“KREIT”

Protocol converter
USP 78
Operation Manual
T10.00.78 RE

Ekaterinburg

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TABLE OF CONTENTS

This Manual covers the USP78 protocol converter (hereinafter referred to as the ‘USP’, or the ‘device’) of all versions.

USP Operation Documentation consists of the Operation Manual and the Data Sheet.

USP is manufactured in C3, P1, V1 environmental designs under GOST R 52931.

Certificate of conformity ***No. S-EPB.001.TU.00553*** confirms that USP is manufactured in accordance with regulations of oil and gas industry safety regulations, declared at hazardous production facilities and regulated by the Federal Service for the Supervision of Environment, Technology and Nuclear Management**.**

CU Declaration ***No. RU D-RU.A301.V.01004*** confirms that USP is produced in accordance with TR CU 020/2011 ‘Electromagnetic compatibility of technical devices’.

List of abbreviations

CS (ДП)	Control Station
DAD	Data Acquisition Device
DS	Dispatching Station
GOST (ГОСТ)	Russian Standard
IRS (ИКП)	Intelligent Remote Station
KREIT (КРЕЙТ)	Original Equipment Manufacturer
RE (РЭ)	Operation Manual
RS (КП)	Remote Station
TC (ТУ)	Telecommand
TM (ТИ)	Telemetering
TS (ТС)	Telesignalization
TU (ТУ)	Russian Technical Specifications
USP (УСП)	Protocol Converter

1 SAFETY REQUIREMENTS

1.1 USP provides protection against electrical shock according to Class III of GOST 12.2.007.0.

1.2 Persons with at least secondary technical education, who have passed the safety training for operating units with voltages of up to 1,000 V, who have read and understood this Operation Manual and skilled to use the configuration software at the IBM/PC, should be permitted to operate USP at the stage of its configuration and installation. Further, USP requires no maintenance in the process of operation.

1.3 Make any connections only when the device is powered off.

1.4. The responsible authority should be informed that the protection provided by the device might be inefficient if the device is operated in a manner not specified by the manufacturer.

2 DEVICE DESCRIPTON AND OPERATION

2.1 Purpose of the device

2.1.1 The USP78 device is intended for operation as part of remote stations (RS) of various telemechanical systems, which include the T-20 series devices united by CAN-BUS, for example:

- TEKON-19 T10.00.60 calculating and measuring transducer;
- MIR-103 T10.00.103 measuring set-adapter;
- MU-71 T10.00.71 control module.

2.1.2 USP connects the stated devices with RS equipment of various telemechanical and teledispatching systems, its purpose is to collect and transfer information to a dispatching station (DS), including telemetering (TM), telesignalization (TS) and telecommand (TC), and remote data recording into devices. USP is available in three versions with different software and interface according to Table 2.1.

Table 2.1- USP versions

Version	Software		Interface	Telemetry system
	Internal in USP	External, at the computer for USP settings		
1	identical	identical	RS-232	To be selected during the configuration according to Table 2.2
3			RS-485	
2	separate		Current loop	'Energiya' complex, developed by Research and Technical company 'Energocontrol', Zarechny city, Penza Region

Table 2.2 – Variants of USP settings, versions 1 and 3

Variant	System	Developer	Comment
1	Magistral-1	'Gazavtomatika', Moscow	
2	Magistral-2	'Gazavtomatika', Moscow	Modbus (basic commands)
	Automated and process systems	'Inkomsystem', Kazan	
	Other Modbus controllers		
3	UNK TM	NII IS (Scientific and Research company, developing measurement systems), Nizhny Novgorod	Superflo simulation
5	Dispatch system	Industrial Group Metran, Chelyabinsk	HART protocol
Other codes	-	-	Idle running

2.1.3 Each USP is a universal programmable device. Exchange channels characteristics, connection of telemechanic system parameters with T-20 parameters, and for USP (ver.1 and ver.3), selection of the required telemechanics system are configured via a computer. The maximum possible set of functions performed by USP on DS commands is agreed with the developers for each telemechanical system.

2.1.4 USP operation is shown in Figure 2.1.

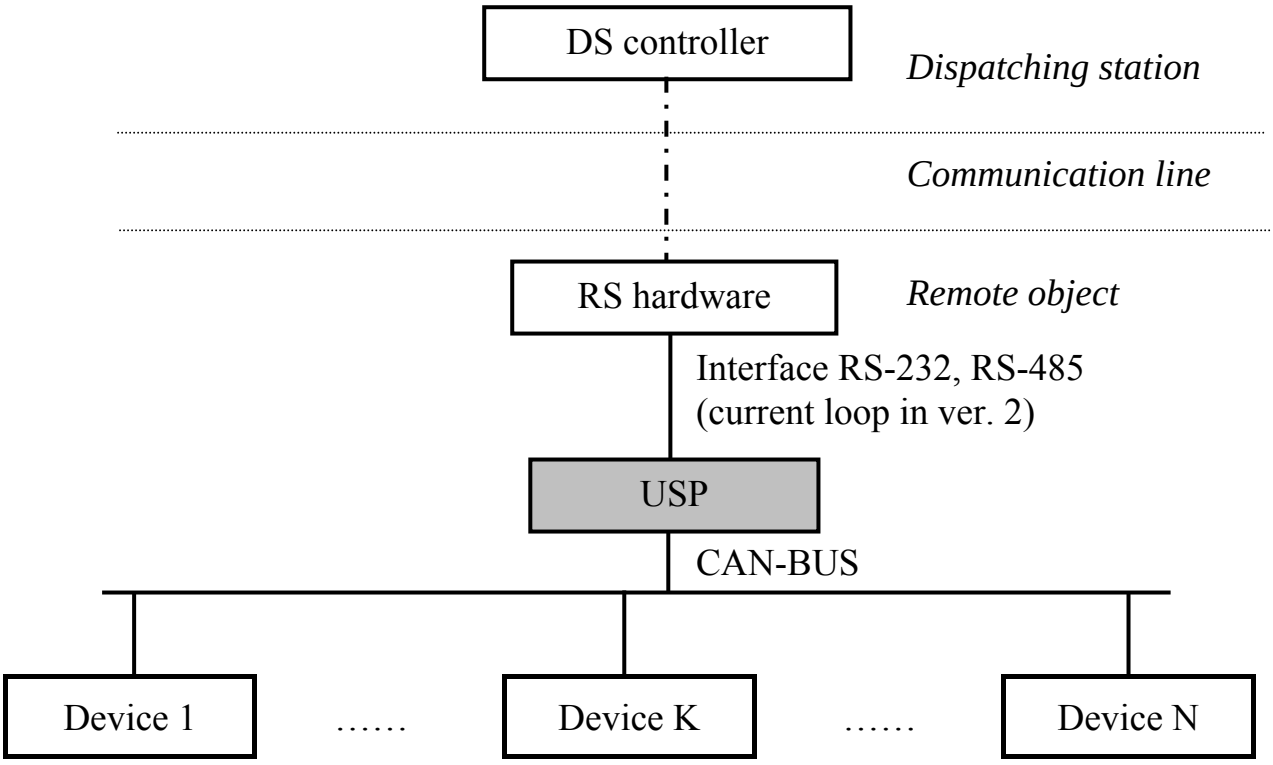

Figure 2.1 – Structure of information transfer system with the use of USP

2.2 Features

2.2.1 USP is manufactured in the Railtec plastic case with the standard DIN rail mounting. The layout is shown in Figure 2.2.

2.2.2 USP has two joint units:

- Terminal connector block for connection to CAN-BUS and power supply – for all versions.
- In version 1 – DB9M type slot for connection to the hardware via standard RS-232 interface.
- In version 2 – additional terminal connector block of 4 terminals for connecting to ‘Energiya’ complex via the current interface.
- In version 3 – additional terminal connector block of 2 terminals for connection to the hardware using standard interface RS-485.

The purpose of contacts is described in subsection 3.1 ‘Connection’.

2.2.3 USP provides programming (setting) via CAN-BUS interface for the specific application by setting the basic characteristics using one of two computer applications included into the scope of supply:

- special ‘USP78 configuration software’ T10.06.187;
- general-use application TELEPORT T10.06.131 for communication of any module of T-20 series.

NOTE: From software version 06, Modbus could be set via RS-232.

2.2.4 The software in versions 1 and 3 is identical and configured for operation with the selected system by setting the required value of the parameter ‘operation variant’ in accordance with Table 2.2. For version 2 this parameter shall not be installed; it operates only with ‘Energiya’ complex. General characteristics and variants are given in 2.2.6 – 2.2.9.

2.2.5 At the exchange via the RS-232 interface, before displaying a message, USP of version 1 always sets the RTS signal active level and removes the RTS signal after the end of displaying. The DTR signal shall always be active. The remaining confirmation signals are not used.

2.2.6 ‘Magistral-1’ mode

2.2.6.1 In ‘Magistral-1’ mode, USP simulates the operations of ‘conventional’ and ‘intellectual’ subunits of ‘Magistral-1’ telemechanics system RS, performing the following list of teleoperations:

a) ‘conventional’ RS, to 14 subunits with numbers from 0 to 13

- Telesignalization with the simulation of TS type telemechanic subunits. 4 TS teleoperations are performed in each subunit, each teleoperation containing 8 discrete signals.
- Telecommand with the simulation of TC type subunits. Each subunit runs up to 6 TC operations.

b) ‘intellectual’ RS, up to 12 subunits with numbers from 0 to 11

- Telemetering with floating - point data transferring from ‘intelligent’ subunits, up to 4 data from each subunit in the common FLOAT format.
- Floating - point data recoding from the control station to ‘intelligent’ subunits, up to 4 data to each subunit, with a possible response to a query of recording end.

2.2.6.2 Other commands of ‘Magistral-1’ are not processed, and the reply to them is not output.

2.2.6.3 The correspondence of subunit numbers and teleoperations to TEKON parameters, and communication channel characteristics - exchange rate in the range from 300 to 9,600 Baud, the number of stop bits and the method of their generation,

addresses of ‘normal’ and ‘intellectual’ RS on the line shall be set at USP configuration.

