ЭЛЕМЕР
Science and production company

RELIABLE INSTRUMENTS AND SYSTEMS OF TECHNOLOGICAL MONITORING

PLATINUM RESISTANCE SENSOR

STANDARD VIBRATION-PROOF

ПТСВ

Operation Manual

НКГЖ.408717.003РЭ

CONTENT

PLEASE NOTE !

During operation of the sensor ПТСВ it is not permitted to expose it to:

- ***an abrupt impact of temperature variation, cooling down and heating of it should be gradual to avoid rupture of its sensitive element;***
- ***mechanical impact in order to avoid short – circuiting of the coils of the sensitive element..***

1. GENERAL GUIDELINES

1.1. The present operation manual (OM) is designed for study of the operation principle, storage regulations, and technical maintenance of the platinum standard vibration-proof resistance sensor ПТСВ (hereinafter - sensor) modifications ПТСВ-1, ПТСВ-2, ПТСВ-3, ПТСВ-4, ПТСВ-5.

Operation manual contains information, reflecting technical conditions of the sensor after manufacturing and during operation, as well as information, certifying manufacturer's guarantees.

1.2. Prior to operating the sensor it is necessary to get acquainted with operation manual.

1.3. Operation manual should be always kept near the sensor.

1.4. In case of making records in the operation manual it is not permitted to make any recordings by a pencil, washable ink and to make any erasures.

1.5. Any wrong recording should be accurately crossed out and nearby a new recording should be made, which should be verified by a responsible person. After signature a surname and initials of the responsible person should be recorded (instead of the signature it is possible to stamp by the personal stamp of the executor).

1.6. Repeated (intermittent) verification of the sensor is performed only if an operation manual is present.

1.7. Accounting of the operations should be performed in the same units which are used for presentation of the operation resource.

1.8. When a sensor is transferred to another enterprise total summing up recordings on operating time should be certified by the seal of the company transferring the instrument.

2. BASIC DATA ON THE PRODUCT

2.1. The platinum standard vibration-proof resistance sensor of ПТСВ type, modification ПТСВ - _____.

2.2. Produced by SPC «ELEMER».

2.3. Factory number _____

2.4. Range of measured temperatures _____

2.5. Grade second (third)

2.6. Manufacturing date _____.

2.7. Certificate № _____, State register №_____

2.8. Sensitive element of the sensor is produced from platinum wire of the mark (Pl 0, Pl 1, Pl 2) according to State Standards СТ 21007, output of the wire are manufactured from the alloy ПР6.

The sensor contains: 0,0920 gr. of platinum; __–__ gr. of rhodium; __-__ gr. of silver.

2.9. Calibrating characteristics in the form of t=f(ΔW) are presented in the table 7 p. 18 and they are the part of every sensor.

3. BASIC TECHNICAL DATA AND CHARACTERISTICS

3.1. The sensor is designed for calibration of instruments for measuring temperature in accordance with the State calibration diagram for measurement temperature (State Standards 8.558-93) and for using as an instrument for measuring temperature of increased precision in different branches of industry and in the process of scientific research within the following ranges of temperature:

ПТСВ-1 3 grade from minus 50 to plus 450 °C,

ПТСВ-1 2 grade from minus 50 to plus 450 °C,

ПТСВ-2 3 grade from minus 200 to plus 200 °C,

ПТСВ-3 from minus 50 to plus 500 °C,

ПТСВ-4 from minus 50 to plus 232 °C,

ПТСВ-5 from minus 50 to plus 250 °C.

3.2. Overall dimensions of the sensor are provided in the Appendix A.

3.3. Nominal; resistance of the sensor at the temperature of the triple point of water (R_{TTB}) - 100 Ohm.

Tolerable deviation of the nominal resistance (R_{TTB}) is not more than ± 0,2 Ohm.

3.4. The value of the relative resistance of the sensor, determined as a ratio of sensor resistance at the given temperature $R(_t)$ to its resistance in the triple point of water (R_{TTB}) provided in the table 1.

