“KREIT”

Calculating and Measuring Transducers TEKON-19 (02M – 06M, 10M, 11, 15, 15M versions)

Operating Manual

T10.00.60 РЭ

Ekaterinburg

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TABLE OF CONTENTS

This Manual covers the TEKON-19 calculating and measuring transducers of **02M - 06M, 10M, 15M, 11, and 15 versions**, and the 'Verification' section is applied to **all versions and modifications** (hereinafter referred to as the 'TEKON-19' or the transducers).

This Manual (except for 'Verification' section) is not applicable to the TEKON-19 **with software version below 95.03.**

The operational documentation for the TEKON-19 consists of this Operating Manual, including the verification procedure and Certificate T10.00.60 ПС.

In terms of stability and resistance to the impact of environmental conditions and mechanical loads, the TEKON-19 corresponds to the C3, P1, V1 versions according to GOST R 52931 (for the 'T' option and 15 - C2, P1, V1 versions).

Number in the National Register of Measuring Equipment of the Russian Federation: ***61953-15.***

Certificate of compliance to Oil and Gas Industry Safety Regulations ***No. C-EPB.001.TU.00553*** for operation at hazardous production facilities regulated by Federal Service for Environmental, Technological and Nuclear Supervision**.**

Customs Union (CU) Declaration ***No. RU D-RU.A301.B.01004*** of compliance with the requirements of TR CU 020/2011 "Electromagnetic compatibility of technical means".

The TEKON-19 complies with the "Rules for the fiscal metering of heat energy and heat carrier" introduced by the Decree of the Government of the Russian Federation No. 1034 of 18/11/2013.

List of symbols and abbreviations:

ADC	АЦП	analog-to-digital converter
DB	БД	data base
MT	ИП	measuring transducer
MC	ИК	measuring channel
MS	ИС	measuring system
CS	КС	control sum;
SW	ПО	software;
PC	ПК	personal computer IBM/PC;
MI	СИ	measuring instrument;
RTC	ТСМ	copper resistance thermotransducer;
RTP	ТСП	platinum resistance thermotransducer;
G	-	consumption of the medium (energy);
R_0	-	resistance value of RTC and RTP at a temperature of 0°C;
W_{100}	-	ratio of the resistance of RTC and RTP at 100°C to the resistance at 0°C;
P	-	pressure in the pipeline;
Q	-	heat energy;
t	-	temperature in the pipeline;
τ	-	time.
KREIT	КРЕЙТ	
TEKON-19	ТЭКОН-19	

SPECIAL OPERATION GUIDELINES

▪ The **main** digital CAN-BUS interface is used in order to address the TEKON-19 parameters during operation. It is an internal bus of measuring complexes based on the TEKON-19 controllers. The CAN-BUS interface is **NOT ALLOWED** to be used for direct connection of non-complex equipment; the connection to the PC should be performed **only** through the appropriate adapters manufactured by the manufacturer and the data communication equipment of data link channels.

The software that supports controller exchange protocols, for example, the Teleport technological program, software complex ISKRA, etc., supplied by the manufacturer, shall be used for operation.

▪ RS-232 TTL Interface is an **Optional (technological) interface. IT IS PROHIBITED** to use the technological interface to create dispatching systems, it is intended **only for connecting the technological data communication equipment of the manufacturer** RI-97 and RI-197 data recorders, RS-232 T20 T10.00.92 USB adapter)

▪ Digital filters on the pulsed measuring channels (MC) are designed to filter out high-frequency interference, for example, the contacts bounce of the measuring transducer (MT).

The digital filters of the corresponding MC for MT with a maximum pulse repetition rate **exceeding 100 Hz shall be switched off.**

The digital filters of the corresponding MC for MT with a maximum pulse repetition rate **below 100 Hz shall be switched on.**

▪ Zero values shall be assigned to all accumulated parameters when commissioning. This procedure is performed by recording “1” in the parameter 0302 “XRAM information clearance”. After this procedure, the value of the parameter 0302 is reset automatically. The fact of "clearance" is recorded in the system log.

▪ **IT IS PROHIBITED** to switch off the power supply of the transducer during entering parameters into the TEKON-19 through any digital interface. It can lead to transducer failure, and repair by the manufacturer may become necessary in order to resolve this issue.

▪ It may be necessary to replace the stationary backup battery after long-term storage or service with a power outage of a total duration exceeding 10 months.

▪ The TEKON-19 repair is performed by the manufacturer or authorized service centers.

The preservation of settings and accumulated information in the device **memory is not guaranteed** in case of repair. It is necessary to carry out pre-commissioning activities before commissioning after the repair.

1 SAFETY REQUIREMENTS

1.1 The TEKON-19 provides protection of personnel against electric shock according to class III of GOST 12.2.007.0.

1.2 Only persons with at least secondary technical education, trained in electrical safety for operation with units under voltage of up to 1,000 V and familiarized with this Operating Manual are allowed to work with the TEKON-19 transducer.

1.3 It must be communicated to the responsible authority that the protection provided by the transducer may be ineffective if it is operated in a manner not specified by the manufacturer.

2 DESCRIPTION AND OPERATION OF THE TRANSDUCER

2.1 Purpose of the device

The TEKON-19 transducers are designed to measure the signals of primary measuring transducers (MT) and convert them into the corresponding physical values measured by the MT, with subsequent calculation of the flow rate, volume and mass of liquids, including water, oil and petroleum products, gases and gas mixtures, including the amount of water vapour, gas distillate and wet petroleum gas, oxygen, carbon dioxide, nitrogen, argon, hydrogen, acetylene, ammonia, bringing it to standard conditions, thermal energy, electricity, accumulation, averaging and archiving measured and calculated parameters at predetermined time intervals.

The field of application includes measuring systems of fiscal metering and automated and processes control at industrial enterprises, heat substations, heat stations, power plants, gas distribution stations, oil and gas producing enterprises, municipal enterprises and the refrigerating industry.

2.2 Features

2.2.1 The TEKON-19 versions

2.2.1.1 TEKON-19 with application as per cl. 2.1 is available in 9 versions - (02M - 06M), 10M, 11, 15, 15M, differing by sets of measuring channels (MC) and digital interfaces, availability of control and indication elements, as well as by sets of functions included in the software in accordance with tables 2.1 to 2.3.

Each version of the TEKON-19, except for version 15, is available in two versions - the basic version and the 'T' version differing by the range of ambient temperature within operating conditions. Version 15 is available only in an extended ambient temperature range.

2.2.1.2 The front panel appearance is shown in Figure 2.1. Terminals numbering is from left to right, firstly in the bottom row and then in the top row.

Table 2.1 – The TEKON-19 versions

Parameter description	Parameter values (parameter availability) for versions								
	02M	03M	04M	05M	06M	10M	11	15	15M
Body standard size, mm	70	70	70	70	105	105	70	70	70
Number of resistance MC	1	3	–	2	4	4	–	–	–
Number of current rate MC, pcs.	3	–	–	2	3	–	4	–	–
Number of frequency MC and number of pulses MC, pcs.	4	3	8	3	4	7	–	–	–
HART, RS-485 interfaces	–	–	–	–	–	–	–	+	+
Clock, keyboard, display, technological interface	+	+	+	+	+	+	–	+	+
Figure 2.1 option	a	a	a	a	c	c	b	a	a

2.2.2 The TEKON-19 software

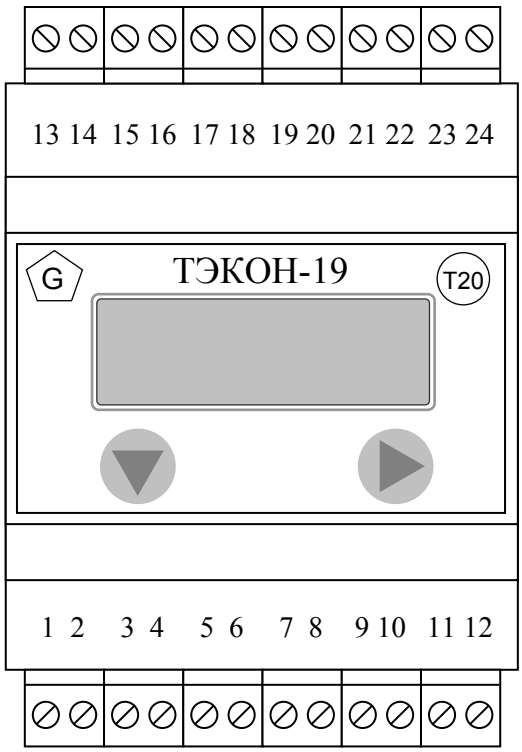
2.2.2.1 The TEKON-19 uses embedded software. The software is divided into the metrologically significant part and the metrologically insignificant part. The identification data of the metrologically significant part of the software used in the TEKON-19 is specified in table 2.2.

Access required to change the parameters and configuration of the TEKON-19 is protected by passwords, which are 8-bit hexadecimal integers.

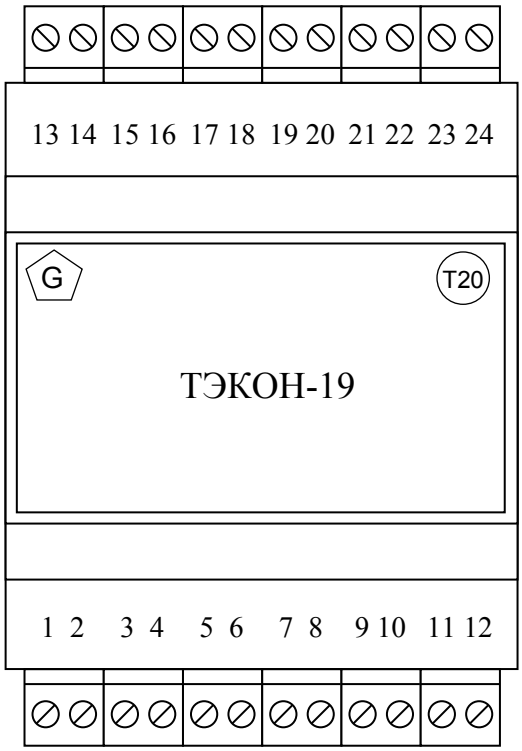
The TEKON-19 software protection level against unintended and deliberate modifications is "high" as per Recommendations P 50.2.077-2014.

The TEKON-19 software corresponds to the GOST R 8.654-2009 requirements.

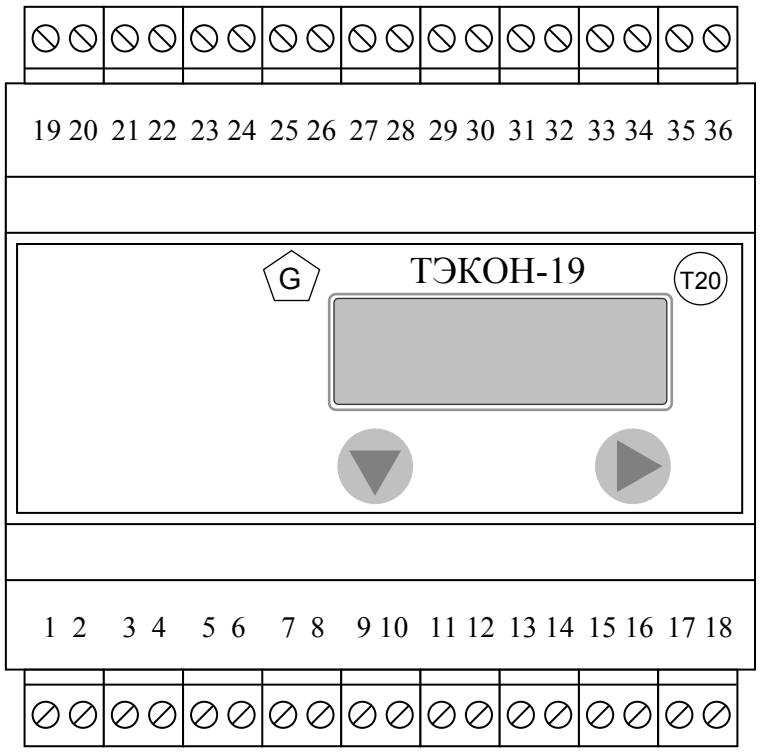
2.2.2.2 The TEKON-19 software includes a set of algorithms to perform basic functions and various calculation, archive and other loadable user tasks depending on the version. An overview of the basic and loadable algorithms is specified in Table 2.3. A detailed list of algorithms is specified in Table B.2 of Annex B. The total number of loadable tasks is up to 256.



a)



b)



c)

Figure 2.1 – The TEKON-19 front panel view and terminals numbering for various versions:
a) – body 70, b) – body 70 without indication, c) – body 105.

Table 2.2 – Software identification details

Identification details (characteristics)	Value			
Software Identification Name	TEKON19-M T10.06.245	TEKON19-M1 T10.06.292	TEKON19-M1 T10.06.292-04	TEKON19-M1 T10.06.292-05
Software version number (identification number)	xx.04	xx.03	04.xx	05.xx
Software digital identifier	39A1B57A	8BF2C4A6	6CFB18A0	CF5A88D2
Algorithm for software digital identifier calculation	CRC32	CRC32	CRC32	CRC32

Table 2.2 continuation

Identification details (characteristics)	Value			
Software Identification Name	TEKON19-M2 T10.06.362-05	TEKON19-11 T10.06.170	TEKON19-15 T10.06.319	TEKON19-15 T10.06.319-05
Software version number (identification number)	05.xx	xx.03	03.xx	05.xx
Software digital identifier	4DA5342F	7AC358D4	BDD26C10	2C48153D
Algorithm for software digital identifier calculation	CRC32	CRC32	CRC32	CRC32

(Revision, Amendment No. 3).

Table 2.3 – The TEKON-19 main tasks

Name	Qty
Basic tasks	
System functions, time, date and status indication on the screen	1
Time measurement, calendaring	1
Resistance and current measurement on analog MC	up to 7 **1)**
Frequency and number of pulses measurement on impulse-number MC	up to 8 **1)**
Recording of the current condition of impulse-number MC	up to 8 **1)**
Receiving data from primary MTs directly via the HART interface channel	up to 16**1)**
Receiving data from primary MT with digital interface outputs (HART, Modbus, etc.) via the Can Bus interface and the corresponding interface adapters manufactured by the manufacturer	up to 16**1)**
Receiving data from primary MT via the HART interface channel	up to 16**1)**
Information exchange through the Can Bus, RS-485 interface channels, and technological exchange	up to 3 **1)**
Display and correction of the required parameters via the screen menu	up to 200
Viewing archived parameters via the screen menu	up to 56
Viewing parameters in the screen cyclic menu	up to 10
TEKON-19 self-monitoring, event and intervention logging	1

Table 2.3 continued

Name	Qty
Set of functions for loadable tasks (in all versions except for 11)	
Calculation of temperature based on temperature resistance measured by MT[2)]	up to 256
Calculation of physical values based on MT measured current (pressure, differential pressure, flow, etc.) [2)]	up to 256
Calculation of the medium flow rate in MT measurement units based on MT frequency [2)]	up to 256
Calculation and accumulation of flow rate, volume and mass of fluids[2)], gases and gas mixtures according to table 3: - using an orifice plate according to GOST 8.586.5-2005 - using an ISA 1932 nozzle according to GOST 8.586.5-2005 [2)] - using TORBAR averaging pitot tubes according to Procedure MI 3173 - using ANNUBAR 485 flow averaging tubes according to Procedure MI 2667-2011 - by the calculated volumetric flow rate, temperature and pressure [2)] - by the number of pulses from the MT, calculated temperature, pressure [2)]	 up to 8 up to 8 up to 8 up to 8 up to 8 up to 8
Calculation of heat energy in a closed or open heat supply system, or in a separate heating pipeline based on calculated values of mass, temperature and pressure in accordance with MI 2412-97, MI 2451-98 and the 'Rules of fiscal metering of heat energy and heat carrier', approved by the Decree of the Government of the Russian Federation No.1034 of 18.11.2013 [2)]	up to 8
Accumulation of electric energy based on the number of pulses from the electricity meter with impulse-number output [2)]	up to 8
Performing of arithmetic, algebraic and logical operations with the parameters	up to 256
Parameter conversion using piecewise linear interpolation method	up to 2
Accumulation of cumulative values of the parameter by intervals, hours, days, months	up to 256
Calculation of parameters average values by intervals, hours, days, months	up to 256
Calculation of weighted-average flow and temperature values by intervals, hours, days, months	up to 256
Archiving of parameters by intervals from 1 to 30 minutes, archive depth is from 1 day to 3 months (1,440 values)	up to 256
Archiving of parameters by hours, archive depth is 16, 32 or 64 days	up to 256
Archiving of parameters by days, archive depth is 1 year	up to 256
Archiving of parameters by month, archive depth is 1 or 4 years	up to 256
Calculation of parameters extreme values by intervals	up to 256
Assessment of the MT condition and overrunning of controlled parameters over the technological settings	up to 256
Parameter input via CAN BUS interface from other modules	up to 128
Time tracking of serviceable and malfunctioning operation	up to 256

Telesignalization	up to 8
Note: 1) By the number of channels in the version 2) Only for versions (02M – 06M), 10M, 15M	

2.2.2.3 The TEKON-19 performs calculations using the following methods:

- flow rate, volume and mass of gases and gas mixtures, including natural and wet petroleum gas, oxygen, carbon dioxide, nitrogen, argon, hydrogen, acetylene, ammonia based on the MT measured signals of flow rate, pressure, temperature and density data under standard conditions calculated or obtained via digital information channel, atmospheric pressure and gas composition converted to standard conditions according to GOST R 8.740-2011, GOST 8.611- 2013, MI 3213-2009, GOST 30319.1-3-2015, Reference data GSSSD MR 113-03, GSSSD MP 118-05, GSSSD MP 134-07
- flow rate, volume and mass of fluids, including water according to MI 2412-97, petroleum and petroleum products in accordance with R 50.2.076-2010, using MT measured signals or flow rate, pressure and temperature data obtained via digital information channel.
- flow rate, volume and mass of fluid, gases and gas mixtures using diaphragms and an ISA 1932 nozzle in accordance with GOST 8.586.5-2005 using MT measured signals or pressure, differential pressure on the diaphragm (nozzle) and temperature data obtained via digital information channel.
- flow rate, volume and mass of liquids, gases and gas mixtures using TORBAR and ANNUBAR 485 averaging pitot tubes in accordance with MI 3173-2008, MI 2667-2011 using the MT measured signals or pressure, differential pressure and temperature data obtained via digital channel;
- flow rate, volume and mass of water vapour based on the MT measured signals or flow rate, pressure and temperature data obtained via digital information channel with the ability to calculate pressure based on measured temperature and temperature based on measured pressure on the saturation curve.
- thermal energy produced or consumed in an element of a heating supply or cooling system based on results of mass, temperature and pressure determination in accordance with GOST R 51649-2014, GOST R EN 1434-1-2011, GOST R 8.728-2010, MI 2412-97, MI 2451-98 and the 'Rules of Fiscal Metering of Heat Energy and Heat Carrier', approved by the Decree of the Government of the Russian Federation No. 1034 of 18.11.2013.
- electric energy in case of application of two-rate metering separately for each rate interval. ***(Revision, Amendment No. 3).***

2.2.2.4 Calculation of the volumetric flow rate of all types of gases carried out by bringing its value to standard conditions in accordance with GOST 2939-63 (temperature: 20° C, atmospheric pressure: 760 mm Hg).

2.2.3 Metrological and technical features of the TEKON-19 are represented in table 2.4.

Table 2.4 – Metrological and technical features of the TEKON-19

Feature description	Value
Permissible absolute error limits:	
- Resistance MC, Ohm, ranging (from 50 to 250) Ohm	± 0.04
- Resistance MC, Ohm, ranging (over 250 and up to 1,000) Ohm	± 0.2
- Resistance MC, Ohm, ranging (over 1000 and up to 4,000) Ohm	± 2
- Current rate MC, mA, ranging (from 0 to 5) mA	± 0.005
- Current rate MC, mA, ranging (over 5 and up to 20) mA	± 0.02
- Frequency MC, Hz, ranging (from 0 to 1,000) Hz (pulse duration not less than 200 μs)	± 0.2
- Impulse quantity MC, ranging (from 0 to 10^6) pulses (pulse frequency (from 0 to 100) Hz, duration not less than 4 msec)	± 1
Permissible conventional error limits for temperature calculation, %	
RTC according to GOST 6651-2009 ranging (from -73.15 to +200) °C	± 0.002
RTP, according to GOST 6651-2009 ranging (from -73.15 to +600) °C	± 0.004
The limits of the permissible conventional error for calculating of pressure, differential pressure and other physical values measured by the MT including unified current output signals with a linear characteristic based on the MT measured current value, %, within the measuring range of the MT	± 0.0001
Watch rate permissible error limits, sec	± 9
Permissible relative error limits for calculations of, %:	
- flow, volume and mass of gases and gas mixtures brought to standard conditions, ranging (from 10^{-6} to 10^6) m^3/h, m^3, t, t/h when measuring the flow:	± 0.005
- with an orifice plate in accordance with GOST 8.586.5-2005	± 0.03
- IRVIS-K-300 flow meters	
- gas flow or volume MT with unified linear output signals, including turbine, rotary and vortex flow meters and counters according to GOST R 8.740-2011	± 0.005
	± 0.1
- with flow averaging tubes ANNUBAR 485 according to MI 2667	± 0.1
- with averaging pitot tubes TORBAR according to MI 3173	
- flow, volume and mass of crude oil and refined products ranging (from 10^{-6} to 10^6) m^3/h, m^3, t, t/h	± 0.03
- flow, volume and mass of fluids, including water, and water vapor, ranging (from 10^{-6} to 10^6) m^3/h, m^3, t, t/h	± 0.05
- thermal energy, ranging (from 10^{-6} to 10^6) Mcal, Gcal, MJ, GJ *)	± 0.15
- electrical energy ranging (from 10^{-6} to 10^6) kWh	± 0.0001
- when performing arithmetic operations with the parameters	± 0.0001
Note: *) In an open heat supply system when the ratio of the mass of water in the supply (m_{SUP}) and reverse (m_{REV}) pipelines is expressed in the same measurement units: $m_{SUP}/m_{REV} \leq 0.96$)	

2.2.4 The total error of the TEKON-19 when measuring temperature, pressure, differential pressure, flow rate, volume, and other physical values measured by primary MT connected to the MC of the transducer are calculated using the following formulas:

$$\Delta(t_{Tc}) = \pm\sqrt{\left(\frac{\Delta(R)}{A \cdot R_0}\right)^2 + \left(\frac{\gamma_{П}(t) \cdot (t_{max} - t_{min})}{100}\right)^2}, \quad (2.1)$$

where **$\Delta(t_{Tc})$** – permissible absolute error limits of the TEKON-19 when measuring temperature (RT), °C,

$\Delta(R)$ – limit of permissible absolute error of resistance measurement according to table 2.4, Ohm,

R_0 – resistance of temperature MT at 0°C, Ohm,

A – equation coefficient in accordance with GOST 6651, equal, for example, to 0.0039692°C^{-1} for RTP with W_{100}=1.391 and 0.00428 °C^{-1} for RTC with W_{100}=1.428,

$\gamma_{П}(t)$ – limit of permissible conventional error of temperature measurement according to table 2.4, %.

T_{max} , t_{min} – upper and lower limits of the temperature measurement according to table 2.4, °C.

$$\gamma(P) = \pm\sqrt{\left(\frac{\Delta(J)}{J_{max} - J_{min}} \cdot 100\right)^2 + \gamma_{П}(J \to P)^2}, \quad (2.2)$$

where **$\gamma(P)$** – limits of permissible conventional error of the TEKON-19 when measuring pressure, differential pressure and other physical values measured with primary MT with current output signal, %,

J_{min} , J_{max} – values of an MT output signal at minimum and maximum value of the measured value, accordingly, mA,

$\Delta(J)$ – limit of permissible absolute error of current measurement within the range corresponding to the range of the MT signal, according to table 2.4, mA,

$\gamma_{П}(J \to P)$ – limit of permissible conventional error for calculation of pressure, differential pressure and other physical values measured with MT with unified linear current output signals based on the MT measured current rate value according to table 2.4, %.

$$\delta(G) = \pm\sqrt{\left(\frac{\Delta(F) \cdot \tau_{мгн}}{F_{min} \cdot \tau_{уср}} \cdot 100\right)^2 + \delta_{П}(X)^2}, \quad (2.3)$$

where **$\delta(G)$** – limits of the permissible conventional error of the TEKON-19 when measuring the flow rate with flow meter with a frequency output, %,

$\Delta(F)$ – limit of the permissible absolute error for frequency measurement according to table 2.4, Hz,

F_{min} – frequency value at minimum estimated flow rate value, Hz,

$\tau_{МГН}$ – measurement time for instantaneous frequency determination (8 s),

$\tau_{уср}$ – estimated period of flow value averaging (5 minutes, hours, day, month, year), s,
$\delta_{П}(X)$ – limit of the permissible relative error when performing arithmetic operation with the parameters in accordance with table 2.4, %.

$$\delta(V) = \pm\sqrt{\left(\frac{\Delta(N)\cdot V_{имп}}{G_{\min}\cdot\tau_{изм}}\cdot 100\right)^2 + \delta_{П}(X)^2}\ , \qquad (2.4)$$

where **δ(V)** – limits of the permissible relative error of the TEKON-19 when measuring the volume (mass) with a flow meter with an impulse-number output, %,
Δ(N) – limit of the permissible absolute error for measuring the number of pulses according to table 2.4, pcs.,
$\mathbf{G_{min}}$ – minimum estimated flow rate value, m^3/h,
$\mathbf{V_{имп}}$ – weight of MT impulse, m^3,
$\tau_{изм}$ – estimated period of volume measurement (5 minutes, hour, day, month, year), h,
$\delta_{П}(X)$ – limit of the permissible relative error when performing arithmetic operation with the parameters in accordance with table 2.4, %.

The limits of permissible error calculated using formulas (2.1 - 2.4) for certain types of primary MTs are shown in table 2.5.

The ranges of the medium measured parameters within which calculations are performed are shown in table 2.6.

The limits of the permissible relative error for calculation of parameters of certain media depending on the type of the measurement medium and method are shown in table D.1 of Appendix D.

Table 2.5 – Permissible error limits for conversion of signals of certain primary MTs.

Parameter measured, UM	Name and type of MT	Range		Permissible error limits	
		MIN	MAX	Designation	Interval
Temperature, °C	RTC-50, W_{100}=1.428 RTP-50, W_{100}=1.391	0 0	200 400	$\Delta(t_{тс})$, °C	± 0.2
	RTC-100, W_{100}=1.428 RTP-100, W_{100}=1.391 RTP-500, W_{100}=1.391	-50 -50 -50	200 400 400	$\Delta(t_{тс})$, °C	± 0.1
	RTP-1000, W_{100}=1.391	-50	400	$\Delta(t_{тс})$, °C	± 0.5
Pressure, kgf/cm^2, MPa	MT with outputs 0-5, 0-20 mA	0	P_{max}	γ(P), %	± 0.1
Differential pressure, kgf/cm^2, kPa	MT with outputs 0-5, 0-20 mA	0	ΔP_{max}	γ(ΔP), %	± 0.1
Pressure, kgf/cm^2, MPa	MT with outputs 4-20 mA	0	P_{max}	γ(P), %	± 0.13
Differential pressure, kgf/cm^2, kPa	MT with outputs 4-20 mA	0	ΔP_{max}	γ(ΔP), %	± 0.13

Table 2.6 – Ranges of the medium parameters being measured

Media	Temperature, °C	Pressure, MPa

	minimum	maximum	minimum	maximum
Water	0	200	0.1	5.0
Vapour	100	600	0.1	30.0
Natural Gas	-23.15	76.85 [1)]	0.1	30.0 [1)]
Pressurised Air	-50	120 [5)]	0.1	20.0 [5)]
Petroleum Gas	-10	226	0.1	15.0
Oxygen, azote, argon, hydrogen ammonia [3)]	-73.15	151.85	0.1	10.0
Carbon dioxide, acetylene [2)]	-53.15	151.85	0.1	10.0
Gas mixture [4)]	-73.15	126.85	0.1	10.0
Crude oil and refined products	-50	100	0.1	10

Notes:

1) For transducers equipped with software 'TEKON19-M1 T10.06.292-05', 'TEKON19-M2 T10.06.362-05', 'TEKON19-15 T10.06.319-05' version 05.xx; for other transducers or when measuring flow rate with an IRVIS-K-300 flow meter, the pressure measurement range is (from 0.1 to 7.5) MPa, the temperature measurement range is (from -23.15 to +50) °C.
2) The lower limit of permissible temperature is determined by the pressure value.
3) The physical state of ammonia (gas or liquid) for any combination of temperature and pressure in the specified range is determined automatically.
4) The lower limit of temperature is determined by the composition of gas mixture and pressure.
5) For the Annubar tube, the maximum temperature is 100°C, pressure – 9 MPa.

