 2.2.2 of the present operation manual):

Table 4.14

Name of the parameter	Symbol designation of the parameter	Parameter value
Primary converter type	«dAt»	U100 (voltage 0...100 mV)
Number of digits after comma	«UF»	3
Number of measurements for averaging of an input signal	«nSU»	1
Permission of control of short-circuit of input measuring circuit	«CutE»	0 (prohibited)
Function of square rooting	«Sqrt»	0 (disconnected)
Lower limit of the range of conversion of unified input signal	«dPLo»	0.0
Upper limit of the range of conversion of unified input signal	«dPHi»	10.0

The values of the remaining parameters may be any other.

4.7.5.4.2. ИКСУ-2000 is prepared for operation in the mode of generation of constant voltage of the voltage range and it is connected to the measuring channel of IPT.

4.7.5.4.3. With the aid of ИКСУ is determined the value of emulated (actual) voltage, equal to 9,5 V.

4.7.5.4. 4. The set readings are recorded by the measured value form the verified IPT.

4.7.5.4.5. The value of the absolute error by the measured value is determined as a difference of measured and actual magnitudes of measured value form the formula (4.1).

4.7.5.5. Determination of the values of the basic errors of IPT in configuration with unified input signals in the form of the strenght of direct current is performed in verified points, provided in the table 4.15, in the following order:

Table 4.15

Input parameters				Limits of the tolerable basic absolute error by the converted value	
Input signal	Conversion range	Verified point		ИРТ 5922А, ИРТ 5922А/Д	ИРТ 5922А/М
		mA	A_0		
0...5 mA	0...100	0	0	± 0,2	± 0,1
		2,5	50	± 0,2	± 0,1
		4,75	95	± 0,2	± 0,1
4...20 mA	0...100	4	0	± 0,2	± 0,1
		12	50	± 0,2	± 0,1
		19,2	95	± 0,2	± 0,1

4.7.5.5.1. Configuration parameters of IPT are set, provided in the table 4.16 (configuration parameters and their designations correspond to item 2.2.2 of the present operation manual):

Table 4.16

Name of the parameter	Symbol designation of the parameter	Parameter value
Primary converter type	«dAt»	t05 (current 0...5mA)
Number of digits after comma	«UF»	3
Number of measurements for averaging of an input signal	«nSu»	1
Function of square rooting	«Sqrt»	0 (disconnected)
Lower limit of the range of conversion of unified input signal	«dPLo»	0.000
Upper limit of the range of conversion of unified input signal	«dPHi»	100.0

The values of the remaining parameters may be any other.

4.7.5.5.2. ИКСУ is prepared for operation in the mode of generation of direct current and it is connected to the measuring channel of IPT by means of connection cable.

4.7.5.5.3. With the aid of ИКСУ is determined the value of emulated (actual) voltage, equal to 0 mA.

4.7.5.5.4. The set readings are recorded by the measured value from the verified IPT.

4.7.5.5.5. The value of the absolute error is determined as a difference of measured and actual magnitude of measured value from formula (4.1).

4.7.5.5.6. Operations provided in items 4.7.5.5.4, 4.7.5.5.5 are repeated, in turn the values of emulated current equal to 2.5 and 4.75 mA are set using ИКСУ.

4.7.5.5.7. Configuration parameters of IPT are set, provided in the table 4.17 ((configuration parameters and their designations correspond to item 2.2.2 of the present operation manual

Table 4.17

Name of the parameter	Symbol designation of the parameter	Parameter value
Type of primary converter	«dAt»	t420 (current 0...5mA)

The values of remaining parameters should correspond to item.. 4.7.5.5.1 and the table 4.16.

4.7.5.5.8. Operations provided in items 4.7.5.5.4, 4.7.5.5.5 are repeated, in turn the values of emulated current equal to 4, 12 and 19,2 mA are set using ИКСУ. .