Table 1

Sensor modification	W_{Ga}, not less	W_{Hg}, not less	W_{100}, not less*)
ПТСВ-1	1,11795	0,844235	1,3924
ПТСВ-2	1,11750	0,844990	1,3908
ПТСВ-3	1,11795	0,844235	1,3924
ПТСВ-4	1,11795	0,844235	1,3924
ПТСВ-5	1,11750	0,844990	1,3908

*) The value W_{100} is provided in the certificate for modification ПТСВ-1, ПТСВ-2, ПТСВ-3, ПТСВ-4.

Notes: 1 W_{Ga}, - relative resistance at the temperature of gallium melting.
2 W_{Hg}, - relative resistance at the temperature of triple point of mercury.
3 W_{100} - relative resistance at the temperature 100 °C.

3.5. Instability.

Measurement of the sensor resistance in the triple point of water (ΔR_{TTB}) after keeping her during 5 hours at the temperature of the upper limit of measurement, and for ПТСВ-2 and for the temperature of the lower limit at the temperature of the lower limit of measurement, not more than 0,004 °С and 0,007 °С, in the temperature equivalent, for the sensors of the 2-nd and 3-rd grade correspondingly.

3.6. The values of the confidence error of the sensor at the confidence probability of 0,95 are provided in the table 2.

Table 2

Modification of the sensor	Confidence error not less than, °С							
	Range of application °С							
	-200....-50	-50...0	0….30	30...150	150...230	230...420	420...450	450...500
ПТСВ-1-2	-	0,02	0,01	0,02	0,02	0,02	0,02	-
ПТСВ-1-3	-	0,03	0,02	0,03	0,04	0,04	0,04	-
ПТСВ-2-3	0,05	0,03	0,02	0,03	0,04	-	-	-
ПТСВ-3-3	-	0,03	0,02	0,03	0,04	0,04	0,04	0,07
ПТСВ-4-2	-	0,02	0,01	0,02	0,02	-	-	-
ПТСВ-4-3	-	0,03	0,02	0,03	0,04	-	-	-
ПТСВ-5-3	-	0,03	0,02	0,03	0,04	-	-	-

3.7. Measuring current of the sensor - (1±0,1) mA.

3.8. The index of the temperature inertia is not more than:

for ПТСВ-1, ПТСВ-3, ПТСВ-4, ПТСВ-5 – 40 с,
for ПТСВ-2 - 10 с.

3.9. Electrical resistance of insulation between the electrical circuit of the sensitive element of the sensor and protective armature, at the temperature of environment media (20±5) °С and relative humidity of air (60±15) not less:

а) 100 MOhm at the temperature of 0 °С,
б) 50 MOhm at the temperature of 200 °С,
в) 20 MOhm at the temperature of 450 °С,
г) 15 MOhm at the temperature of 500 °С.

Notes - The value presented at the temperature 500 °С belongs only to modification ПТСВ-3.

3.10. Sensor resistance is measured by the four –wire diagram.

3.11. The contact method with environment media - by immersion.

3.12. The sensor is a vibroprotected instrument as to the execution group N 3 State Standard 12997.

3.13. According to conditions of operation the sensor belongs to climatic conditions УХЛ4, State Standards 15150-69.

3.13.1. On protectability against environmental effects according to State Standards 15150-69 ПТСВ are resistant against the content of corrosion-active agents for atmosphere type III.

3.14. The sensing element of the sensor is manufactured from platinum wire.

For modification ПТСВ-1 – from the model Пл0 according to State Standards 2107.
For modification ПТСВ-2 - from the model Пл2 according to State Standards 2107.
For modification ПТСВ-3 - from the model Пл0 or Пл1 according to State Standards 2107.
For modification ПТСВ-4 - from the model Пл0 or Пл1 according to State Standards 2107.
For modification ПТСВ-5 - from the model Пл1 or Пл2 according to State Standards 2107.

3.15. The mass of the sensor is not over, kg:

for ПТСВ-1, ПТСВ-3, ПТСВ-4 0,105;
for ПТСВ-2 0,007;
for ПТСВ-5 0,090;
for ЧЭПТ 0,004.

3.16. Probability of unfailing operation of the sensors during 1000 hours or 50 cycles of cooling-heating from the extreme temperature of operation range up to (20±5) °C at the confidence probability P*= 0,8 – not less than 0,95.