(Revision, Amendment No. 3).

2.2.5 The TEKON-19 (except version 11) provides programming (adjusting) for a specific technological facility using a PC by setting the desired project, i.e. an executable set of tasks and a list of parameters to be displayed, as well as types and features of primary MTs. Type projects recommended for use for most customers are contained in the database (DB) supplied on the CD together with the TEKON-19. There is an opportunity to create a project independently, which is different from the standard one.

The TEKON-19 can be connected to a PC for programming via RS-232 TTL technological interface, the CAN-BUS basic digital interface, or an additional RS-485 interface (versions 15, 15M) via the corresponding adapters manufactured by the manufacturer and communication equipment of information communication channels.

2.2.6 The TEKON-19 provides the ability to calculate the average time values of any calculated parameters at specified intervals of time – estimated intervals with a duration from 1 to 30 minutes, hours, days, months.

2.2.7 The TEKON-19 provides the ability to calculate the flow-weighted average of temperature and pressure of the measured medium for specified intervals of time – calculation intervals from 1 to 30 minutes, hours, days, months.

2.2.8 The TEKON-19 provides the ability to archive values of any calculated parameters for specified intervals of time – calculation intervals from 1 to 30 minutes, hours, days, months.

2.2.9 The TEKON-19 provides the ability to accumulate any integral parameters in the range of 0 to 10^6 units. When the corresponding integral meter exceeds 10^6, the parameter integer part is counted again from zero, the fractional part is retained.

2.2.10 The TEKON-19 provides bit signs recording of the current state of each of the input frequency-number-pulse MC.

2.2.11 The TEKON-19 provides communication of any measured and calculated parameters via the main digital CAN-BUS interface or the additional RS-485 interface (versions 15, 15M) via the corresponding adapters produced by the manufacturer and communication equipment of information communication channels on the PC request.

2.2.12 The TEKON-19 (except version 11) provides the ability to display date and time on the two-line screen, as well as the selected parameters along with their names, in the main menu, the archive menu and the cyclic menu. The main menu can include up to 200 parameters, and the archive menu can include up to 56 archive parameters with possible view of each archive to the full depth. The displayed parameter is selected by means of two menu scroll buttons located on the front panel. The cyclic menu can include up to 10 parameters. All menu types are set up at the commissioning stage. The display format is configured for each item separately, the number of decimals (from decimal point) is from 0 to 4, and the total number of characters is up to 8. The name length is up to 12 characters of the Russian and Latin alphabets. The parameters of the main menu can be adjusted if necessary after obtaining the appropriate level of access.

2.2.13 The TEKON-19 provides keeping the system log with information on the last 256 events – power on and off, recording of new parameter values, occurrence and disappearance of failures, keeping of intervention log with modification of parameter values (see 2.3.8). It is possible to generate one or several user event logs with information on the events of status change of the bit parameters set duting configuration.

2.2.14 The TEKON-19 ensures that information on the entered constants, tasks and characteristics entered in the reprogrammable read-only memory with electric information erasure and recording (Data ROM, Program ROM) is stored without distortion during the whole service life. The number of overwriting cycles is up to 100,000.

2.2.15 The TEKON-19 ensures that information on all measured, calculated, accumulated and archive parameters as well as date and time are stored in the random-access memory provided with the lithium battery (External RAM) backup power without distortion for 10,000 hours since the power supply cut off.

2.2.16 The TEKON-19 main power supply is an external DC source with voltage Uп from 18 to 36 V. Maximum power consumption for any version is 6 W.

Table 2.7 – Standard current consumption at the main power input depending on the version and the supply voltage (Uп)

The TECON 19 versions	Current consumption, mA	
	Uп = 24 V	Uп = 18 V
02M, 03M, 04M, 05M, 06M, 10M,15, 15M	90	110
11	120.. 240 *)	120..240 *)
Note: *) depends on the number of connected MTs powered by the TEKON-19-11, and the current growth at the moment		

Table 2.8 – Standard current consumption at power input of frequency MC depending on MC configuration, input voltage (Uпд) and MT input condition

MC configuration	Current consumption, mA/channel			
	Uпд = 24 V		Uпд = 12 V	
	1)	2)	1)	2)
MC is configured according to fig. 3.3, A	0	15	0	7
MC is configured according to fig. 3.3, B, C	0	5	0	2.5
MC is configured according to fig. 3.3, D	5	10	2.5	4.5
Notes: 1) open-circuit MT output (in passive condition) 2) closed MT output (in active condition)				

There is a separate power input for this MC type from an external source with voltage Upd from 10 to 28 V in TEKON-19 versions with measuring channels of frequency and number of pulses. Maximum power consumption is 0.5 W per a channel. Typical current consumption values depending on the version and other conditions are shown in tables 2.7 and 2.8.

2.2.17 The TEKON-19 (version 11 only) provides galvanic isolation of analog measuring channels from each other (and not only from power supply circuits). The insulation parameters are similar to 2.2.18. To power the measuring transducers connected to these MCs, the TEKON-19-11 generates four mutually isolated secondary voltages from its own supply voltage. Thus, the TEKON-19-11 can function as a MT power supply unit. Secondary power supplies have the rated (stabilized) voltage of 24V±1V, the permissible load current is up to 50 mA.

2.2.18 Insulation of measuring electric circuits in relation to the power supply circuits withstands a test voltage of almost sinusoidal shape with the amplitude of 500 V, frequency from 45 to 65 Hz during 1 minute under normal climatic conditions.

2.2.19 The minimum permissible electrical resistance of the electrical power circuits insulation in relation to the body is at least 20 MOhm under normal climatic conditions.

2.2.20 The TEKON-19 is ambient temperature and humidity resistant according to design category C3 as per GOST R 52931 (for the “T” option and version 15 to C2 category).

2.2.21 The TEKON-19 is atmospheric pressure resistant according to design category P1 as per GOST R 52931.

2.2.22 The TEKON-19 is mechanical loads resistant according to design category V1 as per GOST R 52931.

2.2.23 TEKON-19 ingress protection corresponds to protection degree IP20 as per GOST 14254.

2.2.24 The TEKON-19 is resistant to the climatic factors and mechanical loads effects in transport packaging during transportation by road and railroad, as well as by airsraft transport in sealed and heated compartments in accordance with GOST R 52931.

2.2.25 The TEKON-19 meets the electromagnetic compatibility requirements of TR CU 020/2011

(Revision, Amendment No. 3).

2.2.26 The TECON-19 overall dimensions do not exceed 105x110x60 mm.

2.2.27 The TECON-19 mass does not exceed 0.5 kg.

2.2.28 Mean time between failures is 70,000 h. Failure criterion is nonconformance to the ТУ 4213-060-44147075-02 requirements.

2.2.29 The average service life is 12 years. The limit state criterion is the repair costs exceeding 50% of a new unit price.

2.2.30 Mean time to recovery does not exceed 4 h.

2.3 Transducer design and operation

2.3.1 Parameter system and software

2.3.1.1 All data necessary for configuring the TEKON-19 and getting results of its work during operation are available through its interfaces using a **parameter system** stored in the PC database. Each transducer within the system is considered to be the T20 system **module**. Its software consists of a set of **tasks** that process **input parameters** and **constants** following specified **algorithms**, and result in the **output parameters**.

Parameters and tasks are divided into **basic** and **loadable** ones.

2.3.1.2 A **constant** is a numerical value set at the stage of creating a loadable project (the first stage of configuration) unavailable for reading and modification after loading the project into the controller.

2.3.1.3 A **parameter** is a unit of data available for reading and recording. Each **parameter** inside the module is characterized by two names (full and short), its number, purpose, access level, memory location and internal representation. Parameters of **basic** tasks have uniquely defined **hard** numbers that are the same for all the TEKON-19 transducers of this version. Parameters used to make a **loadable** project have **flexible** numbers that are assigned to them at the stage of creating a loadable project and may vary in different projects.

Parameter values, including constant ones, as opposed to **constants**, can be set or changed during the second stage of configuration or during operation.

Parameters are grouped according to their tasks and they form the so-called **parameter tree**.

PC access to a parameter is performed through its number. The parameter numbers correspondence to their name, access level, internal representation and location in the transducer memory is described in the T20 system database located on the PC disk and can be specified in the project loaded into the transducer which can also be stored on the PC disk for convenience.

2.3.1.4 **Basic** tasks are included in the TEKON-19 **basic** software and are components of its operating system. Composition of basic tasks is unchanged for each transducer version. All input and output parameters of basic tasks are **hard (basic).** A summary list of basic tasks and version parameters is specified in Table. B.1 of Annex B.

2.3.1.5. **Loadable** tasks included in the project are loaded at the first stage of the TEKON-19 configuration for each specific application. They compose the **task queue** executed during operation, which forms all the required output parameters. Most parameters for loadable tasks are **flexible**. A loadable task queue is generated based on the database **algorithms**. A summary list of the TEKON-19 algorithms is specified in Table B.2 of Annex B.

2.3.1.6 The loadable tasks are performed by the TEKON-19 operating system in the **background** cycle in accordance with their position in the queue. The program background cycle duration depends on the number and type of loadable tasks, ranges from 1 to 15 seconds, and the basic software always rounds it to an integer number of seconds.

2.3.1.7 All parameters of any module can be accessed via the RS-232 TTL technology interface for their configuration, or via the CAN-BUS digital interface using the corresponding adapters produced by the manufacturer and communication equipment of data link channels for configuration and dispatching.

The PC software for setting the parameter values is supplied on a CD in set with the TEKON-19 (software Teleport T10.06.208). Dispatch software should be purchased separately.

The most important operation parameters can be displayed on the screen via the screen “menu” on the TEKON-19 front panel.

2.3.1.8 All the parameters are divided into the groups according to their application:

- Factory constants (“FC” in the list of parameters tables) characterizing the design features and electrical characteristics of the transducer equipment. The FC values are entered by the TEKON-19 manufacturer and do not change in the process of operation.

- Configuration parameters (“CP” in the list of parameters tables) ensuring the TEKON-19 programming for a specific technological object within the the project being implemented. These include a list of tasks to be performed, the MT characteristics, method of pressure measurement, flow rate units of measurement, time parameters, settings for exchange interfaces, a list of parameters displayed in the menu, etc. These parameters are PC entered either by the manufacturer according to the specification of a particular customer, or by the consumer during the commissioning at the facility. Their multiple overwring is possible during operation.

- Calculated parameters (“C” in the list of parameters tables), which are the result of the tasks operation that are loaded into the TEKON-19. These are, for example, the instantaneous and accumulated value of the flow rate, heat and electrical energy, average temperature and pressure, current time and date, etc. The most important parameters for the user can be displayed in the screen menu.

- Archival parameters (“A” in the list of parameters tables) as per calculated intervals, hours, days, months.

- Service parameters (“S” in the list of parameters tables) containing intermediate results of calculations for all tasks, self-check results, as well as information that can be used to assess the correctness of the TEKON-19 work during operation, adjustment and maintenance and repair works.

2.3.1.9 Several levels that are given below in order of increasing priority can be outlined following the parameters access:

- ***User***, the lowest priority. The user can read parameters, which reading access code is equal to "1". There is no option to record the parameters.

- ***Service Engineer*** performs the TEKON-19 configuration for a specific technological object. The service engineer can read and record parameters, which access codes are equal to "1" or "2", including the loadable tasks queue.

- ***Customer Engineer and Developer*** performs the TEKON-19 initial configuration at the manufacturer. The customer engineer can read and record parameters, which access codes are equal to "1" through "3".

For additional access levels information see 2.3.10.

2.3.2 Measurement of analog signals

2.3.2.1 If there are analog MCs in this TEKON-19 version (resistance and current rate MCs), they are numbered separately by channel types, "Ti" is for resistance measurement with indices "i" from 0 to the maximum value and "Ji" is for current rate measurement also with indices from 0 to the maximum value. Availability and quantity of each type MCs depends on the version (see Table 2.1).

2.3.2.2 To measure voltage at analog MCs, an analog-to-digital converter with a conversion time (from 120 to 160) ms per each MC is used. The start of conversion and readout is performed through the processor interrupt system, which slightly affects the duration of the background cycle. The measured voltages are converted to the float point form and placed in circular buffers of 8 positions each.

2.3.2.3 Voltage digital filtering of each MC is performed for noise smoothing and accidental runouts. For this reason, the arithmetic average of the last 8 measurements is calculated once at the beginning of each background cycle. It is stored as "measured voltage" parameters 011C-0123. Further for each of them one of the two main parameters, the resistance or the current rate, is calculated depending on the MC purpose.

2.3.2.4 The obtained values of the MT current rate (parameters 0400-0403) and the thermal transducer resistance (parameters 0404-0407) can be input for the loaded tasks of physical parameters calculation, that are actually measured by sensors connected to the channels. The person that was in charge of the commissioning shall be responsible for control of the correct use of parameters.

2.3.3 Measurement of frequency and number of pulses

2.3.3.1 The availability and number of discrete parameters MCs (MC of frequency and pulse numbers) "Fi" depends on the version (see Table 2.1). MCs are numbered, starting from zero, without missing numbers.

The current state of each discrete MC is reflected in 0506 - 050D bit parameters, however, the update rate for these parameters in the software is low and allows to evaluate signals that change maximum once per cycle ((1 - 15) seconds).

2.3.3.2 To avoid false responses of pulse meters caused by short-term pulse noise and “bounce” of the MT contacts with a reed output, hardware-software filtering of pulses can be enabled in the TEKON-19 by means of their decimation at a frequency of about 250 Hz. It is switched on for each channel separately by setting the single value of bit parameters 0200 - 0207 “250 Hz digital filter on”. Filtering is permissible only in the case when the maximum frequency of pulses on a given MC does not exceed 100-120 Hz.

2.3.3.3 Three independent counters of the number of pulses are programmed using software and hardware to measure the number of pulses and the frequency for each MC.

2.3.3.4 The first counter (parameter 0410-0417) determines the number of pulses received at the input during the last cycle of the main program. It is a two-byte unsigned integer (from 0 to 65,535), the counting starts on each program cycle beginning from zero. The parameter is updated at the beginning of each program cycle and can be used by loadable tasks to calculate the flow rate from the sensors readings with the pulse-number outputs.

2.3.3.5 The second counter (parameter 0208-020F) keeps the total count of incoming pulses. It is a two-byte unsigned integer, with ring counting performed from 0 to 65,535, and then again from zero. It has a purely service purpose for a single transducer; operating as part of a module system, it can be used by external modules to calculate the flow rate. The parameter is updated once during each program cycle.

2.3.3.6 The third counter is used to determine the frequency of the input pulses and counts the number of pulses received at the input during the last second. At the end of each second its value is copied to parameters 0210-0217 as an instantaneous frequency value on the corresponding channel used only for debugging purposes, and represented by a two-byte unsigned integer. In addition, the same values for each input are recorded every second into circular buffers of 8 positions each. Once at the beginning of each background cycle, the data from the buffers are converted to floating point and digitally filtered by calculating the arithmetic average of the 8 most recent frequency samples. The averaging result is stored until the end of the cycle as parameter 0408-040F and can be used by loadable tasks to calculate the flow rate by readings of sensors with frequency outputs (“power” sensors).

2.3.4 Principles of accumulation (integration) of information

The following principles are used for integration of any accumulated parameters (flow, thermal energy, operating time):

2.3.4.1 Integration is performed by adding the previous value of the accumulated parameter with its increment corresponding to a given cycle.

2.3.4.2 Flow calculation algorithms using MT signals with pulse-frequency outputs, the flow increment for each cycle are calculated directly by the number of pulses received during the cycle. The instantaneous flow "power" value (units/hour) is not calculated. For most media, the increment is calculated and the flow is accumulated both in units of volume and in units of weight.

2.3.4.3 Flow calculation algorithms using MT signals with current or frequency outputs that measure the instantaneous value of pressure drop on the restriction device or the flow "power" calculate the "flow power" corrected value normalized to an hour for most media both in volume and in mass units. To obtain an increment for a cycle, it is multiplied by the cycle duration, expressed in hours, and then added to the previous value of the accumulated flow.

2.3.4.4 To improve the summarization accuracy, any accumulated values are stored as three separate parameters, each in a floating-point format. Two interconnected internal parameters that are inaccessible to the user, store the integer and fractional parts of the accumulated value separately. The integer part is incremented only if the sum of the increment for the cycle and the previous fractional part exceeds one. In parallel, the third parameter is used in the algorithm, which is the current sum of the integer and fractional parts of the accumulated value; it is the actual output commercial parameter. When correcting the value of the accumulated commercial parameter, its integral and fractional parts are adjusted automatically.

2.3.4.5 If the integer part of any accumulated parameter exceeds 10^6, its counting starts again from zero without loss of the fractional part.

2.3.4.6 It is possible to calculate the flow weighted mean values of a parameter (for example, temperature or pressure) with the calculated interval ranging from 1 to 30 minutes, per hour, day, and per month.

NOTE: if within the given time period the flow equals zero, the "not a number" code is set as a weighted mean value, and is shown as "****" when viewed on the display indicator.

2.3.5 Time service

2.3.5.1 The TEKON-19 (except for version 11) has an internal clock powered from an internal power source, which keeps current timing and the current date counting, including the day of the week and two last digits of the year.

2.3.5.2 Automatic switch to daylight saving time and back to standard time is enabled or disabled during commissioning. If the switch is enabled, it is carried out:

- to daylight saving time: on the last Sunday of March, setting the clock forward, from 2:00 to 3:00 a.m.;
- to standard time - on the last Sunday of October, setting the clock back from 2:00 to 1:00 a.m.

When switching to daylight saving time, a “gap” with no information is generated from 02:00 to 03:00 a.m. in the hour and interval archives. When switching back to standard time, the time archive from 01:00 to 02:00 a.m. contains data from 01:00 a.m. daylight saving time to 01:59:59 standard time, i.e. data corresponding to two hours. For averaged parameters, it is an average of two hours; for accumulated parameters, the accumulated value for two hours, i.e. a double value. The interval archives, recorded initially during the period from 01:0n:00 to 02:00:00 daylight saving time, are overwritten with their new values during the same period of the standard time (here ‘n’ is the interval duration in minutes).

Since the swich to daylight saving time has been canceled since the spring of 2015 in the Russian Federation, the automatic switch character should be removed.

2.3.5.3 The start of accumulation and averaging operations for specified time intervals, transcription of parameters “corresponding to the current time interval” into the parameter “corresponding to the previous time interval” is carried out during a work cycle, at the beginning of which the following time conditions are met:

- By calculated intervals – the moment of the next interval end. Duration of the calculated intervals is set at the commissioning stage via the F020 parameter within the range from 1 to 30 minutes and is common for all tasks. It is recommended to choose such duration that an hour could contain an integer number of intervals (1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30 minutes).
- By 30-minute periods – the moment of next period change, i.e. at moments of time 00 minutes and 30 minutes of each hour.
- By hours – the end of the next astronomical hour.
- By days – the end of the next calculation day, i.e. beginning of the calculation hour set via the F023 parameter ranging from 0 to 23.
- By months – the end of the next calculation month, i.e. beginning of the calculation hour of the calculation day of the month, set via the F022 parameter, ranging from 01 to 31. If there is no set date in the current month (for example, the 30th day in February), the last day of the month will be taken as the set date.

The corresponding period is archived during the next cycle.

2.3.5.4 To perform two-rate electricity metering, it is necessary to include into the project the tasks based on two-rate metering algorithms 021E and/or 020E in an amount equal to the number of metering circuits and, once, the task of choosing a rate by time and date (algorithm 0201). The duration of the discount rate on working days and canceled weekends is from HNB (hours of nighttime beginning) to HDB (hours of daytime beginning). On Saturdays, Sundays and holidays (according to the legislation of the Russian Federation as of the date of the device release or software version update), postponed weekends (they can be changed in a timely manner), the discount rate for natural persons is valid around the clock, for legal entities – as on working days.

2.3.5.5 During breaks in the transducer power supply, the “not a number” code is entered into all the archives in which recording moments were missed during the power outage, which is displayed as ‘****’ when viewed on the display indicator. Dyring this time, no information is accumulated, except for the transducer malfunction time; the entire period of the power failure (plus one cycle after power recovery) is activated during malfunction. When recorded to the archive, any information in the first moment after power restoration will be referred to the recording period during which the power was off.

Let us examine this by the example of hourly archives. Let them archive the average water temperature per hour, the water consumption per hour and from the beginning of the day, the time of successful operation and malfunctioning of the metering station per hour and from the beginning of the day. Let us assume that the actual water temperature and the current flow are approximately constant, and the transducer is in good condition. At 13:20:45 the network power supply disappeared, and at 16:51:10 of the same day, it was restored. When viewing the archives, for example, after 18 hours, their condition may look like this:

Time	Temperature, °C	Flow, m^3		Successful operation, hours		Faulty operation, hours	
		per hour	per day	per hour	per day	per hour	per day
12-13	63.15	6.00	72.10	1.00	13.00	0	0
13-14	63.09	2.13	74.23	0.34	13.34	3.51	3.51
14-15	****	****	****	****	****	****	****
15-16	****	****	****	****	****	****	****
16-17	63.25	0.85	75.08	0.15	13.49	0	3.51
17-18	63.16	6.12	81.20	1.00	14.49	0	3.51

It is evident that the period of power fail (approximately 3.5 hours) is taken into account only as the time of malfunction and is archived to the hour during which the power was off. The accumulated value of water consumption for part-time hours is taken into account only from 13:00:01 to 13:20:45 and from 16:51:10 to 17:00:00, therefore during these hours its value in the archive is less than the real one. The partial time of the hour is practically not reflected in average values (in this case, for temperature), since averaging occurs constantly.

2.3.5.6 Similarly, the archives are also filled in when the transducer is temporarily swiched to the STOP process mode and back into the OPERATION mode (see 2.3.11).

2.3.6 List of TEKON-19 loadable algorithms

2.3.6.1 Software configuration, i.e. selection of loadable algorithms from the database, compilation of a list of loadable tasks, setting up and loading into the TEKON-19, is performed via a PC using the Dialog-19 and Teleport software (delivered on CD with TEKON-19). Principles of working with programs are set out in the embedded help functions.

2.3.6.2 A complete list of the TEKON-19 algorithms that are available in the database is specified in Table B.2, Appendix B. Input and output parameters of the loadable tasks, as a rule, have “flexible” numbers and names assigned during the configuration process. Only those input parameters of loadable tasks have “hard” numbers that are used to enter information from the input channels (MT currents and frequencies, number of pulses per cycle, etc.).

2.3.6.3 During configuration, tables of loadable tasks and their parameters, as well as the screen menu are loaded, stored and used in the TEKON-19 program ROM. For display indication, the standard name of the created task queue and a user-defined arbitrary object name are loaded and stored.

In addition, a list of “short” task names is loaded for storage, which is used only when a lost project task queue file is restored from the controller into the PC. It is not used for operation of the controller itself.

The remaining information about the set of tasks loaded into the TEKON-19 is stored only in the PC database.

2.3.7 Features of serial exchange interfaces

2.3.7.1 The **main** information channel for recording and reading data of all the TEKON-19 versions is a high-speed interface under the CAN BUS international standard, data transfer rate is up to 300 kBaud.

2.3.7.2 The CAN BUS interface features are set using parameter number 0004. Parameter 0004 defines the configuration and the exchange rate, and, as a rule, it must be equal to 41E0 (see table 2.10). See also 4.1.3.3.

2.3.7.3 RS-232 TTL is an **additional (technological)** interface (except version 11). The exchange rate can be assigned within the range from 1,200 to 28,800 Baud, the exchange protocol corresponds to standard FT1.2 of GOST R IEC 870-5-1-95 with features described in working documentation T10.06.59 РД (T10.06.59 RD)and Appendix 1 thereto.

IT IS PROHIBITED to use the technological interface to create dispatching systems; it is **intended only for connection of manufacturer technological communication equipment** (information recorders РИ-97 and РИ-197, USB adapter - RS-232 T20 T10.00.92).

2.3.7.4 The RS-232 TTL interface is configured via parameters 0005 – 0007. The 0005 parameter means a transducer network number; it is recommended to assign it within the range from 01 to FE. The binary representation of parameter 0006 sets the implemented protocol features (for identification, see T10.06.59 РД):

- Digit 3 - protocol FT1.1 (= 0) or FT1.2 (= 1);
- Digit 2 - without CRC (= 0) or with CRC (= 1);
- Digit 1 - CRC instead of CS (= 0) or CRC in the data body (= 1);
- The remaining digits are not used.

It is recommended to set the FT1.2 protocol without CRC, i.e. to set code 08. Network number codes 00 or FF are invalid and are perceived as setting up exchange for the FT1.2 protocol without CRC with network number 01. The number of stop bits is not configurable and always equals to one.

Table 2.10

RS-232 TTL interface		CAN BUS interface	
Rate, Baud	0007 parameter code	Rate, kBaud	0004 parameter code
115,200 *)	FF84		
57,600 *)	FF80		
28,800	FF00	300	41E0
19,200	FD80	150	43E0
9,600	FD00	100	45E0
4,800	FA00	50	4BE0
2,400	F400	20	5DE0
1,200	E800		
Note: *) – not recommended			

2.3.7.5 The 0007 parameter sets the exchange rate constant according to table 2.10. Any code of this parameter other than those listed in the table, is automatically perceived as exchange setting up for the RS-232 TTL interface at 9,600 Baud, network number 01, the FT1.2 protocol without CRC.

2.3.7.6 To read and record the TEKON-19 parameters via a PC the ‘Teleport’ T10.06.208 software is delivered on a CD as a set with the TEKON-19.

2.3.8 TEKON-19 self-monitoring, event log and intervention log

2.3.8.1 TEKON-19 has an extensive system of periodic software self-test. According to the self-test results, the two-byte 0500 parameter ‘failure condition’ is generated; its binary digits are characteristics of current serviceability (condition ‘0’) or fault (condition ‘1’), in accordance with tables 2.11 and 2.12. The 0513 parameter ‘additional failures’ was added in version 11, in other versions there is the 4-byte 0516

parameter ‘extended failures’, the first two bytes of which coincide with parameter 0500. For numbering of digits, see Appendix B.

The digit with number 1 of byte 0 ‘factory default settings error’ is set by the ‘OR’ operation from three low-order digits of byte 2.

When viewing the values of these parameters via the ‘Teleport’ software, the failures decoding on the PC screen is performed automatically.