4.7.5.6. Determination of the values of the basic errors of the current output of IPT is performed in the verification points, provided in the table 4.18, in the following order:

Table 4.18

Parameters of the instrument configuration					Limits of tolerable basic absolute error by converted value mA
Input signal *	Range of conversion of input signal	Range of conversion of incorporated measuring converter	Range of current output	Actual value of output current I_o , mA	
0...5mA	5...5	0...100	0...5mA	0,25	$\pm 0,01$
	50...50			2,5	$\pm 0,01$
	95...95			4,75	$\pm 0,01$
0...5mA	0...0	0...100	4...20mA	4	$\pm 0,032$
	50...50			12	$\pm 0,032$
	95...95			19,2	$\pm 0,032$

Notes – * the value of input signal is equal to 0 mA

4.7.5.6.1. The following parameters of configuration of IPT are set that are provided in the table 4.19 (configuration parameters and their designation correspond to art. 2.2.2 of the present operation manual):

Table 4.19

Parameter name	Designation of the parameter	Value of the parameter
Type of primary converter	«dAt»	t05 (current 0...5mA)
Number of digits after comma	«UF»	3
Number of measurement for averaging of input signal	«nSu»	1
Function of square-rooting	«Sqrt»	0 (disconnected)
Lower limit of the conversion range of unified input signal	«dPLo»	5
Upper limit of the range of conversion of unified input signal	«dPHi»	5
Range of unified output signal of incorporated measuring converter	«IOdP»	1* (0...5 mA)
Lower limit of the conversion range of incorporated measuring converter	«IoLo»	0
Upper limit of the range of conversion of incorporated measuring converter	«IoHi»	100

Notes - * range switch of incorporated measuring converter in the position «5mA»

The values of the other parameters may be different.

4.7.5.6.2. To the output of incorporated measuring converter of verified IPT a resistive load MJIT-0,125-1,8 кOhm ±5 % is connected in series with the load is connected ИКСУ in the mode of current measuring.

4.7.5.6.3. The values of output current incorporated measuring converter $I_{\text{облх}}$ are read from ИКСУ.

4.7.5.6.4. The value of the absolute error ΔI of incorporated measuring converter is determined from the formula

$$\Delta I = I_{\text{облх}} - I_0, \quad (4.2)$$

where I_0 – actual value of output current of incorporated measuring converter (table. 4.18).

4.7.5.6.5. In series the parameters «dPLO» и «dPHi» are set equal to 50, 95 and operations from the art. 4.7.5.6.3., 4.7.5.6.4 are repeated.

4.7.5.6.6. Parameters of IPT configuration are set, provided in the table 4.20 (parameters of configuration and their designation correspond to the article 2.2.2 of the present operation manual):

Table 4.20

Parameter name	Designation of the parameter	Value of parameter
Range of unified output of incorporated measuring converter signal	«IOdP»	2* (4...20 mA)
Notes - * range switch of incorporated measuring converter in the position «20 mA»		

The values of the rest parameters should correspond to art. 4.7.5.5.1, table 4.18.

4.7.5.6.7. Resistive load is connected to current output of verified IPT, MJIT-0,125-470 Ohm ±5 %, in series with the load is connected to ИКСУ in the mode of current measurement.

4.7.5.6.8. Parameters «dPLO» и «dPHi» are set in series equal to 0, 50, 95 and operations provided in the art. 4.7.5.6.3, 4.7.5.6.4. are repeated.

4.7.6. Determination of the values of basic errors of IPT, configured for a specific type of a primary converter.

4.7.6.1. For determination of the values of the basic reduced errors of IPT, configured for the certain type of a primary converter, to the verified IPT is connected the measuring calibrator of unified signals standard to ИКСУ in accordance with the present operation manual and the manual of ИКСУ operation.

To the current output of verified IPT a resistive load is connected: for current output of 0...20 or 4...20 mA - MJIT-0,125-470 Ом ±5 %, for current output of 0...5 mA - MJIT-0,125-1,8 кОм ±5 %. In series with the load ИКСУ is connected.