3.17. The term of life - not less than 5 years.

4. COMPLETE SET

4.1. The complete set of the sensor delivery should correspond to the table 3.

Table 3

Name	Designation	Number	Notes
The platinum standard vibration-proof resistance sensor ПТСВ-	НКГЖ.408717.003	1	Provided designation for delivered modification
Operation manual	НКГЖ.408717.003РЭ	1	
The platinum standard vibration-proof resistance sensor ПТСВ. Verification method	НКГЖ.408717.003МП	1	By the order of the client
Calibration certificate		1	

5. DESIGN AND OPERATION OF THE INSTRUMENT

5.1. The principle of the sensor operation lies in employment of temperature response of electric resistance of platinum.

5.2. The main part of the sensor is the sensing element (SE).

SE is a resistor in the spiral form wire, located in the channels of the ceramic framework. To every end of the spiral are soldered two outputs, leading to the head of the sensor and serving for connection of the sensor to electrical measuring equipment.

SE is located in the sealed protective metallic tube, at which the head of the sensor is fixed with outputs. The metallic tube with SE and outputs is filled with alumina powder.

5.3. Measuring of resistance of the sensor is performed using four-wire circuit. The sensor has got four outputs – two current and two potential. In every pair selection of current and potential outputs is - arbitrary. For measuring of the resistance of the sensor it is recommended to use measuring equipment, providing measuring of sensor resistance, with an error not more than 0,001 °C, in the temperature equivalent.

Determination of temperature by measured resistance of the sensor is performed by the method provided in the Appendixes А and Б State Standards Р 8.571-98, using calibration characteristics T=f(W) (table 7 p. 18 МО), or calibration characteristics form the calibration certificate.

5.4. On the body of the sensor or in the label attached to it should be recorded: symbol (type), factory number, trade mark of the manufacturer.

6. GUIDELINES OF SAFETY MEASURES.

6.1. Only persons having required qualification are admitted to operation of sensors, they should be trained in strictly abiding with safety measures when operating the sensor, they should also study Operation Manual of the sensor.

6.2. When operating the sensor it is required to follow the safety measures provided in the technical documentation for the operated measuring devices and the ПТСВ sensor.

6.3. When operating the sensor it is prohibited to touch the heated (cooled) parts of it, having the temperature above 50°C and below minus 30°C in order to get burns and chilblains, as well it is prohibited to place heated sensors on the highly inflammable surfaces in order to avoid burning.

6.4. When operating a sensor in liquified gases, it is required to use means of individual protection (spectacles and glasses) and be extremely careful, because ingress of liquified gases on unprotected surfaces of skin and mucous tunic result in severe injuries.

6.5. All operations when servicing and maintaining the sensor should be performed only when all its parts has the temperature of (25±10) °C.

7. PREPARATIONS FOR OPERATION

7.1. Check complete set of the sensor in accordance with the section 4 of the present operation manual.

7.2. Check correspondence of the number of the sensor in the Operation Manual (see. sec. 13 Acceptance certificate) and on the housing of the sensor (or on the label).

7.3. Check by way of external examination if there any rupture of connecting wires, cracks, soiling.

In case of discovery of any soiling in order to eliminate it, prior to immersion of the sensor in defined points or in the oven, it is required to wipe the protective tube by rectified spirit State Standard 18300.

7.4. Check the electrical circuit of the sensor by a digital multimeter. There should not be any open circuits.

8. OPERATION PROCEDURE

8.1. Record the time of the beginning of operations with the sensor in Operation Manual. (table 6).

8.2. Place the sensor in the media, temperature of which is necessary to determine, and connect the sensor to electrical circuit of the measuring diagram (measuring equipment).

Notes. 1. Minimal depth of the sensor immersion during operation depends on heat-exchange of the sensor with the measured object and surrounding media and it is determined experimentally. The criteria of the tolerable minimal depth of immersion at the given measured temperature of the object is the variation of the sensor's readings at the constant temperature of the surrounding media At the selected depth of immersion and increase of the depth of immersion with a constant temperature for the length of the sensitive element of the sensor should not result in variation ot he readings of the sensor for more than 0,5 of the value of the tolerable error of the sensor.

2. For connection of the sensor of ПТСВ-2 modification it is recommended to use wires with a diameter not more than 0,12 mm each. During making measurements the specified connecting wires should be temperature-controlled at the length not less than 150 mm from the head of the thermometer at the temperature of measuring.