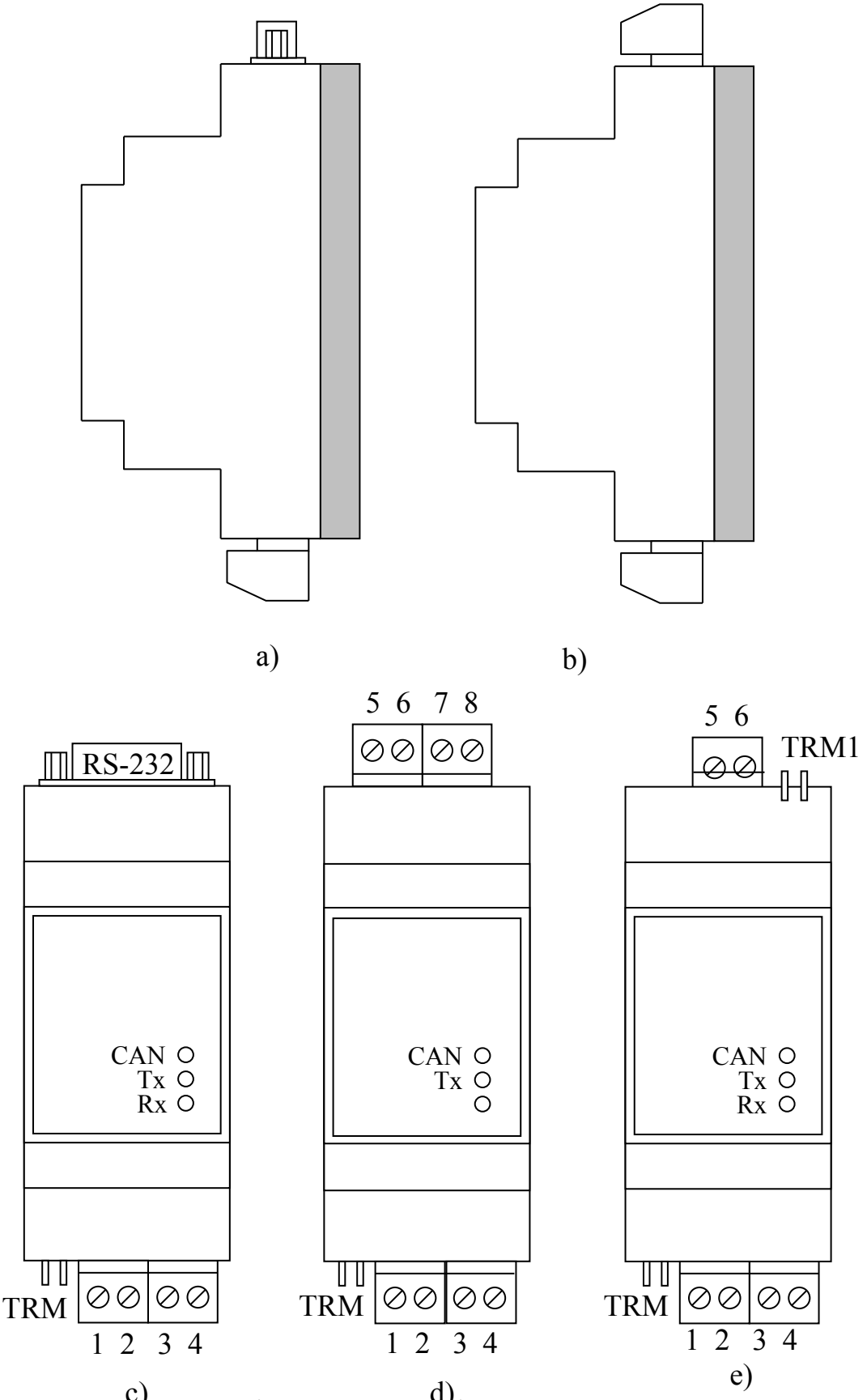

Figure 2.2 – USP layout

Side – view: version 1 (a), version 2 and 3 (b)

Front panel view: version 1 (c), version 2 (d), version 3 (e)

*2.2.7. 'Modbus' mode (Magistral-2, automated control system 'Inkomsys*tem')

2.2.7.1 In '**Modbus'** mode, USP allows interaction with 'Magistral-2' and 'Inkomsystem' telemechanical systems. Both of these systems are used for exchanging a subset of **Modbus RTU** standard protocol commands. Generally, the operation with other systems using **Modbus RTU** protocol is possible. USP is a **slave** device in protocol and has its own address in the line, and, with regard of the features of T-20 series devices, it performs a list of protocol functions, given in Table 2.3.

Table 2.3

Function code (16)	Name	Note
01	reading of the telecommand condition	
02	reading of the discrete parameters (TS)	
03	reading of the parameters	Two-byte or floating-point parameters
04	reading of the two-byte register	Starting from version 06
05	control of output setting (TC)	
10	recording of the floating-point parameters	Backup command
45	reading of the floating-point parameter	Starting from version 06
46	recording of the floating-point parameter	Magistral-2
47	recording of the floating-point parameters	Magistral-2
48	reading of the floating-point parameters	Magistral-2

2.2.7.2 Other **Modbus** protocol commands are not processed, and an error message appears when addressing them to USP. The **Modbus** protocol broadcast commands are also not supported.

2.2.7.3 The floating-point numbers of the FLOAT format in the conventional standard IEEE-754 take 4 bytes and are represented in the form of a mantissa (3 bytes) and an order (1 byte). In the messages of 'Magistral-2', the transfer of the FLOAT format number begins with the mantissa low byte and ends with the order transfer. The 'Inkomsystem' controller requires a reverse order of bytes in the FLOAT format number, thus, at USP configuration in this case, it is required to set the reverse byte sequence marker. Other systems may provide different variants (see Table 2.16A).

2.2.7.4 The correspondence of the **Modbus** protocol address space and TEKON parameter numbers, and the communication channel characteristics - exchange rate in the range from 300 to 9600 Baud, the number of stop bits and the method of their formation, USP **slave**-address in the line, shall be set during the configuration.

2.2.8. 'UNK TM' mode

2.2.8.1. In 'UNK TM' mode, USP simulates data exchange with the TEKON-19 computing device, as with a Superflo-II type gas meter, because UNK TM system was designed originally to work with this gas meter. The TS and TC signal exchange is not provided. USP is a **slave**-device with its own address in the line, and, taking into consideration features of TEKON-19 performs a limited list of functions given in Table 2.4.

Table 2.4

Command code (10)	Name	Note
01	Reading of initial data	
02	Reading of the static parameters	
03	Recording of the static parameters	with some limitations
20	Reading of daily data	
21	Reading of hourly data	
30	Time and date setting	

2.2.8.2. Other protocol commands are not processed, and when addressing them to USP, a reception error message is displayed.

2.2.8.3. The connection of commands and the UNK TM protocol parameters with TEKON-19 parameters, and the communication channel characteristics shall be set by the user during USP configuration. The standard exchange rate is 1200 Baud, one stop bit.

2.2.9. 'HART' mode

2.2.9.1 In 'HART' mode, USP is intended to connect TEKON-19 as a local concentrator (LC), performing the heat meter functions, into an exchange network developed by METRAN, industrial group from Chelyabinsk, using a variant of the standard HART-protocol. In HART protocol, USP is a **slave**-device with two configured network addresses (short and long), and executes a limited list of protocol commands given in Table 2.5.

Table 2.5

Command code (10)	Name	Note
00	reading of the unique identifier	
130	reading of measuring system configuration	
141	time synchronization and initiation of TEKON parameters query	broadcast
	Initiation of TEKON parameters repeat query	address
142	heat meter measurement information request	
143	preliminary request of heat meter archives	
144	delivery of prepared heat meter archives	

2.2.9.2 The remaining HART-protocol commands are not processed, and no response is output at their addressing to USP. The processing of commands is made according to METRAN document ‘Exchange commands of house and local concentrators. The programmer’s manual’ as amended on July 8, 2004. The features of command execution are described further in 2.3.7.

2.2.9.3 Compliance of HART protocol devices and TEKON parameter numbers, and communication channel characteristics – the exchange rate in the range from 300 to 19200 Baud (the standard is 19200 Bod), the number of stop bits and the method of their formation (the standard is 2 stop bits with odd parity), USP **Slave**-address in line, shall be set during the configuration.

2.2.10. Version 2 – ‘Energiya’ complex

2.2.10.1. Version 2 of USP has no variants and operates only as part of ‘Energiya’ complex, delivering a unipolar current signal with an amplitude of (10+5) mA, frequency of 100 Hz to the simplex two-wire communication line with the protocol, required by ‘Energiya’.

2.2.10.2. Data are transferred to the line every 15 seconds by USP initiative, each byte transmission format meets ‘Energiya’ protocol. USP serves as one of the data acquisition devices (DAD) of ‘Energiya’ complex, operating in the mode ‘16 counters and 16 telesignals’. No reception to USP from the line is provided, and TC operations are absent.

2.2.10.3. Data transferred by USP include the so-called 'comb busbar of parameters' which includes up to 16 measured or calculated values, scaled in USP within the specified limits and represented as one-byte integers without a sign in the range from 0 to 250 units. Moreover, up to 16 discrete TS signals may be transferred.

2.2.10.4. Selection of the parameters for the comb busbar and the telesignalization, initial and final scale values for scaling the comb busbar parameters and the direct or inverse view of each TS signal shall be set during the configuration.

2.2.11. Characteristics of USP as a module connected to CAN BUS - the network number, mask, configuration, and rate shall be set during the configuration in accordance with the characteristics of CAN-BUS to which USP will be connected during operation. The factory default settings are listed in Table 2.47.

2.2.12. USP power supply shall be an external DC power source with a voltage of 15–24 V. Power consumption shall not exceed 0.5 W.

2.2.13. Isolation of RS-232 interface electrical circuits or current output relative to the CAN-BUS interface circuits and relative to the power supply circuits shall withstand the test voltage of a practically sinusoidal shape with an amplitude of 1,000 V, frequency from 45 to 65 Hz within 1 minute under normal climatic conditions.

2.2.14. USP is stable and resistant to the impact of ambient temperature and humidity as per B4 group under GOST R 52931.

2.2.15. USP is stable and resistant to the impact of atmospheric pressure as per P1 group under GOST R 52931.

2.2.16. USP is stable and resistant to the impact of mechanical loads as per L1 group under GOST R 52931.

2.2.17. USP corresponds to IP20 protection degree against penetration of water and external solid objects under GOST 14254.

2.2.18. USP resistant to the impact of climatic factors and mechanical loads in packing case while transported by railroad and motor transport, and by motor transport in sealed and heated compartments under GOST R 52931.

2.2.19. USP external dimensions do not exceed 110x40x60 mm.

2.2.20. USP weight shall not exceed 0.3 kg.

2.2.21. Average error-free running time shall be not less than 50,000 hours. Error is defined by technical specifications TU 4233-023-44147075-12.

2.2.22. Average service life shall be at least 12 years. The limit state is considered when repair cost exceeds 50% of a new device cost.

2.2.23. The average recovery time shall not exceed 4 hours.

2.3 Description

2.3.1 USP Design and operation

2.3.1.1 USP consists of x51 family control microcontroller, RS-232 interface circuits (version 1), RS-485 interface circuits (version 3), a current output (version 2), CAN BUS interface circuit, a power supply unit and electrical isolation elements. Microcontroller executes the program stored in its internal non-volatile memory, implementing the device functions. Versions 1 and 3 use the same software, version 2 uses a separate software. During the configuration, all data are stored in the microcontroller non-volatile memory.

2.3.1.2. The RS-232 interface is implemented directly on the basis of a serial microcontroller transceiver. The current output and RS-485 interface circuits are controlled by one of the microcontroller internal port positions. Communication in CAN-BUS is performed via a separate CAN-controller. The physical connection to both interfaces is provided through special microchips – transceivers; at this, the CAN transceiver is powered from a separate power supply, and CAN BUS data lines are connected via an optical isolator. The remaining circuit is powered by another independent power source. Both power supplies are developed inside USP from an external supply voltage of 15–24 V and are galvanically isolated from it.

2.3.1.3. USP front panel contains three LED indicators signalling the current exchange mode via communication channels. One end wall of the case contains terminals for connecting CAN-BUS and external power source, and a jumper for installing the terminator on the CAN. Another end wall contains either RS-232 inter-

face DB9M slot plug in version 1, or current output terminals in version 2, or RS-485 interface terminals in version 3.