4.7.6.2. Determination of values of basic reduced errors of IPT in TC and ТП configurations is carried out in the points, corresponding to 5, 25, 50, 75, 95 % of measuring range, indi-

cated in the table 2.1. Verification of IPT, operating with TC is performed only by 3-wired circuit. Verification of IPT, operating with ТП it is necessary to perform graduation of the compensator of cold end in accordance with the art. 2.7.1.2. Verification operation is performed in the following sequence:

4.7.6.2.1. ИКСУ and verified IPT are switched on and prepared to operation, ИКСУ and PT are kept in switched on condition during 30 minutes.

4.7.6.2.2. With the aid of ИКСУ emulated (actual A_0) temperature value in degrees is set, equal to 5, 25, 50, 75, 95 % of measuring range.

4.7.6.2.3. The magnitudes of measured value A_{u3M} are read from IPT indicator.

4.7.6.2.4. The value of the basic reduced error of measuring of IPT is determined from the formula

$$\gamma = \frac{(A_{u3M} - A_0)}{(A_{ex\ max} - A_{ex\ min})} \times 100\% , \quad (4.3)$$

where $A_{ex\ max}$ – upper limit of the measuring range, provided in the table 2.1;

$A_{ex\ min}$ – lower limit of the measuring range, provided in the table 2.1.

4.7.6.2.5. With the aid of ИКСУ the output current of incorporated measuring converter $I_{\theta bIX}$ for every emulated point is measured.

The value of measured temperature corresponding to the value of measured output current of incorporated measuring converter is measured from the formula

$$A_{\theta bIX} = \frac{(I_{\theta bIX} - I_{\theta bIX\ min})}{(I_{\theta bIX\ max} - I_{\theta bIX\ min})} \times (A_{\theta bIX\ max} - A_{\theta bIX\ min}) + A_{\theta bIX\ min} , \quad (4.4)$$

где $I_{\theta bIX}$ – measured value of output current, mA;

$I_{\theta bIX\ min}$ – lower limit of the range of unified output signal 0 or 4 mA;

$I_{\theta bIX\ max}$ – upper limit of the range of unified output signal of output signal 5 or 20 mA;

$A_{\theta bIX\ max}$ – upper limit of the range of conversion of incorporated measuring converter

$A_{\theta bIX\ min}$ – lower limit of the range of conversion of incorporated measuring converter

4.7.6.2.6. The values of the basic reduced error of incorporated measuring converter (current output of IPT) for TC и ТП are determined from the formula

$$\gamma_I = \frac{(A_{\theta bIX} - A_0)}{(A_{\theta bIX\ max} - A_{\theta bIX\ min})} \times 100\% , \quad (4.5)$$

where $A_{\theta bIX\ max}$ and $A_{\theta bIX\ min}$ – are decoded in art. 4.7.6.2.5.

4.7.6.2.7. For control of open-circuit fault of the input circuit ИКСУ is disconnected from ИРТ, on the indicator of ИРТ should appear a message «CUT». The values of output current for the range of current output 4.....20 mA should be within the range (3,5±0,1) mA

4.7.6.3. Determination of values of basic reduced errors of ИРТ in configuration with input unified signals in the form of direct current strength and voltage is performed in the points corresponding to 5, 25, 50, 75, 95 % of the measurement range, provided in the table 2.2. Verification operation is carried out in the following sequence:

4.7.6.3.1. ИКСУ and verified ИРТ are switched on and prepared to operation, ИКСУ and ИРТ are kept in switched on condition during 30 minutes.

4.7.6.3.2. With the aid of ИКСУ the emulated (actual I_{∂}) value equal to 5, 25, 50, 75, 95 % of the measurement range is set.