8.3. Measuring current should be installed through the sensor, according to the item 3.7.

8.4. Measurement of ther sensor resistance in accordance with the operation manual for the employed measuring equipment (instrument).

8.5. By the measured value of the sensor resistance the temperature is determined according to the methods of the Appendix Б (or State Standard P 8.571-98, Appendix A and Б), using graduation table T=f(W), provided in the Operation Manual for the sensor, or calibrating characteristics from the acceptance certificate.

8.6. In case of need remove the sensor from the media with the measured temperature.

9. TECHNICAL MAINTENANCE

9.1. Prior to immersion of the sensor into an oven, thermostat and defined points it is necessary to wipe its body with rectified spirit State Standard 18300 and control if there is any soiling of the housing in the form of oil, textile fibres etc.

9.2. After measuring when all parts of the sensor reach safe temperature (see. item. 4.5), the housing of the sensor should be wiped by textile and wiped by spirit State Standard 18300.

9.3. Technical examination of the sensor is done not less than once a year, according to verification instruction (item. 10).

10. VERIFICATION INSTRUCTIONS

10.1. All newly manufactured sensors should be verified as well as repaired ones and operational sensors.

10.2. Verification of sensors is performed by State bodies of metrological service and other authorised bodies, having the verification right. Periodical verification of the sensor should be performed after 1000 running hours 1000 at the maximum temperature, but not less than once a year.

10.3. Verification of the sensor of the 2-nd category is performed in accordance we with State Standards P 8.571.

Requirements to verification, procedure and methods of its performance for the sensors of the 3-rd category are determined in accordance with the document НКГЖ.408717.003МП «Platinum standard vibration-proof resistance sensor ПТСВ».

11. TRANSPORTATION AND STORAGE

11.1. Transportation os sensors is performed is performed in packaging of the manufacturing company and it may be done by any type of covered transport at any distance.

11.2. Transportation is performed in accordance with acting presently transportation regulations.

11.3. Climatic conditions of transportation should correspond to storage conditions 3 by State Standards 15150.

11.4. Mechanical conditions of transportation should correspond to conditions of transportation 3 (Ж3) according to State Standards ГОСТ 231170.

11.5. Sensors should be stored in packaging of the manufacturing company in premises corresponding to storage conditions 3 according to State Standards ГОСТ 15150.

Air in the storage premises should not content any aggressive ingredients.

11.6. Without packaging a sensor may be stored at the temperature of ambient air from 5 до 60°C and relative humidity from 30 to 80 %.

In the premises for storage should be no dust present as well as no acid vapours, no alcaline vapours and other aggressive vapours and ingredients causing corrosion.

12. POSSIBLE FAULTS AND METHODS OF THEIR ELIMINATION

12.1. Possible faults of the sensor, their causes and methods of their elimination are provided in the table 4.

Table 4

Name of the fault, external manifestation and additional features	Possible reason	Elimination method	Notes
Fault of resistance insulation when measuring resistance of a sensor unstable readings are registered, castings. Absence of the contact in the place of connection of a sensor.	Ingress of moisture or soiling of the contacts connecting a sensor to the measuring circuit.	Check and provide a reliable contact. Wash the connection contacts by rectified spirit State Standard 18300, dry at the temperature (65 ± 5) °C	

13. ACCEPTANCE CERTIFICATE

The platinum standard vibration-proof resistance sensor ПТСВ-_____ factory number №_____ safety category ___4____ by ОПБ-88/97 produced and accepted in accordance with obligatory requirements of state standards, actual technical documentation and admitted fit for operation.

Head of the quality control department

S.P. _____ _____
(personal signature) (transcript of the signature)

_____
(year, month, date)

14. PACKAGING CERTIFICATE

The platinum standard vibration-proof resistance sensor ПТСВ-_____ factory number №_____ packed by the science – production company «ELEMER» according to requirements, set by designer's documentation.

Package data _____

S.P.

Packed by _____
(signature)

The product was accepted after packaging _____
(signature)

15. MANUFACTURER'S GUARANTEE

15.1. The manufacturer guarantees correspondence of the sensor to requirements of technical conditions ТУ 4211-041-13282997-2002 provided all conditions of transportation, storage and operation set by technical conditions are adhered to.