2.3.2 Parameters

2.3.2.1 All data required for configuring any device included in TEKON-20 series, and for obtaining results of its operation in the process of operation, are available through its interface only with the use of the **parameter system**. Each device in it is considered as a system **module**. Its software consists of a set of **tasks** processing the **input parameters** under the set **algorithms** with the purpose to obtain **output parameters**. Both parameters and tasks may be **rigid** and **flexible**.

2.3.2.2 **Parameter** is a data unit accessible from the outside under the certain conditions for reading and recording. Each **parameter** inside the module is characterized by two names (full and short), its full number in the form of a four-digit hexadecimal number, intent, access method, location in memory and internal representation. The first two digits of the parameter full number are called a **type**, the last two, a **number**. The type may be assigned within the range from 00 to FEh. The parameter is called **rigid** if its full number is set by the module software developers and cannot be changed during the configuration. If the parameter full number is assigned at the task creation stage, the parameter is called **flexible**. USP provides only rigid parameters, and, for example, TEKON-19, MIR-61, MU-71 provide both rigid and flexible parameters.

2.3.2.3 **Rigid tasks** are included into the module basic software, which is constantly present in each device instance, and are integral parts of its operation the system. The composition of rigid tasks depends only on the device version and cannot be changed.

2.3.2.4 **Flexible tasks** are loaded during the configuration of certain types of modules for each specific application. A **task queue** is executed during operation, forming all the required output parameters, it is formed from the flexible tasks. USP provides only rigid tasks, and TEKON-19, MIR-61, MU-71 provide both rigid and flexible tasks.

2.3.2.5 By access level, parameters are divided into 4 groups:

- Level 3, maximum (‘customer engineer’), for the manufacturing facility. Any actions for the reading and recording are allowed.
- Level 2, ‘service engineer’. Actions for the parameters reading and recording at the stage of the module putting into operation are allowed.
- Level 1, ‘user’. Minimum access level, only for reading in the process of operation.
- Level 0 – no access.

The allowed access level, separately for reading and recording for each parameter, is stored in the program module. The current access level by the channel is announced by special commands of access setting during the exchange. If the current level is lower than the allowed level for this exchange type (reading or recording), the exchange command will not be performed. The value of the current access level in any module is equal to 1 by default.

2.3.2.6 Each module within one CAN BUS should have its own unique address in the form of a single sexadecimal number within the range from 01 to FEh. Address 00 has a special destination, and address FF is forbidden. Access to the parameters of one module may be performed either through special exchange tasks included in the software of other modules on the same backbone, or with the use of special computer software, for example, TELEPORT. The exchange command indicates the exchange type, the module address and the full number of the parameter in it. The access increase functions at reading the parameters are not included into the software of all modules, including USP. Thus, a module can read only the parameters, access to reading which is equal to '1', from another module. USP software includes the function of automatic configuration of access level '2' for parameter recording to other modules and its return to level '1' after recording.

NOTE: software for reading and recording tasks in all modules, including USP, is designed so that when a module address 00 or FFh or the parameter full number of the form FFxxx (where FF is the parameter type) is assigned, the task is not executed.

2.3.2.7 By destination, all module parameters are divided into the following groups:

- Factory constants ('FC') in tables of parameter list) characterize design features and electrical characteristics of this module hardware and are recorded at the manufacturing facility.

- Parameter settings ('PS') for the certain technical object are recorded in the period of commissioning.

- Calculation parameters ('C'), representing the result of operation of tasks loaded into the module during the operation. USP has no such parameters.

- Archive parameters ('A'), for example, by hours, days, months. USP has no such parameters

- Service parameters ('S') in tables of parameter list) contain the information to assess whether the module operates correctly.

2.3.2.8 A description of all parameters and tasks shall be stored in a database (DB) that should accompany any module for the entire service life. If the database is lost, any calls to the module from the computer side become impossible.

2.3.2.9 All USP parameters are formally divided into 10 different tasks. The performance of any tasks depends on USP version, and for versions 1 and 3, it also depends on the operation variant specified by the system parameter ‘operation variant’. Tasks are listed in Table 2.6, and parameters could be seen in Table 2.7.

Table 2.6

Algorithm in the DB	Name	Tasks					
		Versions 1 and 3, variants					version 2
		1	2	3	5	other	
00B0	System	+	+	+	+	+	+
00B8	Setting CAN	+	+	+	+	+	+
00B1	General setting of exchanges	+	+	+	+	–	–
00B2	Intelligent RS M-1	+	–	–	–	–	–
00B3	Common RS M-1	+	–	–	–	–	–
00B4	Setting of Modbus	–	+	–	–	–	–
00B5	General setting of UNK TM	–	–	+	–	–	–
00B6	Setting of pipeline according to UNK TM	–	–	+	–	–	–
00B7	Setting of HART	–	–	–	+	–	–
00B9	Setting of ‘Energiya’	–	–	–	–	–	+

Table 2.7 USP parameters

Parameter	**Name**	Format	Location	Description	Access
1 General USP configuration					
1.1 System					
F001	Factory number	S2	Data ROM	FC	13
0100	Operation variant	S1	Data ROM	US	12
F000	Module type	S2	Data ROM	S	10
F002	Software version	S1	Program ROM	S	20
F01C	Current USP access	S1	RAM	S	10
F01A	Current mode of operation	S1	RAM	S	10
0006	Failure condition (see 2.3.2.13)	S1	RAM	S	10
0007	Window address	S4	RAM	S	22
0008	Window condition	S1	RAM	S	20
1.2 CAN configuration					
0001	Network address (see 2.3.2.6)	S1	Data ROM	US	12
0002	Main mask (=FFh)	S1	Data ROM	US	12
0003	Additional address (=0)	S1	Data ROM	US	12
0004	Additional mask (=0)	S1	Data ROM	US	12
0005	Configuration and rate (see 2.3.2.10)	S2	Data ROM	US	12
1.3 General exchange configuration (versions 1, 3)					
0105	TEKON query period, s	D2	Data ROM	US	12
0103	External rate constant (see 2.3.2.11)	S2	Data ROM	US	12
0104	Transfer and reception formats (see 2.3.2.12)	S1	Data ROM	US	12
0106	Delay from reception to transmission, ms	D1	Data ROM	US	12
0107	Detection of message end, ms	D1	Data ROM	US	12
010A	RTS signal delay, 100 μs	D1	Data ROM	US	12
2 Magistral-1					
2.1 Intelligent Remote Stations (IRS)					
0101	IRS address	S1	Data ROM	US	12
020N(i)	IRS parameters, operations 1-4 (i=0..3). IRS number n=0..11 corresponds to N=0..Bh	S4	Program ROM	US	12

Table 2.7 continued

Parameter	**Name**	Format	Location	Description	Access
	2.2 Common RS				
0102	Common RS address	S1	Data ROM	US	12
020C(i)	Description of common RS 0-13, i=0..13	S1	Program ROM	US	12
020D(i)	Group parameters 0-3, i=0..3	S4	Program ROM	US	12
021N(i)	RS0, TOn, signals TS 1-8 (i=0..7). Number TO n=1..4 corresponds to N=0..3	S4	Program ROM	US	12
021N(i)	RS1, TOn, signals TS 1-8 (i=0..7). Number TO n=1..4 corresponds to N=4..7	S4	Program ROM	US	12
021N(i)	RS2, TOn, signals TS 1-8 (i=0..7). Number TO n=1..4 corresponds to N=8..Bh	S4	Program ROM	US	12
021N(i)	RS3, TOn, signals TS 1-8 (i=0..7). Number TO n=1..4 corresponds to N=Ch..Fh	S4	Program ROM	US	12
022N(i)	RS4, TOn, signals TS 1-8 (i=0..7). Number TO n=1..4 corresponds to N=0..3	S4	Program ROM	US	12
022N(i)	RS5, TOn, signals TS 1-8 (i=0..7). Number TO n=1..4 corresponds to N=4..7	S4	Program ROM	US	12
022N(i)	RS6, TOn, signals TS 1-8 (i=0..7). Number TO n=1..4 corresponds to N=8..Bh	S4	Program ROM	US	12
022N(i)	RS7, TOn, signals TS 1-8 (i=0..7). Number TO n=1..4 corresponds to N=Ch..Fh	S4	Program ROM	US	12
023N(i)	RS8, TOn, signals TS 1-8 (i=0..7). Number TO n=1..4 corresponds to N=0..3	S4	Program ROM	US	12
023N(i)	RS9, TOn, signals TS 1-8 (i=0..7). Number TO n=1..4 corresponds to N=4..7	S4	Program ROM	US	12
023N(i)	RS10, TOn, signals TS 1-8 (i=0..7). Number TO n=1..4 corresponds to N=8..Bh	S4	Program ROM	US	12
023N(i)	RS11, TOn, signals TS 1-8 (i=0..7). Number TO n=1..4 corresponds to N=Ch..Fh	S4	Program ROM	US	12
024N(i)	RS12, TOn, signals TS 1-8 (i=0..7). Number TO n=1..4 corresponds to N=0..3	S4	Program ROM	US	12
024N(i)	RS13, TOn, signals TS 1-8 (i=0..7). Number TO n=1..4 corresponds to N=4..7	S4	Program ROM	US	12
024N(i)	RSn, signals TC 1-6 (i=0..5). Number RS n=0..7 corresponds to N=8..Fh	S4	Program ROM	US	12
025N(i)	RSn, signals TC 1-6 (i=0..5). Number RS n=8..13 corresponds to N=0..5				
025N(i)	RSn, duration of TC 1-6 (i=0..5), seconds. Number RS n=0..9 corresponds to N=6..Fh	S4	Program ROM	US	12
026N(i)	RSn, duration of TC 1-6 (i=0..5), seconds. Number RS n=10..13 corresponds to N=0..3				

Table 2.7 continued

Parameter	**Name**	For-mat	Loca-tion	De-scrip-tion	Ac-cess
3 Modbus (Magistral-2, Inkomsystem)					
0101	Slave-address USP in the Modbus line	S1	Data ROM	US	12
0300(i)	Address Modbus of the floating-point parameter 0-63, i=0..63	S2	Program ROM	US	12
0301(i)	Description of the floating-point parameter 0-63, i=0..63	S4	Program ROM	US	12
0302(i)	Address of Modbus signal TS 0-127, i=0..127	S2	Program ROM	US	12
0303(i)	Description of the parameter TS 0-127, i=0..63	S4	Program ROM	US	12
0304(i)	Address of Modbus signal TC 0-15, i=0..15	S2	Program ROM	US	12
0305(i)	Description of the parameter TC 0-15, i=0..15	S4	Program ROM	US	12
0306(i)	Duration of signal TC 0-15, i=0..15 (c)	D1	Program ROM	US	12
0307(i)	TC signal type 0-15, i=0..15	S1	Program ROM	US	12
0308(i)	Description of the RS TU parameter 0-15, i=0..15	S4	Program ROM	US	12
0309(i)	Address of Modbus two-byte TM 0-15, i=0..15	S2	Program ROM	US	12
030A(i)	Description of the parameter TM 0-15, i=0..15	S4	Program ROM	US	12
030B(i)	Description of parameter groups TS 0-3, i=0..3	S4	Program ROM	US	12
0108	Generating polynom CRC (=A001h)	S2	Data ROM	US	12
010B	Reverse byte sequence in the floating-point parameter	bit	Data ROM	US	12
010C	Byte pairwise exchange in the floating-point parameter	bit	Data ROM	US	12
4 UNK TM					
4.1 General setting					
0101	USP address in the line	S1	Data ROM	US	12
0400	Number of pipelines	D1	Program ROM	US	12
0401(i)	Time and date recording password, 16 digits, i=0..15	S1	Program ROM	US	22
4.2 Setting of a pipeline with the number n=1..3 (corresponds to N=5..7)					
0N00(i)	Pipeline name, 16 characters, i = 0..15	S1	Program ROM	US	12
0N01	Flow measurement type	S1	Program ROM	US	12