4.7.6.3.3. The magnitudes of measured value A_{uzM} are read from ИРТ indicator.

4.7.6.3.4. The actual value of a measured parameter is calculated from the formula

$$A_{\partial} = \frac{(I_{\partial} - I_{ex\ min})}{(I_{ex\ max} - I_{ex\ min})} \times (A_{ex\ max} - A_{ex\ min}) + A_{ex\ min} \quad (4.6)$$

where A_{∂} – actual value of measured parameter;

I_{∂} – actual value of input signal;

$I_{ex\ min}$ – lower limit of the range of unified input signal;

$I_{ex\ max}$ – upper limit of the range of unified input signal;

$A_{ex\ max}$ – upper limit of the range of conversion of input unified signal;

$A_{ex\ min}$ – lower limit of the range of conversion of input unified signal.

4.7.6.3.5. When square-rooting function is present in the instrument the actual value of a measured parameter is calculated from the formula

$$A_{\partial} = \sqrt{\frac{(I_{\partial} - I_{ex\ min})}{(I_{ex\ max} - I_{ex\ min})} \times (A_{ex\ max} - A_{ex\ min}) + A_{ex\ min}} \quad (4.7)$$

4.7.6.3.6. The basic reduced error of measurement of ИРТ is calculated from the formula (4.3).

4.7.6.3.7. In emulated points from ИКСУ is taken the value of output current of incorporated measuring converter $I_{\partial bx}$.

4.7.3.8. The actual value of a measured parameter is calculated from the formula

$$I_{\partial bx\partial} = \frac{(A_{\partial} - A_{\partial bx\ min})}{(A_{\partial bx\ max} - A_{\partial bx\ min})} \times (I_{\partial bx\ max} - I_{\partial bx\ min}) + I_{\partial bx\ min} \quad (4.8)$$

where $I_{\partial bx\partial}$ – Calculated value of output current;

$I_{\partial bx\ min}$ – lower limit of the range of output current 0 or 4 mA;

- $I_{\text{выхmax}}$ – upper limit of the range of output current 5 or 20 mA;
- $A_{\text{д}}$ – actual value of measured value (calculated from the formula (4.6) or (4.7);
- $A_{\text{выхmax}}$ – upper limit of the range of incorporated measuring converter conversion;
- $A_{\text{выхmin}}$ – lower limit of the range of incorporated measuring converter conversion.

4.7.6.3.9. The actual value of the basic reduced error of current output of ИРТ is calculated from the formula

$$\gamma_I = \frac{(I_{\text{вых}} - I_{\text{выхд}})}{(I_{\text{выхmax}} - I_{\text{выхmin}})} \times 100\% , \quad (4.9)$$

where $I_{\text{outputmax}}$ and $I_{\text{outputmin}}$ – are given in art. 4.7.6.3.8.

4.7.7. Determination of output characteristics of the incorporated power supply source is carried out in the following sequence:

4.7.7.1. ИКСУ is prepared for operation in the mode of voltage measuring within the range of 0...120V.

4.7.7.2. ИКСУ is connected to clamps 8 and 9 of the verified ИРТ.

4.7.7.3. The value of output voltage of idle running U_{xx} is measured.

4.7.7.4. The value of the absolute error ΔU_{xx} is determined as a difference of measured and nominal $U_{\text{ном}}$ values of output voltage from the formula

$$\Delta U_{xx} = U_{xx} - U_{\text{ном}} , \quad (4.10)$$

4.7.7.5. The resistor МЛТ-1-820 Ом $\pm 5\%$ is connected to clamps 8 and 9.

4.7.7.6. The voltage value of the incorporated voltage source under load $U_{\text{назр}}$ is measured.

4.7.7.7. The value of the absolute error is determined from the formula

$$\Delta U_{\text{назр}} = U_{\text{назр}} - U_{\text{ном}} , \quad (4.11)$$

4.7.8. Processing of verification results.

4.7.8.1. When verifying ИРТ, designed for operation with variable configuration, the values of the basic absolute errors by measured value, calculated from the formula (4.1) should not exceed the values provided in tables 4.5, 4.8, 4.13, 4.15. The values of the basic absolute errors of incorporated measuring converter calculated from the formula (4.2) should not exceed the values provided in the table 4.18.