Table 2.11 – Bit-by-bit decoding of parameters 0500 “failure condition” and 0516 “extended failures”

Byte	Digit	Characteristic	Period	Possible reason	Elimination method
0	0	Restart (power on)	1 cycle after restart	Power on, WDT watchdog restart	Eliminate power failures. If the power is known to work properly and the failure still occurs, send for repair.
	1	Factory default settings error	256 cycles	Failures during recording, equipment failure	Send for repair.
	2	CS error of the user settings area	256 cycles	Failures during settings recording	Check the settings parameters, re-record the corrupted ones. If the failure persists, send for repair.
	3	Task queue error	each cycle	Queue creation errors	Check the task queue correctness, re-record it. If the failure persists, send for repair.
	4	ADC failure	constantly	ADC is not ready during more than 1 s	If failure occurs frequently, send for repair.
	5	Failure of recording in flash-memory	during recording	Record failure or program ROM failure	Send for repair.
	6	Invalid parameter	constantly	Setup errors	Check task settings, re-record incorrect parameters.
	7	CS error of settings menu	256 cycles	Failures during recording of the menu description	Check the menu setting, re-record corrupted parameters. If the failure persists, send for repair.

Table 2.11 continued

Byte	Digit	Characteristic	Period	Possible reason	Elimination method
1	0	Algorithmic failure	each cycle	Parameter 0501 is equal to 1	Find out the causes and eliminate them
	1	CS error of the program ROM task name space	256 cycles	Task queue recording failure	Re-record task names from the DB. If the failure persists, send for repair
	2	Stop	each cycle	Technological	It is set and deleated through the exchange channels or the service menu; it does not appear on its own.
	3	Technological jumper	256 cycles	The jumper is not removed	Remove the technological jumper and switch the power off and on
	4	CAN failure		Failure	Switch the power off and on
	5	Task queue mismatch with its ID	256 cycles	Task queue and its ID recording failure	Check the task queue, re-record the incorrect parameters from the database. If the failure persists, send for repair
	6	Task queue CS error	256 cycles	Task queue recording failure	
	7	General failure (parameter 050E)	each cycle	Formed by OR from the rest	Eliminate the failure causes in other digits
2	0	Factory default settings CS error	256 cycles	Recording failure, equipment failure	Send for repair
	1	Program CS error			
	2	Software version number error			
	3	Invalid integral	each cycle	Settings failure, equipment failure	Check the tasks settings, take special care that there is no dividing by zero and invalid integral values, record the correct values.
	4	Invalid increment			
	7..5	-			

Table 2.12 – Bit-by-bit decoding of the 0513 parameter ‘additional failures’ (only for the TECON 19-11)

Byte	Digit	Characteristic	Period	Possible reason	Elimination method
0	0-3	ADC failure of channels I0-I3	constantly	Channel ADC is not ready during more than 1 s	If failure occurs frequently, send for repair.
	4	CAN failure		CAN controller failure	Send for repair
	5-7	-	-	-	-
1	0-7	-	-	-	-

2.3.8.2 During each work cycle, the TEKON-19 basic software analyzes the state of parameter 0516 and performs three basic operations:

- It generates a general serviceability/malfunction symptom for the TEKON-19 as the 050E bit parameter. The TEKON-19 is serviceable during the current cycle and parameter 050E is set to condition ‘0’ if there is no failure got in the analyzed

parameter. Otherwise, the TEKON-19 is faulty during the current cycle, and parameter 050E is set to condition ‘1’. This parameter is recommended for time management control of the TEKON-19 servicability/malfunction.

- It records the possible fact of a change in the failures condition in the analyzed parameter, i.e. generation of ‘new’ or removal of ‘old’ failures, in the system event log (some events are additionally recorded immediately at the moment of their occurrence).

- It reflects the malfunction symptom status on the front panel indicator (see 4.2.2.4).

2.3.8.3 Some of the loadable tasks may form additional bit malfunction symptoms that no longer relate to hardware failures of the TEKON-19 itself, but that are external failures that violate the logically normal operation of one of the metering units. These features include, for example:

- features of the external measuring circuits opening, generated by algorithms of the (current and frequency) linear sensors and temperature calculation algorithms of the thermal transducers;

- bit signs of any parameter exceeding the technological tolerances;

- bit signs of lack of response to an external parameter request from another module in the CAN-BUS line, generated by algorithms of the external parameters input and archiving;

- other bit signs at the request of the user.

If the user wants to combine external symptoms of failures with the general TEKON-19 failures system, he should assign the bit parameter 0501 ‘Algorithmic failure’ as an output symptom of external failures collected according to the logical ‘OR’ sense from individual failure symptoms. The condition of this parameter is checked by the basic software, but not set.

2.3.8.4 In order to form the serviceability/malfunction time each metering unit implemented in the TEKON-19 should combine the total TEKON-19 failure (parameter 050E) according to the logical ‘OR’ principle with bit signs of malfunction related to this metering unit, and submit the resulting serviceability/malfunction symptom to the input of the ‘operating time’ task (algorithm 0200). In case of the resulting symptom zero condition, the serviceability time counter for the metering unit will be incremented during the current cycle, in case of a single condition – the malfunction time counter.

2.3.8.5 The TEKON-19 system event log is made following the principle of a ring stack and it saves information about 256 recent events at any time. It is available only for reading through index parameters 0901 - 0904. Parameters with index ‘0’ contain information about the most recent event, with index ‘1’ – about the last but one, etc. The event log has a complex structure and is decoded when viewed by the ‘Teleport’ software.

Recordable events include in particular:

- Initial launch of the program, cleaning of the external memory, full test of the external memory, erasing of the original content.
- Powerup and powerdown (including restart due to hardware and software issues).
- Recording of any parameter with a record access level not lower than ‘2’. In the STOP mode, the number of recorded parameters is simply counted.
- Change in the number of the current TEKON-19 failures.
- Attempt of a background task to either call for an unknown parameter for reading or recording or to record into a parameter located in the read-only memory (program ROM, data ROM).
- The program switch over to the OPERATION and STOP modes.
- Retrofit of the basic software version (first power-up after software retrofit).
- Detection of unacceptably large numbers during the calculation process.

2.3.8.6 The TEKON-19 intervention system log is is made following the principle of a ring stack and it saves information about last 1,024 changes in the parameter values at any time. It is available only for reading through index parameters 0905 – 090B. Parameters with ‘0’ index ‘0’ contain information on the most recent intervention, those with index ‘1’ – on the last but one, etc. The intervention log has a complex structure and is decoded when viewed by means of the ‘Teleport’ software.

This log records date and time of the parameter change, parameter number as well as its previous and new value.

2.3.8.7 The TEKON-19 controls the occurrence of unacceptably large numbers in arithmetic calculations that appear, as a rule, when an attempt to divide by zero is made. A detected large number is automatically replaced by a zero value. Due to absence of free bits in the 0500 parameter, the fact of the large number occurrence is recorded only in digits 3 or 4 of the second byte of the 0516 extended failure parameter, but it is also reflected in parameter 050E and is entered into the system event log.

ATTENTION! If the internal battery is discharged below the permissible level (see 8.1.3), information in the event and intervention logs may be distorted.

2.3.9 Information updating

2.3.9.1 During each program cycle, the following is updated:

- instantaneous values of all measured and calculated parameters;
- all accumulated and average parameters, entitled as ‘during the cycle’, ‘during the current interval’, ‘during the current 30 minutes’, ‘during the current hour’;
- all accumulated values of flow entitled as ‘during the current interval’, ‘during the current 30 minutes’, ‘during the current hour’, ‘during the current day’, ‘during the current month’, integral flow.

2.3.9.2 At the time of the next calculation interval change, all the information entitled as ‘during the previous interval’ is updated as well as the average values for the current day. The information is entered into the intervals archives, with the index of an element in the archive referring to the time of HH:MM of the completed interval **end**.

2.3.9.3 At the time of the next 30-minute period change, all the information entitled as ‘during the previous 30 minutes’ is updated. The information is entered in the 30-minute archives, with the index of an element in the archive referring to the time of HH:MM of the completed interval **end**.

2.3.9.4 At the time of each hour change the following is updated:

- all information entitled as ‘during the previous hour’;
- average values for the current month;
- information is recorded in the clock archives, with the index of an element in the archive referring to the ‘HH’ number of a **completed** hour.

2.3.9.5 At the time of the calculation day change, at the moment of HH_{CALC} hours 00 minutes, all the information entitled as ‘during the previous day’ is updated. The information is entered in the archives of the day, with the index of an element in the archive referring to a **completed** date. This should be considered when viewing the archive through the menu (see 4.2.5.6).

2.3.9.6 When the calculation month changes, at the moment of HH_{CALC} hours 00 minutes of DD_{CALC} of each month, all information entitled as ‘during the previous month’ is updated. Information is entered in the archives of the months. The index of the element in the archive refers to the **completed** month, if the calculation date is before the 20th day, and to the **current** month otherwise. This should be taken into account when viewing the archive through the menu (see 4.2.5.6).

2.3.10 Protection of information against unauthorized access

2.3.10.1 Access to any TEKON-19 information included in the system of its parameters is regulated by the specified level of access to it for reading and recording operations: ‘User’, ‘Service Engineer’, ‘Customer Engineer’, as described in 2.3.1.10 and table B.1, and the current level of access for the channel. The specified access level to “hard” parameters is set in the TEKON-19 program itself and cannot be changed (see table B.1). The specified level of access to the parameters of the loadable tasks is set when the project is created, and it must be chosen so that the parameters of interest for the ‘User’ are available for him to read (level 1), but, as a rule, not available for recording, with the possibility of their correction only by the ‘Service Engineer’ (Level 2). It ensures that the most important parameters, configuration and commercial ones are protected from unauthorized changes.

2.3.10.2 Since the main way to read and record any TEKON-19 parameters is to exchange data via serial channels, CAN BUS line or RS-232 TTL interface, PC running exchange programs supply the TEKON-19 with data on the level of current access via a channel. If this level is lower than the level assigned to a specific parameter, the operation of its reading or recording into the TEKON-19 is blocked. PC notice on the level of current access is given through a system of program passwords; methods of their application are described in the documentation for the corresponding application. When energized, the TEKON-19 program automatically sets the current access level for all channels to ‘1’, i.e. ‘User’.

2.3.10.3 Channel access levels are declared independently of each other. If an increased level of access was announced via the CAN BUS line, access with such a level will be allowed only to the module that declared it (let's call this module the first one); for other modules, the access level remains at ‘1’. Another module can change the access level only after the first module either reduced the access level to ‘1’ or did not perform exchange with the TEKON-19 during 256s. If an increased level of access was announced through the RS-232 TTL interface, it allows access for any module connected to the interface. After no interface exchanges within 256s, the current access level is automatically reduced to ‘1’.

2.3.10.4 For additional protection of the TEKON-19 commercial and setting parameters against unauthorized recording, the possibility of internal protection is provided by means of a built-in password system, which blocks arbitrary increase in the current level of access for the channels. There are two levels of internal password – the customer engineer password protecting the factory default settings (parameter F026), blocking access to level 3, and the service engineer password protecting the commercial parameters (parameter F025), blocking access to level 2. Both passwords are eight-digit hexadecimal numbers stored in the non-volatile memory with a high degree of protection. Thus, the total number of different combinations for each password is 2^{32}, i.e. 4,294,967,296.

If the password value differs from two reserved codes 00000000 or FFFFFFFF, the appropriate access level can be set only by first sending the required password through the channel using the access authorization procedure. This procedure is included in the channel exchange protocol, the method of entering the password is set out in the documentation for the PC software, but the password value itself should be known only to the person protecting the information of this level.

2.3.10.5 The customer engineer factory password is set when the transducer is released by the manufacturer, it protects the factory default settings, and is not reported to the operating organizations.

Upon release by the manufacturer, the service engineer password is removed (it is usually FFFFFFFF), and, if necessary, is set by the operating or supervising organization upon completion of commissioning and acceptance of the transducer into operation, either via a channel or via the service menu.

2.3.10.6 It follows from the above that it is only possible to read or change the service engineer password, as well as any parameters with the specified access level ‘2’, if the access level is already set to not lower than the “Service Engineer”, i.e. this can only be done by a person who knows the current value of the service engineer password. It is also possible to switch the transducer into the STOP technological mode only if you know the service engineer password. The memory area, in which the passwords are located, is unavailable for reading by conventional methods.

The factory password is known only to the representative of the manufacturer; reading and recording with the access level below the “Customer Engineer” level is not available.

2.3.10.7 To exclude the possibility of password mining for the purpose of unauthorized access to commercial information and password-protected task settings, after several wrong passwords are entered consecutively, further attempts to change the access level over the channel are blocked for a long time, only parameter read and record commands are executed at the current access level.

2.3.10.8 If the value of a set password is unknown, the password can be removed or its value can be restored only at the manufacturing factory, and this operation is not covered by the warranty.

2.3.10.9 In order to protect the program and data against task queue errors caused by errors during queue creation, failures during its recording or due to incorrect configuration, the following types of program controls are implemented:

- If the format of a loaded queue does not meet the standard requirements, execution of the task queue is completely blocked with a failure indication ‘task queue error’ (see table 2.11).
- If a parameter specified in the task queue to be read or recorded is unknown, operation involving it is not performed, the ‘invalid parameter’ failure symptom is registered (see table 2.11), but the task and the queue as a whole continue to run until the end.

- If a parameter assigned in the task for recording is placed in one of the ROM types, the recording operation is not performed, the ‘invalid parameter’ failure symptom is registered (see table 2.11), but the task and the queue as a whole continue to run until the end.
- If the background cycle duration has exceeded 128 seconds, the TEKON-19 program automatically restarts, as if a power failure has occurred.
- The input task is not executed if the number of the external module specified in it iquals 00 or FF, or the response from the module is not received within 1 second. The exchange failure is registered, the queue continues to run until the end.

In all the above cases, except for input task errors, information about the failure situation is registered in the system event log, where it can be viewed and decoded using the ‘Teleport’ software.

2.3.10.10. To ensure the required ‘high’ level of software protection as per Guidelines R 50.2.077-2014, the integrity of the metrologically significant software is periodically monitored based on the calculation of the program checksum using the CRC32 algorithm and comparing the result with the reference standard. If the CRC32 does not match, as well as in case of factory default settings CS failure or a failure of the main program version number, the corresponding symptoms are generated in byte 2 of parameter 0516 (see 2.3.8.1) with registration made in the system event log. Execution of all measurements, as well as execution of the task queue is stopped, and the ‘#’ sign is displayed on the indicator as a symbol of the operation mode (see 4.2.2.5).

2.3.11. Operating modes

2.3.11.1 The TEKON-19 can be in one of the two modes of operation: OPERATION and STOP. Change of modes can be performed either through the serial exchange channel or through the service menu of the front panel display. In order to change the mode it is necessary to know the “Service Engineer” level password.

2.3.11.2 During operation, the TEKON-19 should always be in the OPERATION mode. In this mode, all the transducer functions are performed; all rigid algorithms are carried out, including measurement of input values; the loaded task queue is executed, including input, accumulation and archiving of information; operations with any display menu items are possible.

NOTES: when the technological jumper is set as well as in case of factory default settings failure (see 2.3.10.10), execution of the task queue is blocked.

2.3.11.3 The STOP mode is a technological one. It runs all the rigid algorithms, including measurement of input values, but the loaded task queue is not executed. The mode is applied in two cases:

- When loading a task queue, menu description and in some other configuration-related cases, the corresponding PC programs automatically switch the transducer

into the STOP mode briefly and then return it to the OPERATION mode. Menu operations are not recommended at these times.

- During the operation stage, when removing the transducer from its working position for verification or repair, it is recommended to switch the TEKON-19 to the STOP mode preliminarily via the display service menu (see 4.2.6) entering the password. The transducer records the date and time of shutdown, accumulation of integral values and the archiving is stopped. After this, the transducer can be turned off and sent for repair or verification operations. Special PC programs used at the manufacturer and authorized service centers guarantee preliminary saving of the information accumulated in the transducer and its subsequent restoration, with the transducer again being in the STOP mode. Upon the return of the transducer to the place of operation and connection of all circuits, it is required to switch the TEKON-19 to the OPERATION mode. Accumulated integral values did not change during the repair, and archives of all kinds from the memorized moment of switching to STOP until the moment of switching to the OPERATION mode will be filled with the code ‘not a number’.

2.4 Scope of supply

The TEKON-19 scope of supply is specified in Table 2.14.

Table 2.14 – The TEKON-19 scope of supply

Name	Designation	Quantity	
		As per TU	Act.
TEKON-19 calculating and measuring transducer	T10.00.60	1	1
Certificate	T10.00.60PS	1	1
Operation manual with the verification method provided in Section 6 ‘Verification’ (on CD)	T10.00.60RE	1	1
CD with software and operational documentation	T10.06.295	1	1

(Revision, Amendment No. 3).

NOTE: Power supply source for the TEKON-19 and connecting cables are not included in the scope of supply and must be purchased separately.

2.5 Package

2.5.1 The TEKON-19 is packed in a box of corrugated cardboard.

2.5.2 Before stacking in the box, the TEKON-19 is packed in a plastic bag.

2.5.3 Accessories and maintenance documentation are placed in a plastic bag in a packing box with the transducer.

2.5.4 After packing, the TEKON-19 is compacted with auxiliary materials.

2.6 Marking and sealing

2.6.1 The TEKON-19 bears the following marking on the front panel:

- measuring device type approval mark;
- logo of the manufacturer ‘KREIT’;
- transducer name ‘TEKON-19’.

2.6.2 The TEKON-19 bears the following marking on the rear panel:

- manufacturer product code;
- version;
- series and serial number;
- rated value and supply voltage range;
- maximum power consumption in watts.

2.6.3 Sealing is carried out at the junction of the front panel with the base of the body by gluing the label with the manufacturer logo.

3 INSTALLATION

3.1 Connection

3.1.1 The TEKON-19 is installed in a cabinet on a DIN-rail.

3.1.2 An external power supply, measuring transducers, exchange line and power outputs for galvanically isolated circuits are connected to detachable screw terminals for easy dismantling during system debugging and scheduled verification. For installation, it is recommended to use MKESh (МКЭШ) type cable (PVC sheathed shielded cable) according to GOST 10348-80 (or similar) with the required number of cores with a minimum cross section of 0.35 mm^2.

The terminals designation and the circuits name are shown in tables 3.1.a and 3.1.b. For designation of the MT power supply polarity, the '+' symbol indicates the source current from the TEKON-19, the '–' symbol indicates the sink current. For location and numbering of terminals, see Figure 2.1.

3.1.3 The TEKON-19 power supply is provided by connecting an external DC power source to the 'Uп' terminals. Power should be connected after all other circuits have been installed. Electrical equipment of a building should include a switch or a circuit breaker installed in a cabinet near the TEKON-19 and its power source, marked as a shutdown device. Installation and dismantling of the TEKON-19 and its external circuits should be carried out with the transducer itself and all primary MTs connected to it de-energized.

3.1.4 The RS-232 TTL interface is connected to the computer's USB port using the USB adapter RS-232 T10.00.92 via a 4-pin USB-A socket located under the front panel of the TEKON-19.

3.1.5 MT connection

3.1.5.1 Connection of the temperature MT of RTC and RTP types is made to the resistance MC labeled 'Ti', where 'i' is the MC number. Connection is carried out only using a four-wire circuit in accordance with the diagrams shown in Figure 3.1, to the terminals numbered as per in Table 3.1.a. Connection of the Ji+ circuit with the U_ri+ circuit and the Ji– circuit with the U_ri– circuit is performed directly at the point of connection to the MT. For connection, it is recommended to use a four-wire shielded cable with a minimum core cross-section of 0.35 mm^2, the cable length should not exceed 100m. Shields of all cables should be connected to the grounding bus at one point at the TEKON-19 side as close to the power supply source as possible.

ATTENTION! On the vacant (not used) resistance MC, it is **obligstory** to interconnect the Ji+, Ji–, U_ri+ and U_ri– circuits as shown in Figure 3.1, b. Total resistance of all temperature MT of RTC and RTP type connected to one transducer over the entire operating range of measured temperatures should not exceed 4,000 Ohm.

3.1.5.2 Connection of the MT with standard current outputs is carried out to the current rate MC marked ‘Ji’, where ‘i’ is the MC number, according to the diagrams shown in Figure 3.2. For connection, it is recommended to use a two-wire shielded cable with a minimum core cross-section of 0.35 mm^2. Cable length should not exceed 150m. Shields of all cables should be connected to the grounding bus at one point at the TEKON-19 side as close to the power supply source as possible.

Note. When connecting sensors using spark protection barriers, the transfer resistance of the barriers should be taken into account in the sensor supply circuit.

In case of a transducer of the TEKON-19-11 version, each MT should be powered from a separate isolated power source in order to ensure mutual galvanic isolation of the measuring channels. It is recommended to use MT connected using the two-wire circuit – in this case, the power can be obtained from an isolated source of 4 x 24V, that is embedded into the TEKON-19-11 (diagram in Fig.3.2, c) If, nevertheless, a four-wire connection diagram is chosen, power should be supplied to the MT from an external power supply unit as shown in Figure 3.2, a.

3.1.6 Connection of flow MT and energy meters with number-pulse or frequency outputs.

3.1.6.1 Connection is made based on a two-wire circuit by connecting the same-named MT circuits with the TEKON-19 terminals marked ‘Fi’, where ‘i’ is the MC number and the numbers according to Table 3.1.a with observation of the polarity. It is possible to connect MT of three types:

- with an active output signal from -24V to 24V (MC input resistance is 50 kOhm)
- with a passive output signal designed for currents of up to 10 mA.
- with a passive output signal designed for currents of up to 0.5 mA.

The MT type is chosen by installing jumpers located under the terminals of a corresponding MC. Options for the jumpers installation are shown in Figure 3.3. For a MT with a passive dry contact output, the polarity of the circuits connection does not matter.

3.1.6.2 **ATTENTION!** The MC are combined into groups (see Table 3.1.a), each of these groups has one power input for all the channels of the group. When connecting the MT to at least one MC in the group, voltage from an external **insulated** power source must be connected to the power input of the group. In this case, all channels within the group are galvanically connected to each other, but they are galvanically isolated from the MC of the other group and the transducer power supply circuit.

It is possible to combine the power supply circuits of the MC groups with the transducer power supply circuit with observance of the polarity, provided that the characteristics of the power sources provided in 2.2.15 are observed. In this case, the measuring circuits of all MT will be galvanically connected with each other and with the transducer power supply circuit.

3.1.6.3 The use of MT with the maximum pulse repetition rate exceeding 100 Hz requires **mandatory disconnection** of digital filters of corresponding MC when setting up the transducer (see 2.3.3.2). Connection of such MT should be carried out by means of a separate two-wire shielded cable for each MC. MT power circuits are made separately. The length of connection lines in this case should not exceed 100 m.

It is possible to perform the MT connection with a four-wire cable, combining signal circuits and power circuits of one MT in it.

3.1.6.4 It is **recommended to enable** digital filters of the corresponding MC when setting up the transducer, when using a MT with a maximum pulse repetition rate of less than 100 Hz (see 2.3.3.2). Connection of such power supply devices is **allowed to be** carried out by multi-conductor shielded cable, positioning the signal lines together with other measuring circuits. The length of connection lines in this case should not exceed 300 m.

3.1.7 The transducer is connected to the CAN BUS information exchange line by connecting CAN L and CAN H terminals with the line buses of the same name. Terminal numbers for connection are given in tables 3.1.a, 3.1.b.

ATTENTION! The line topology shall satisfy a “common bus” type scheme. It is **necessary** to install the “TRM” jumper located under the CAN L and H terminals on two transducers that are located at the opposite ends of the line, the jumpers shall be removed **mandatorily** on all other transducers connected to this line. Normal operation of the data exchange system in the line composed, based on the topologies like “Star”, “Cluster”, etc., is not guaranteed. The length of one CAN line segment with a point-to-point connection type should not exceed 50m. When connecting two or more segments that include several endpoints, it is recommended to use “RS-62 line segment separators” that match the physical characteristics of the communication line and distributed loads. It is recommended to use the RS-485 AI-80 adapter in case of a sufficiently remote location of distributed segments.