15.2. Guarantee term of operation - 12 months from the selling date, in case of running hours not exceeding 1000 hours or 50 cycles of cooling - heating.

15.3. Guarantee does not cover sensors with mechanical damage.

16. RECLAMATION INFORMATION

16.1. In case of any fault or disrepair of a sensor during the period of guarantee obligations a client should compile a report. This report is sent to the manufacturing company for deciding the issue of a procedure of their elimination or the instrument replacement.

The address of the manufacturing company:

124460, Moscow, Zelenograd ,
korpus. 1145, entrance 1, SPC «ELEMER»

Tel : (495) 925-51-47
Fax: (499) 710-00-01
E-mail: elemer@elemer.ru

16.2. In this report the following information should be provided:

1) number, date of production and putting into operation of the sensor

2) nature of the fault

3) number of your contact telephone and address.

16.3. All reclamations are registered in the table 5.

Table 5

Concise content of the reclamation	Measures, taken on the reclamation	Date, signature of the person, responsible for instrument operation

17. OPERATIONS RECORDS

17.1 Records of operation of the sensor should be performed in the table 6.

Table 6

Date	Time		Number of hours and cycles	Running hours from beginning of operation (hours and cycles)	Signature of the operator	Position, Surname and signature of the registrar of Operation Manual
	Beginning of the work	End of the work				

Notes – The form is filled in during operation of the sensor.

18. PERIODICAL CONTROL OF BASIC OPERATION – TECHNICAL CHARACTERISTICS

18.1. Information on results of the primary and periodical verifications (calibration characteristics) are provided in the table 7.

Table 7

Verified characteristic	Date of measurements and results		
Name	_____200_г.	_____200_г.	_____200_г.
	Actual value	Actual value	Actual value
Resistance in the triple point of water Rттв, Ohm			
Relative resistance in the triple point of mercury W_{Hg}			
Relative resistance in the point of melting of gallium W_{Ga}			
The value of the function deviation by МТШ-90 at the temperature of indium hardening, ΔW_{In} and T, °C			
The value of the function of deviation by МТШ-90 at the temperature of tin hardening ΔW_{Sn} and T, °C			
The value of the function of deviation by МТШ-90 at the temperature of hardening of zinc, ΔW_{Zn} и T, °C			
The value of the function of deviation by МТШ-90 at the temperature 500 °C $W_{500°C}$ and T, °C			
The value of the constant of function of deviation by results of calibration of the sensor (according to State Standards Р 8.571 and methods of verification НКГЖ.408717.003МП) a в c M			

Notes - During verification calibration of the sensor is performed only at the temperatures required for computation of constants of the deviation function by МТШ-90 of its operational range of temperatures.

APPENDIX A

Main dimentions of the sensors ПТСВ-1, ПТСВ-2, ПТСВ-3, ПТСВ-4, ПТСВ-5

Modifica-tions	Designation	L, мм	I, ММ	D, мм	d, мм	Material ЧЭПТ
ПТСВ-1	НКГЖ.408717.009	595 ± 5	550 ± 5	22 ± 0.5	6 ± 0,2	Пл 0 0,05
	НКГЖ.408717.009-01	575 ± 5	530 ± 5	22 ± 0,5	6 ± 0,2	
ПТСВ-2	НКГЖ.408717.010	74 ± 1	50 ± 1	6 ± 0,2	4 ± 0,2	Пл2-АТ 0,03
ПТСВ-3	НКГЖ.408717.003	626 ± 5	550 ± 5	22 ± 0,5	6 ± 0,2	Пл 0 0,05
	НКГЖ.408717.003-00.01	426 ± 2	350 ± 2	22 ± 0,5	6 ± 0,2	
ПТСВ-4	НКГЖ.408717.003-01	629 ± 5	550 ± 5	22 ± 0,5	6 ± 0,2	Пл 0 0,05
ПТСВ-5	НКГЖ.408717.003-02	626 ± 5	550 ± 5	22 ± 0,5	6 ± 0,2	Пл2-АТ 0,04
	НКГЖ.408717.003-02.01	426 ± 2	350 ± 2	22 ± 0,5	6 ± 0,2	
ЧЭПТ	ЛАВГ.240.40.00.00	58 ± 1	50 ± 1	-	4 ± 0,2	Пл 0 0,05
	ЛАВГ.240.40.00.00-01	48 ± 1	40 ± 1	-	2,8 ± 0,2	Пл2-АТ 0,03
	ЛАВГ.240.40.00.00-02	58 ± 1	50 ± 1	-	4 ± 0,2	Пл2-АТ 0,04