4.7.8.2. When verifying ИРТ, configured for the certain type of a primary converter, when operating with input signals TC and ТП the values of basic reduced errors, calculated from the formula (4.2), should not exceed the values provided in the table 2.1.

4.7.8.3. When verifying ИРТ with input signals from TC and ТП, the values of the basic

reduced errors of current output, calculated from the formula (4.5), should not exceed the values determined in accordance with the art. 2.2.16.

4.7.8.4. When verifying IPT with unified input signals, the values of the basic reduced errors, calculated from the formula (4.3), should not exceed the values provided in the table 2.2.

4.7.8.5. When verifying IPT with unified input signals, the values of the basic reduced errors of current output, calculated from the formula (4.9), should not exceed the values of errors provided in the table 2.2. determined in accordance with the art. 2.2.16.

4.7.8.6. When determining the output parameters of an incorporated power conditioner, the values of absolute errors, calculated from the formulas (4.10) and (4.11), should not exceed $\pm 0,48V$.

4.8. Registration of verification results

4.8.1. Positive results of IPT verification, for operation with a variable configuration are registered in the certificate of state standard verification according to ИП 50.2.006-94 or a marking in the registration certificate.

4.8.2. Results of IPT verification, configured for the certain type of a primary converter, are registered by issuing of a certificate of state standard verification according to ИП 50.2.006-94 or by marking in the registration certificate with specifying the certain verified range.

4.8.3. In case of negative results verification an IPT is not permitted to be used until the reasons of the fault are determined and it is eliminated.

After elimination of detected faults a second verification is carried out, the results of the second verification – are final.

5. MAINTENANCE SERVICE

5.1. IPT servicing comes to observing operation, storage and transportation rules, given in the present operation manual, maintenance inspections, periodic verification and repairs.

5.2. Maintenance inspections are carried out according to the rules, established by the organization, using IPT, and they include:

- 1) external examination;
- 2) checking safety of connection of IPT communication circuits with the primary converters, power supply source, and commutation channels loads as well as absence of rupture of grounding wire ;
- 3) performance check

IPT is considered operational when its readings approximately coincide with a measured value.

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

5.4. IPT with defects that 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 IPT is performed by manufacturer.

6. STORAGE

6.1. Storage conditions of IPT 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 IPT in storage facilities should ensure easy access to them.