Table 2.7 continued

Parameter	**Name**	Format	Location	Description	Access
0N02	Selection method	S1	Program ROM	US	12
0N03	CAN-address of the pipeline module	S1	Program ROM	US	12
0N04	Parameter ‘gas density’	S2	Program ROM	US	12
0N05	Parameter ‘CO2 percentage’	S2	Program ROM	US	12
0N06	Parameter ‘nitrogen percentage’	S2	Program ROM	US	12
0N07	Parameter ‘pipe diameter’	S2	Program ROM	US	12
0N08	Parameter ‘diaphragm diameter ’	S2	Program ROM	US	12
0N09	Parameter ‘atmospheric pressure’	S2	Program ROM	US	12
0N0A	Parameter ‘minimal drop’	S2	Program ROM	US	12
0N0C(i)	Recording password, 16 characters, i = 0..15	S1	Program ROM	US	22
0N0D	Parameter ‘flow archive by days’	S2	Program ROM	US	12
0N0E	Parameter ‘backup archive by days’	S2	Program ROM	US	12
0N0F	Parameter ‘drop archive by days’	S2	Program ROM	US	12
0N10	Parameters ‘pressure archive by days’	S2	Program ROM	US	12
0N11	Parameter ‘temperature archive by days’	S2	Program ROM	US	12
0N12	Parameter ‘backup archive by days’	S2	Program ROM	US	12
0N13	Parameter ‘flow archive of by hours’	S2	Program ROM	US	12
0N14	Parameter ‘backup archive by hours’	S2	Program ROM	US	12
0N15	Parameter ‘drop archive by hours’	S2	Program ROM	US	12
0N16	Parameter ‘pressure archive by hours’	S2	Program ROM	US	12
0N17	Parameter ‘temperature archive by hours’	S2	Program ROM	US	12
0N18	Parameter ‘backup archive by hours’	S2	Program ROM	US	12
0N19	Depth of hour archives for a pipeline	D1	Program ROM	US	12

Table 2.7 continued

Parameter	Name	Format	Location	Description	Access
5 HART					
0101	Short address	S1	Data ROM	US	12
0800	2nd byte of the long address	S1	Program ROM	US	12
0801	3rd byte of the long address	S1	Program ROM	US	12
0802	4th byte of the long address	S1	Program ROM	US	12
0803	Number of HART devices (to 16)	D1	Program ROM	US	12
0804(i)	HART device type, i=0..15	S1	Program ROM	US	12
0805(i)	HART device number, i=0..15	S1	Program ROM	US	12
0806(i)	HART device code, i=0..15	S1	Program ROM	US	12
0807(i)	HART device module CAN-address	S1	Program ROM	US	12
0808(i)	Parameter ‘for the current month’	S2	Program ROM	US	12
0809(i)	Failure parameter	S2	Program ROM	US	12
080A(i)	Depth of hour archives for a device	D1	Program ROM	US	12
080B(i)	Parameter ‘hour archive’	S2	Program ROM	US	12
080C(i)	Parameter ‘daily archive’	S2	Program ROM	US	12
080D(i)	Parameter ‘monthly archive’	S2	Program ROM	US	12
6 ‘Energiya’ (only version 2)					
0200(i)	Comb busbar parameter 0-15, i=0..15	S2	Program ROM	US	12
0201(i)	CAN-address of the comb busbar parameter module 0-15, i=0..15	S1	Program ROM	US	12
0202(i)	Beginning of scale of the comb busbar parameter 0-15, i=0..15	F	Program ROM	US	12
0203(i)	End of scale of the comb busbar parameter 0-15, i=0..15	F	Program ROM	US	12
0204(i)	Specification of the parameter TS 0-15, i=0..15	S1	Program ROM	US	12
0205(i)	Parameter TS 0-15, i=0..15	S2	Program ROM	US	12
0206(i)	CAN-address of parameter module TS 0-15, i=0..15	S1	Program ROM	US	12

Table 2.7 continued

Parameter	**Name**	Format	Location	Description	Access
0207(i)	Group parameter for TS 0-3, i=0..3	S4	Program ROM	US	12
0208(i)	CAN-address of the group parameter module 0-3, i=0..3	S1	Program ROM	US	12
0101	Test issue at the frequency of 110 Hz	bit	RAM	S	22
0102	Test issue in the direct code	bit	RAM	S	22

Notes:
1. Format: S – sexadecimal, D – decimal, 'bit' – single bit, F – floating-point. The digit denotes the amount of bytes in a number.
2. Location: Program ROM - Program Read Only Memory, Data ROM- Data Read Only Memory, RAM – random access memory without information saving upon power failure.
3. Description: FC – factory constant, US – users setting, S – service parameter.
4. Access: the first number for reading, the second for recording (see 2.3.2.5).

2.3.2.10 The value of parameter 0005 'configuration and rate' shall be set during the configuration according to Table 2.8. in accordance with characteristics of CAN BUS, to which it is planned to connect USP during operation. It is not recommended to change values of 0002, 0003, 0004 parameters indicated in Table 2.7.

Table 2.8

Rate, kBaud	0005 parameter code
300	41E0
150	43E0
100	45E0
50	4BE0
20	5DE0

2.3.2.11 The value of parameter 0103 'external rate constant' in USP of versions 1 and 3 shall be set during the configuration, depending on the exchange rate with the external system according to Table 2.9. USP of version 2 has no rate configuration, always outputting information at a frequency of 100 Hz.

Table 2.9

Rate, kBaud	0103 parameter code	Note
19,200	FD80	Standard for HART
9,600	FD00	
4,800	FA00	
2,400	F400	
1,200	E800	Standard for UNK TM
600	D000	
300	A000	

2.3.2.12 The value of parameter 0104 ‘reception and transfer format’ in USP of versions 1 and 3 shall be set at the bitwise configuration depending on a method of formation of stop bits, accompanying each byte of information in the line, required by the system, according to Table 2.10. The numbering of bits (binary digits) in the parameter is implied from right to left, from 0 (lower) to 7 (higher). USP of version 2 has no format configuration, always displaying information according to the description of ‘Energiya’ protocol.

Table 2.10

Bit number	Direction	Condition ‘0’	Condition ‘1’
0	Transfer from USP to the line	-	-
1		complement to unevenness at the control on	complement to evenness at the control on
2		at 2 stop bits the control is off, both bits are ‘1’	at 2 stop bits the control is on
3		1 stop bit	2 stop bits
4	Receipt from the line to the USP	-	-
5		complement to unevenness at the control on	complement to evenness at the control on
6		control is off at 2 stop bits, both bits are ‘1’	control is on at 2 stop bits
7		1 stop bit	2 stop bits

2.3.2.13 The parameter 0006 ‘failure condition’ is a sexadecimal number, the binary representation of which is a set of failure situations signs detected by the constantly running USP self-monitoring (binary digits are numbered from right to left from 0 to 7):

- Position 0 – incorrect check sum of program ROM
- Position 1 – incorrect check sum of data ROM
- Position 2 – failure to record in program ROM
- Positions from 3 to 6 – not used
- Position 7 – time is not read (only for UNK TM).

2.3.2.14 The detailed description of the purpose and the internal structure of the parameters for each variant of USP operation is given below, in the sections of USP variants description.

2.3.2.15 All the parameters shall be recorded into USP from the configuration software launched on the computer via CAN BUS (it is possible via RS-232 for Modbus) after setting the access level for the recording to USP equal to ‘2’. Moreover, the parameters located in the program ROM are available for recording only after switching the main USP program to the ‘stop’ mode, which is performed by recording the code ‘01’ in the parameter F01A ‘operation mode’. If the computer makes no

calls to USP via CAN BUS within 255 seconds, the access level in it is automatically reduced to '1'.

2.3.2.16 In all variants and versions of USP performing the telesignalization function, the possibility is implemented to use the so-called group bit parameters, for example, available in TEKON-19. A group parameter includes up to 32 separate bit signals. USP allows using up to 4 such parameters. As any other parameter, the group parameter is read from the module in one call. Thus, if the module contains group parameters, their use allows sharply speeding up the process of telesignalization data reading. Further, multiple references are possible for TS to the condition of any set bit with the number from 0 to 31 from the introduced group with the number from 0 to 3.

2.3.3 Operation (ver. 1 and ver.3)

2.3.3.1 After power is on, USP operation main program is started. Both communication channels are configured under the entered configuration constants. The condition of the system parameter 0100 'operation variant' is analyzed. If its value is within the limits specified in Table 2.2, the program is set for the selected operation variant and enters the background mode of waiting for external inquiries. Otherwise, no operations are performed, queries to CAN BUS from USP are not formed, the front panel indicators are off.

Starting from version 06, for the possibility to configure USP via the RS-232 interface, the logic of the software operation after powering on is slightly changed. Immediately after power is on, regardless of the actual settings, the RS-232 interface is automatically set to the exchange rate of 9600 baud with one stop bit, and USP receives the network number 25 (sexadecimal) on this interface, and is enabled to receive messages in FT1.2 format without CRC, standard for any TEKON devices. If the required command to start the exchange has not been received within 20 seconds, or the received command is not the command required for starting the exchange via FT1.2, USP rebuilds its interface using the configuration constants stored in memory and moves to the normal operation mode. If the command is received, USP switches to the configuration mode, providing an exchange with the configuration software and entering new parameter values without exchanging via CAN BUS interface. If a pause in exchanges with the computer exceeding 255 seconds is detected during the configuration process, USP automatically switches to the normal operating mode.

NOTE: Configuration via the RS-232 interface is guaranteed only for Modbus mode, and only in case when prior to the configuration start, either no mode was assigned in USP, or Modbus has already been assigned.

2.3.3.2 At the normally assigned operation variant, even in the absence of external inquiries, in most variants, USP periodically, with the cycle time set via the parameter 0105 'TEKON query period', performs the reading of a line of the parameters from modules connected to CAN BUS and stores the values obtained in its RAM. This is done in order to accelerate the formation of a response to possible inquiries. In principle, the limits of the parameter 0105 change are from 1 to 65,535 seconds, the recommended cycle time is from 5 to 20 seconds.

2.3.3.3 To record the parameters located in the microcontroller software memory (program ROM), USP may be temporarily transferred to the special STOP mode during the configuration. In this mode, the input messages are not processed, inquiries to the modules from USP are not formed, only the possibility of responding to commands sent via CAN BUS from the computer, on which the configuration software is running, is saved. See 3.2.9.2 for more details.