Table 3.1.a – Designation of terminals and name of signals for versions (02M - 06M), 10M, 11

Signal and body marking		Circuit and its designation in the diagrams		Terminal No. for each version						
				02M	03M	04M	05M	06M	10M	11
Resistance MC No.0	T0	Current circuit	JR0+	8	8	–	8	8	36	–
			JR0–	5	5	–	5	5	33	–
		Measuring circuit	UR0+	7	7	–	7	7	35	–
			UR0–	6	6	–	6	6	34	–
Resistance MC No.1	T1	Current circuit	JR1+	–	4	–	4	4	32	–
			JR1–	–	1	–	1	1	29	–
		Measuring circuit	UR1+	–	3	–	3	3	31	–
			UR1–	–	2	–	2	2	30	–
Resistance MC No.2	T2	Current circuit	JR2+	–	16	–	–	26	28	–
			JR2–	–	13	–	–	23	25	–
		Measuring circuit	UR2+	–	15	–	–	25	27	–
			UR2–	–	14	–	–	24	26	–
Resistance MC No.No. 3	T3	Current circuit	JR3+	–	–	–	–	22	24	–
			JR3–	–	–	–	–	19	21	–
		Measuring circuit	UR3+	–	–	–	–	21	23	–
			UR3–	–	–	–	–	20	22	–
Current rate MC No.0	Uп0	Power supply output	Uп0+	–	–	–	–	–	–	16
			Uп0–	–	–	–	–	–	–	15
	J0	Measuring circuit	UJ0+	4	–	–	16	14	–	14
			UJ0–	3	–	–	15	13	–	13
Current rate MC No.1	Uп1	Power supply output	Uп1+	–	–	–	–	–	–	20
			Uп1–	–	–	–	–	–	–	19
	J1	Measuring circuit	UJ1+	2	–	–	14	12	–	18
			UJ1–	1	–	–	13	11	–	17
Current rate MC No.2	Uп2	Power supply output	Uп2+	–	–	–	–	–	–	24
			Uп2–	–	–	–	–	–	–	23
	J2	Measuring circuit	UJ2+	14	–	–	–	10	–	22
			UJ2–	13	–	–	–	9	–	21
Current rate MC No.3	Uп3	Power supply output	Uп3+	–	–	–	–	–	–	4
			Uп3–	–	–	–	–	–	–	3
	J3	Measuring circuit	UJ3+	–	–	–	–	–	–	2
			UJ3–	–	–	–	–	–	–	1
Group of frequency MC and number of pulses MC No.0 ... 3	Uпд 1	Power supply input	Uпд1 +	24	24	2	24	36	20	–
			Uпд1 –	23	23	1	23	35	19	–
	F0	MC input No. 0 *)	F0+	22	22	8	22	34	14	–
			F0–	21	21	7	21	33	13	–
	F1	MC input No. 1 *)	F1+	20	20	6	20	32	12	–
			F1–	19	19	5	19	31	11	–
	F2	MC input No. 2 *)	F2+	18	18	4	18	30	10	–
			F2–	17	17	3	17	29	9	–
	F3	MC input No. 3 *)	F3+	16	–	–	–	28	–	–
			F3–	15	–	–	–	27	–	–

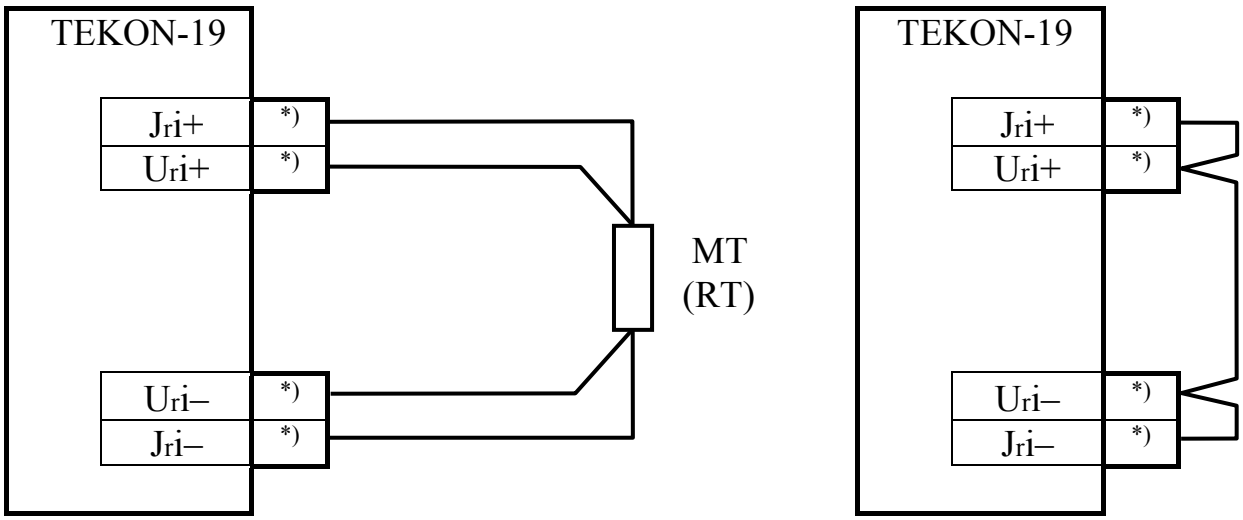
Table 3.1.a continued

Signal and body marking		Circuit and its designation in the diagrams		Terminal No. for each version						
				02M	03M	04M	05M	06M	10M	11
Group of frequency MC and number of pulses MC No.3…7	Uпд 2	Power supply input	Uпд2+	–	–	14	–	–	20	–
			Uпд2–	–	–	13	–	–	19	–
	F3	MC input No. 3 *)	F3+	–	–	24	–	–	8	–
			F3–	–	–	23	–	–	7	–
	F4	MC input No. 4 *)	F4+	–	–	22	–	–	6	–
			F4–	–	–	21	–	–	5	–
	F5	MC input No. 5 *)	F5+	–	–	20	–	–	4	–
			F5–	–	–	19	–	–	3	–
	F6	MC input No. 6 *)	F6+	–	–	18	–	–	2	–
			F6–	–	–	17	–	–	1	–
	F7	MC input No. 7 *)	F7+	–	–	16	–	–	–	–
			F7–	–	–	15	–	–	–	–
Uп		Power supply input	Uп+	12	12	12	12	18	18	12
			Uп–	11	11	11	11	17	17	11
CAN		CAN-BUS line	H	10	10	10	10	16	16	10
			L	9	9	9	9	15	15	9

Note: *) The polarity corresponding to connection of equipment with a passive output signal is indicated (Fig. 3.3, A and B). For equipment with an active output signal (Fig. 3.3, C and D) the polarity is opposite, i.e. "+" of signal source is connected to the "-" of the TEKON-19 input

Table 3.1.b – Designation of terminals and name of signals for the 15, 15M versions

Signal name	Desig.	Terminal No.	
		15	**15M**
18..36 V DC power supply	+Uп	12	12
	–Uп	11	11
CAN-BUS communication exchange line	Can H	10	10
	Can L	9	9
RS-485 communication exchange line	Can H	16	16
	Can L	15	15
	Term +	14	14
	Term –	13	13
HART1 interface	Hart1+	8	8
	Hart1–	7	7
	Prm1+	6	6
	Prm1–	5	5
HART2 interface	Hart1+	4	4
	Hart1–	3	3
	Prm1+	2	2
	Prm1–	1	1
Control key 1	+K1	24	24
	–K1	23	23
Control key 2	+K2	22	22
	–K2	21	21
Control key 3	+K3	20	20
	–K3	19	19
Control key 4	+K4	18	18
	–K4	17	17

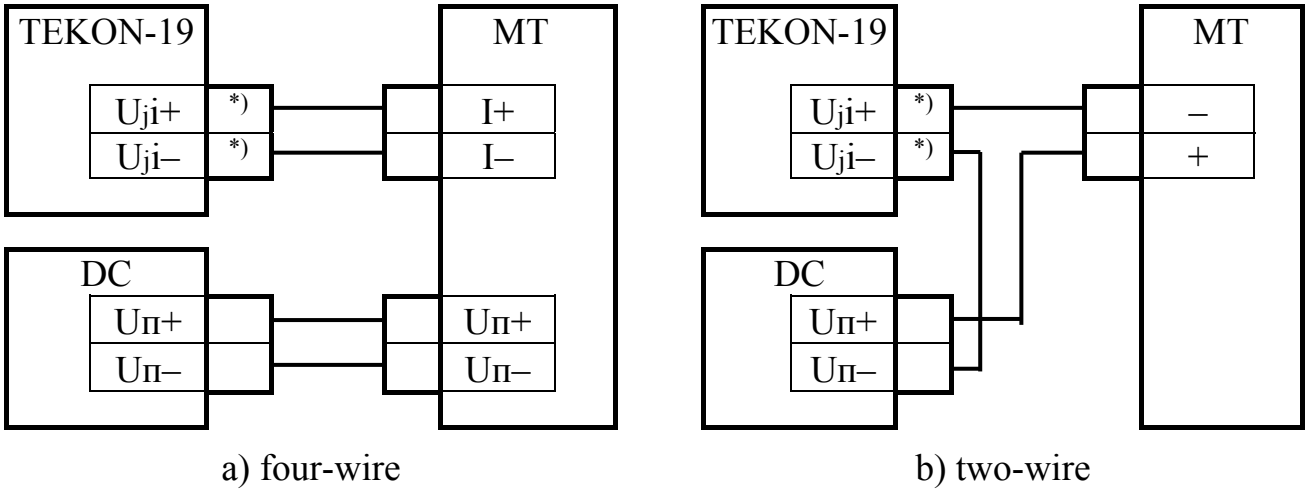


a) Wiring diagram b) Vacant channel

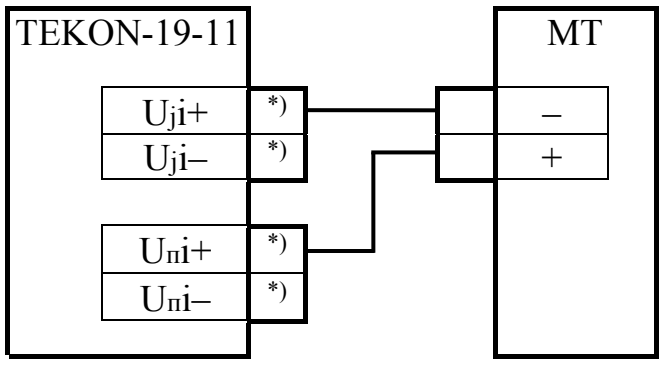
Figure 3.1 – Wiring diagram of the temperature MT of RTC and RTP type

i – channel number, MT – temperature measuring transducer,

*) – terminal numbers as per table 3.1.a.



a) four-wire b) two-wire



c) two-wire (TEKON-19-11)

Figure 3.2 – Wiring diagrams of MT with current output

i – channel number, MT – measuring transducer with current output,

DC – direct current power supply,

*) – terminal numbers as per table 3.1.a.

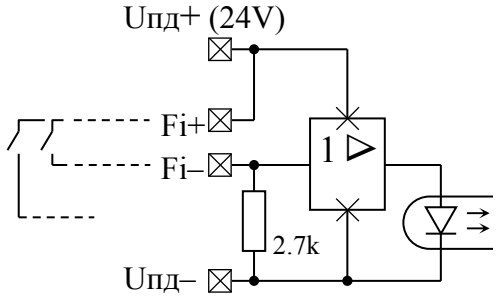
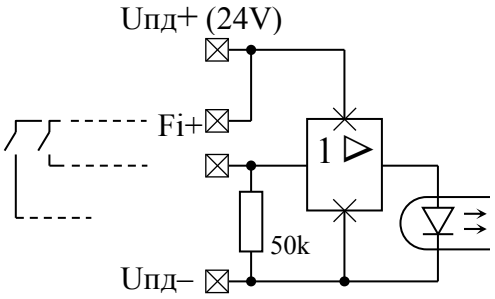
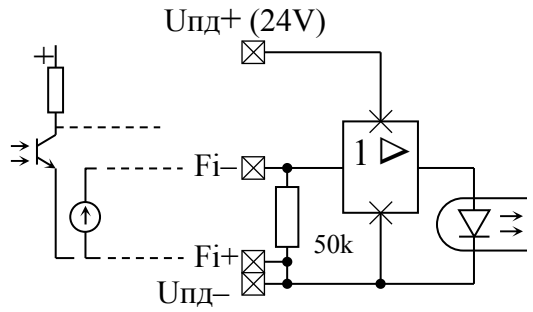
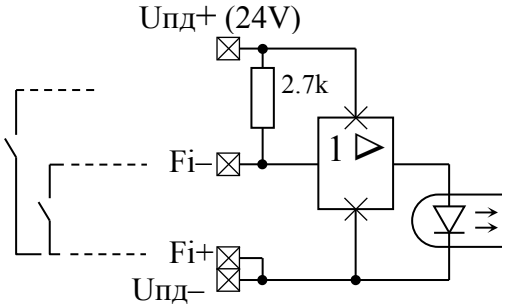
<table>
<tr><td>A)  (factory default</td><td>B)  </td></tr>
<tr><td> 
</td><td> 
</td></tr>
<tr><td>Type of MT output:
* passive contact (common +)
Features:
1) Current through contact: up to 10 mA
2) Contact is closed = condition ‘1’</td><td>Type of MT output:
* low-current passive contact (common +)
Features:
1) Current through contact: not exceeding 0.5 mA
2) Contact is closed = condition ‘1’</td></tr>
<tr><td>C)  </td><td>D)  </td></tr>
<tr><td> 
</td><td> 
</td></tr>
<tr><td>Type of MT output:
* active signal (common -)
Features:
1) Input resistance: (50 - 100) kOhm
2) Input voltage range: –24 .. + 24V
3) Input voltage: 5..24V - condotion = ‘1’;
input voltage –24..3V - condition = ‘0’;</td><td>Type of MT output:
* passive contact (common -)
Features:
1) Current through contact: up to 10 mA
2) Contact is closed = condition ‘0’
3) Jumper is installed using a 4-pin socket from the SPTA kit (added to the kit upon request)</td></tr>
</table>

Figure 3.3 – Options of jumper installation when connecting MT with a number-pulse or frequency output

3.2 Tasks loading and configuration of the TEKON-19 parameters

3.2.1 The main way to access the TEKON-19 parameters for their configuration is to exchange with a PC via the CAN BUS line using the ‘Teleport’ T10.06.208 software supplied on a disk with the transducer. The ways to work with the program are described in its documentation and in the help function (HELP) section included in the program.

3.2.2 Configuration of the TEKON-19 for a specific facility is generally performed in three stages. In the following description, it is assumed that all factory constants are already set at the manufacturing plant, exchanges are performed with a PC via the CAN BUS interface. The TEKON-19 is released from the manufacturer set up to network number 01 (parameter 0000 is 01) according to Table 7.2 and the exchange rate is 300 kBaud (parameter 0004 is equal to 41E0).

3.2.3 The first stage: creation of the project (except version 11)

3.2.3.1. During this stage, the project is designed, i.e. the list of loadable tasks required for a specific application is generated based on the set of algorithms available in the database; the project files are saved onto the PC hard disk in the database.

3.2.3.2 For most customers, this step is not required when setting up the transducer. The TEKON-19 manufacturer has developed an extensive library of standard projects, and a ready-made project file from among those stored in the database on disk T10.06.152, supplied together with the transducer, can be used for operation.

3.2.3.3 As a rule, development of cutomized projects is carried out at the TEKON-19 manufaturer according to the customer specification. In some cases, this stage can be performed by the customer itself, provided that it has sufficient qualification. For the first stage, the ‘Dialogue-19’ T10.06.200 software is used, which is supplied on the disk with the device. The rules for working with it can be studied based on the built-in help functions.

3.2.4 The second stage: loading of the project

3.2.4.1 The stage suggests selecting a project from the database, which includes the queue of loadable tasks and a description of the display menu, and loading it into the TEKON-19.

3.2.4.2. The stage can be performed either at the TEKON-19 manufacturer according to the customer specifications, or by the customer himself. For implementation of the stage, the software ‘Teleport’ T10.06.208 version not lower than 2.61 or ‘Dialogue-19’ T10.06.200 can be used. Access level is the ***Service Engineer***. Loading and configuration can be carried out via CAN BUS from a PC both in the laboratory and at the facility itself. During loading of the queue, the TEKON-19 is automatically switched to the technological mode STOP, after which it returns to the mode in which it was before loading.

ATTENTION! During the whole procedure of the project recording in the TEKON-19, the power cut of the transducer is **NOT ALLOWED**. This may lead to distortion of information and failure of the transducer, leading to the need of repair at the manufacturer's site in order to resolve the issue.

3.2.5 The third stage: setting of the parameter values.

3.2.5.1 The third and final stage of setting the TEKON-19 consists in assigning numerical values to all configuration parameters.

3.2.5.2 The stage is carried out, as a rule, by the specialists of the organization conducting the commissioning works at a specific facility, or by the user himself. To complete the stage, software 'Teleport' T10.06.208 is also used, as a rule.

ATTENTION! During recording into the TEKON-19 the value of any parameter located in the program ROM or data ROM reprogrammable memory (for parameter allocation see Appendix B, table B.1), de-energizing of the transducer is **NOT ALLOWED**. In addition, it is **NOT allowed** to simultaneously record one list of parameter values located in different areas of the memory (program ROM and data ROM). These actions may lead to distortion of information and failure of the transducer, leading to the need of repair at the manufacturer's site in order to resolve the issue.

3.2.5.3 In general, specific numerical values must be assigned to the following 'rigid' parameters present in this TEKON-19 version (excluding factory constants):

- Features of the CAN BUS interface (parameters 0000 – 0004).
- If exchange via the RS-232 TTL channel is intended, its features (parameters 0005-0007).
- Control parameters for pulse decimation (250 Hz filters) 0200-0207. When using a MT with a number-pulse output in the form of a reed switch and a pulse frequency not exceeding 100-120 Hz, it must be turned on, otherwise it must be turned off.
- Common configuration for calculation of thermal energy is the temperature of the cold source Тхи (Tcs), in relation to which it is calculated. If its value is assumed to be constant, the numerical Тхи (Tcs) value is entered in the parameter 0300 'standard temperature Тхи'(Tcs), and in the parameter 0306 'number of the parameter used as Тхи (Tcs)', the 0300 code (reference to constant) must be entered. If temperature Тхи (Tcs) is supposed to be measured, then the value of parameter 0300 can be arbitrary, and the code of the number of that parameter from the queue of loadable tasks, which represents the measured temperature Тхи (Tcs), should be entered in parameter 0306.
- Common configuration for calculation of absolute pressure and calculation of thermal energy is atmospheric pressure Ратм. If its value is assumed to be constant, the numerical Ратм value is entered in the parameter 0301 'standard atmospheric pressure', and in the parameter 0307 'number of the parameter

used as Ратм', code 0301 should be entered (reference to the constant). If the pressure Ратм is supposed to be measured, then the value of parameter 0301 can be arbitrary, and in parameter 0307 the code of the number of that parameter from the queue of loadable tasks should be entered, which represents the measured pressure Ратм. In any case, both when specifying by means of a constant, and when measuring of Ратм, its value can be expressed in millimeters of mercury, kilograms per square centimeter or megapascals. To inform the program about the units of measurement used, they must be indicated via the parameter 0304 'Ратм units of measurement', which takes one of three values: 0 (mm Hg.), 1 (kgf/cm^2), 2 (MPa).

- The remaining settings for commercial calculations are the estimated time interval in minutes (F020), the calculation hour (F023), the calculation day (F022), the current date (F017), the current time (F018), the daylight saving time ban / permission (0303).
- Settings of up to 200 items of the display main menu with numbers 'N' from 00 to 199.
- Settings of up to 56 archives menu items with numbers 'N' from 00 to 55.
- Settings of up to 10 items of the display cyclic menu.

It is allowed to assign the displayed items not in a row, but with gaps, which will be automatically bypassed when displayed.

Values of the facility settings made by the manufacturer are shown in Table 3.2. The values of the remaining parameters are not defined.

Table 3.2 – Facility configuration parameter values

No.	Parameter name	Value
0000	CAN-BUS network number	01
0004	CAN-BUS configuration	41E0
0005	RS-232 TTL network number	01
0006	RS-232 TTL interface descriptor	08
0007	RS-232 TTL frequency constant	FD00 (9600Hz)
0200..0207	250 Hz digital-data filter at the input is on	0
0300	Heat sink reference temperature	0.0
0306	Parameter number used as Тхи	0300
0301	Standard atmospheric pressure	745.0
0307	Parameter number used as Ратм	0301
0304	Ратм units of measurement	0 (mm Hg)
0303	Daylight saving time permission	0 (prohibited)
F017	Date	Current values are set
F018	Time	
F020	Calculation time interval	05
F023	Calculation hour	00
F022	Calculation date	01
F025	Service engineer password	FFFFFFFF (no)

3.2.5.4 For all **loaded** tasks, specific numerical values of the setting parameters (features of sensors, narrowing devices and pipelines, units of measurement, etc.) should be specified.

3.2.5.5 The output accumulated parameters of all tasks must be assigned initial values, usually zero. This can be done either by assigning directly to each parameter of number ‘0.0’, or by thoroughly cleaning the area of the external RAM allotted for parameters of loadable tasks. The second method is more preferable and is performed by setting a single value of the bit parameter 0302 ‘clearing of information of the external RAM’. The TEKON-19 program performs cleaning of the entire external RAM area allocated for storing the parameters of loadable tasks, sets markers of all archive types, after which parameter 0302 is reset. The cleaning event is entered into the system event log.

3.2.5.6 In exceptional cases, it is possible to perform the initial start-up operation of the TEKON-19 program (except version 11). It is also performed by recording ‘1’ into the bit parameter 0302, but only when the technological jumper is installed in the RS-232 TTL connector. A full cleaning of all TEKON-19 RAM, including the system area, is performed with a time setting of 23:59:00 and a conventional program development date on January 1, 2013. The initial launch fact is recorded in the system event log. Next, the jumper should be removed, and the time and date – reset.

3.2.5.7 In order for all accumulation, archiving and display tasks to start working normally after commissioning, it is sufficient after completing the commissioning works to perform the memory clearing operation in accordance with the instructions given in 3.2.5.5.

3.2.5.8 Upon completion of the configuration, the TEKON-19 programming cards can be issued, for example, using the ‘Teleport’ software.

3.2.5.9 The programmed TEKON-19 is ready for operation at the facility. If necessary, after completing the setup and putting the transducer into operation, a service engineer password can be set, which protects the task settings and commercial parameters from unauthorized changes.

4 USE OF THE TRANSDUCER

4.1 Reading parameters via CAN BUS

4.1.1 The main way to access the TEKON-19 parameters in operation is to exchange with a PC via the main digital CAN-BUS interface through the corresponding adapters produced by the manufacturer and the communication equipment of information communication channels using various software that support the controller exchange protocols (for example, the ‘Teleport’ software, dispatching software complex ‘ISKRa’, etc.). The ways of programs usage are set out in the documentation thereto and in their help functions (HELP).

4.1.2 When working in operation as part of an automated information collection system at the ‘User’ access level, all calculated values for all assigned tasks are displayed; their correction is impossible.

4.1.3 If after executing all the necessary connections and settings, the exchange program launched on the PC (for example, the ‘Teleport’ software) cannot establish the connection to a specified network address, the following actions should be performed:

4.1.3.1 Check the integrity of the cables, polarity of connections, reliability of the contacts, operability of the PC port, correct installation of the COM port number in the program and try communication again;

4.1.3.2 In the program, launch the function of searching for connected modules of the system by automatically searching for network numbers along the whole range from 00 to FF. If a response is received for one of the numbers, the cause of the malfunction is the incorrectly set network address in parameter 0000. Contacting the address found, replace it with the desired one.

4.1.3.3 If the search function did not find the connected module, it is possible that in the TEKON-19 the configuration parameter 0004, which sets the speed and information characteristics of the interface is distorted. In this case, turn off the TEKON-19 power supply and install a special plug in the RS-232 TTL connector (you can make it yourself from a cable plug by connecting pins 2 and 3 to each other). After powering on the TEKON-19, regardless of the condition of the memory addresses associated with the parameters 0000 and 0004, these parameters acquire the default values: address 00, configuration 41E0. By contacting the address 00 at 300 kBaud, correct the configuration settings.

4.1.3.4 After switching off the power again, **it is obligatory** to remove the plug, and after turning on the power, check again the connection with the address already set.

4.1.3.5 Network addresses and baud rates received by the TEKON program for execution can also be monitored via the display service menu (see 4.2.11).

4.2 Reading information from the front panel indicator

4.2.1 General

4.2.1.1 The TEKON-19 (except version 11) are equipped with an alphanumeric display located on the front panel with two control buttons. The display has 2 lines of 12 symbols each. Using the display, the user can view the condition of a number of parameters and their names, which have been pre-programmed to be read using a special 'menu'. The menu consists of three levels – the initial level (constant starting point), the intermediate level of titles and the level of operations. In turn, the level of operations consists of three parts: the main menu, the archive menu and the service menu. The overall menu structure is shown in figure 4.1. Partial correction of parameters displayed in the main menu is possible after performing some auxiliary operations in the service menu.

NOTE: The TEKON-19 in version 15 has its own unique menu structure, its description is provided in the OD to the measuring complex, which includes it. It is not described in this document.

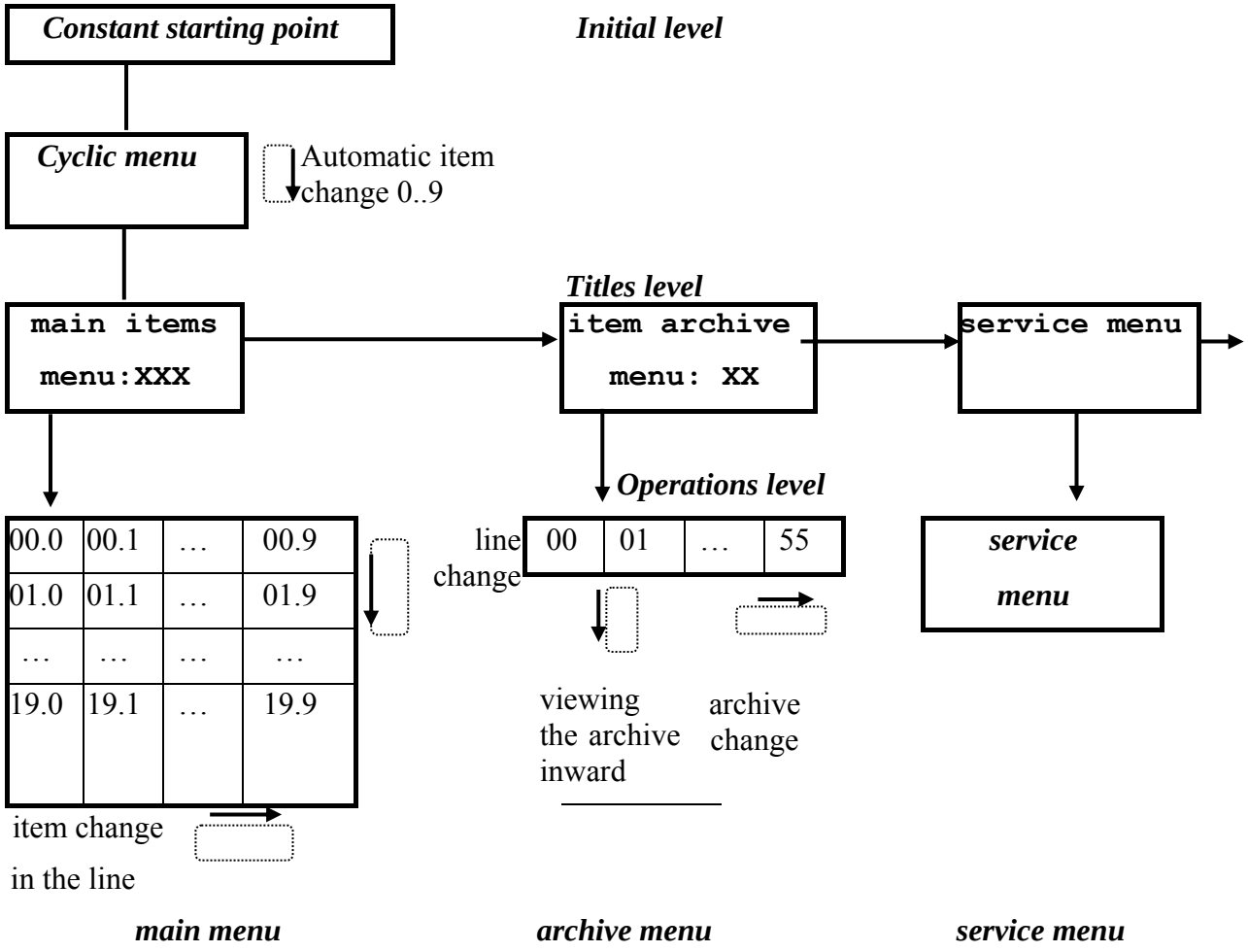


Figure 4.1 – Display menu structure

4.2.1.2 In general, the movement through the menu, i.e. transition from one menu item to another is performed by briefly pressing the control buttons on the front panel, labeled ‘down arrow’, ‘▼’ and ‘right arrow’ ‘►/. When pressing, the service symbol lights up in the first position of the bottom line (an analogue of the ‘beeper’ on the keyboards of many devices). At the level of operations, movement occurs only across active items (which displayed parameter code is different from FFxx) with automatic omission of inactive items (the displayed parameter code of the in which is equal to FFxx), both upwards and downwards in terms of the item number.

4.2.1.3 The TEKON-19 parameters, which have an internal representation in the form of float-point numbers, are usually assigned to the display in the menu. Display accuracy, i.e. the number of decimal places after the comma, is set when setting within the range from 0 to 4. The range of displayed numbers is from -10^6 to $+10^7$; otherwise, an overflow sign ($) appears on the indicator. If the value of the displayed parameter is a special code ‘not a number’ (hexadecimal code FFFFFFFF), the symbols of four asterisks (****) are displayed on the indicator. The ‘+’ sign is not displayed. Numbers smaller than 10^{-7} in modulus are displayed to be strictly equal to zero, without decimal places. The number on the display is rounded upwards if the first discarded order is 5 or more.

4.2.1.4 If necessary, it is allowed to include in the main menu parameters that have an internal representation in the form of unsigned one- and two-bit integers within the range from 0 to 65,535, as well as bit parameters and hexadecimal numbers (one, two and four bytes). The principle is as follows:

- The parameter is displayed as a float-point number if its internal representation is 4 bytes long, and the ‘display accuracy’ is set within the range from 0 to 4 symbols.
- A parameter of any length (one-, two-, and four-byte) is displayed as a hexadecimal number (see tables B.1 and B.2) if the conditional ‘display accuracy’ for it is set to more than 4. If the display accuracy is set to FF, the multibyte number is displayed entirely and so that the ‘high’ byte is located on the left, for example, 8825FD13. If the accuracy is set within the range from 05 to FE, the multibyte number is displayed byte-wise and so that the lowest byte is located on the left, for example, 12 FD 25 88.
- A parameter of 1 or 2 bytes in length is displayed as an unsigned integer decimal number if the conditional ‘display accuracy’ for it is 4 or less. If the accuracy of 0 is set for a two-byte number, it is displayed entirely within the range from 0 to 65,535. The accuracy within the range from 1 to 3 determines the byte-wise number indication, with the high byte located on the left.
- The bit parameters are automatically recognized, for them the ‘display accuracy’ is not analyzed.