6.3. IPT should be stored on the racks.

6.4. The space between the walls, the floor of the storage facility and IPT 5920 should not be less than 100mm.

7. TRANSPORTATION

7.1. IPT is 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.

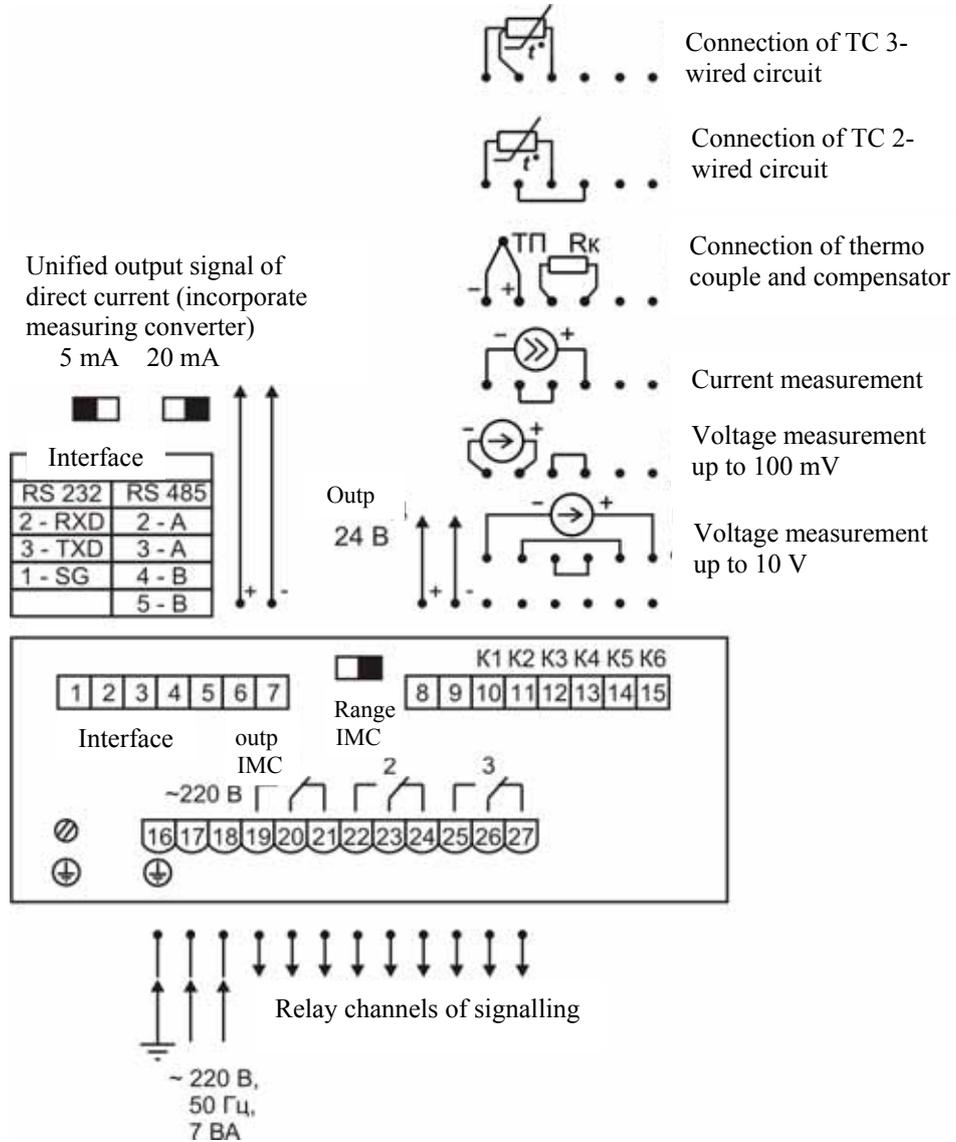
7.2. IPT transportation conditions should meet requirements 5 according to State Standards 15150-69 at the ambient temperature from minus 50 to +50°C, and should comply with anti-shock and anti-vibration measures.