2.3.3.4 In the operation mode after the start of receiving the input message, the time intervals between the received bytes shall be controlled. If a long interval is detected, the message shall be considered prematurely completed. As a rule, it is not analyzed, and the next byte is considered as the beginning of a new message. The acceptable interval is set via parameter 0107 ‘detection of message end’; its value is expressed in timer delays of 1000 Hz and can be set within the range from 1 to 255 units (i.e. from 1 to 255 ms). The value of the parameter equal zero, shall be taken as ‘1’.

2.3.3.5 If the message is fully received, it is analyzed. The proper operation of each byte and the message as a whole, and the correctness of its addressing to USP, are assessed. If the message is addressed to this USP, operates properly and is included into the number of allowed functions, the function execution starts. Further reception from the line is temporarily prohibited. Depending on the operation variant and the set function, the response formation either starts immediately from the information stored in USP memory, or one or several calls to the modules are performed first via CAN-BUS, and the response is formed based on their results. In version 1, the response message is always displayed framed by the RTS signal active condition.

2.3.3.6 When reception is finished and last byte of the incoming message from the line to the RTS signal configuration is received, the period in milliseconds is followed, not less than the time specified in the configuration parameter 0106 ‘delay from reception to transmission’. The delay range is from 1 to 255 ms (value ‘0’ is perceived as ‘1’) with the step of 1 ms. If the function execution required several calls to CAN BUS, the actual delay time can additionally be equal up to several tens or even hundreds of milliseconds. From the time of the RTS signal setting up until the issue of the response message first byte in version 1, the time set via the parameter 010A ‘RTS signal delay’ is followed additionally within the range from 0 to 25500 μs with the step of 100 μs. In version 3, this parameter is ignored.

2.3.3.7 The response message bytes are output one after another without delays. When the last byte is transferred, the same period, indicated in the parameter 010A ‘RTS signal delay’ is taken, after which the RTS signal is removed. Input messages can be received again, and USP is ready for the next exchange cycle.

2.3.3.8 LEDs on the front panel are used to indicate the condition of exchange channels at the current moment:

- The green indicator ‘Rx’ lights up at the moment when the first byte of the message is received and it is off after receiving the last byte of the message.

- The yellow indicator ‘Tx’ lights up at the moment when the first byte of the response message is output to the line and it is off after the output of its last byte.
- The red indicator ‘CAN’ lights up when CAN-BUS controller is initialized for transfer and it is off after receiving a response.

Starting from version 06, the red indicator operates in the following way after activation:

- Immediately after switching on, the indicator starts flashing very frequently (around 16 Hz), indicating a 20-second waiting period for a possible transition to the configuration mode.
- If the configuration start command is received, the indicator flashes less frequently, at around 8 Hz, indicating that USP is in CONFIGURATION mode.
- When configuration is ended, for example, and there is no exchange with the computer for 255 seconds after the configuration start, or when the correct Modbus command is received immediately before CONFIGURATION mode start, the indicator is re-configured to signalling the exchanges via CAN, as specified above.

2.3.3.9 Calls to CAN BUS, either periodically or in response to external inquiries, are made only if the module number in the backbone and the full number of the parameter required from it are set correctly. ‘Correctly’ means that:

- module number is within the range from 01 to FEh;
- the parameter full number does not have the form FFxxh, i.e. the parameter type differs from FFh.

The remaining correctness control, including tracking the access level by reading the selected parameter, is not carried out, and configuration errors will lead to exchange failures, because no reading of an erroneous parameter will take place. Red LED will be on within a long period of time (more than 0.5 seconds).

2.3.3.10 In cases when the function requires USP to record the parameter into the module (including during telecommunication), the actual level of access to it by the record announced in the module itself should not exceed '2', otherwise, the recording will not be performed. If the module is password-protected, the recording will not be performed as well.

2.3.4 ‘Magistral-1’ mode

2.3.4.1 In accordance with 2.2.5, in ‘Magistral-1’ USP acts both as conventional RS and intelligent RS. In the absence of inquiries from the side of the external system, USP, with the period set during the configuration, reads the following information from CAN BUS modules and stores it in its RAM:

- Up to 4 group parameters for TS (if they are described) with the formation of internal signs of each parameter readiness.
- Up to 128 bit parameters, defined during the configuration of conventional ’RS, with the formation of signs of readiness of each teleoperation.
- Up to 48 floating-point parameters, described during the configuration of ‘intelligent’ RSs with the formation of signs of parameter readiness.

2.3.4.2 A message from 'Magistral-1' starts with a preamble, which includes at least one byte with the FFh value (two preamble bytes are further conditionally shown in all Tables), and ends with a password representing the result of the addition of all preceding byte (after the preamble) by the operation 'exclusive OR'. Response messages have a similar structure, with USP always forming two preamble bytes.

2.3.4.3 A command ‘reading PCD parameters’ and USP response to it have the format according to Table 2.11.

The ATOI code is considered bitwise. The binary digits 6:3 contain the subunit number within the range from 0 to 13, the binary digits 2:0 contain the initial teleoperation number from 1 to 4.

For the response formation, the information earlier by USP and already stored in its RAM is taken. After that, the sign of its readiness is cleared and a flag is set, making USP to read the information from CAN BUS prematurely, without waiting for the end of the next query period.

If the requested parameter is not ready, for example, due to the absence of communication with the module, the code FF FF FF FF shall be taken as its value.

Table 2.11

Byte number (10)	Value (16) or name	**Description**
Query		
0,1	FF FF	preamble
2	0	IRS marker
3	ARS	IRS address
4	03	command code ‘reading’
5	ATOI	Subunit number and teleoperations in it
6	N	Number of parameters from 1 to 4
7	PW	password
Response		
0, 1	FF FF	Preamble
2	40h	IRS response marker
3	ARS	IRS address
4..(3+N*4)	data	4 bytes for each parameter
4+N*4	PW	password

2.3.4.4 The command ‘recording of Intelligent Remote Stations’ parameters’ and USP response to it shall have the format according to Table 2.12.

Table 2.12

Byte number (10)	Value (16) or name	**Description**
Query		
0,1	FF FF	preamble
2	0	IRS marker
3	ARS	IRS address
4	08	command code ‘recording’
5	ATOI	Subunit number and teleoperations in it
6	N	Number of parameters from 1 to 4
7..(6+N*4)	data	4 bytes for each parameter
7+N*4	PW	password
Response		
0, 1	FF FF	IRS response marker
2	40h	IRS address
3	ARS	IRS address
4	PW	password

The ATOI code shall be considered similarly to the ‘reading’ command. The response is formed immediately, without waiting for the operation results. The information for recording is transferred to the internal buffer, an internal flag is set, making USP to start the procedure of data recording to the required module.

Recording of each parameter is performed in one stage, if its specification defines the access level ‘1’, and in three stages at the access level ‘2’. In the latter case, first, a command ‘increase access to 2’ is sent to the module, followed by the recording command, and finally, by the command ‘lower access to 1’. During normal backbone operation, the recording process takes not more than 100 - 200 milliseconds,

making it difficult to track it. However, in the process of recording, the status byte is formed (see Table 2.14), which may be read by a separate command.

2.3.4.5 The command ‘query of the execution of the command for recording into PCD’ and USP response to it shall have the format according to Table 2.13.

Table 2.13

Byte number (10)	Value (16) or name	**Description**
Query		
0,1	FF FF	preamble
2	0	IRS marker
3	ARS	IRS address
4	09	command code ‘recording execution query’
5	PW	password
Response		
0, 1	FF FF	preamble
2	40h	IRS response marker
3	ARS	IRS address
4	status	recording result according to Table 2.14
5	PW	password

Table 2.14 – Status condition

Status (10)	Meaning
0	the process of recording has been initiated
131	the process of recording has been completed successfully
254	Failure registered in the process of recording
255	recording denied

The response is output immediately by the results of the last recording command execution.

2.3.4.6 The ‘reading the telesignalization’ command for the common RS and USP response to it shall have the format according to Table 2.15.

Table 2.15

Byte number (10)	Value (16) or name	**Description**
0,1	FF FF	Preamble
2	ARS	address of the common RS from 1 to 63
3	ATOI	TS subunit number and number of the teleoperation in it
4	PW	Password
Response		
0, 1	FF FF	Preamble
2	ARS+I	RS address with the proper operation marker
3	ATOI	subunit number and teleoperation in it
4	TS	TS condition in the teleoperation
5	PW	Password

The ATOI code is considered bitwise. The binary digits 6:3 contain the subunit number within the range from 0 to 13, the binary digits 2:0 contain the initial teleoperation number from 1 to 4. The command is the 'TS reading' command if the subunit with the number i in the PCD specified in it is described as having the TS type, i.e., the value ‘1’ has been assigned to the parameter 020C with the index ‘i’.

The TS condition in the selected teleoperation is collected bitwise from 8 described bit parameters read earlier and stored in USP memory. These can be either individual bit parameters or selected bits from the group parameters. If no parameters in the teleoperation are ready, the RS response address will be output with the RS fault sign (‘1’ in the 6th binary digit). After the command is used, the teleoperation readiness is cleared, internal flags are set, forcing USP to re-read the telesignalization parameters from CAN BUS prematurely, without waiting for the end of the specified TEKON query period.

2.3.4.7 The telecommand in USP shall mean setting the output signal specified in the command (bit parameter) into condition ‘1’ for the time in seconds specified at the configuration, after which the parameter is assigned the value ‘0’ again. No return signals are analyzed at TC. According to ‘Magistral-1’ operation logic, only two-step telecommand is possible, with preliminary and executive commands. The ‘telecommand’ and its response shall have the format according to Table 2.16.

Table 2.16

Byte number (10)	Value (16) or name	**Description**
Query		
0,1	FF FF	preamble
2	ARS	address of common RS from 1 to 63
3	ATOI	command type, number of subunit and its signal
4	PW	password
Response		
0, 1	FF FF	preamble
2	ARS+I	RS address with the proper operation sign
3	ATOI	subunit and teleoperation number
4	PW	password

The ATOI code shall be considered bitwise. The binary digit 7 contains the sign of a preliminary (‘0’) or executive (‘1’) command. The binary digits 6:3 contain the number of the subunit 'i' within the range from 0 to 13, the binary digits 2:0 – the output signal number from 1 to 6. The command is 'telecommand' if the subunit with the number ‘i’ specified in it in USP is described during the configuration as having the TC type, i.e., the value ‘2’ was assigned to the parameter 020C with the index ‘i’.

Until the previous TC process is completed, the new TC cannot be started, and when the system attempts to send a TC command, the RS response address will be issued with an RS fault sign (‘1’ in the 6th binary digit).

After receiving the preliminary command, USP issues a response receipt and remembers the transferred subunit and signal numbers.

After receiving the executive command, USP compares the stored subunit and signal numbers with the newly received ones, forms a positive receipt if they match, and sets internal flags that cause the program to start TC operation. The telecommand process is in many aspects similar to the process of recording the parameters into the IRS, and consists of the following steps:

- If the access level '2' is indicated in the output signal parameter specification during the configuration, the command 'access level 2' is output to the set module.
- The command of recording a single value to the selected module bit parameter is issued.
- The signal duration set at the configuration is counted under USP internal timer.
- The command of recording a zero to the selected module bit parameter is issued.
- If an increased access level is set, then the command 'setting the access level 1' is sent to the module.