4.2.1.5 The main direction in the menu is the movement in the direction of increase of the item number. Using the right button '►', you move along the line from left to right, using the left button '▼' – you move along the column from top to bottom or view the archive from the current moment deeper into the archive. To change the direction of movement, you must hold down the corresponding button for 2 seconds. The change of direction is performed in a similar way; a reverse transition is also possible. The current direction of movement is periodically displayed on the display in the form of arrow symbols upwards '↑', downwards '↓', to the right '>', to the left '<'. If there are no keystrokes within 256 seconds and also when entering the initial level of the menu, the direction of movement automatically switches to the main one (right and down).

NOTE: in the service menu, as well as after the start of correction (see 4.2.10), the possibility of changing the direction is blocked, only the main direction of movement remains.

4.2.1.6 Since the operations performed by the button depend on the duration of pressing, the menu item is changed not at the moment of pressing, but at the moment of releasing the button (except exit to the permanent menu item, see 4.2.2.1).

4.2.2 Initial menu level

4.2.2.1 The initial level of the menu is the original one at power-on of the TEKON-19. It is also transitioned to from any item in the menu by simultaneously pressing both buttons. The level consists of three consecutive automatic steps. The duration of the first and second steps is 5 seconds each, the duration of the third one is not limited.

4.2.2.2 At the first step, the general information identifying this transducer is displayed: in the top line: transducer version (02M, 03M, 04M, 05M, 06M, 10M), then –series and serial number in the form of an 8-digit number 'XXXXYYYY', where XXXX is the series, YYYY is the serial number. The bottom line shows the software version number as 'XX.YY' (for the algorithm set 03) or 'YY.XX' (for algorithm set 04), where XX is the version number of the basic software, YY is the version number of the calculation algorithm library (metrologically significant software), i.e. 03 or 04, for example:

06M 00011234 version 82.03
06M 00011234 версия 82.03

05M 00014321 version 04.01
05M 00014321 версия 04.01

4.2.2.3 During the second step, the standard name formed during the stage of creating a task queue, consisting of two lines of 12 characters each, is displayed, for example:

2 heating pipes	2 трубы отопление

This name is loaded along with the task queue. If the name is not loaded, i.e. the space allocated to it in the device's memory begins with two consecutive codes '00' or 'FF', then, the message «очередь без имени» ('queue without a name') is displayed. If no tasks are loaded, «задач: НЕТ» ('tasks: NONE') is displayed in the top line, the bottom line is empty. If the queue is loaded with errors, the top line displays «задач: ОШИБКА» ('tasks: ERROR'), the bottom line shows the queue identifier.

4.2.2.4. During the third step, the current date in the form of DD.MM.YY and the day of the week are displayed in the top line. The bottom line shows the current time in the form of HH:mm:ss and three service symbols, reflecting the current operating mode of the TEKON-19, for example:

18.05.15 Mon 15:36:54 ■*)	18.05.15 пн 15:36:54 ■*)

In the last position of the bottom line in the «РАБОТА» (OPERATION) mode, symbols of the left '(' and right ')' parenthesis are alternately displayed. The indication change occurs at the end of the next cycle of the TEKON-19 program account. In the «ОСТАНОВ» (STOP) mode, and also when the technological jumper is in place (see 4.1.3.3), the minus sign is constantly displayed in this position, i.e. '–'. For further information, see 2.3.10.10.

The asterisk '*' in the penultimate position of the bottom line indicates the absence of failures (zero state of the bit parameter of common failure 050E). If there are failures, instead of the asterisk the question mark '?' will be displayed. If there is at least one failure in the 0th bit of the parameter 0500 (see table 2.9), the question mark is lit permanently, which indicates critical failures of the equipment or the program of the TEKON-19 itself. If the 0th bit is clear, and there are signs of failure only in bit 1, the question mark flashes with a periodicity of 1 s.

The symbol in the previous position of the bottom line, other than a space, is displayed only if there are loaded tasks of two-rate electricity metering. During the main rate (daytime on working days) a transparent hexagon symbol is displayed. At the time of the discount rate at night, a black rectangle symbol is displayed. In the daytime on holidays and weekends the indicated symbols are displayed alternately with a periodicity of 1 second.

4.2.2.5 If there is a cyclic menu, the third step of the initial menu is automatically included in the cyclic menu. In this case, the duration of this step is 5 seconds.

4.2.3 Title level

4.2.3.1 Exit from the initial level of the menu to the intermediate level of titles occurs when pressing any button at any step of the initial item or cyclic menu. At the intermediate level, there are three items that represent the titles of the menu level of operations. Changing the item is done by pressing the right button, the items change in a loop.

4.2.3.2 The first two items of the title level «меню основн» (‘main menu’) and «меню архивов» (‘archive menu’) are intended for users. Under the title, the number of active items in the corresponding menu is displayed. If it is different from zero, pressing the down arrow key takes the menu to the performance level.

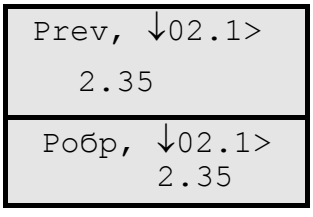
4.2.3.3 The last item of the title level «меню служебн» (‘service menu’) is the service one, and users, as a rule, should skip it by pressing the right button. Pressing the left button will take you to the service menu.

4.2.4 Main menu

4.2.4.1 The main menu contains 200 individual items with decimal numbers ‘MN’ from 000 to 199 inclusive, arranged in a table of 20 lines with 10 elements in each, as shown in figure 4.1. In this case, the two-digit number ‘M’ from 00 to 19 determines the line number, the ‘N’ number from 0 to 9 – the element number in the line. Placement of active items by numbers is selected during configuration and can be arbitrary. The availability of inactive items anywhere in any line, and the presence of entirely empty lines are allowed.

4.2.4.2 Entering the main menu is possible from the «меню основн» (main menu) item of the title level if the main menu contains at least one display parameter, which code is different from FFxx, and is performed by single pressing of the ‘down arrow’ button. The first item to be displayed will be the active item with the minimum number.

4.2.4.3 In all active points in the top line, the name line entered when creating the menu is displayed, and in the bottom line – the numerical value of the specified parameter with the specified accuracy. Periodically, every few seconds, and also after pressing any button or holding it for 2s, instead of the last six characters of the top line of the display, the number of the current menu item is displayed as the number of the menu line and the element number in the line, separated by a dot symbol, as well as the current direction of movement by buttons. For example, if the pressure in the return pipeline is 2.3467 kg/cm^2, then at the exit to item 21, the display will take the following form:



4.2.4.4 When in the main menu, the ‘right arrow’ button is used to move within the current line only (scrolling the line to the right or left, see 4.2.1.5). Pressing it once

brings up the next active item in the line. After the last active item of the line, it automatically returns to the first active item of the current line.

4.2.4.5 When in the main menu, the ‘down arrow’ button is used to change lines (scroll up or down the column, see 4.2.1.5). Pressing it once causes transition to the next line containing the active item in this column. After the last line, it automatically returns to the first active line.

4.2.4.6 The update of the parameter value indication in any menu item occurs initially at the moment of entering a new item, and then periodically from one to several times per second.

4.2.5 Archive menu

4.2.5.1 The archive menu contains 56 separate items with decimal numbers ‘MN’ from 00 to 55, inclusive, arranged in one line, as shown in figure 4.1. Allocation of active items by number is selected during configuration and can be arbitrary. The availability of inactive items anywhere in the line is allowed.

4.2.5.2, It is allowed to include in the archive menu the parameters of loadable tasks only, which are output for loaded tasks of archives of months (for 1 and 4 years), archives of days, archives of hours (for 16, 32 and 64 days), archives of user’s events. In addition, the inclusion of the ‘rigid’ parameter 0904, which is the output for the system event log, is allowed. Other options and other types of archives are not allowed.

4.2.5.3 You can enter the archive menu from the «меню архивов» (‘archive menu’) item of the title level if there are at least one display parameter in the archive menu, the code of which matches the number of the output parameter of one of the loaded archive tasks or is equal to 0904, and it is performed by pressing the left button ‘down arrow’ once. The first active item with the minimum number is displayed.

4.2.5.4 When you exit to any menu item, following is indicated first of all:

- in the top line of the display – the name entered when setting the item. Periodically, once every few seconds, instead of the last three characters in the top line, the number of the current menu item and the direction of movement are briefly displayed when changing the archive (see 4.2.1.5);
- in the bottom line of the display – the type of archive automatically determined when displaying («месячный 12м» ‘monthly 12m’, «месячный 48м» ‘monthly 48m’, «суточный» ‘daily’, «часовой 16дн» ‘hourly 16d’, «часовой 32дн» ‘hourly 32d’, «часовой 64дн» ‘hourly 64d’, «события сист» ‘sys events’, «события» ‘events’), e.g.:

Q 135 school daily	Q 135 sc 25< daily
Q 135 школа суточный	Q 135 шк 25< суточный

4.2.5.5 Viewing the contents of an archive is performed by repeatedly pressing the ‘down arrow’. Viewing is performed in the direction from the last moment of

recording of information in this type of archive deeper into the archive, to its end, with a circular transition in time from end to beginning. Each pressing of the ‘down arrow’ button shifts the archive viewing point by one record unit of the corresponding archive type (by month, day or hour). The viewing direction can be reversed by holding down the ‘down arrow’ for 2 seconds according to 4.2.1.5.

4.2.5.6 When viewing any numeric archive, the bottom line displays the numerical value of the archive contents with a given accuracy, and the top line shows the viewing direction (depthward ‘↓’, backward ‘↑’, time and date of the archive. For the months archives there are the month number MM and the year YYYY, for the archive of days – the full date in the form of DD.MM.YYYY, for the archive of hours – the date in the form of DD.MM and the hour of recording (its beginning and end in the form of HH – HH+1), for example:

monthly	daily	hourly
04 2015 ↓ 182.6	15.06.2015 ↓ 45400.0	15.09 16-17↓ 7.66

месячный	суточный	часовой
04 2015 ↓ 182.6	15.06.2015 ↓ 45400.0	15.09 16-17↓ 7.66

It should be noted that the time and date of the archives are not really stored in the archives themselves and are formed only by the display program, based on the current time and date, the type of archives and the current viewing depth.

4.2.5.7 In the archive menu, the ‘right arrow’ button is used to change the displayed archive. Pressing it once at any current viewing depth of the current archive causes a transition to the beginning of the next active item (right or left – by long pressing the button according to 4.2.1.5) with an indication of the archive title according to 4.2.5.4 and automatically returning to the archive view mode. After the last active item, it automatically returns to the first active item.

4.2.5.8 Since the information stored in the archives is not updated during the viewing time, the display is generated for each menu item of the archives only at the moment when the button is pressed to change the archive, depth or viewing direction; then the value on the indicator is simply saved.

4.2.5.9 When viewing archives of events, the top line displays the date of the event in the form of DD.MM and the moment with an accuracy of minutes HH:mm. The bottom line on the right displays the content of the event as an 8-digit hexadecimal number. The code of the event type is displayed on the left in the system log (see table 2.13), and in the user archive – the current viewing depth relative to the last record marker, on a loop from 0 to 255. If less than 256 events are recorded, when accessing the blank area, the bottom line displays the message «исчерпан» (“no events”).

4.2.6 Service menu

The last item of the intermediate level «меню служебн» (‘service menu’) is the service one. At the level of operations, it has at least two main points: «состояние» (‘condition’) and «доступ» (‘access’), which let you know or change the current mode of operation of the transducer and set a password of the ‘Service Engineer’ level. The «коррекция» ‘correction’ item allows or prohibits the correction of parameters in the main menu. The «настройки каналов» item ‘channel settings’ displays network numbers and baud rates via the CAN and RS-232 TTL channels. Further, there is transition to three items of names and numerical characteristics of the task queue and the item about software integrity.

The transition from one item to another is carried out by pressing the right button. Transitions are made in circles, the movement is only from left to right, the reversal direction of movement is blocked.

4.2.7 «Состояние»(‘Condition’) item of the service menu

4.2.7.1 In the «состояние» (‘condition’) item, the current TEKON-19 mode of operation is displayed, i.e. in operation mode – «РАБОТА» (‘OPERATION’).

Condition operation	Состояние работа

No other actions in this item are RECOMMENDED for users. The exit from the item is made by pressing the right button (to the «доступ» ‘access’ item) or by simultaneously pressing both buttons (on the constant initial point).

4.2.7.2 The «состояние» ‘condition’ item allows changing the current mode of operation, i.e. to switch the TEKON-19 to the «ОСТАНОВ» (STOP) technological mode and back to the «РАБОТА» OPERATION mode. This may be required when the transducer is temporarily taken out of service, for example, for verification or repair, with the possibility to preserve the information accumulated in the transducer (see 2.3.11).

4.2.7.3 The first pressing of the left button takes the «состояние» ‘condition’ item to the next level, preparing the mode change to the opposite one:

condition change?	состояние изменить?

If there is no such need, press the ‘right arrow’ button, and you will go back to the service menu title level. If the mode really needs to be changed, click the ‘down arrow’ button.

This button starts the next level of the service menu, which requires entering the correct value for the service engineer password (see 2.3.10). Initially, the original password code consisting of eight points, the blinking cursor in the left position of the bottom line and the word ‘yes’ in the right part of the bottom line light up:

ent. password:	вв. пароль: ▮..... да

Password entry rules:

- Each pressing of the left button changes the value of the digit in the position indicated by the cursor by one (the initial symbol of the point is replaced by a zero). All numbers are hexadecimal, changing upwards in a circle-like form: 0.1, .., 9, A, .. F, 0, ...
- Each pressing of the right button shifts the cursor one position to the right. Shifting to the left is impossible, the reverse function does not work.
- If the transducer has not been supplied with a service engineer password, i.e. its real value is 00000000 or FFFFFFFF, it is allowed to enter an arbitrary combination of numbers, as long as there is not a single point in all positions.
- After entering all eight digits, the cursor is immediately placed on the first character of the word «да» (‘yes’). Each pressing of the left button changes the word «да» (‘yes’) to the word «нет» (‘no’) and back.

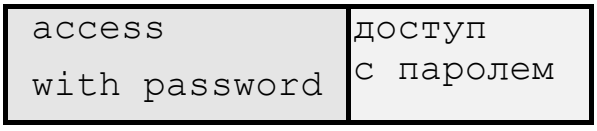
The result of pressing the right button depends on the word displayed after the password. If ‘no’, the mode change operation is not performed, the menu returns to the title level of the service menu. If ‘yes’, when the password is entered correctly, the mode change operation is actually performed, the menu goes to the result indication level. In the upper line, a new mode is displayed, in the lower line - the word ‘executed’, for example:

Mode change is accompanied by a notice in the system event log. Pressing any button returns to the title level of the service menu.

4.2.7.6 If the password is entered incorrectly, the message ‘no access’ is displayed. Pressing any button returns the menu to the title level of the service menu, and if necessary, all actions to change the mode of operation must be performed again.

4.2.8 The «доступ» (‘access’) item of the service menu

4.2.8.1 If the transducer was not supplied with a service engineer password, i.e. its real value is 00000000 or FFFFFFFF, the word «свободный» (‘vacant’) is displayed in the «доступ» (‘access’) section; otherwise – the words «с паролем» (‘with password’), for example:



No other actions in this item are RECOMMENDED for users. Exit the item by pressing the right button (to the «состояние» ‘condition’ item), or by simultaneously pressing both buttons (to the constant starting point).

4.2.8.2 The «доступ» (‘access’) item allows you to change the current password value. This may be required when commissioning the transducer after precommissioning has been completed.

4.2.8.3 The first pressing of the left button takes the «доступ» ‘access’ item to the next level, preparing the possibility of checking and changing the password:

access change?	доступ изменить?

If there is no such need, press the ‘right arrow’ button, which will take you back to the title level of the service menu. If the password really needs to be changed, click the ‘down arrow’ button.

4.2.8.4 This button starts the next level of the service menu, which requires entering the correct value for the service engineer password (see 2.3.10). The indications and rules for entering the current password are similar to those described in 4.2.7.4.

4.2.8.5 The result of pressing the right button after entering the current password depends on the word displayed after the password. If «нет» (‘no’), the further operations are canceled, and you will be returned to the title level of the service menu. If «да» (‘yes’), but the password is entered incorrectly, the message «нет доступа» (‘no access’) is displayed, and any button returns to the title level of the service menu. If the password is entered correctly, this message is displayed:

access executed	доступ исполнено

If you are still sure that you need to set a new password, press the left button. A flashing cursor appears in the first position of the bottom line, and the display takes the following form:

new password XXXXXXXX yes	новый пароль XXXXXXXX да

Here, XXXXXXXX is the value of the current password. Using the left button to scroll the value of each digit, and the right – to change the position, enter the value of the new password and, without changing the word «да» (‘yes’), press the right button again. An indication appears indicating that the new password value has been accepted:

new password executed	новый пароль исполнено

The fact of changing the password is noted in the system event log. Pressing any button returns to the header level of the service menu.

4.2.9 The «коррекция» ‘correction’ item of the service menu

4.2.9.1 In the «коррекция» (‘correction’) item, the current mode of the possibility of parameters' correction is displayed through the transducer's main menu, i.e. usually in the mode of operation – «запрещено» (‘prohibited’).

Correction prohibited	Коррекция запрещено

No other actions in this item are RECOMMENDED for users. Exit from the item is made by pressing the right button (to the «состояние» ‘condition’ item) or by simultaneously pressing both buttons (to the constant starting point).

4.2.9.2 In principle, the «коррекция» (‘correction’) item allows permitting or prohibiting the correction of float-point parameters included in the display of the main menu and having an access level not higher than the “Service Engineer”. This may be required for the rapid change of some settings without using a PC.

4.2.9.3 The first pressing of the left button takes the «коррекция» ‘correction’ item to the next level, preparing the ability to verify the password:

correction change?	коррекция изменить?

If there is no need to change the correction mode, press the ‘right-arrow’ button, it will take you back to the title level of the service menu. If you really need to change the mode, click the ‘down arrow’.

4.2.9.4 This button starts the next level of the service menu, which requires entering the correct value for the service engineer password (see 2.3.10). The indication and rules for entering the current password are similar to those described in 4.2.7.4.

4.2.9.5 The result of pressing the right button after entering the current password depends on the word displayed after the password. If «нет» (‘no’), further operations are canceled, and return to the title level of the service menu takes place. If «да» (‘yes’), but the password is entered incorrectly, the message «нет доступа» (‘no access’) is displayed, and any button returns to the title level of the service menu. With a correctly entered password, a new state of the correction mode is displayed, for example:

allowed! executed	разрешена! Исполнено

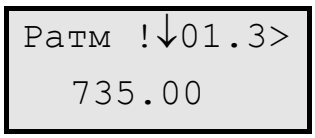
4.2.9.6 When the correction is allowed, a special internal marker is installed in the software. Further, proceed as described in 4.2.10.

4.2.10 Parameter correction procedure

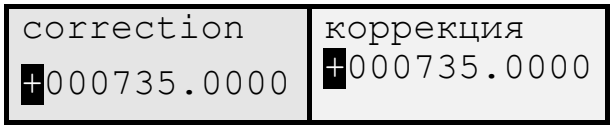
4.2.10.1 It is possible to correct the value of only single parameters that have a float-point representation and recording access level not higher than the “Service Engineer”. The corrected modulo number may not exceed 1,000,000, after the decimal point 4 decimal places. The real accuracy of the number representation does not exceed 7-8 decimal digits, i.e. for large numbers the fractional part will be introduced with a noticeable error. In order to correct, perform the operations described below.

4.2.10.2 Through the service menu, allow the correction in accordance with the instructions of 4.2.9. Double-click the ‘right arrow’ to go to the title level of the main menu. Going through the constant starting point by pressing two buttons does not make sense, because this resets the set indication of the correction permission.

4.2.10.3 Enter the main menu and go to the display item of the desired parameter. The reversal of the movement direction using the buttons when the correction is enabled is blocked, movement is only possible in the main direction. Please note that, if the correction is enabled in all the menu items that contain parameters that can be adjusted (see 4.2.10.1), together with the item number and the direction of movement, an exclamation point symbol is periodically displayed, for example:



After selecting the desired item, press the left button for a long time (at least 2 seconds). The beginning of the correction is indicated by a change in indication. The word «коррекция» (‘correction’) is displayed in the top line, and the value symbols appear in the bottom line in all positions of the line, including the sign of the number, non-significant zeros before the number, all 4 decimal places after the comma and the blinking cursor in the first position of the bottom line:



NOTE: if the original modulo number was equal to or exceeded 1,000,000, it would appear on the indicator as “+999999.9999” and can be corrected starting from this value.

Correction rules:

- Each short pressing of the left button changes the value of the digit in the position marked by the cursor by one. All digits are decimal, changing in the direction of increasing in a ring-like manner: 0.1,.., 9.0,... At the position of the number sign, the ‘+’ symbol changes to ‘–’, and vice versa.
- Each short pressing of the right button shifts the cursor one position to the right. The decimal point position is bypassed automatically. Shifting to the left is impossible, the reverse function does not work, but when the extreme right position is reached and the right button is pressed, the cursor moves to the

leftmost position again, which allows correcting of the number in several passes if necessary.

After completing the correction, press the left button for a long time (at least 2 seconds). The corrected parameter will be copied from the indicator to the microprocessor memory, which is accompanied by a brief indication on the indicator of the following message:

Correction recording in progress	коррекция идет запись

After that, the original indication display shown in 4.2.10.3 is restored, but with the new value of the corrected parameter.

4.2.10.7 If there is another parameter that requires correction, go to the menu containing the item and adjust it according to 4.2.10.4 - 4.2.10.6.

4.2.10.8 If due to any reason it is necessary to cancel the started correction (i.e., being in 4.2.10.5), press the right button for a long time, more than 2 seconds. The correction process of this parameter will be interrupted, preserving the original value of the parameter and the possibility of performing correction of other parameters.

4.2.10.9 As in case of parameters recording via serial exchange channels, the fact of correction is noted in the system event log according to table 2.10, if the recording access level to the corrected parameters was the “Service Engineer”.

4.2.10.10 After completing the correction of all the required parameters, remove the sign of permission of correction in one of the following ways:

- Simultaneous pressing of two buttons with exit to the permanent menu item (recommended).
- Prohibition of correction through the service menu (possible, but inconvenient).
- Power switching.
- No button pressing for 256 seconds automatically prohibits the correction.

4.2.11 The «<u>настройка каналов</u>»‘channel setting’ item of the service menu

The item does not have a special title, the current settings of the communication channels are immediately displayed, i.e. network addresses in hexadecimal form and exchange rate in kilobauds for example:

CAN 01 300 RS 0E 9.6	CAN 01 300 RS 0E 9.6

The top line refers to CAN-BUS, the bottom line to RS-232 TTL. Not set values of parameters, but real channels settings are displayed, taking into account, for example, the installed technological jumper.

4.2.12 Indication of names and numerical characteristics of the task queue

4.2.12.1 Consists of three items:

- The standard task queue name. Fully repeats the indication of the second menu step in the same way as 4.2.2.4.
- An arbitrary object or queue name assigned by the user during configuration and containing two lines of 12 symbols each. If the name is not assigned, i.e. the first two characters of the first line have codes ‘00’ or ‘FF’ in the device memory, then the message ‘object without a name’ is displayed.
- Numerical characteristics of the task queue, i.e. their number and code, similar to 4.2.2.3.

If at the moment the TEKON-19 is functioning without failures, i.e. all binary digits of the parameter 0500 (or 0516) are cleared (see table 2.11), the display of the standard or user name lasts indefinitely. If there are failures, a failure message is periodically displayed according to table 4.1.

If there are several failures of different priority simultaneously, only one message is displayed, the conditional priority of which has a lower numerical value.

This indication due to its blinking should only attract the attention of the attendants to the occurrence of failures. For more detailed diagnostics, you can view the system event log or, by including the parameter 0500 or 0516 in the main menu, view its condition.

Table 4.1

Conventional priority	Indication	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
		Byte 0 of parameter 0500								Byte 1 of parameter 0500							
1	Нет счета (No account)							+						+	+		
2	Отказ прибора (Instrument failure)			+	+								+				
3	Отказ настроек (Settings failure)	+	+			+	+				+	+				+	
5	Отказ алгоритмич (Algorithm failure)																+
		Byte 2 of the parameter 0516								-							
4	Большое число (Large number)				+	+											

4.2.13 The menu item «КС метрол ПО» (‘KS Metrol Software’) allows assessing the software integrity. The display type is as follows:

KS Metrol Software xx00mmmmmmmm	КС метрол ПО xx00mmmmmmmm

Indication in the bottom line is hexadecimal. The last eight characters ‘mmmmmmmm’ indicate the value of the CRC32 checksum of the metrologically significant part of the program. The first two characters ‘xx’ are service ones, the next

two characters reflect the condition of bit 2 of parameter 0516 (see 2.3.8.1) and are displayed as ‘00’ when the program is operational.

4.2.14 The following are the menu items that allow you seeing the information on the MC. If the TEKON-19 frequency MC and pulse number MC are present in this version, the following message (for example) can be seen on the indicator:

Frequency, Hz F0 23,2	Частота, Гц F0 23,2

F0 – frequency and pulse number MC No. 0.

View all MC by pressing the ‘down arrow’.

When you press the ‘right arrow’ button, you can go to view the resistance values and then the current rate (if there are analog MC in this version of the TEKON-19). You can also view all the MCs by pressing the ‘down arrow’.

The display type is as follows:

Resistance, Ohm T0 104,7	Сопротивл,Ом T0 104,7

Current rate, mA I0 16,5	Сила тока,мА I0 16,5

T0 – resistance MC No. 0, I0 – current rate MC No. 0.

The last menu item that can be accessed by pressing the ‘right arrow’ button is the number of pulses per MC. Viewing of all the MCs is similar.

The display type is as follows:

Num. pulses F0 127	Кол импульс F0 127

4.2.14 Cyclic menu

4.2.14.1 In the TEKON-19, it is possible to assign a cyclic menu, in which each parameter from the specified list is displayed alternately with an automatic change in time.

4.2.14.2 The list can include up to 10 parameters. The assignable parameters must meet the same requirements as the main menu parameters (see 4.2.4). Indication rules are also similar to those of the main menu.

4.2.14.3 Each assigned parameter from the list is displayed for 5 seconds. In addition, each cycle begins with a transition to the third step of the initial menu item, where the current time and date are displayed (see 4.2.2.5). Thus, if there is an assigned parameter in the list N + 1, the frequency of indication of all parameters will be 5 * (N + 1) seconds.

4.2.14.4 The cyclic menu is entered automatically after all the steps of the initial indication have been completed, if at least one parameter is specified in the cyclic menu. Time of being in a cyclic menu is indefinite. Exit is possible either to the title level by pressing any button or to the level of the starting point by simultaneous pressing of two buttons.

5 TECHNICAL SERVICE

5.1 Maintenance and periodic verification

5.1.1 During operation, the TEKON-19 is subject to periodic verification. Verification is carried out in accordance with the requirements of Section 6. The results of periodic verification and initial verification after repair are recorded in the corresponding print form.

5.1.2 It is necessary to follow recommendations of 2.3.11.3 before disconnecting the transducer for verification, as well as before its commissioning after the verification. The transducer is mounted and dismounted according to the requirements of 3.1.

5.1.3 It may be necessary to replace the stationary backup battery after long-term storage or service with a power outage of a total duration exceeding 10 months. A battery discharge below an acceptable level may lead, amongst others, to resetting the clock, distorting the event log and accumulated archival information.

Maintenance in order to determine the level of charge and, if necessary to replace the battery, is performed at the manufacturer site or authorized service centres.

5.2 Repair

5.2.1 The TEKON-19 repair is performed at the manufacturer site or authorized service centres.

5.2.2 The transducer should be sent to the repair complete with the filled service log, a cover letter describing the fault following no particular form, **without terminal connectors**, as well as fixing and other elements not included in the scope of supply.

5.2.3 The preservation of settings and accumulated information in the device memory **is not guaranteed** in case of repair. It is necessary to carry out pre-commissioning activities before commissioning after repair.