APPENDIX Б

Computation of temperature using calibration characteristics of the sensor

Б.1. Calibration characteristics of the sensors are determined in the form of the function o0f the deviation ΔW/(T) relative to resistance of the sensor W(T) from the standard function МТШ-90 $W_{СТ}(T)$.

$$\Delta W/(T) = W(T) - W_{СТ}(T) \qquad (Б.1)$$

Б.2. The mode of the function of deviation for different ranges of temperatures are provided in the table Б.1

Table Б.1

Range of temperatures, ° C	Δ W(T)
Minus 200 - 0	M[W(T)-1]
0 -- 29.7646	a[W(T)-1]
0-0.156.598	a[W(T)-1]
0-231.928	$a[W(T)-1]+b[W(T)-1]^2$
0-419.527	$a[W(T)-1]+b[W(T)-1]^2$
0 - 660.323	$a[W(T)-1]+b[W(T)-1]^2+c[W(T)-1]^3$

Б.3. Coefficients, b, c, M of the function ΔW(T) are computed using the data of calibration of the sensor in defined points.

Б.4. In case of need this table of values of the function ΔW(T) are computed or W(T) depending o the temperature.

Б.5. Computation of the temperature by calibration characteristic of the sensor.

Б.5.1. According to the result of measurements of sensor resistance R(T) is calculated the following:

$$W(Tx) = R(Tx) / RT \qquad (Б.2),$$

where W(Tx) – relative resistance of the sensor at the temperature Tx;

R(Tx) – the resistance of the sensor at the temperature Tx, Ohm;

Tx - measured temperature, K;

RT - resistance of the sensor in the triple point of water, Ohm.

Б.5.2. If a calibration characteristic is provided in the form ΔW/(T), then for determination of the temperature the standard function МТШ-90 Wст(T) is used. In this case using the formulas of the table Б.1 is determined $\Delta W(T_x)$, and after that $W_{СТ}(TX)$ is computed using the formula (Б.1). The value of the temperature T_x corresponding to $W_{СТ}(T_X)$. is determined according to the dependence $W_{СТ}(T)$.

Б.5.3. The temperature value may be also calculated with the help of the reverse function МТШ-90 - T (W_{CT}).

Б.5.3.1. Within the range of temperatures from minus 196 to 0 °C the reverse function T (W_{CT}) will have the following form:

$$T(W_{CT})/273.16 = B_0 + \sum_{i=1}^{i=15} Bi \frac{\left\{W_{CT}(T)^{1/6} - 0.65\right\}^i}{0.35}$$

The values of coefficients Bo, Bi are provided in the table Б.2.

Б.5.3.2 Within the range of temperatures from 0 to 660.323 °C the reverse function T (WCT) will have the following form:

$$T(W_{CT}) - 273.15 = D_0 + \sum_{i=1}^{i=9} Di \left\{ \frac{W_{CT}(T) - 2.64^i}{1.64} - \right\}$$

The values of coefficients Do, Di are provided in the table Б.2.

The values of coefficients Bo, Bi, Do, Di of standard functions

Table Б.2

Bo	0.183324722	D_0	439.932854
B_1	0.240975303	D_1	472.418020
B_2	0.209108771	D_2	37.684494
B_3	0.190439972	D_3	7.472018
B_4	0.142648498	D_4	2.920828
B_5	0.077993465	D_5	0.005184
B_6	0.012475611	D_6	-0.963864
B_7	-0.032267127	D_7	-0.188732
B_8	-0.075291522	D_8	0.191203
B_9	-0.056470670	D_9	0.049025
B_{10}	0.076201285		
B_{11}	0.123893204		
B_{12}	-0.029201193		
B_{13}	-0.091173542		
B_{14}	0.001317696		
B_{15}	0.026025526		

Б.5.4. If calibration characteristic is presented in the form of the table of values W(T), then the value of the temperature is determined by the value W(Tx), calculated by Б.2.