7.3. IPT should be transported parceled or separately.

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

Appendix A

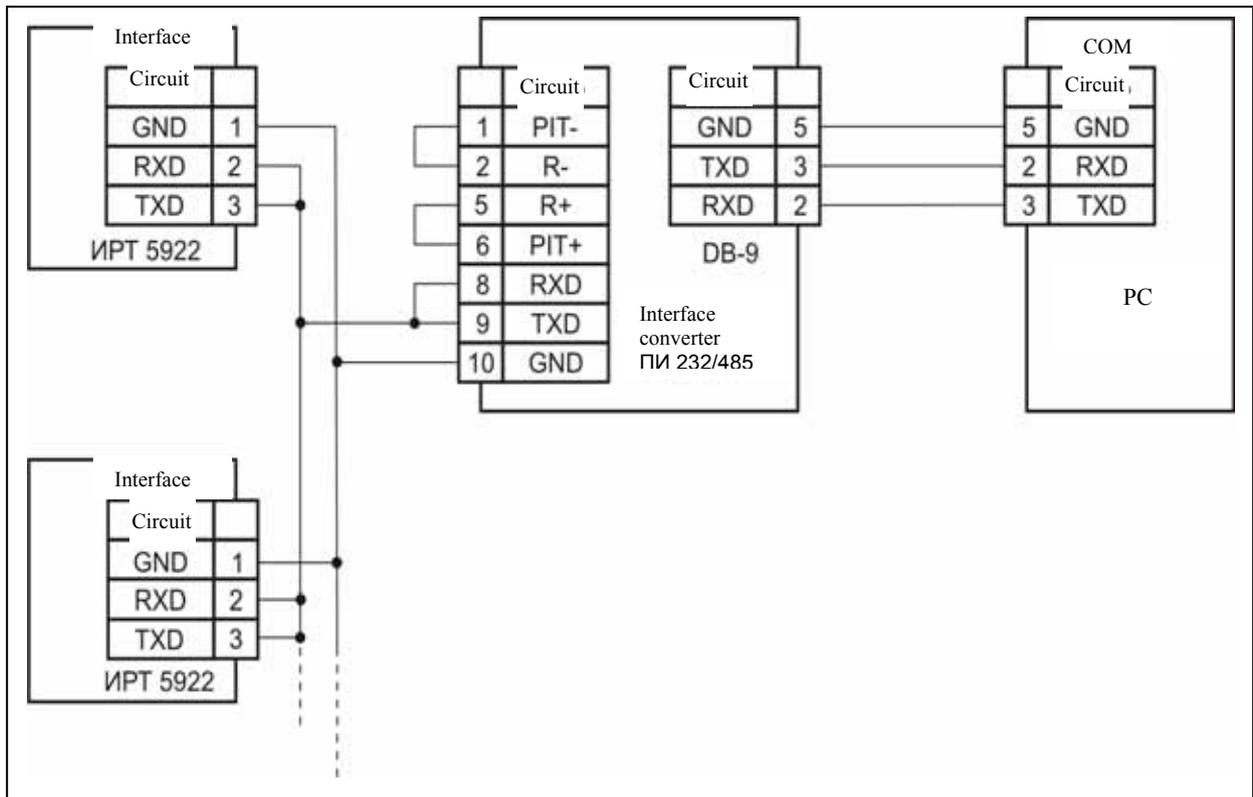
Electric connections circuit of ИРТ 5922А, ИРТ 5922А/Д, ИРТ 5922А/М