5.2.4 It is necessary to carry out the initial verification in accordance with the requirements of section 6 after repair.

5.2.5 Information on each repair performed, factory default settings after the repair and service centre warranties are recorded in the service log and attached repair certificates.

6 VERIFICATION

This section describes the procedure for initial, scheduled and unscheduled verification.

The procedure applies to the TEKON-19 calculation and measurement transducers of **all versions and modifications, regardless of the manufacturing date.**

Not all MC and (or) not in all subranges of measurements are allowed to be verified in accordance with the statement of the TEKON-19 owner, indicating the information about the scope of performed verification in the verification certificate and (or) device certificate.

(Revision, Amendment No. 3).

6.1 It is necessary to perform operations specified in Table 6.1 when performing the TEKON-19 verification.

When receiving negative results on any verification operation, the verification is stopped and the TEKON-19 is declared unfit for operation.

6.2 If the TEKON-19 was manufactured after 01.10.07, the interval between verifications is 4 years, for other transducers it is 2 years.

(Revision, Amendment No. 3).

Table 6.1 – List of verification operations

Name of operation	Para. No.	Operations during verification	
		initial	scheduled
Visual inspection	6.7.1	yes	yes
Testing	6.7.2	yes	yes
Determination of the insulation resistance and strength	6.7.3	yes	no
Checking the measurement range and determining the absolute error of the resistance MC	6.7.4	yes	yes
Checking the measurement range and determining the absolute error of the current rate MC	6.7.5	yes	yes
Checking the measurement range and determining the absolute error of the frequency and pulses MC	6.7.6	yes	yes
Determination of the watch rate (relative error in the time measurement)	6.7.7	yes	yes
Verification of the software identity *)	6.7.8	yes	yes
*) - not performed for transducers with manufacturing date before 28.10.2013			

(Revision, Amendment No. 3).

6.3 Verification means

6.3.1 The following means are used during verification:

- direct current standard, category 3, within the range of values from $1 \cdot 10^{-3}$ A to $2 \cdot 10^{-2}$ A;
- working resistance standard, category 3, within the range of values from 50 Ohm to 4 kOhm;
- time standard within the range of values from $1.8 \cdot 10^{2}$ seconds to $1 \cdot 10^{4}$ seconds, standard of frequency within the range of values from 0.1 Hz to 1,000 Hz;
- M-67 type barometer, measurement range is from 600 to 800 mm Hg, accuracy of 1 mm Hg.;
- TL-1 thermometer, range: from 0 to 50°C, scale division is 1°C.
- Time server of FSUE 'VNIIFTRI' time servers group (ntp1.vniiftri.ru, ntp2.vniiftri.ru or ntp3.vniiftri.ru);

(Revision, Amendment No. 3).

6.3.2 It is allowed to use similar means of verification, which ensure the determination of the TEKON-19 metrological characteristics with the required accuracy.

6.4 Safety requirements and qualifications of verification officers

6.4.1 Only persons who have studied these procedures, TEKON-19 operating manuals and the verification tools, who are trained as measuring device verification officers and work in an organization accredited for verification are allowed to perform verification.

(Revision, Amendment No. 3).

6.4.2 During the TEKON-19 verification it is necessary to comply with the safety requirements stipulated by the Order of the Ministry of Labor of Russia of 07.24.2013 No. 328n 'On Approval of Rules on Occupational Safety during Operation of Electrical Installations', GOST 12.2.007.0-75, GOST 12.1.019-2009, GOST 12.2.091-2012, as well as the safety requirements specified in the TEKON-19 technical documentation, verification tools and auxiliary equipment.

6.5 Verification conditions

6.5.1 Verification is performed under the following conditions:

- ambient temperature, °C 20 ± 5;
- relative humidity, % 30 – 80;
- atmospheric pressure, kPa (mm Hg) 84 – 106.7 (630 – 795);
- voltage supply, V 24 ± 2.5.

6.5.2 The room should be free of dust, smoke, gases and vapours polluting equipment over the maximum allowable concentration for the radioelectronic industry.

6.5.3 The vibration level in the verification room should not exceed the norms established in the standards or technical specifications for specific types of verification means.

6.5.4 Connection of resistor banks to the TEKON-19 terminals is carried out with copper untinned wires.

6.6 Preparation for verification

6.6.1 Means of verification and the TEKON-19 are prepared for operation in accordance with the operational documentation of these means. Before verification, the TEKON-19 is warmed up for 30 minutes minimum.

6.6.2 The setting of the TEKON-19 parameters is checked in accordance with Table 3.2 and the display of the measured parameters in the display menu of all MCs (resistance, current, frequency) is checked according to the guidelines of section 3 hereof. If necessary, adjust the parameters and the display menu using the 'Teleport' software (it is supplied on a CD with the TEKON-19), guided by the description and help functions of the program.

(Revision, Amendment No. 3).

6.7 Verification performance

6.7.1 Visual inspection

During visual inspection of the TEKON-19, it is required to check the marking, availability of necessary inscriptions on the outer panel, scope of supply, absence of mechanical damage. The TEKON-19 that have unsatisfactory fixation of connectors, gross mechanical damage to the external parts and other damage are not allowed for further verification.

6.7.2 Testing

6.7.2.1 The serviceability of the operating and display controls, compliance of the display of the transducer service information (serial number, software algorithms version number) with the data given in the operating documentation and on nameplate of the rear panel are checked during testing, and also the possibility of displaying of all the TEKON-19 parameters and service information programmed in the display menu is checked.

6.7.2.2 Testing is considered to be successful if the transducer service information, all names and parameter values are correctly displayed on the front panel display, there is no indication of critical failures, programming errors and emergency situations.

6.7.3 Determination of insulation resistance and strength

6.7.3.1 Determination of the resistance and dielectric strength of the insulation is carried out between the measuring circuits terminals and the transducer housing

according to GOST R 52931. The measurement results are recorded in the protocol of verification following no particular form.

6.7.3.2 The insulation of the measuring electrical circuits with respect to power supply circuits shall withstand a test voltage of almost sinusoidal shape with amplitude of 500 V, frequency from 45 to 65 Hz under normal climatic conditions for 1 minute, the insulation resistance shall be 20 MOhm minimum.

6.7.4 Checking the measurement range and determining the absolute error of the resistance MC

6.7.4.1 Make a wiring diagram as shown in Figure 6.1.

6.7.4.2 The resistance values ($Робр_{ij}$) are sequentially set at five points on the resistor bank for each of the measurement ranges for two MC selected in accordance with the requirements of Recommended Practice MI 2539, and at three points for the other MC (resistance values are selected from Table 6.2). Counting of the measured signal parameters ($Rизм_{ij}$) is made on the TEKON-19 front panel display or through the CAN-BUS interface.

Where i is the point number of the input signal range,
j is the number of MC of this type,

ATTENTION! The resistance values within the range of 1,000 – 4,000 Ohm are set only for transducers manufactured after 01.10.07.

(Revision, Amendment No. 3).

Measurement results are recorded in the verification report following no particular form.

Table 6.2

Measuring ranges, Ohm	Checkpoints of resistance, Ohm	
	for two channels selected in accordance with MI 2539	for other channels
50 – 250	50, 100, 150, 200, 250	50, 150, 250
250 – 1,000	300, 500, 700, 900, 1,000	300, 700, 900
1,000 – 4,000	1,500, 2,000, 2,500, 3,000, 4,000	1,500, 2,500, 4,000

6.7.4.3 The absolute error of the resistance MC shall be within the following intervals:

- in the resistance range of 50 – 250 Ohm ± 0.04 Ohm; *)
- in the resistance range exceeding 250 – 1,000 Ohm ± 0.2 Ohm;
- in the resistance range exceeding 1,000 – 4,000 Ohm ± 2 Ohm.

* for transducers manufactured before 01.10.07 ± 0.05 Ohm

(Revision, Amendment No. 3).

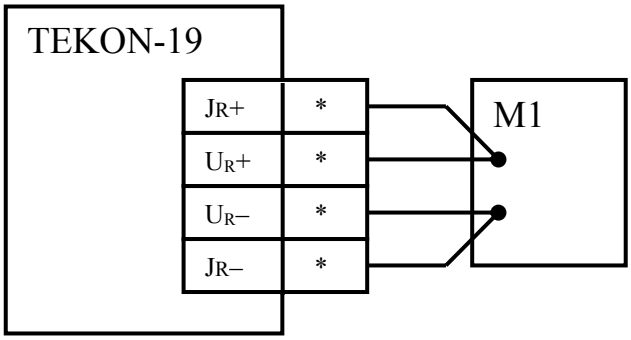


Figure 6.1 - Wiring diagram of the verification means during the verification of the resistance MC
M1 – resistor bank, *– terminal numbers as per Table 3.1

6.7.5 Checking the measurement range and determining the absolute error of the current rate MC

6.7.5.1 Make a wiring diagram as shown in Figure 6.2.

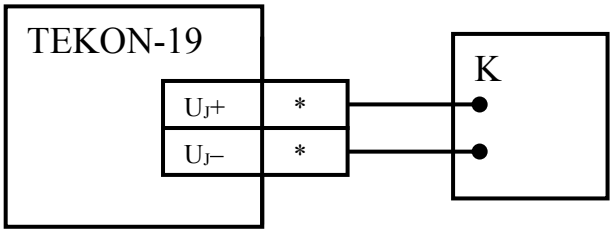


Figure 6.2 - Wiring diagram of the verification means during the verification of the current rate MC. K – current rate, *– terminal numbers as per Table 3.1

6.7.5.2 The current rate values ($Jобр_{ij}$) are sequentially set on the current rate calibrator at five points for each of the measurement ranges (1, 2, 3, 4, 5 mA and 6, 8, 10, 15, 20 mA) for two MC selected in accordance with the requirements of Recommended practice MI 2539, and at three points (1, 3, 5 mA and 6, 10, 20 мА) for the other MC. Counting of the measured signal parameters (Jm_{ij}) is made on the TEKON-19 front panel display or through the CAN-BUS interface.

Where i is the point number of the input signal range,
j is the number of MC of this type

Measurement results are recorded in the verification report following no particular form.

6.7.5.3 The absolute error of the current rate MC shall be within the following intervals:

– in the current rate range of 0 - 5 mA ± 0.005 mA;
– in the current rate range exceeding 5 – 20 mA ± 0.02 mA.

6.7.6 Checking the measurement range and determining the absolute error of the frequency and pulses MC

(Revision, Amendment No. 3).

6.7.6.1 Make a wiring diagram as shown in Figure 6.3.

Set the jumpers for selecting the MT type to the position corresponding to the MT with an active output signal as shown in Figure 3.3, C).

6.7.6.2 Reset the frequency indicator and set it to measure the pulse repetition rate. The calculation time of frequency indicator for transducer manufactured before 30.10.2015 is set to 100 seconds minimum and for other transducers it is 10 seconds minimum. It is allowed to use the frequency standard without a frequency meter, if it provides the determination of the TEKON-19 metrological characteristics with the required level of accuracy.

(Revision, Amendment No. 3).

6.7.6.3 On the pulse generator, set the pulse duration of (500±50) μs with an amplitude of 10 V and the pulse frequency at five points for each of the measurement ranges (100, 300, 500, 800, 1,000 Hz) for two MCs selected in accordance with the requirements of Recommended practice MI 2539, and at three points (100, 500, 1,000 Hz) for other MCs. Counting of measured signal parameters ($F_{изм_{ij}}$) is made on the TEKON-19 front panel display or through the CAN-BUS interface. The values of the input signal frequency ($F_{обр_{ij}}$) are measured using the frequency indicator. In case of using a frequency standard without the frequency indicator and the values specified in this standard are used as ($F_{обр_{ij}}$).

Where i is the point number input signal range,
j is the number of MC of this type

Measurement results are recorded in the verification report following no particular form.

(Revision, Amendment No. 3).

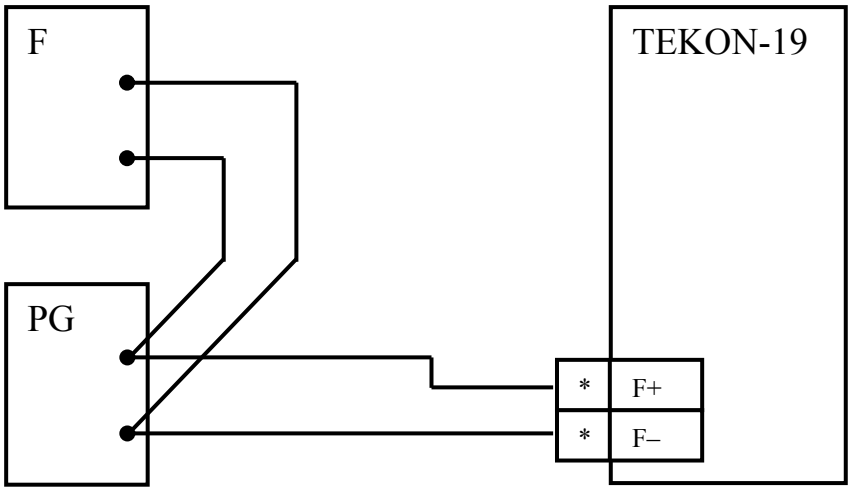


Figure 6.3 - Wiring diagram of the verification means during the verification of the frequency and pulses MC

F – frequency indicator in the pulse counting mode,
PG – pulse generator,
*– terminal numbers as per Table 3.1

6.7.6.4 The absolute error of the MC when measuring frequency shall be within the interval of ± 0.2 Hz.

6.7.6.5 The absolute error of the MC when measuring the number of pulses shall be within the interval of ± 1 pulse.

6.7.7 Determination of the watch rate (relative error in the time measurement)

6.7.7.1 The watch rate is determined by the TEKON-19 indicator or via CAN-BUS interface.

6.7.7.2 When determining the watch rate using the TEKON-19 indicator the indication of time is set on the TEKON-19 front panel display, the indication of the PC clock is set on the PC display, and the PC clock is set according to the standard (time server of the FSUE 'VNIIFTRI' time server group (ntp1.vniiftri.ru, ntp2.vniiftri.ru or ntp3.vniiftri.ru) using the NTP protocol).

6.7.7.3 When determining the watch rate via CAN-BUS interface, perform periodic reading of the parameter No. F018 'Time' via the interface, and waiting for its change, note the readings of the clock standard.

At the same time, the required time between the start and end of measurements is determined by $\tau_{изм}$, which ensures the TEKON-19 watch rate determination with the required accuracy depending on the response time to the 'Time' parameter change received from the TEKON-19 via the CAN-BUS interface, but not less than 180 seconds.

6.7.7.4 When determining the watch rate using PC with the time server, the time between the start and end of measurements $\tau_{изм}$ is selected within the range of (16 – 24) hours.

6.7.7.5 The initial value $\tau_{нач}$ of the TEKON-19 clock correction is recorded as the difference between the readings of the TEKON-19 clock and the standard (PC clock) in seconds.

6.7.7.6 After $\tau_{изм}$ time, re-conduct the operations according to 6.7.7.2 (6.7.7.3).

6.7.7.7 Record the final value $\tau_{кон}$ of the TEKON-19 clock correction in the verification report as the difference between the readings of the TEKON-19 clock and the standard (PC clock) in seconds.

6.7.7.8 It is allowed to conduct verification under 6.7.7 simultaneously with other verifications.

6.7.7.9 Daily watch rate shall be within the interval of ± 9 seconds.

6.7.7.10 The nominal error in the time measurement is determined only for transducers manufactured before 31.10.2013, the obtained value shall be within the interval of ± 0.01 %.

(Revision, Amendment No. 3).

6.7.8 Verification of the software identity

Verification of the TEKON-19 software identity is carried out by comparing the software identification data on the TEKON-19 display with the identification data specified in table 2.2.

The results are considered to be positive if the software identification data corresponds to those specified in table 2.2.

6.8 Processing of measurement results

6.8.1 Processing of measurement results when determining the absolute error of the resistance MC

6.8.1.1 Calculate the absolute error value using the formula:

$$\Delta R_j = \max_i \{(|R_{изм_{ij}} - R_{обр_{ij}}|)\} \quad (6.1)$$

6.8.1.2 Check on inequation compliance:

in the resistance range of 50 – 250 Ohm $\Delta R_j \leq 0.04$ Ohm; *) (6.2)

in the resistance range exceeding 250 – 1000 Ohm $\Delta R_j \leq 0.2$ Ohm; (6.3)

in the resistance range exceeding 1000 – 4000 Ohm $\Delta R_j \leq 2$ Ohm. *) (6.4)

* the inequation compliance (6.4) for the transducers manufactured before 01.10.07 is not checked, and the inequation (6.2) has the following form:

$$\Delta R_j \leq 0.05 \text{ Ohm}; \quad (6.5)$$

(Revision, Amendment No. 3).

6.8.2 Processing of measurement results when determining the absolute error of the current rate MC

6.8.2.1 Calculate the absolute error value using the formula:

$$\Delta J_j = \max_i \{(|J_{изм_{ij}} - J_{обр_{ij}}|)\} \quad (6.6)$$

6.8.2.2 Check on inequation compliance:

in the current rate range of 0 - 5 mA $\Delta J_j \leq 0.005$ mA; (6.7)

in the current rate range exceeding 5 – 20 mA $\Delta J_j \leq 0.02$ mA; (6.8)

6.8.3 Processing of measurement results when determining the absolute error of the frequency and pulses MC

6.8.3.1 Calculate the absolute error value of the frequency MC using the formula:

$$\Delta F_j = \max_i \{(|F_{изм_{ij}} - F_{обр_{ij}}|)\} \quad (6.9)$$

6.8.3.2 Check on inequation compliance:

$$\Delta F_j \leq 0.2 \text{ Hz} \quad (6.10)$$

6.8.3.3 Calculate the absolute error value of the MC when measuring the number of pulses using a frequency indicator using the formula (6.11), and in case of using the frequency standard without a frequency indicator (pulse generator) using the formula (6.12):

$$\Delta N_j = (\Delta F_j - 1/\tau_ч) \cdot \tau_т , \quad (6.11)$$

$$\Delta N_j = \Delta F_j \cdot \tau_т , \quad (6.12)$$

Where $\tau_ч$ is counting time of the frequency meter in seconds,

$\tau_т$ is counting time of the TEKON-19 equal to 10 seconds when measuring the frequency for transducers manufactured after 30.10.2015 and for other transducers it is 8 seconds.

6.8.3.4 Check on inequation compliance:

$$\Delta N_j \leq 1 \text{ pulse} \quad (6.13)$$

(Revision, Amendment No. 3).

6.8.4 Processing of measurement results when determining watch rate and nominal error when measuring the time

6.8.4.1 Calculate the watch rate value in seconds using the formula:

$$\Delta(\tau) = (\tau_{кон} - \tau_{нач}) \cdot 24 \cdot 3600 / \tau_{изм} , \quad (6.14)$$

where $\tau_{изм}$ is the time between the start and the end of measurements in seconds.

6.8.4.2 The nominal error when measuring the time, %, for the transducers manufactured before 31.10.2013, is calculated using the formula:

$$\delta(\tau) = (\tau_{кон} - \tau_{нач}) \cdot 100 / \tau_{изм} \quad (6.15)$$

6.8.4.3 Check on inequation compliance:

$$|\Delta(\tau)| \leq 9 \text{ c} \quad (6.16)$$

Check on inequation compliance for the transducers manufactured before 31.10.2013:

$$|\delta(\tau)| \leq 0.01 \% \quad (6.17)$$

(Revision, Amendment No. 3).

6.8.5 The verification results are considered to be positive if the requirements of 6.8.1.2, 6.8.2.2, 6.8.3.2, 6.8.4.3 are met.

6.9 Registration of the verification results

6.9.1 In case of positive verification results, the TEKON-19 is recognized as serviceable and a verification certificate is drawn up in accordance with the Order of the Ministry of Industry and Trade No. 1815 of 02.07.2015, or the results are recorded in the device certificate (service log).

6.9.2 In case of negative verification results, the TEKON-19 is recognized as unserviceable and a notice of unworthiness indicating the reasons is issued in accordance with the Order of the Ministry of Industry and Trade No. 1815 of 02.07.2015, or the results are recorded in the device certificate (service log).

(Revision, Amendment No. 3).

7 TRANSPORTATION AND STORAGE

7.1 Transportation

Transportation of the packed TEKON-19 should be carried out in covered vehicles by all means of transportation, by air transport in sealed and heated compartments only in accordance with GOST R 52931.

7.2 Storage

The TEKON-19 storage should comply with the OZh4 storage conditions according to GOST 15150.

8 DISPOSAL

8.1 The TEKON-19 calculation and measuring transducer does not contain precious metals and materials posing hazard to life.

8.2 The TEKON-19 disposal is performed separately by groups of materials: plastic elements, metal fasteners.

ANNEX A - List of regulatory and technical documents referenced in the Operation Manual

GOST R 52931-2008 ГОСТ Р 52931-2008	Technological processes monitoring and control instruments. General specifications.
GOST 15150-69 ГОСТ 15150-69	Machines, instruments and other industrial products. Modifications for different climatic regions. Categories, operating, storage and transportation conditions in terms of ambient climatic condition influence.
GOST 14254-2015 ГОСТ 14254-2015	Degrees of protection provided by enclosures (IP Code).
GOST 12.2.007.0-75 ГОСТ 12.2.007.0-75	Occupational safety standards system. Electrical equipment. General safety requirements.
GOST 2.601-2013 ГОСТ 2.601-2013	Unified system for design documentation. Operational documents.
GOST 6651-2009 ГОСТ 6651-2009	Resistance temperature transducers. General specifications.
GOST R 8.740-2011 ГОСТ Р 8.740-2011	State system for ensuring the uniformity of measurements. Flow rate and quantity of gas. Measurements procedure by turbine, rotary and vortex flow meters and gas meters.
GOST 8.586.5-2005 ГОСТ 8.586.5-2005	Measurements of liquids and gases flow rate and quantity by means of orifice instruments. Principle of the method of measurements.
GOST 30319.1-2015 ГОСТ 30319.1-2015	Natural gas. Methods of calculation of physical properties. General statements.
GOST 30319.2-2015 ГОСТ 30319.2-2015	Natural gas. Methods of calculation of physical properties. Calculation of physical properties on the basis of information on density under standards conditions and nitrogen and carbon dioxide contents.
GOST 30319.3-2015 ГОСТ 30319.3-2015	Natural gas. Methods of calculation of physical properties. Calculation of physical properties on the basis of information on component composition.
GOST R IEC 870-5-1-95 ГОСТ Р МЭК 870-5-1-95	Telecontrol equipment and systems. Part 5. Transmission protocols. Section 1. Transmission frame formats.
GOST R EN 1434-4-2011 ГОСТ Р ЕН 1434-4-2011	Heat meters. Type approval tests.

MI 2412-97 МИ 2412-97	State system for ensuring the uniformity of measurements. Recommended Practice. Piped Hot Water Heat Supply Systems. Equations for Measurement of Thermal Energy and Quantity of Heat Transfer Agent.
MI 2451-98 МИ 2451-98	State system for ensuring the uniformity of measurements. Recommended Practice. Steam Pipe Heat Supply Systems. Equations for Measuring Thermal Energy and Quantity of Heat Transfer Agent.
MI 2539-99 МИ 2539-99	Measuring channels of controllers, measuring and computing, control, software and hardware systems. Verification methods.
MI 3173-2008 МИ 3173-2008	State system for ensuring the uniformity of measurements. Recommended Practice. Liquids and gases flow rate and quantity. Principle of the method of measurements using TORBAR averaging pressure tubes.
MI 3213-2009 МИ 3213-2009	State system for ensuring the uniformity of measurements. Gas flow rate and quantity. Principle of the method of measurements using ultrasonic flow transducer.

(Revision, Amendment No. 3).

MI 2667-2011 МИ 2667-2011	State system for ensuring the uniformity of measurements. Recommended Practice. Liquids and gases flow rate and quantity. Principle of the method of measurements using ANNUBAR DIAMOND II+ and ANNUBAR 485 averaging pressure tubes. General statements.
GSSSD MR 113-03 ГСССД МР 113-03	Determination of density, compressibility factor, adiabatic exponent and dynamic viscosity coefficient of wet petroleum gas
GSSSD MR 118-05 ГСССД МР 118-05	Calculation of density, compressibility factor, adiabatic exponent and dynamic viscosity coefficient of moderately compressed gas mixtures.
GSSSD MR 122-06 ГСССД МР 122-06	Calculation of the basic thermodynamic properties and dynamic viscosity coefficients and thermal conductivity of nitrogen.
GSSSD MR 134-07 ГСССД МР 134-07	Calculation of density, compressibility factor, adiabatic exponent and dynamic viscosity coefficient of nitrogen, acetylene, oxygen, carbon dioxide, ammonia, argon and hydrogen.
R 50.2.077-2014 P 50.2.077-2014	Recommended Practice. Type evaluations of a measuring instrument for type approval. Software validation for protection assurance.
R 50.2.076-2010 P 50.2.076-2010	State system for ensuring the uniformity of measurements. Density of petroleum and petroleum products. Methods of calculation. Programs and tables of calculation.
TU 4213-060-44147075-02	TEKON-19 calculating and measuring transducers.
ТУ 4213-060-44147075-02	Specifications.
T10.06.59 RD Т10.06.59 РД	TEKON-10, TEKON-17 heat power controller. Exchange via serial link. Programmer manual.