At this, the TC process is completed, and USP is ready to accept the next TC command. The TC process does not affect the execution of other commands.

2.3.5 'Modbus' mode (Magistral-2, Automated control system

2.3.5.1 As noted in the previous sections, USP in the 'Modbus' mode continuously reads the following information with pre-set period from CAN BUS modules and stores it in its RAM:

- programmed parameters to read floating point - up to 64;
- two-byte parameters programmed for reading – up to 16 (as a rule, do not apply);
- programmed individual parameters (up to 128) and group bit parameters (up to 4).

Upon receipt of **Modbus** inquiries for reading the specified parameters, a response is issued immediately, containing data taken from USP memory. If data from the modules were not received in time, for example, due to the bus failure, an error code 04 will be output instead of a response 'error in the connected device'. If a new query for the same information is submitted before its update, an error code 05 will be generated 'data are not ready'. If over 8 floating-point parameters are requested at the same time, or an odd number of registers is specified in command 03, then error code 03 is displayed. If at least one register address was not specified during configuration and was found among the requested parameters, the error code 02 'forbidden address' will be output.

The four-byte sequence, representing the floating-point number, in any reading and recording commands shall be set during the configuration the installation of two bit parameters in accordance with Table 2.16A.

Table 2.16A Setting of byte sequence

010B parameter 'Byte reverse order'	010C parameter 'Byte pairwise exchange'	Byte sequence *)
= 0	= 0	1,2,3,4
= 1	= 0	4,3,2,1
= 0	= 1	2,1,4,3
= 1	=1	3,4,1,2
Note: Byte 1 – the least significant part of the mantissa, byte 3 – the most significant part of the mantissa, byte 4 – the number position and sign according to IEEE-754.		

Thus, for 'Magistral-2', both parameters are set as '0', for 'Inkomsystems' the parameter 010C is set as '1'. Different parameter values may be used for other systems.

Responding to queries on functions 01, 02, 03, 04, 45h, 48h, USP software sets internal flags forcing it to perform premature reading from the modules in order to update the parameters on time, without waiting for the end of the specified period.

2.3.5.2 Both single-stage and two-stage telecommand is possible, with an imitation of the execution of preliminary and executive commands. The form of each of 16 possible TC signals is indicated during the configuration. Generally under 'telecommand' in USP 'Modbus' variant is meant one of the two operations:

- Set the bit parameter value specified in the TC command in one of the bus modules, waiting for certain conditions (the expiration of a given time or the appearance of a specific return signal), then recording the inverse value of this parameter. This TC method shall be hereinafter referred to as the 'pulse'.
- Simply set the determined bit parameter in one of the bus modules to a specified condition (single or zero). This TC method shall be hereinafter referred as to the 'potential'.

2.3.5.3 Formats of executable commands were briefly listed in Table 2.3. They are described in details below.

2.3.5.4 Function 01. Reading the telecommand condition (**Coil**)

Table 2.17

Byte number	Value	Description
Query		
1		Network address **Slave** USP
2	01	Command code
3		High byte of the first **Coil** address
4		Low byte of the first **Coil** address
5	00	High byte of the number of the required **Coils**
6	02	Low byte of the number of the required **Coils**
7		Low byte of CRC16 code
8		High byte of CRC16 code
Response		
1		Repeating of **Slave** USP network address
2	01	Command code repeating
3	01	Number of data bytes
4		Data, byte collected bitwise
5		Low byte of CRC16 code
6		High byte of CRC16 code

The first **Coil** address should be obligatory even, otherwise, USP displays the error code 02.

The binary digits of the response data byte from the 7th to the 2nd contain zeros, and the positions 1 and 0 contain the result of the last TC command (preliminary or executive) in accordance with Table 2.18:

Table 2.18

Position condition		TC result
Position 1	Position 0	
0	0	Command completed successfully
0	1	Command in progress
1	0	Error occurred while executing, repeat is possible
1	1	Fatal error occurred while executing

2.3.5.5 Function 02. Reading of N condition of discrete signals (**Discrete Inputs**)

Each Discrete Input specified in this function should be associated with a two-byte parameter with the reading access level of '1' at USP configuration.

The condition of the discrete signal, the address of which is specified in the query in the Discrete Inputs space, is recorded into the 0 position of the first data byte, a signal with an address higher by 1, is recorded into the 1st position, etc. If more than 8 signals are requested, two data bytes are transferred, over 16 – three bytes, etc. The unused positions of the last data byte (if the number of requested signals is not a multiple of 8) are filled with zeros. The number of data bytes in response is equal to the integer part of the N/8 division result, always rounded up to.

Table 2.19

Byte number	Value	Description
	Query	
1		Network address **Slave** USP
2	02	Command code
3		High byte of the first signal address
4		Low byte of the first signal address
5	00	High byte of the number of the required signals
6	N	Low byte of the number of the required signals
7		Low byte of CRC16 code
8		High byte of CRC16 code
	Response	
1		Repeating of the network address **Slave** USP
2	02	Command code repeating
3		Number of bytes in data transferred below
4		Data, 1st byte collected bitwise
...		Data (2nd and the following bytes)
		Low byte of CRC16 code
		High byte of CRC16 code

2.3.5.6 Functions 03 and 04. Reading

1) 03 – Reading the condition of two-byte N parameters (**Holding Registers**)

04 – Reading the condition of two-byte N registers (starting from versions 06)

To be executed in accordance with Table 2.20, if each register specified in this function was assigned a two-byte parameter with the reading access level of '1' at USP configuration. If one command requests several parameters at once, the address of each subsequent register is assumed to be higher by 1 than the previous.

2) 03 – Reading the condition of N parameters (**Holding Registers**) in the format **FLOAT,** for example, in 'Inkomsystem'

To be executed in accordance with Table 2.21, if each Holding Register specified in this function was assigned a parameter in the floating-point format with the reading access level of '1' at USP configuration. If several parameters are requested

at once, the address of each subsequent register is assumed to be higher by 2 than the previous. It is allowed to request maximum 8 parameters at once.

Table 2.20

Byte number	Value	Description
	Query	
1		Network address **Slave** USP
2	03 (04)	Command code
3		High byte of the first Holding Register address
4		Low byte of the first Holding Register address
5	00	High byte of the number of the required parameters
6	N	Low byte of the number of the required parameters
7		Low byte of CRC16 code
8		High byte of CRC16 code
	Response	
1		Repeating of the network address **Slave** USP
2	03 (04)	Command code repeating
3	2*N	Number of bytes in data transferred below
4		High byte of the first parameter data
5		Low byte of the first parameter data
...		...
4+2*(N-1)		High byte of the Nth parameter data
5+2*(N-1)		Low byte of the Nth parameter data
6+2*(N–1)		Low byte of CRC16 code
7+2*(N-1)		High byte of CRC16 code

Table 2.21

Byte number	Value	Description
	Query	
1		Network address **Slave** USP
2	03	Command code
3		High byte of the first Holding Register address
4		Low byte of the first Holding Register address
5	00	High byte of the doubled number of parameters
6	2*N	Low byte of the doubled number of parameters
7		Low byte of CRC16 code
8		High byte of CRC16 code
	Response	
1		Repeating of the network address **Slave** USP
2	03	Command code repeating
3	4*N	Number of bytes in data transferred below
4..7		Value of the first parameter (see Table 2.16A)
...		...
4..7+4*(N-1)		Value N of the Nth parameter (see Table 2.16A)
8+4*(N-1)		Low byte of CRC16 code
9+4*(N-1)		High byte of CRC16 code

2.3.5.7 Function 48h. Reading the condition of N parameters (**Holding Registers**) in the format **FLOAT** (Magistral-2)

Function 45h. Reading the condition of one parameter (**Holding Registers**) in the format **FLOAT** (Magistral-2), starting from version 06

Each Holding Register specified in this function should be assigned to TEKON parameter in the floating-point format with the reading access level of '1' at USP configuration. If several parameters are requested at once, the address of each subsequent register is assumed to be higher by 2 than the previous one. It is always allowed to request maximum 8 parameters for the function 48 and one parameter for the function 45.

Table 2.22

Byte number	Value	Description
	Query	
1		Network address **Slave** USP
2	48h	Command code
3		High byte of the first parameter address
4		Low byte of the first parameter address
5	00	High byte of the number of the required the parameters
6	N	Low byte of the number of the required the parameters
7		Low byte of CRC16 code
8		High byte of CRC16 code
	Response	
1		Repeating the network address **Slave** USP
2	48h	Command code repeating
3	4*N	Number of bytes in data transferred below
4..7		Value of the first parameter (see Table 2.16A)
...		...
4..7+4*(N-1)		Value of the Nth parameter (see Table 2.16A)
8+4*(N-1)		Low byte of CRC16 code
9+4*(N-1)		High byte of CRC16 code
Note: the function 45 is performed in a similar way, the command code at receipt and response is 45h, value N=1.		

2.3.5.8 Function 05. Setting the control output (**Coil**), i.e. TC

Each **Coil** specified in this function should be assigned to a bit parameter with the recording access level not exceeding '2' (one parameter at a potential TC, two parameters at pulse TC) at USP configuration.

At the potential TC, one control signal corresponds to one **Coil** address (a pair of Modbus addresses at a two-step TC). To set it into condition '1', the FF00h value code shall be transferred; to set it into condition 0', the code shall be '0000'. The remaining codes output an error message with code 03 'incorrect data'.

At the pulse TC, two different control parameters correspond to one **Coil** address (a pair of Modbus addresses at a two-stage TC), for example, signals for the valve opening and closing. To send a single pulse to the first parameter (conventionally referred to as the 'TC1'), the FF00h code value is transferred. To send a single pulse to the second parameter (conventionally referred to as the 'TC0'), the 0000h code value is transferred. The remaining codes output an error message with code 03 'incorrect data'. Sending 'zero' pulse to any of the outputs is impossible.

Regardless of the TC type (potential or pulse), if the given **Coil** is specified as being set by a single-stage TC operation, its Modbus address should be even. The command to install the corresponding control output is immediately transferred to CAN BUS module. An odd address outputs an error message with code 02 'incorrect address'.

Table 2.23

Byte number	Value	Purpose
Query		
1		Network address **Slave** USP
2	05	Command code
3		High byte of the signal address (**Coil)**
4		Low byte of the signal address (**Coil)**
5		High byte of the value
6	00	Low byte of the value
7		Low byte of CRC16 code
8		High byte of CRC16 code
Response		
1		Network address **Slave** USP
2	05	Command code
3		High byte of the signal address (**Coil)**
4		Low byte of the signal address (**Coil)**
5		High byte of the value
6	00	Low byte of the value
7		Low byte of CRC16 code
8		High byte of CRC16 code

With a two-step TC, the preliminary command is sent with an even **Coil** address. Information is not transferred to the module via it, but the fact of receiving a preliminary command is stored in USP. Moreover, the current condition of the bit signal of proper operation of control circuits set during the configuration is checked. If the signal corresponds to the proper operation, a normal receipt for the preliminary command is issued. Otherwise, an error message is displayed with code 04 'error in the attached device'.

The executive command should have the **Coil** address higher by 1 than the preliminary address, in this case the command for installation of the corresponding control output is transferred to the required module. Otherwise, an error message is displayed with code 02 'incorrect address'.