Picture A.1

Continuation of the appendix Б

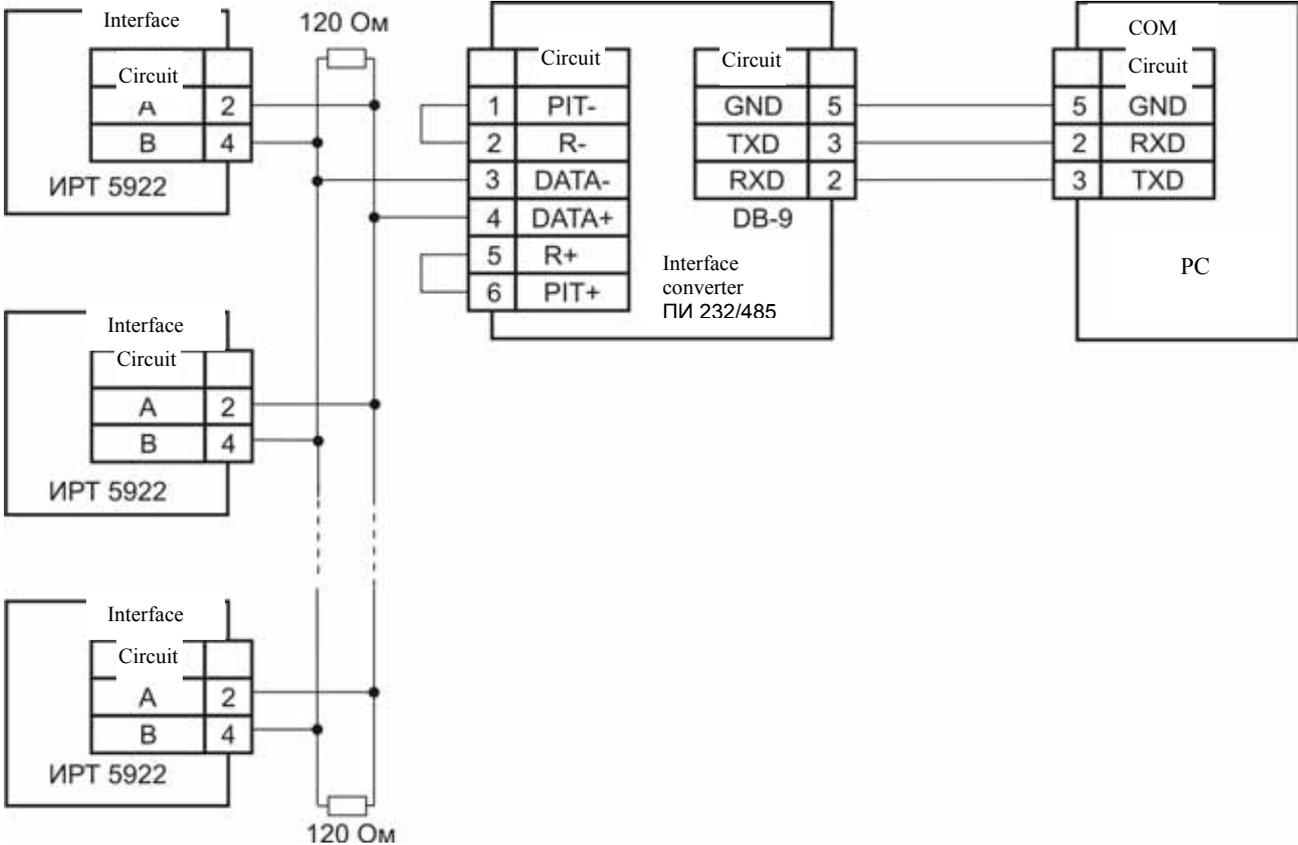
Double-wire connection circuit of IPT 5922 to PC by RS 485 using the converter of interface ПИ-232/485 with an automatic determination of transfer direction (up to 100 IPT 5922 with the connection line up to 1000 m)



Picture Б.2

Continuation of the appendix Б

Double-wire connection circuit of IPT 5922 to PC by RS 485 using the converter of interface ПИ-232/485 with an automatic determination of transfer direction



APPENDIX B

AN EXAMPLE OF A RECORD OF DESIGNATION WHEN ORDERING IPT 5922

IPT 5922 X X X X X X X X
1 2 3 4 5 6 7 8 9

1. Type of the instrument
 2. Modification code (in accordance with art. 2.1.9)
 3. Safety category for instruments with the modification code A, A/Д, A/M supplied to Nuclear Power Stations 2 or 3
 4. Code of climatic version: t0550, t1050 (in accordance with art. 2.1.16, 2.1.16.1)
 5. Group of versions by ЭМС: - index of order III (group of version III, criteria of quality of functioning A,
group of version IV, criteria of quality of functioning B);
- - index of order IV (group of version IV, criteria of quality of functioning A)
 6. Interface type: RS 232 or RS 485
 7. Additional stand testing during 360 hours (order index: 360П)
 8. State verification (order index: ГП)
 9. Designation of technical conditions
-

Example of an order

Basic version

IPT 5922 - / - / - / - / - t1050 / - III - RS232 - / - / - / - / - ТУ 4220-040-13282997-02
1 2 3 4 5 6 7 8 9

Versions with consideration of all positions of the order form

IPT 5922 - A - 2 - / t1050 / - III - RS232 - 360П - ГП - ТУ 4220-040-13282997-02
1 2 3 4 5 6 7 8 9

IPT 5922 - A/Д - 2 - / t0550 / III - RS232 - 360П - ГП - ТУ 4220-040-13282997-02
1 2 3 4 5 6 7 8 9

IPT 5922 - A/M - 3 - / t0550 / IV - RS485 - 360П - ГП - ТУ 4220-040-13282997-02
1 2 3 4 5 6 7 8 9