ANNEX B – Lists of the TEKON-19 parameters and algorithms

Table B.1 –List of 'rigid' parameters of the TEKON-19 of all versions

Parameter number	Parameter name		Designation 7)	Type 1)	Place 2)	Access 3)	Availability in version 12) 11111 12345678901234
	full	short					
1 Task "Analogue measurements"							
0101	Измерительный ток на ТС, мА Measuring current on the resistance temperature transducer, mA	Ток ТС	ЗК	П	Program ROM	23	+++–++++–+––+–
0102	Опорное напряжение АЦП, мВ ADC reference voltage, mV	Uопорн	ЗК	П	Program ROM	23	+++–++++–++–++
0103	Порог переключения Кус АЦП min, max Switching threshold ADC GF min, max	Uпорог	ЗК	Ш2	Program ROM	23	+++–++++–++–++
0104	Кус для больших напряжений, i=1,2,3 GF for high voltages, i = 1,2,3	АЦП0 ADC0	Кус Umax	ЗК	П	Program ROM	23 +++–++++–++–++
i104		АЦПi ADCi	КусUmaxi	ЗК	П	Program ROM	23 ––––––––––+–––
0105	Кус для средних напряжений, i=1,2,3 GF for medium voltages, i = 1,2,3	АЦП0 ADC0	Кус Ucp	ЗК	П	Program ROM	23 +++–++++–++–++
i105 0106		АЦПi ADCi	Кус Ucpi	ЗК	П	Program ROM	23 ––––––––––+–––
	Кус для малых напряжений GF for low voltages		Кус Umin	ЗК	П	Program ROM	23 +++–++++–+––+–
0108	Смещение Кус для больших напряжений, мВ, i=1,2,3 GF shift for high voltages, mV, i = 1,2,3	АЦП0 ADC0	dK Umax	ЗК	П	Program ROM	23 +++–++++–++–++
i108		АЦПi ADCi	dK Umaxi	ЗК	П	Program ROM	23 ––––––––––+–––
0109	Смещение Кус для средних напряжений, мВ, i=1,2,3 GF shift for medium voltages, mV, i = 1,2,3	АЦП0 ADC0	dK Ucp	ЗК	П	Program ROM	23 +++–++++–++–++
i109		АЦПi ADCi	dK Ucpi	ЗК	П	Program ROM	23 ––––––––––+–––
010A	Смещение Кус для малых напряжений, мВ GF shift for low voltages, mV		dK Umin	ЗК	П	Program ROM	23 +++–++++–+––+–
0110	Смещение канала ИК0-ИК9, мВ MC0-MC9 channel shift, mV		dU Ti 10), dU Ji 10)	ЗК	П	Program ROM	23 +++–++++–++–++
0111							+++–++++–++–++
0112							+++–++++–++–++
0113							++––++–+–++–++
0114							–––––+–––––++
0115							–––––+––––––+
0116							–––––+––––––+
010C	Входное сопротивление ИК, Ом MC terminal impedance, Ohm		Rвх Ji 10)	ЗК	П	Program ROM	23 –––––+––––+––+
010D							++––+––––+––+
010E							++––++–+––+––+
010 F							++––+––+––+––+

Table B.1 continued

Parameter number	Parameter name			Designation	Type [1]	Place [2]	Access [3]	Availability in version [12] 11111 12345678901234
	full		short					
0118	Калибровка ИК, мВ MC calibration, mV		КалибрJi [10]	НП	П	Program ROM	22	––––+––––+––+
0119								++–––+––––+––+
011A								++––++–+––+––+
011B								++––+––+––+––+
011C	Напряжение на канале ИК0-ИК9, мВ MC0-MC9 channel voltage, mV		Uri [10], Uji [10]	С	П	XRAM	13	+++–++++–++–++
011D								+++–++++–++–++
011E								+++–++++–++–++
011 F								+++–++++–++–++
0120								––––+––––––++
0121								––––+–––––––+
0122								––––+–––––––+
0400	Ток в канале ИК, мА MC channel current, mA		Ii [10]	Р	П	XRAM	13	––––+––––+––+
0401								++–––+––––+––+
0402								++––++–+––+––+
0403								++––+––+––+––+
0404	Сопротивление в канале «Ti», Ом. I=0..4 ‘Ti’ channel resistance, Ohm. I=0..4	T0	Rтс 0	Р	П	XRAM	13	+++–++++–+––+–
0405		T1	Rтс 1					––+–++++–+––+–
0406		T2	Rтс 2					––+––++––+––+–
0407		T3	Rтс 3					––––+–––+––+–
2 Task “Impulse-number and frequency measurements”								
0200	Цифровой фильтр 250 Гц на входе Fi включен 250 Hz digital filter at Fi input is switched on	input 0	фильтр 0	НП	bit	Program ROM	22	++++++++++–+––
0201		input 1	фильтр 1					++++++++++–+––
0202		input 2	фильтр 2					++++++++++–+––
0203		input 3	фильтр 3					++–+–+––++–+––
0204		input 4	фильтр 4					––––+––––––+–+––
0205		input 5	фильтр 5					––––+––––––+–+––
0206		input 6	фильтр 6					––––+––––––+–+––
0207		input 7	фильтр 7					––––+–––––––+––
0408	Текущая частота на входе Fi, Гц Current Fi input frequency, Hz	input 0	Fтек 0	Р	П	XRAM	13	++++++++++–+––
0409		input 1	Fтек 1					++++++++++–+––
040A		input 2	Fтек 2					++++++++++–+––
040B		input 3	Fтек 3					++–+–+––++–+––
040C		input 4	Fтек 4					––––+––––––+–+––
040D		input 5	Fтек 5					––––+––––––+–+––
040E		input 6	Fтек 6					––––+––––––+–+––
040 F		input 7	Fтек 7					––––+–––––––+––
0410	Число импульсов за цикл на входе Fi Number of pulses per cycle at Fi input	input 0	Nимп ц 0	Р	Д2	XRAM	12	++++++++++–+––
0411		input 1	Nимп ц 1					++++++++++–+––
0412		input 2	Nимп ц 2					++++++++++–+––
0413		input 3	Nимп ц 3					++–+–+––++–+––
0414		input 4	Nимп ц 4					––––+––––––+–+––
0415		input 5	Nимп ц 5					––––+––––––+–+––

Table B.1 continued

Parameter number	Parameter name			Designation	Type [1]	Place [2]	Access [3]	Availability in version [12] 11111 12345678901234
	full		short					
0416		input 6	Nимп ц 6					---+-----+-+--
0417		input 7	Nимп ц 7					---+-------+--
0506	Состояние дискретного входа Fi Discrete Fi input status	input 0	Вход 0	C	bit	RAM	10	++++++++++-+--
0507		input 1	Вход 1					++++++++++-+--
0508		input 2	Вход 2					++++++++++-+--
0509		input 3	Вход 3					++-+-+--++-+--
050A		input 4	Вход 4					---+-----+-+--
050B		input 5	Вход 5					---+-----+-+--
050C		input 6	Вход 6					---+-----+-+--
050D		input 7	Вход 7					---+-------+--
0210	Мгновенная целая частота на входе Fi, Гц Instantaneous frequency at Fi input, Hz	input 0	Fмгнов 0	C	Д2	XRAM	22	++++++++++-+--
0211		input 1	Fмгнов 1					++++++++++-+--
0212		input 2	Fмгнов 2					++++++++++-+--
0213		input 3	Fмгнов 3					++-+-+--++-+--
0214	Мгновенная целая частота на входе Fi, Гц Instantaneous frequency at Fi input, Hz	input 4	Fмгнов 4					---+-----+-+--
0215		input 5	Fмгнов 5					---+-----+-+--
0216		input 6	Fмгнов 6					---+-----+-+--
0217		input 7	Fмгнов 7					---+-------+--
0208	Общее число импульсов на входе Fi General number of pulses at Fi input	input 0	общимп 0	C	Д2	XRAM	12	++++++++++-+--
0209		input 1	общимп 1					++++++++++-+--
020A		input 2	общимп 2					++++++++++-+--
020B		input 3	общимп 3					++-+-+--++-+--
020C		input 4	общимп 4					---+-----+-+--
020D		input 5	общимп 5					---+-----+-+--
020E		input 6	общимп 6					---+-----+-+--
020 F		input 7	общимп 7					---+-------+--
3 Task “Indication”								
3.1 Main menu								
0700(i)	Индицируемый параметр, i=0..199 Displayed parameter, i=0..199		параметр	НП	Ш2	Program ROM	22	-+++++---+----
0701(i)	Число знаков после запятой, i=0..199 Number of decimals, i=0..199		точность	НП	Д1	Program ROM	22	-+++++---+----
0702(i)	Наименование, i=0..2399 Name, i=0..2399		имя	НП	Ш1 [8]	Program ROM	22	-+++++---+----
3.2 Archives menu								
0704(i)	Индицируемый параметр, i=0..55 Displayed parameter, i=0..55		параметр	НП	Ш2	Program ROM	22	-+++++---+----

Table B.1 continued

Parameter number	Parameter name		Designation	Type [1)]	Place [2)]	Access [3)]	Availability in version [12)] 11111 12345678901234
	full	short					
0705(i)	Число знаков после запятой, i=0..55 Number of decimals, i=0..55	точность	НП	Д1	Program ROM	22	–+++++–––+––––
0706(i)	Наименование, i=0..671 Name, i=0..671	имя	НП	Ш18 [9)]	Program ROM	22	–+++++–––+––––
3.3 Cyclic menu							
0707(i)	Индицируемый параметр, i=0..9 Displayed parameter, i=0..9	параметр	НП	Ш2	Program ROM	22	–+++++–––+––––
0708(i)	Число знаков после запятой, i=0..9 Number of decimals, i=0..9	точность	НП	Д1	Program ROM	22	–+++++–––+––––
0709(i)	Наименование, i=0..119 Name, i=0..119	имя	НП	Ш1 [8)]	Program ROM	22	–+++++–––+––––
4 Task “System”							
4.1 Description of the software module							
F000	Тип модуля Module type	Тип	С	Ш2	Program ROM	10	++++++++++++
0512	Исполнение модуля Module version	Исполнен	ЗК	Ш1	Program ROM	33	++++++++++––––
F040	Серия Series	Серия	ЗК	Ш2	Data ROM	13	–+++++–––++–––
F001	Заводской номер Manufacturer number	Зав N	ЗК	Ш2	Data ROM	13	++++++++++++
F002	Версия программы Program version	Прогр	С	Ш1	Program ROM	10	++++++++++++
F004(i)	Очередь загружаемых задач (массив 256 задач) Loadable tasks queue (array of 256 tasks)	Очередь	НП	Ш4	Program ROM	22	++++++++++––––
F005-F008	Начало таймерных задач 512Гц, 64Гц, 8Гц, 1Гц Start of timer tasks 512Hz, 64Hz, 8Hz, 1Hz	-	ЗК	Ш2	Program ROM	22	not applicable
F009	Начало задач по запросу Start tasks on request	-	ЗК	Ш2	Program ROM	22	not applicable
F00A(i)	Таблица параметров загружаемых задач, i=0..2047Table of parameters of loaded tasks, i=0..2047	Пар зад	НП	Ш4	Program ROM	22	++++++++++––––
F00B(i)	Таблица описания гибких параметров, i=0..1019 Table of flexible parameters, i=0..1019	опис гиб	НП	Ш4	Program ROM	22	++++++++++––––

Table B.1 continued

Parameter number	Parameter name		Designation	Type [1]	Place [2]	Access [3]	Availability in version [12] 11111 12345678901234
	full	short					
F00C	Длина области очереди задач (=1024 байт) Length of the task queue area (= 1024 bytes)	дл очере	ЗК	Д2	Program ROM	20	++++++++++----
F00D	Длина таблицы параметров загружаемых задач (=4096 байт) Length of the table of parameters for loadable tasks (= 4096 bytes)	дл пар з	ЗК	Д2	Program ROM	20	++++++++++----
F00E	Длина области описания гибких параметров (=4080 байт) Length of the flexible parameter description area (= 4080 bytes)	дл гиб п	ЗК	Д2	Program ROM	20	++++++++++----
F00F	Длина области размещения гибких параметров Length of flexible parameter placement area — in RAM (=48 bytes)	гиб РПД	ЗК	Д2	Program ROM	20	++++++++++----
F010	in XRAM (=512000 bytes)	гиб ОЗУ	ЗК	Д2	Program ROM	20	++++++++++----
F011	in data ROM (=1024 bytes)	гиб РПЗУ	ЗК	Д2	Program ROM	20	++++++++++----
F012	in program ROM (=0)	гиб прог	ЗК	Д2	Program ROM	20	++++++++++----
F013	Начальный адрес размещения гибких параметров Initial address for flexible parameters placement — in RAM (=0080h)	Агиб РПД	ЗК	Ш2	Program ROM	20	++++++++++----
F014	in XRAM (=1000h)	Агиб ОЗУ	ЗК	Ш2	Program ROM	20	++++++++++----
F015	in program ROM (=300h)	АгибРПЗУ	ЗК	Ш2	Program ROM	20	++++++++++----
F016	in program ROM	-	ЗК	Ш2	Program ROM	20	++++++++++----
F026	Заводской пароль Manufacturer password	Пароль3	ЗК	Ш4	Program ROM	30	++++++++++-++
F028(i)	Идентификатор, i=0..3 Identifier, i=0..3	Идентиф	НП	Ш4	Program ROM	23	++++++++++----
F029(i)	Символ короткого имени задачи, i=0..2047 Task short name symbol, i=0..2047	Зад имя	НП	Ш1	Program ROM	23	++++++++++----
F02A	Дата останова Stop date	ДатаОст	С	[5]	XRAM	23	++++++++++----
F02B	Время останова Stop time	ВремяОст	С	[4]	XRAM	23	++++++++++----

Table B.1 continued

Parameter number	Parameter name		Designation	Type [1)]	Place [2)]	Access [3)]	Availability in version [12)] 11111 12345678901234
	full	short					
F02C	Маркеры останова Stop markers	МаркОст	С	9Ш2	XRAM	23	++++++++++----
F02D	Фиксация останова Stop fixation	ФиксОст	С	Ш2	XRAM	23	++++++++++----
4.2 Interfaces adjustment							
0000	Сетевой номер CAN-BUS CAN-BUS network number	сет N	НП	Ш1	Data ROM	22	++++++++++++
0004	Конфигурация и скорость CAN BUS CAN BUS configuration and rate	скорость	НП	Ш2	Data ROM	22	++++++++++++
0005	Сетевой номер RS-232 TTL RS-232 TTL network number	номер RS	НП	Ш1	Data ROM	22	++++++++++----
0006	Описатель интерфейса RS-232 RS-232 interface descriptor	интер RS	НП	Ш17 [7)]	Data ROM	22	++++++++++----
0007	Константа частоты RS-232 RS-232 frequency constant	част RS	НП	Ш27 [7)]	Data ROM	22	++++++++++----
4.3 General settings for calculations							
F025	Пароль наладки Setup Password	Пароль2	НП	Ш4	Data ROM	22	++++++++++-++
0300	Стандартная температура холодного источника, °С Standard cold source temperature, °С	Тхи стан	НП	П	Data ROM	12	++++++++++----
0306	Номер параметра, используемого как Тхи Number of parameter used as Тхи	номерТхи	НП	Ш2	Data ROM	12	++++++++++----
0308	Используемая Тхи, °С Тхи used, °С	Тхи	Р	П	XRAM	12	++++++++++----
0301	Стандартное атмосферное давление Standard atmospheric pressure	Ратм ста	НП	П	Data ROM	12	++++++++++----
0307	Номер параметра, используемого как Ратм Number of parameter used as Patm	номерРат	НП	Ш2	Data ROM	12	++++++++++----
0304	Размерность Ратм: мм рт ст \ кгс/см2 \МПа (0\1\2) Patm dimension: mm Hg\kgf/cm2 \ MPa (0\1\2)	РазмРатм	НП	Д1	Data ROM	12	++++++++++----
0309	Используемое Ратм Ратм used	Ратм	Р	П	XRAM	12	++++++++++----

Table B.1 continued

Parameter number	Parameter name		Designation	Type [1]	Place [2]	Access [3]	Availability in version [12] 11111 12345678901234
	full	short					
F020	Длительность расчетного интервала, минут Duration of the estimated interval, minutes	интервал	НП	П	Data ROM	12	++++++++++----
F023	Расчетный час Checkout time	Расч час	НП	Д1	Data ROM	12	++++++++++----
F022	Расчетный день месяца Estimated day of the month	Расч день	НП	Д1	Data ROM	12	++++++++++----
F017	Дата НН ДД ММ ГГ Date HH DD MM YY	Дата	Р	[5]	XRAM	12	++++++++++----
F018	Время 00 сс мм чч Time 00 ss mm hh	Время	Р	[4]	XRAM	12	++++++++++----
0302	Очистка ХОЗУ XRAM Cleanup	очистка	НП	bit	RAM	22	++++++++++----
0303	Запрет \ разрешение летнего времени (0\1) Summer time allowance/ban (0/1)	Летн вр	НП	bit	Data ROM	12	++++++++++----
0501	Отказ алгоритмический Algorithmic failure	АлгОтказ	НП	bit	RAM	12	++++++++++----
4.Intermediate and service parameters							
0305	Энтальпия ХИ, МДж/кг Enthalpy CI, MJ / kg	Энт ХИ	Р	П	XRAM	23	++++++++++----
F01A	Режим работы Operation mode	режим	С	Ш1	RAM	23	++++++++++----
F01C	Код пользователя User code	пользов	С	Ш1	RAM	20	++++++++++--++
F01E	Длительность цикла расчета (hours)	Цикл, ч	Р	П	XRAM	13	++++++++++----
F01F	Длительность цикла расчета (seconds) Calculation cycle length	Цикл, с	Р	П	XRAM	13	++++++++++----
0500	Состояние отказов Failure Status	отказы	С	Ш2 [6]	RAM	10	++++++++++++++
0516	Расширенные отказы Extended failures	Расш отк	С	Ш4 [6]	RAM	10	++++++++++++++
0513	Дополнительные отказы Additional failures	ДопОтказ	С	Ш1 [6]	RAM	10	----------+--++
050E	Общий отказ ТЭКОН-19 TEKON-19 general failure	Общ отк	Р	bit	RAM	10	++++++++++----
0502	Флаги времени Time flags	-	С	Ш1	RAM	23	++++++++++----
0503	Контрольный адрес Control address	Пар\адр	С	Ш4	XRAM	22	++++++++++----
0504	Содержимое контрольного параметра/адреса Content of the control parameter/address	Адр плав	С	П	XRAM	23	++++++++++----
0505		Адр 16		Ш4			
050 F	Счет секунд за 30 минут Counting seconds in 30 minutes	Т30 с	С	Д1	XRAM	23	++++++++++----
0510	Счет секунд интервала Counting interval seconds	Сек инт	С	Д2	XRAM	23	++++++++++----

Table B.1 continuation

Parameter number	Parameter name		Designation	Type [1]	Place [2]	Access [3]	Availability in version [12] 11111 12345678901234
	full	short					
0900	Маркер системных событий System Event Marker	маркер	С	Д1	XRAM	20	++++++++++––––
4.5 Testing parameters							
0511	Технологическая перемычка Technological jumper	перемычк	С	bit	RAM	23	++++++++++––––
F02A	Дата останова Stop date	ДатаОст	С	[5]	XRAM	23	++++++++++––––
F02B	Время останова Stop time	ВремяОст	С	[4]	XRAM	23	++++++++++––––
F02C	Маркеры останова Stop markers	МаркОст	С	9Ш2	XRAM	23	++++++++++––––
F02D	Фиксация останова Stop fixation	ФиксОст	С	Ш2	XRAM	23	++++++++++––––
4.6 System event log (256 elements)							
0901	Дата события Date of event	дата соб	С	[5]	XRAM	10	++++++++++––––
0902	Время события Event time	врем соб	С	[4]	XRAM	10	++++++++++––––
0903	Вид события Event type	вид	С	[9]	XRAM	10	++++++++++––––
0904	Событие Event	Событие	С		XRAM	10	++++++++++––––
4.7 Interference system log (1024 elements)							
0906	Дата вмешательства Interference date	дата Вмеш	С	[5]	XRAM	10	++++++++++––––
0907	Время вмешательства Interference time	врем Вмеш	С	[4]	XRAM	10	++++++++++––––
0908	Номер параметра Parameter number	НомерПар	С		XRAM	10	++++++++++––––
090A	Старое значение параметра Previous parameter value	СтарЗнач	С		XRAM	10	++++++++++––––
090B	Новое значение параметра New parameter value	НовоеЗна	С		XRAM	10	++++++++++––––
4.8 System expansion							
F034(i)	Стандартное имя очереди, i=0..6 Queue standard name, i=0..6	Имя очер	НП	S4 [11]	Program ROM	13	–+++++–––+––––
F035(i)	Имя объекта, i=0..6 Object name, i=0..6	Имя объе	НП	S4 [11]	Program ROM	12	–+++++–––+––––
F036	КС метрологич ПО эталон Standard software metrolog CS	М ПО эт	ЗК	Ш4	Program ROM	10	–+++++–––+––––
F037	КС метрологич ПО реально Actual software metrolog CS	М ПО р	С	Ш4	XRAM	10	–+++++–––+––––
F040	Номер серии приборов Instrument Series Number	серия	ЗК	Ш4	Program ROM	13	–+++++–––+––––
030A	Частота процессора CPU frequency	ЧастПроц	НП	Ш1	Data ROM	22	–+++++–––+––––

Table B.1 continuation

Parameter number	Parameter name		Designation	Type [1]	Place [2]	Access [3]	Availability in version [12] 11111 12345678901234
	full	short					
0518	Первый цикл после перезапуска First cycle after restart	Вкл пит	C	bit	RAM	13	–+++++–––+––––

NOTES:

1. П – float-point number; Ш – hexadecimal number, Д – decimal number, S – symbol. The number indicates the number of bytes in the internal representation of the number. Floating decimal numbers in IEEE-754 standard format (short real numbers, 4 bytes).
2. Data ROM, program ROM is a reprogrammable memory data and programs, respectively. XRAM is external RAM with power from an internal source. RAM is internal RAM, when external power is disconnected, information is not saved.
3. 3. The first digit indicates the access level for reading, the second for recording: 0 — no operation, 1 — user, 2 — service engineer, 3 — customer engineer (see 3.2).
4. Four bytes with a binary decimal time representation: empty, seconds from 00 to 59, minutes from 00 to 59, hours from 00 to 23.
5. Four bytes with a binary decimal representation of the date: the day of the week (00 Monday, ..., 06 Sunday), the date from 01 to 31, the month from 01 to 12, the minor digits of the year from 00 to 99.
6. A hexadecimal number whose binary digits are indicative of health (condition ‘0’) or malfunction (condition ‘1’). For bitwise decoding see tables 2.11 (parameters 0500 and 0516) and 2.12 (parameter 0513).
7. Designation see 2.3.1.8.
8. Every 12 consecutive elements of the array are the string of the parameter name in the text encoding of Windows.
9. Assignment see 2.3.8.
10. The distribution of channels by numbers and types depends on the version.
11. Groups of 4 characters.
12. Versions 01, 07-09 are discontinued. For versions, 12-14 there is separate documentation.

Table B.2 – List of the TEKON-19 loadable algorithms in the database

Algorithm number		Name		Number of parameters		XRAM necessary amount (bytes)	Note
internal (in DB)	external	full	short	Input [1]	Output [2]		
Arithmetic operations on parameters and constants from a floating decimal							
0030	01	X1+X2->Y	Y=X1+X2	2	1	4	
0031	02	X+K->Y	Y=X+K	1(+1)	1	4	
0032	03	X1-X2->Y	Y=X1-X2	2	1	4	
0033	04	X-K->Y	Y=X-K	1(+1)	1	4	
003C	05	K-X->Y	Y=K-X	1(+1)	1	4	
0034	06	X1*X2->Y	Y=X1*X2	2	1	4	
0035	07	X*K->Y	Y=X*K	1(+1)	1	4	
0036	08	X1/X2->Y	Y=X1/X2	2	1	4	
0037	09	X/K->Y	Y=X/K	1(+1)	1	4	
0038	0A	K/X->Y	Y=K/X	1(+1)	1	4	
0089	0 F	Comparison Sign(X2-X1)->Y	Sig(2-1)	2	1	-	Y –bit
Logical operations on bit parameters							
0199	0B	X1vX2vX3vX4->Y	X1v..vX4	4	1	-	“OR”
019A	0C	X1&X2->Y	X1&X2	2	1	-	“AND”
006A	1B	X1 (+) X2->Y	X1(+)X2	2	1	-	excl. “OR”
006B	1B	X1 (+) X2->Y	X1(+)X2	2	1	-	EXCL. “OR”, X2 in ROMD
0073	0D	^X->Y	Y=^X	1	1	-	inversion
Measurement and conversion of physical quantities							
0190	10	Расчет температуры с ТСМ\ТСП Temperature calculation with RTC/RTP	t ТС	4	2	4	Rтс -> t With the failure monitoring
0191	11	Токовый линейный датчик X(I) Current Line Sensor X(I)	Лин X(I)	5	2	4	Iдат -> X With the failure monitoring
0192	12	Токовый квадратичный датчик X(I) Current Squared Sensor X(I)	Кв X(I)	5	2	4	
0193	13	Частотный линейный датчик X(F) Frequency linear sensor X(F)	X(F)	6	2	4	Fдат -> X
0197	14	Расчет температуры насыщенного пара по давлению Temperature calculation of saturated vapour by pressure	T насыщ	1	1	4	Рабс -> Табс

Table B.2 continued

Algorithm number		Name		Number of parameters		XRAM necessary amount (bytes)	Note
Internal (in DB)	external	full	short	Input [1]	Output [2]		
0198	15	Расчет давления насыщенного пара по температуре Pressure calculation of saturated vapour by temperature	Р насыщ	1	1	4	Табс -> Рабс
0194	16	Ограничение параметра Parameter constraint	Огранич	5	3	4	With access control
0195	17	Перевод давления из кгс/см^2 в МПа с приведением к абсолютному Pressure conversion from kgf/cm^2 to MPa with reduction to absolute	В абсМПа	3	1	4	
0196	18	Перевод перепада давления из кгс/м^2 в кПа Conversion of pressure drop from kgf/m^2 to kPa	dP в кПа	2	1	4	
019B	19	Выбор поддиапазона перепада Drop subrange selection	Диап dP	4	1	4	Choice of 1 of 2 sensors
Calculation of instantaneous and accumulated consumption by the method of variable differential: Gm,Gv =f(dP,Tc, Рабс) with angular, flange and three radius selection methods [3]							
0210, 02A0	20, 70	Расчет расхода воды Calculation of water consumption	Water dP	11	6(+4)	256	Cold, hot
0213, 02A3	21, 73	Расчет расхода природного газа Calculation of natural gas consumption	Gas dP	14	4(+2)	256	Gv only
02FB	CE	Расчет расхода природного газа (ГОСТ 30319.3) Calculation of natural gas consumption (GOST 30319.3)	ПрГаздР	28	6(+4)	44	Gv only
0211, 02A1	22, 71	Расчет расхода перегретого пара Calculation of the superheated vapour consumption	Ппар dP	11	6(+4)	256	
0212, 02A2, 0850	23, 72, B6	Расчет расхода насыщенного пара Calculation of saturated vapour consumption	Нпар dP	11	6(+4)	256	

Table B.2 continued

Algorithm number		Name		Number of parameters		XRAM necessary amount (bytes)	Note
Internal (in DB)	external	full	short	Input [1]	Output [2]		
024A, 02AA	44, 77	Расчет расхода газа с заданными характеристиками Calculation of gas flow with specified characteristics	НГаз dP	14	6(+4)	256	
0805	91	Расчет расхода диоксида углерода Calculation of carbon dioxide consumption	CO2 dP	11	7(+4)	256	
0806	92	Расчет расхода Кислорода Calculation of oxygen consumption	O2 dP	11	7(+4)	256	
0246, 02A6	47, 76	Расчет расхода сжатого воздуха Calculation of the consumption of compressed air	возд dP	11	7(+4)	256	
02F3	94	Расчет расхода влажного нефтяного газа Calculation of wet petroleum gas consumption	НефГаздР	26	7(+12)	1024	Gv, Gm
02F6	97	Расчет расхода смеси газов Calculation of gas mixture consumption	СмГаздР	30	9(+10)	512	Gv, Gm
0800	9A	Расчет расхода азота Nitrogen consumption calculation	N2 dP	12	9(+10)	256	Gv, Gm
0801	9B	Расчет расхода аргона Argon consumption calculation	Ar dP	12	9(+10)	256	Gv, Gm
0802	9C	Расчет расхода водорода Hydrogen consumption calculation	H2 dP	12	9(+10)	256	Gv, Gm
0803	9D	Расчет расхода ацетилена Acetylene consumption calculation	C2H2 dP	12	9(+10)	256	Gv, Gm
0804	9E	Расчет расхода аммиака Ammonia consumption calculation	NH3 dP	12	9(+10)	256	Gv, Gm
Calculation of the instantaneous and accumulated consumption using the "power" (current, frequency) flow sensor: Gm,Gv =f(Gдат,Tc, Рабс)							
020 F	43	Произвольная среда Free medium	ПроизGм	1	2(+1)	256	Gv =Gдат

Table B.2 continued

Algorithm number		Name		Number of parameters		XRAM necessary amount (bytes)	Note
Internal (in DB)	external	full	short	Input [1]	Output [2]		
0214	24	Расчет расхода воды Calculation of water consumption	Вода Gм	4	6(+4)	256	Cold, hot
0217	25	Расчет расхода природного газа Calculation of natural gas consumption	Газ Gм	7	4(+2)	256	Gv only
02FC	CF	Расчет расхода природного газа (ГОСТ 30319.3) Calculation of natural gas consumption (GOST 30319.3)	Газ Gм	21	7(+2)	36	Gv only
0215	26	Расчет расхода перегретого пара Calculation of the superheated vapour consumption	Ппар Gм	4	6(+4)	256	
0216, 0852	27, B8	Расчет расхода насыщенного пара Calculation of saturated vapour consumption	Нпар Gм	4	6(+4)	256	
024B	48	Расчет расхода газа с заданными характеристиками Calculation of gas flow with specified characteristics	НГаз Gм	5	6(+4)	256	
0825	AC	Расчет расхода диоксида углерода Calculation of carbon dioxide consumption	CO2 Gм	4	7(+4)	256	
0826	AD	Расчет расхода кислорода Calculation of oxygen consumption	O2 Gм	4	7(+4)	256	
0249	4B	Расчет расхода сжатого воздуха Calculation of the consumption of compressed air	возд Gм	4	7(+4)	256	
02D3	83	Расчет расхода природного газа от преобразователя ИРВИС Calculation of natural gas consumption from IRVIS transducer	газИРВИС	17	7(+6)	256	Gv in operating and standard conditions