Generally the process of pulsed two-stage TC consists of the following steps:

- Receive a preliminary command with an even address, check its internal consistency, check the condition of the signal of proper operation of control circuits (if programmed during the configuration). If errors are registered, the executive command will be ignored.

NOTE: response to the command 01 ‘TC reading’ after the preliminary command, will have a binary code of the mode 00, if the device is ready, and code 11, if it is not ready.

- Receive an executive command with an odd address, check its internal consistency, and issue a normal receipt.
- Recheck the signal for proper operation of control circuits (if programmed during configuration). If it is not operated properly, TC is not executed, the TC condition code is set equal to the binary number 11.
- If the configured output signal parameter specification specifies an access level by recording ‘2’, then the command ‘setting the access level 2’ is sent to the specified module.
- The command of recording value ‘1’ is given to the selected bit parameter module (determined by TC1 or TC0 values delivered in the command).
- The duration of this configured signal is counted by the internal timer USP.
- The return signal (RS) condition is periodically checked by reading the configured RS bit parameter, connected with TC1 or TC0.
- When the required value of the RS signal appears, or after the set time expires, the command of recording the value ‘0’ into the selected module parameter is given.
- If an increased access level has been set, a command ‘setting the access level 1’ is given to the module.

The TC process is completed and USP is ready to receive the next TC pulse command. In the process of executing a command, the TC condition binary code is 01. When TC is completed, the code 00 is set if the required RS signal appears before the set time expiration (or not programmed at all). If the RS signal is programmed, but its required value does not appear until the control pulse ends, condition code 10 is set. The condition of this TC operation can be read by command 01 prior to any other TC command sending.

The TC process does not affect the execution of other commands.

2.3.5.9 Function 46h (Magistral-2)

Record the parameter (**Holding Register**) in the format **FLOAT**

The Holding Register specified in this function should be assigned to a parameter in the floating-point format with the recording access level not exceeding ‘2’ at USP configuration.

Table 2.24

Byte number	Value	Description
Query		
1	46h	Network address **Slave** USP
2		Command code
3		High byte of the parameter address
4		Low byte of the parameter address
5..8		Value of the parameter (see Table 2.16A)
9		Low byte of CRC16 code
10		High byte of CRC16 code
Response		
1	46h	Repeating of the network address **Slave** USP
2		Command code repeating
3		High byte of the parameter address
4		Low byte of the parameter address
5..8		Value of the parameter (see Table 2.16A)
9		Low byte of CRC16 code
10		High byte of CRC16 code

USP response is issued immediately, followed by the parameter recording process. It consists of the following steps:

- If access level ‘2’ is indicated in the parameter specification during the configuration, a command ‘access level 2’ is sent to the set module.
- The command of recording the specified value to the selected module parameter is given.
- If an increased access level has been set, a command ‘setting the access level 1’ is given to the module.

2.3.5.10 Function 47h (Magistral-2).

Recording the condition of N parameters (**Holding Registers**) in the format **FLOAT**

Each Holding Register specified in this function should be assigned to a parameter in the floating-point format with the recording access level not exceeding ‘2’ at USP configuration. If several parameters are recorded at once, the address of each subsequent register is higher than the previous one by 2. It is allowed to record maximum 4 parameters at once.

USP response is issued immediately and the parameters are recorded. Each parameter shall be recorded step by step similar to 46h command.

Table 2.25

Byte number	Value	Description
		Query
1		Network address **Slave** USP
2	47h	Command code
3		High byte of the first parameter address
4		Low byte of the first parameter address
5	00	High byte of the number of recorded parameters
6	N	Low byte of the number of recorded parameters
7	2N	Number of recorded bytes
8..11		Value of the 1st parameter according to Table 2.16A
...		...
8..11+4*(N-1)		Value of the Nth parameter according to Table 2.16A
12+4*(N-1)		Low byte of CRC16 code
13+4*(N-1)		High byte of CRC16 code
		Response
1		Repeating of the network address **Slave** USP
2	47h	Command code repeating
3		High byte of the parameter address
4		Low byte of the parameter address
5	00	High byte of the number of recorded parameters
6	N	Low byte of the number of recorded parameters
7		Low byte of CRC16 code
8		High byte of CRC16 code

2.3.5.11 Function 10h. Recording 2N **Holding Registers** (N parameters) in **FLOAT** format

This is a backup command, used for compatibility with the telemechanics system, operating in the general **Modbus RTU** protocol. It is assumed that the floating-point number holds two consecutive Holding Registers. Each Holding Register specified in this function (with the lowest number in pair), should be assigned to a parameter in the floating-point format with the recording access level not exceeding '2' at USP configuration. If several parameters are recorded at once, the address of each subsequent register is higher than the previous one by 2. It is allowed to record maximum 4 parameters at the same time (8 registers). The byte sequence in each parameter representation is shown in Table 2.16A. The function performance is completely similar to 47h command.

Table 2.26

Byte number	Value	Description
Query		
1		Network address **Slave** USP
2	10h	Command code
3		High byte of the first parameter address
4		Low byte of the first parameter address
5	00	High byte of the number of recorded registers
6	2N	Low byte of the number of recorded registers
7	4N	Number of recorded bytes
8..11		Value of the 1st parameter according to Table 2.16A
...		...
8..11+4*(N-1)		Value Of the Nth parameter according to Table 2.16A
12+4*(N-1)		Low byte of CRC16 code
13+4*(N-1)		High byte of CRC16 code
Response		
1		Repeating of the network address **Slave** USP
2	10h	Command code repeating
3		High byte of the parameter address
4		Low byte of the parameter address
5	00	High byte of the number of recorded registers
6	2N	Low byte of the number of recorded registers
7		Low byte of CRC16 code
8		High byte of CRC16 code

2.3.6 UNK TM mode

2.3.6.1 As stated in 2.2.7, in ‘UNK TM’ mode, USP simulates data exchange with TEKON-19 computing device, as with the Superflo-II type gas meter, executing a limited set of commands given in Table 2.4. Detailed description of commands is given below.

2.3.6.2 The Superflo calculator has 1 - 3 calculated ‘threads’ (sometimes referred to as the ‘series’, or ‘pipelines’). USP also simulates work with up to 3 ‘threads’. Unlike other variants, in this variant, USP does not read any information from the modules connected to CAN BUS, except the current time and date, in the absence of external inquiries. All information required in the query command is read from the modules directly while the command is executed. The considerable difference between the exchange rates in the external line and CAN BUS leads to a slight delay not exceeding 100 – 200 ms, delay in start of transmission for a response message. Part of the information in commands (various descriptive information, for example, names, passwords, some settings) is not read from modules but is entered into USP during configuration stage step by step and is stored in its program ROM.

2.3.6.3 Each message in UNK TM, both the query and the response, consists of a 4-byte prefix (see Table 2.27), a variable-length data field, and two bytes of the CRC-16 security code. The length of the message L specified in the prefix is complete, with regard to prefix length and CRC bytes.

Table 2.27 Prefix structure

Byte number	Contents	Code in the query (16)	Code in the (16)
1	Synchrobyte	AA	55
2	Flow meter address	01..FE	repeating of data transferred in the query
3	L message length	Depends on function	To be determined by data availability
4	Function code K	see Table 2.4	K+80h or error code

If in the process of collecting data for a response to any command, a communication error occurred in CAN BUS, the response is issued in the form of an error code according to Table 2.28.

Table 2.28

Byte number	Contents	Note
Response		
1-4	Prefix	55h, address, FFh, L=6
5,6	CRC	

2.3.6.4 Function 1 – Reading initial data (Superflo identifier)

Table 2.29

Byte number	Contents	Note
Query		
1-4	Prefix	AAh, address, K=1, L=6
5,6	CRC	
Response		
1-4	Prefix	55h, address, K=81h, L=65d
5	Number of threads	From USP settings, parameter 0400
6-21	Thread name 1	From USP settings, parameter 0500(i=0..15)
22	Thread type 1	From USP settings, parameter 0501
23-38	Thread name 2	From USP settings, parameter 0600(i=0..15)
39	Thread type 2	From USP settings, parameter 0601
40-55	Thread name 3	From USP settings, parameter 0700(i=0..15)
56	Thread type 3	From USP settings, parameter 0701
57	Current month	The representation format is binary. All parameters are read from the module related to this thread. The time and date parameters for all modules of TEKON-20 are standard
58	Current day	
59	Current year	
60	Current hour	
61	Current minute	
62	Current second	
63	Check-out hours	
64,65	CRC16	

2.3.6.5 Function 2 – Reading static pipeline parameters

Table 2.30

Byte number	Contents	Note
Query		
1-4	Prefix	AAh, address, K=2, L=7
5	Thread number	From 1 to 3
6,7	CRC	
Response		
1-4	Prefix	55h, address, K=82h, L=72d
5	Thread number	Repeating of the transferred data
6-21	Thread name	From USP settings, parameter 0500, 0600 or 0700 (i=0..15)
22-25	Gas density	To be read from the module related to the specified pipeline (the number is specified in parameter 0503, 0603 or 0703), through its corresponding configured parameters, in the floating-point format
26-29	CO2 content	
30-33	Nitrogen content	
34-37	Pipe diameter	
38-41	Membrane diameter	
42-45	Atmospheric pressure	
46-49	Minimal dP	
50-63	Backup	Free condition
64	Selection type	parameter 0502, 0602 or 0702 of USP settings
65	Current month	The representation format is binary. All parameters are read from the module related to this thread. The time and date parameters for all the modules of TEKON-20 are standard
66	Current day	
67	Current year	
68	Current hour	
69	Current minute	
70	Current second	
71,72	CRC16	

2.3.6.6 Function 3 – Recording the static parameters of the pipeline

When the command is read, a transferred password of recording into a pipeline is compared with the password of the corresponding pipeline entered in USP at configuration stage. If the passwords do not match, the operation is not executed, and the error code is displayed.

In this function, USP uses only the values of gas density parameters, CO2 and nitrogen content, atmospheric pressure; other values are ignored. Their values in the floating-point format are recorded into the parameters of the corresponding module on CAN BUS specified during USP configuration. Preliminarly, the command to set the access level ‘2’ is sent to the module, after the recording ends, the command to set the access level ‘1’ is sent to the module.

If all commands of exchange via CAN BUS are executed successfully, 83h code is filled in the function field as response; if any errors occur, FFh code is filled in the field.

Table 2.31

Byte number	Contents	Note
Query		
1-4	Prefix	AAh, address, K=3, L=72d
5	Thread number	From 1 to 3
6-21	Recording password to a thread	It will be compared with parameter 050C, 060C or 070C (i = 0..15) set in USP settings
22-37	Thread name	To be ignored while reading
38-41	Gas density	see below
42-45	CO2 content	see below
46-49	Nitrogen content	see below
50-53	Pipe diameter	To be ignored while reading
54-57	Membrane diameter	To be ignored while reading
58-61	Atmospheric pressure	see below
62-65	Minimal dP	To be ignored while reading
66-81	Backup	To be ignored while reading
82	Selection type	To be ignored while reading
83,84	CRC16	
Response		
1-4	Prefix	55h, address, 83h (standard) or FFh (error), L=6
5,6	CRC	

2.3.6.7 Function 20d (14h) – Reading the daily data

The initial query should have number 0. Only in this case, the transferred query dates are analyzed, and a conclusion on the possibility of reading daily archives is made. The daily archives in TEKON-19 have a depth of one year from the current date, if the initial query date goes beyond this limit, an error code is generated and the command is not executed. An error code will be generated also in the case when the final date is earlier than the initial date. If the final date is older than the current date, the archives will be read only until yesterday inclusively, without generating an error.