Table B.2 continued

Algorithm number		Name		Number of parameters		XRAM necessary amount (bytes)	Note
Internal (in DB)	external	full	short	Input [1]	Output [2]		
02FF	D2	Расчет расхода природного газа от преобразователя ИРВИС (ГОСТ 30319.3) Calculation of natural gas consumption from IRVIS transducer (GOST 30319.3)	газИРВИС	31	6(+8)	68	Gv in operating and standard conditions
0820	A4	Расчет расхода азота Nitrogen consumption calculation	N2 Gm	4	9(+10)	256	Gv, Gm
0821	A5	Расчет расхода аргона Argon consumption calculation	Ar Gm	4	9(+10)	256	Gv, Gm
0822	A6	Расчет расхода водорода Hydrogen consumption calculation	H2 Gm	4	9(+10)	256	Gv, Gm
0823	A7	Расчет расхода ацетилена Acetylene consumption calculation	C2H2 Gm	4	9(+10)	256	Gv, Gm
0824	A8	Расчет расхода аммиака Ammonia consumption calculation	NH3 Gm	4	9(+10)	256	Gv, Gm
02F8	99	Расчет расхода смеси газов Calculation of gas mixture consumption	СмГаз Gm	22	9(+10)	512	Gv, Gm
02F5	96	Расчет влажного нефтяного газа Calculation of wet petroleum gas	НефГазGм	18	8(+10)	1024	Gv, Gm
02FA	CA	Расчет сжиженного газа (жидкая фаза) Calculation of liquefied gas (liquid phase)	СжГаз Gm	8	9(+9)	68	Gv, Gm
Calculation of instant and accumulated consumption Gm,Gv =f(dP,Tc, Рабс) using TORBAR pressure tubes							
02C0	78	Расчет расхода воды Calculation of water consumption	ВодаTOR	10	6(+4)	256	
02C3	79	Расчет расхода природного газа Calculation of natural gas consumption	Газ TOR	12	4(+2)	256	Gv only

Table B.2 continued

Algorithm number		Name		Number of parameters		XRAM necessary amount (bytes)	Note
Internal (in DB)	external	full	short	Input [1]	Output [2]		
02FE	D1	Расчет расхода природного газа (ГОСТ 30319.3) Calculation of natural gas consumption (GOST 30319.3)	газTOR	26	7 (+6)	52	
02C1	7A	Расчет расхода перегретого пара Calculation of the superheated vapour consumption	ПпарTOR	10	6(+4)	256	
02C2, 0853	7B, B9	Расчет расхода насыщенного пара Calculation of saturated vapour consumption	НпарTOR	10	6(+4)	256	
02CA	7 F	Расчет расхода газа с заданными характеристиками Calculation of gas flow with specified characteristics	НГазTOR	13	6(+4)	256	
02C4	7C	Расчет расхода диоксида углерода Calculation of carbon dioxide consumption	CO2 TOR	10	6(+4)	256	
02C5	7D	Расчет расхода кислорода Calculation of oxygen consumption	O2 TOR	10	6(+4)	256	
02C6	7E	Расчет расхода сжатого воздуха Calculation of the consumption of compressed air	возд TOR	10	6(+4)	256	
Calculation of the accumulated flow rate using an integrating number-pulse flow sensor: Gm,Gv =f(Nимп,Tc, Рабс) for water, vapour, gases; G =f(Nимп) in the rest of cases							
0218	28	Расчет расхода воды Calculation of water consumption	Вода имп	5	4(+4)	256	Cold, hot
021B	29	Расчет расхода природного газа Calculation of natural gas consumption	Газ имп	8	2(+2)	256	Gv only

Table B.2 continued

Algorithm number		Name		Number of parameters		XRAM necessary amount (bytes)	Note
Internal (in DB)	external	full	short	Input [1]	Output [2]		
02FD	D0	Расчет расхода природного газа (ГОСТ 30319.3) Calculation of natural gas consumption (GOST 30319.3)	Газ Gч	22	6(+2)	36	
0219	2A	Расчет расхода перегретого пара Calculation of the superheated vapour consumption	Ппар имп	5	4(+4)	256	
021A, 0851	2B, B7	Расчет расхода насыщенного пара Calculation of saturated vapour consumption	Нпар имп	5	4(+4)	256	
024C	4C	Расчет расхода газа с заданными характеристиками Calculation of gas flow with specified characteristics	НГаз имп	6	4(+4)	256	
0815	A9	Расчет расхода диоксида углерода Calculation of carbon dioxide consumption	CO2 имп	5	5(+4)	256	
0816	AA	Расчет расхода кислорода Calculation of oxygen consumption	O2 имп	5	5(+4)	256	
0252	4 F	Расчет расхода сжатого воздуха Calculation of the consumption of compressed air	возд имп	5	5(+4)	256	
0810	9 F	Расчет расхода азота Nitrogen consumption calculation	N2 Gи	5	9(+10)	256	Gv, Gm
0811	A0	Расчет расхода аргона Argon consumption calculation	Ar Gи	5	9(+10)	256	Gv, Gm
0812	A1	Расчет расхода водорода Hydrogen consumption calculation	H2 Gи	5	9(+10)	256	Gv, Gm
0813	A2	Расчет расхода ацетилена Acetylene consumption calculation	C2H2 Gи	5	9(+10)	256	Gv, Gm

Table B.2 continued

Algorithm number		Name		Number of parameters		XRAM necessary amount (bytes)	Note
Internal (in DB)	external	full	short	Input [1]	Output [2]		
0814	A3	Расчет расхода аммиака Ammonia consumption calculation	NH3 Gи	5	9(+10)	256	Gv, Gm
02F7	98	Расчет расхода смеси газов Calculation of gas mixture consumption	СмГаз Gи	23	9(+10)	512	Gv, Gm
02F4	95	Расчет влажного нефтяного газа Calculation of wet petroleum gas	НефГазИм	19	5(+10)	1024	Gv, Gm
02F9	C9	Расчет сжиженного газа (жидкая фаза) Calculation of liquefied gas (liquid phase)	СжГазИм	9	4(+9)	62	Gv, Gm
021C	2C	Произвольный счетчик Custom counter	Люб имп	2	2(+2)	16	
021D	2D	Расчет расхода электроэнергии по однотарифной схеме Calculation of electricity consumption on a single rate scheme	Электр 1	2	2(+2)	16	
021E	2E	Расчет расхода электроэнергии по двухтарифной схеме Calculation of power consumption in a two-rate scheme	Электр 2	3	6(+4)	40	Individuals (with holidays)
020E	8E		Элек 2т				Legal entities (without holidays)
021 F	33	Расчет расхода электроэнергии с 30-минутками 30-minute power consumption calculation	Электр30	4	6(+4)	256	
Calculation and accumulation of thermal energy							
019C	1C	Расчет энтальпии горячей воды Calculating the enthalpy of hot water	Энт воды	2	1	4	Function from Tc, Рабс
019D	1D	Расчет энтальпии перегретого пара Calculation of the superheated vapour enthalpy	Энт ппар	2	1	4	Function from Tc, Рабс

Table B.2 continued

Algorithm number		Name		Number of parameters		XRAM necessary amount (bytes)	Note
Internal (in DB)	external	full	short	Input [1]	Output [2]		
019E, 0855	1E, BB	Расчет энтальпии насыщенного пара Calculation of saturated vapour enthalpy	Энт нпар	2	1	4	Function from Tc, Рабс
01A1	D7	Этиленгликоль, числоимпульсный датчик Ethylene Glycol, Pulse Sensor	ЭглколИ	8	10(+6)	76	By mass flow and temperature
01A2	D8	Этиленгликоль, мощностной датчик Ethylene glycol, power sensor	ЭглколМ	8	10(+6)	76	By mass flow and temperature
0220, 12204)	2 F C4	Тепловая энергия в трубопроводе относительно холодного источника Thermal energy in the pipeline relative to a cold source	Тепло тр Qтр откл	4 5	2(+2) 2(+2)	4*4 4*4	By mass flow and enthalpy
0221, 12214)	30 C5	Тепловая энергия в закрытой водяной системе отопления Thermal energy in a closed water heating system	Закр теп Qзакр	7 8	4(+2) 4(+2)	4(+2) 4(+2)	By mass flow, temperature and pressure
0222, 12224)	31 C6	Тепловая энергия в открытой водяной системе отопления Thermal energy in open water heating system	Откр теп Qоткр	8 9	10(+8) 10(+8)	18*4 18*4	
02B2, 12B24)	42 C7	Тепловая энергия ГВС суммарное с утечками Total gas-air mixture thermal energy with leaks	ГВС+утеч Qгвс ут	6 7	9(+1) 10(+1)	17*4 17*4	
Other operations							
0200	32	Расчет и накопление времени исправной и неисправной работы узла учета Calculation and accumulation of time of serviceable and malfunctioning operation of the accounting unit	Врем раб	1	4(+4)	8*4	

Table B.2 continued

Algorithm number		Name		Number of parameters		XRAM necessary amount (bytes)	Note
Internal (in DB)	external	full	short	Input [1]	Output [2]		
0201	1A	Выбор тарифа при двухтарифном учете Tariff selection for two-rate accounting	Rate	5	1	4*4	
0289	0E	Объединение 32 битовых параметров в 4-байтовый Combining 32 bit parameters into 4-byte	Тариф	32	1	8	
0299	67		Сбор бит	33	2	8	
028B	40	Архив событий пользователя User Event Archive	СбБитС	2	7	3*256*4 +8	
Auxiliary floating-point operations							
0121	80	Переключатель Switcher	перекл	3	1	4	
02B3	81	Чтение элемента массива Reading array element	Чт элем	2	1	-	
Accumulation, averaging and archiving over time intervals							
028A	36	Интегрирование Integration	Интегр	1	1(+2)	12	
0223	34	Накопление расхода (любого интегрируемого параметра) Accumulation of consumption (of any integrated parameter)	Накоплен	1	8(+8)	18*4	By estimated intervals, hours, days, months
0224	35	Усреднение параметра Parameter averaging	Усреднен	1	8(+12)	20*4	
0844	8 F	Средневзвешенный по расходу параметр Flow weighted average	Взвешен	2	8(+16)	24*4	
0225	37	Архив месяцев, на 12 месяцев Archive of months for 12 months	Арх меся	1	1	12*4	From calculation dates
0235	3 F	Архив месяцев, на 48 месяцев Archive of months for 48 months	Архмес48	1	1	48*4	From calculation dates
0226	38	Архив суток на 365/366 дней Archive of the day for 365/366 days	Арх суто	1	1	366*4	From calculation hours
0227	39	Архив часов, на 16 суток Archive hours for 16 days	Архчас16	1	1	384*4	

Table B.2 continued

Algorithm number		Name		Number of parameters		XRAM necessary amount (bytes)	Note
Internal (in DB)	external	full	short	Input [1]	Output [2]		
0228	3A	Архив часов, на 32 суток Archive hours for 32 days	Архчас32	1	1	768*4	
0229	3B	Архив часов, на 64 суток Archive hours for 64 days	Архчас64	1	1	1536*4	
0233	3D	Архив 30-минуток, на 16 суток Archive 30-minute, for 16 days	Арх30-16	1	1	768*4	
0234	3E	Архив 30-минуток, на 96 суток Archive 30-minute, for 96 days	Арх30-96	1	1	4608*4	
0230	3C	Архив расчетных интервалов, на 1440 значений Archive of calculated intervals, for 1440 values	Арх инте	1	1	1440*4	
Exchange with other modules via CAN-BUS							
027B, 0290	50, 1 F	Ввод параметра с плавающей запятой Parameter entry with floating decimal	Вв плав Вв пл dT	2 3	2 3	4 4	XRAM inout
027C	51	Ввод целого двухбайтового параметра Enter the whole two-byte parameter	Ввод 2	2	2	2	XRAM input
027D	52	Ввод целого однобайтового параметра Entering the entire one-byte parameter	Ввод 1	2	2	1	XRAM input
027E	53	Ввод битового параметра Input bit parameter	Ввод бит	2	2	-	RAM input
027 F	54	Ввод 16-ричного 4-байтового параметра Entering a hexadecimal 4-byte parameter	Вв4 HEX	2	2	4	XRAM input
0280	55	Ввод параметра в формате времени Entering the parameter in time format	Вв4врем	2	2	4	XRAM input
0281	56	Ввод параметра в формате даты Entering the parameter in date format	Вв4дата	2	2	4	XRAM input
0282	57	Ввод числа импульсов Enter the number of pulses	Ввод имп	2	3	8	XRAM input

Table B.2 continued

Algorithm number		Name		Number of parameters		XRAM necessary amount (bytes)	Note
Internal (in DB)	external	full	short	Input [1]	Output [2]		
0292	90	Ввод числа импульсов модернизированный Enter the number of pulses modernized	Вв имп м	3	5	16	XRAM input
0283	58	Часовой архив внешнего параметра, 16 суток Hour archive of external parameter, 16 days	АЧ16внеш	2	4	384*4	
0284	59	Часовой архив внешнего параметра, 32 суток Hour archive of external parameter, 32 days	АЧ32внеш	2	4	768*4	
0285	5A	Часовой архив внешнего параметра, 64 суток Hour archive of external parameter, 64 days	АЧ64внеш	2	4	1536*4	
0286	5B	Суточный архив внешнего параметра Daily archive external parameter	АСУТвнеш	2	4	366*4	
0287	5C	Архив внешнего параметра на 12 месяцев External parameter archive for 12 months	АМ12внеш	2	4	12*4	
0288	5D	Архив внешнего параметра на 48 месяцев External parameter archive for 48 months	АМ48внеш	2	4	48*4	
029A	5E	Изменение битового параметра Change the bit parameter	Изм бит	3	3	6	
029B	5 F	Изменение четырехбайтового параметра Four-byte parameter change	Изм байт	3	3	9	
02B4	82	Синхронизация времени Time synchronization	Синхр Т	1	-	-	
Calculate extremums for floating decimal parameters							
028C	6E	Максимум Maximum	MAX	1	18	76	
028D	6 F	Минимум Minimum	MIN	1	18	76	

Table B.2 continued

Algorithm number		Name		Number of parameters		XRAM necessary amount (bytes)	Note
Internal (in DB)	external	full	short	Input [1]	Output [2]		
Calculation of instantaneous and accumulated consumption using a multi-parametric sensor like "Metran-33x" Gv, Gm = f (Gдат,Tc, Рабс)							
0255	60	Расчет расхода воды Calculation of water consumption	Вода М33	2	9(+1)	256	Cold, hot
0258	63	Расчет расхода природного газа Calculation of natural gas consumption	Газ М33	5	8(+1)	256	Gv only
0256	61	Расчет расхода перегретого пара Calculation of the superheated vapour consumption	Ппар М33	2	9(+1)	256	
025A	64	Расчет расхода диоксида углерода Calculation of carbon dioxide consumption	CO2 М33	2	11(+1)	256	
025B	65	Расчет расхода кислорода Calculation of oxygen consumption	O2 М33	2	11(+1)	256	
025C	66	Расчет расхода сжатого воздуха Calculation of the consumption of compressed air	возд М33	2	11(+1)	256	
Algebraic operations on floating decimal parameters							
0082	68	Natural logarithm	Y=lnX	1	1	8	
0083	69	Logarithmic decimal	Y=lgX	1	1	8	
0084	6A	Exponent	Y=expX	1	1	8	
0081	6B	Square root	Y=sqrtX	1	1	8	
0087	6C	Power function	Y=X1**X2	2	1	12	
008C	6D	Exponentiation	Y=X1**N	2	1	9	N – integral
028E	41	Кусочно-линейная аппроксимация Piecewise-linear approximation	Кус-лин	105	1	8	Up to 100 segments
01A0	C8	Оценка разности Difference estimate dX=X1 – X2	ОценРазн	3	2(+1)	6	
Calculation of consumption and heat dissipation in the refrigeration industry							

Table B.2 continued

Algorithm number		Name		Number of parameters		XRAM necessary amount (bytes)	Note
Internal (in DB)	external	full	short	Input [1]	Output [2]		
02E0	8C	Углекислота жидкая, числоимпульсный датчик Carbon dioxide liquid, pulse number sensor	CO2жид И	5	8(+2)	40	Gv, Gm
02E1	8D	Углекислота жидкая, мощностной датчик Liquid carbon dioxide, power sensor	CO2жид М	5	8(+2)	40	Gv, Gm
02E2	88	Пропиленгликоль, числоимпульсный датчик Propylene glycol, pulse number sensor	ГликольИ	8	12(+4)	64	Gv, Gm, Q
02E3	89	Пропиленгликоль, мощностной датчик Propylene glycol, power sensor	ГликольМ	8	12(+4)	64	Gv, Gm, Q
02E4	8A	Аммиак жидкий, числоимпульсный датчик Ammonia liquid, pulse number sensor	Аммиак И	6	12(+4)	64	Gv, Gm, Q
02E5	8B	Аммиак жидкий, мощностной датчик Ammonia liquid, power sensor	Аммиак М	6	12(+4)	64	Gv, Gm, Q
Principle of the method of measurements using ANNUBAR 485 averaging pressure tubes.							
0830	B0	Вода Water	ВодаANN	8	8(+4)	128*4	Gv, Gm
0831	B1	Пар перегретый Superheated vapour	ППарANN	8	8(+4)	128*4	Gv, Gm
0832, 0854	B2, BA	Пар насыщенный Saturated vapour	НПарANN	8	8(+4)	128*4	Gv, Gm
0833	B3	Газ природный Natural gas	Газ ANN	12	6(+2)	128*4	Gv
02F2	D3	Газ природный (ГОСТ 30319.3) Natural gas (GOST 30319.3)	Газ ANN	26	5(+2)	36	Gv
0834	B4	Воздух Air	Возд ANN	9	7(+2)	128*4	Gv, Gm
Calculation of consumption of petroleum and petroleum products							
0860	BC	Нефтепродукты, числоимпульсный датчик Petroleum products, pulse number	МазутИмп	5	7(+2)	8*4	Gv, Gm without P

		sensor					

Table B.2 continued

Algorithm number		Name		Number of parameters		XRAM necessary amount (bytes)	Note
Internal (in DB)	external	full	short	Input [1)]	Output [2)]		
0861	BC	Нефть и нефтепродукты, числоимпульсный датчик Petroleum and petroleum products, pulse number sensor	НефИмпtP	7	7(+2)	8*4	Gv, Gm accounting t and P
0862	BD	Нефть и нефтепродукты, мощностной датчик Petroleum and petroleum products, power sensor	НефМощtP	5	9(+2)	9*4	Gv, Gm accounting t and P
Flow calculation with ISA 1932 nozzle							
02A7	C0	Вода Water	Вода ИСА	8	8	8*4	Gv, Gm
02A8	C1	Пар перегретый Superheated vapour	ППар ИСА	8	8	8*4	Gv, Gm
02A9	C2	Пар насыщенный Saturated vapour	НПар ИСА	9	8	8*4	Gv, Gm
Algorithms of SCADA							
0863	D9	Дублированный сигнал 1 Duplicate signal 1	ДублСиг1	12	3	9	
0864	DA	Дублированный сигнал 2 Duplicate signal 2	ДублСиг2	17	5	9	

NOTES:

1. Number of constants is indicated in brackets
2. The number of auxiliary internal parameters is indicated in brackets.
3. In algorithms with numbers like 02Ah, there is an additional output parameter of algorithmic failure.
4. Comply with the ‘Rules of commercial accounting of heat energy’, introduced by the Government of the Russian Federation No. 1034 of 18.11.2013.

ANNEX C (reference) - Binary and hexadecimal codes

Table C.1 – Binary codes for hexadecimal numbers

hexadecimal number	binary code	hexadecimal number	binary code	hexadecimal number	binary code	hexadecimal number	binary code
0	0000	4	0100	8	1000	C	1100
1	0001	5	0101	9	1001	D	1101
2	0010	6	0110	A	1010	E	1110
3	0011	7	0111	B	1011	F	1111

Hexadecimal numbers are a shortcut for writing binary codes. Each data byte consists of eight binary digits (bits), numbered from right to left from 0 to 7 (0 lower order, 7th order upper order). Every four binary digits are called a tetrad, which can be displayed in hexadecimal form. A byte consists of two tetrads, on the right (binary digits 3-0) is minor, on the left (binary digits 7-4) is greater. Thus, each byte is represented by two hexadecimal digits. In the hexadecimal image of parameters consisting of several bytes, bytes are numbered from left to right: the leftmost byte has the conditional number 0, the rightmost byte has number 1 in two-byte parameters and number 3 in four-byte parameters (see Table B.2).

The transition from hexadecimal to binary encoding and vice versa can be performed using table C.1. For example, in hexadecimal form, bytes are displayed as A5. Using data from rows "A" and "5" of table C.1, we obtain the binary number 1010 0101, containing codes "1" in bits 7,5,2,0 and codes "0" in the other bits.

Table C.2 – Location of bytes and binary digits when displaying hexadecimal numbers

Single byte

byte							
7	6	5	4	3	2	1	0

Two byte

Byte 0 (left)								Byte 1 (right)							
7	6	5	4	3	2	1	0	15	14	13	12	11	10	9	8

Four byte

Byte 0 (left)								Byte 1								Byte 2								Byte 3 (right)							
7	6	5	4	3	2	1	0	15	14	13	12	11	10	9	8	23	22	21	20	19	18	17	16	31	30	29	28	27	26	25	24

ANNEX D (reference) - Calculation errors

Table D.1 – Limits of permissible fractional error of calculation ($\delta_П$)

Calculation parameter	Flow measurement method	Medium	Algorithm in the DB	$\delta_П$, %	
				volume	weight
Consumption and volume and mass of the medium, m^3/h, m^3, t/h (kg/h), t (kg) (for gases - consumption and volume reduced to standard conditions, m^3/h, m^3)	MT of consumption or volume 'with unified output signals' with linear characteristic	water	0214, 0218	± 0.0001	± 0.02
		superheated vapour	0215, 0219	± 0.0001	± 0.001
		saturated vapour	0216, 021A	± 0.0001	± 0.014
		natural gas	0217, 021B	± 0.003	± 0.004 [1)]
			02FC, 02FD	± 0.001	± 0.001 [1)]
		air	0249, 0252	± 0.003	± 0.003
		oxygen	0826, 0816	± 0.001	± 0.001
		carbon dioxide	0825, 0815	± 0.001	± 0.001
		petroleum gas	02F5, 02F4 0818, 0819	± 0.001	± 0.001
		nitrogen	0810, 0820	± 0.005	± 0.005
		argon	0811, 0821	± 0.004	± 0.004
		hydrogen	0812, 0822	± 0.002	± 0.002
		acetylene	0813, 0823	± 0.001	± 0.001
		ammonia: gas liquid	0814, 0824	± 0.004 ± 0.004	± 0.001 ± 0.001
		gas mixture	02F7, 02F8	± 0.001	± 0.001
		petroleum, petroleum products	0861, 0862	± 0.03	± 0.03
	variable pressure drop method at standard restriction devices (diaphragm)	water	0210, 02A0	± 0.021	± 0.02
		superheated vapour	0211, 02A1	± 0.008	± 0.008
		saturated vapour	0850	± 0.019	± 0.017
		natural gas	0213, 02A3, 02FB	± 0.001	± 0.001 [1)]
		oxygen	0806	± 0.001	± 0.001
		carbon dioxide	0805	± 0.002	± 0.003
		petroleum gas	02F3, 0817	± 0.001	± 0.001
		nitrogen	0800	± 0.003	± 0.002
		argon	0801	± 0.002	± 0.001
		hydrogen	0802	± 0.005	± 0.001
		acetylene	0803	± 0.003	± 0.001
		ammonia: gas liquid	0804	± 0.001 ± 0.003	± 0.001 ± 0.003
		gas mixture	02F6	± 0.001	± 0.001
	using TORBAR averaging pressure tube	water	02C0	± 0.05	± 0.05
		superheated vapour	02C1	± 0.05	± 0.05
		saturated vapour	02C2	± 0.05	± 0.05
		natural gas	02C3	± 0.08	± 0.08 [1)]
		compressed air	02C6	± 0.1	± 0.1
		carbon dioxide	02C4	± 0.036	± 0.025
	using ISA 1932 nozzle	water	02A7	± 0.011	± 0.011
		superheated vapour	02A8	± 0.012	± 0.012
		saturated vapour	02A9	± 0.03	± 0.033

Table D.1 continued

Calculation parameter	Flow measurement method	Medium	Algorithm in the DB	$\delta_П$, %	
				volume	weight
	using the ANNUBAR flow averaging tube	water	0830	± 0.03	± 0.03
		superheated vapour	0831	± 0.025	± 0.025
		saturated vapour	0832	± 0.016	± 0.016
		natural gas	0833	± 0.002	± 0.002 [1)]
		air	0834	± 0.06	± 0.06
	IRVIS-K-300 flow meter	natural gas	02D3	± 0.026	± 0.026 [1)]
Heat energy, Gcal, MJ	any	water	019C+0220	± 0.1	
		superheated vapour	019D+0220	± 0.07	
		saturated vapour	019E+0220	± 0.13	
Electricity, kWh, according to 1 and 2-rate schemes	Electricity, kWh, according to 1 and 2-rate schemes		021D, 021E	± 0.0001	
Arithmetic operations on parameters	-	any	0030 ... 0038	± 0.0001	

Note:
1. In tons of reference fuel.

(Revision, Amendment No. 3).

ANNEX E (reference) – Flow calculation algorithms

Table E.1 - Availability of flow calculation algorithms for various media ('+' - the algorithm is available, '–' - there is no algorithm)

Medium	Orifice plate	ISA 1932 nozzle[3)]	Annubar 485 tube	TORBAR tube	Flow meter[1)]	Counter[2)]	Metran-33x	IRVIS flow meter
Commercial calculations								
Water	+	+	+	+	+	+	+	-
Superheated vapour	+	+	+	+	+	+	+	-
Saturated vapour	+	+	+	+	+	+	-	-
Natural gas	+	-	+	+	+	+	+	+
Air	+	-	+	+	+	+	+	+
Oxygen	+	-	-	+	+	+	+	+
Carbon dioxide (gas)	+	-	-	+	+	+	+	+
Petroleum and petroleum products [3)]	-	-	-	-	+	+	-	-
Nitrogen, argon, hydrogen, acetylene	+	-	-	-	+	+	-	-
Ammonia (gas)	+	-	-	-	+	+	-	-
Mixture of dry gases	+	-	-	-	+	+	-	-
Wet petroleum gas	+	-	-	-	+	+	-	-
Gas with desired properties	+	-	-	+	+	+	-	+
Electricity	-	-	-	-	-	+	-	-
Any medium (in units of measurement of flow rate)	-	-	-	-	+	+	-	-
Technological calculations								
Propylene glycol	-	-	-	-	+	+	-	-
Ethylene glycol	-	-	-	-	+	+	-	-
Carbon dioxide liquid	-	-	-	-	+	+	-	-
Ammonia liquid	-	-	-	-	+	+	-	-

Note:

1) Flow meter: flow rate MT with current or frequency output, the signal value at which is proportional to the current flow rate.

2) Counter: a flow rate MT or energy meter with a number-pulse output and a given 'weight' of the pulse (or a given number of pulses per unit of flow).

3) Certified for algorithm version 04 only.