The data for the last three days are included into the response. Each subsequent query should have a number higher than the previous one by 1, then the data will be given for the next three days, etc. until reaching the final date. In inquiries with numbers differ from 0, the transferred dates are not analyzed. If the query number differs from 0 and repeats the previous one, then the response represents the repeat output of the previous data block stored in USP random access memory without re-accessing CAN BUS.

Table 2.32

Byte number	Contents	Note	
Query			
1-4	Prefix	AAh, address, K=14h, L=14d	
5	Thread number	From 1 to 3	
6	Query number	From 0 to 255	
7	Initial month	In binary form	
8	Initial day		
9	Initial year		
10	Final month		
11	Final day		
12	Final year		
13,14	CRC16		
Response			
1-4	Prefix	55h, address, 94h, L от 9d (no records) to 90d (three records)	
5	Thread number	Repeating of the inquired data	
6	Number of daily records in the message	From 0 to 3	
7	Response status	0 end, otherwise more data are available	
8	Month of recording	USPs are formed, increasing in each record by one hour from the initial time.	First daily record, if available
9	Day of recording		
10	Year of recording		
11-14	Gas flow per day	To be read from the module assigned to the thread. The numbers of daily archives parameters shall be set during USP configuration. The archive reading index shall be formed by the requested and current dates.	
15-18	Backup parameter		
19-22	Average pressure drop		
23-26	Average pressure		
27-30	Average temperature		
31-34	Backup parameter		
(35-61)	Second daily record	If available	
(62-88)	Third daily record	If available	
L-1,L	CRC		

2.3.6.8 Function 21d (15h) – Reading the hourly data

Initial query should have number 0. Only in this case, the transferred date and time of the query are analyzed, and a conclusion is made about the possibility of reading hourly archives. Since TEKON-19 hourly archives can have different depths (16, 32, 64 days from the current date), this depth is set in USP during the pipeline configuration using parameter 0519, 0619 or 0719. All hourly archives should have the same depth. If the query initial date and time goes beyond the archive depth, an error code is generated and the command is not executed. The error code will also be generated in case when the final time moment less than the initial one. If the final moment time exceeds the current one, the archives will be read only until the last passed hour without generating an error.

Data within the last three hours are included into the response. Each subsequent query should have a number higher by 1 than the previous one, then the data

will be given for the next three hours, etc. until reaching the final moment. In inquiries with a number differing from 0, the transferred date and time are not analyzed. If the query number differs from 0 and repeats the previous one, then the same response with the previous data stored in USP RAM without re-accessing CAN BUS is given.

Table 2.33

Byte number	Contents	Note	
Query			
1-4	Prefix	AAh, address, K=15h, L=16d	
5	Thread number	From 1 to 3	
6	Query number	From 0 to 255	
7	Initial month	In binary form	
8	Initial day		
9	Initial year		
10	Initial hour		
11	Final month		
12	Final day		
13	Final year		
14	Final hour		
15,16	CRC16		
Response			
1-4	Prefix	55h, address, 95h, L from 9d (no records) to 96d (three records)	
5	Thread number	Repeating of the inquired data	
6	Number of hour records in the message	From 0 to 3	
7	Response status	0 end, otherwise, data are available	
8	Month of recording	USPs are formed, increasing in each record by one hour from the initial time.	First hour record, if available
9	Day of recording		
10	Year of recording		
11	Hour of recording		
12	Minute of recording	=0	
13-16	Gas flow per hour	To be read from the module assigned to the thread. The numbers of hourly archives parameters shall be set during USP configuration. The archive reading index shall be formed by the requested and current moments.	
17-20	Backup parameter		
21-24	Average pressure drop		
25-28	Average pressure		
29-32	Average temperature		
33-36	Backup parameter		
(37-65)	Second hour record	If available	
(66-94)	Third hour record	If available	
L-1,L	CRC		

2.3.6.9 Function 30d (1Eh) – date and time setting

Date and time are set only in the module assigned to the 1st pipeline during USP configuration. The 16-character recording password is also stored in USP and is set during the configuration. The time and date parameter numbers in any module of TEKON-20 are standard and known to USP. The parameter 'date' in TEKON-20 modules also includes the day of the week, it is calculated by USP based on the given date.

The command is executed as follows:

- The password is checked for correctness, date and time are verified. If they are not correct, an error occurs, and the operation is not executed.
- The date and time are converted to the TEKON-20 internal presentation form, the day of the week is calculated;
- The increased access level '2' to the module is set;
- The date and time are recorded;
- Access level is decreased to '1';
- Date and time are read from the module, transferred to binary form and packed into a response message.

Table 2.34

Byte number	Contents	Note
Query		
1-4	Prefix	AAh, address, K=1Eh, L=28d
5-20	Recording password	To be compared with the password set in USP settings by parameter 0401 (i=0..15)
21	New month	In binary form
22	New day	
23	New year	
24	New hour	
25	New minute	
26	New second	
27,28	CRC16	
Response		
1-4	Prefix	55h, address, 9Eh, L=12d
5	Month	In binary form
6	Day	
7	Year	
8	Hour	
9	Minute	
10	Second	
11,12	CRC	

2.3.7 HART mode

2.3.7.1 As indicated in 2.2.8, USP executes the set of commands given in Table 2.5 in ‘HART’ mode. The commands are described in details below. The HART-protocol determines the certain exchange rate, the format of transferred and received bytes, the time characteristics of switching from reception to transfer. All of them should be set during USP configuration, no default settings are provided.

2.3.7.2 USP allows to read data from TEKON modules and to give them in the form of information related to the HART-protocol ‘devices’. The number of such ‘n’ devices is from 1 to 16, their correspondence to TEKON-20 parameters and modules used by the archives is set solely by the user during USP configuration for a specific object. USP does not check whether the device descriptors are correct.

2.3.7.3 When the incoming messages are decoded, its general proper operation is preliminarily checked for odd features transferred as part of each byte, and for the presence of preamble containing not less than three ‘FF’ bytes. The messages with errors are found and are not considered further.

Then the start byte type, USP address, command code, amount of transferred data bytes, and check sum are sequentially controlled. If any deviations are found, the message is considered as the faulty one, the response is not formed. A proper message with the familiar command, addressed to USP, is accepted for execution. The input line temporarily does not receive any messages. The check sum is the result of the byte-wise addition of all sending bytes, starting with the start byte, under the ‘exclusive OR’ function.

Response to commands 0 and 130d, and to address command 141d, is formed and immediately transferred, as these commands do not require receiving data from TEKON. Response to the broadcast command 141d is not formed, its performance is described below. Response to commands 142d and 143d is generated and transferred immediately. Moreover, by accepting the command 141d or 143d, USP starts exchanging information with TEKON, reading the required set of the parameters from it for temporary storage in USP RAM. The input procedure takes no more than 100–200 ms, after which reception via the input line is allowed again. Further, after receiving the command 142d or 144d, USP immediately forms a response to the information stored in its memory. At the time of the full transfer of a response message to the line, the reception is prohibited again, and allowed immediately after the transfer of the last stop bit of the last character of the message.

2.3.7.4 USP can operate with primary and secondary master devices. The primary device sends queries with the start byte 02h or 82h, and receives responses with start byte 06h or 86h from USP, respectively. The secondary device sends inquiries with the start byte 42h or 0C2h, and receives responses from USP with the start byte 46h or 0C6h, respectively. The following command formats show only operation with a primary Master device.

2.3.7.5 All USP responses start with the preamble, always consisting of three ‘FFh’ bytes. Inquiries to USP may have any length of the preamble, but not less than three ‘FFh’ bytes. The first byte, different from the ‘FFh’ code after not less than three ‘0FFh’ codes in a row, is considered the start byte of the message.

2.3.7.6 The first byte of USP ‘Status-1’ always has zero value in the response message. In the second byte ‘Status-2’ the fourth bit (counting from zero, from right to left) is set to position‘1’, if the previous command was a properly processed broadcast command 141d. In response to the address command 141d in the second byte ‘Status-2’ the third bit is set to position‘1’, if after the previous broadcast command 141d is executed, all information from TEKON was read without failures and its re-reading is not required. Moreover, according to the results of cyclic USP self-monitoring, a message ‘USP failure’ may be formed by setting the seventh binary digit of byte ‘Status-2’ into position ‘1’. The remaining binary bits always have value ‘0’.

2.3.7.7 The byte transfer sequence in floating-point digits shall be determined similarly to the Modbus variant according to Table 2.16A.

2.3.7.8 Command 00d. Read the unique identifier

The command invokes no calls to TEKON. Bytes of the long address from the 2nd to the 4th are read from the general configuration parameters stored in USP. Other bytes included into the response data field are rigidly formed by USP software.

Table 2.35

Value	Description
Query	
FFh FFh FFh	Preamble (not less than 3 bytes)
02	Start byte
	Short 1-byte network address **Slave** USP
00	Command code
00	Number of data bytes
	Check sum
Response	
FFh FFh FFh	Preamble (3 bytes)
06	Start byte
	Short 1-byte network address **Slave** USP
00	Command code
14d	Number of data bytes
00	Status-1
	Status-2
254d	
00	Manufacturer’s code (0 byte of the long address)
02	Device type (1st byte of the long address)

Table 2.35 continued

Value	Description
02	Number bytes waiting for response
01	Version of universal commands
01	Version of specific commands
01	Software version
45h	Hardware version
00	Function flags
	2nd byte of the long address 3rd byte of the long address } shall be configured 4th byte of the long address
	Checksum

2.3.7.9 Command 130d. Query of the measurement system configuration

The command generates no calls to TEKON. All device descriptors are read from their USP configuration parameters. It should be noted that according to HART - protocol logic and terminology, the sequence of devices, device types, numbers and codes are not controlled by USP software, and are configured taking into consideration the features of the certain object.

Table 2.36

Value	Description
	Query
FFh FFh FFh	Preamble (not less than 3 bytes)
82h	Start byte
	Long 5-byte network address **Slave** USP
130d	Command code
00	Number of data bytes
	Checksum
	Response USP
FFh FFh FFh	Preamble (3 bytes)
86h	Start byte
	Long 5-byte network address **Slave** USP
130d	Command code
4+n*3	Number of data bytes (decimal)
00	Status-1
	Status-2
00	Apartment number
20h	Type of device (heat meter)
	Device type Device number } ‘n’ times for devices in the order of their Device code setting in USP configuration table
	Checksum

2.3.7.10 Command 141d broadcast. Synchronization between the device and apartment-level devices

It is a broadcast command and there shall be no response. Date and time values are stored for possible synchronization.

Table 2.37

Value	Description
Query	
FFh FFh FFh	Preamble (not less than 3 bytes)
82h	Start byte
00 00 00 00 00	Long 5-byte broadcast address
141d	Command code
06	Number of data bytes
	Year = (Current year) – 1900
	Month
	Day
	Hour
	Minute
	Second
	Checksum
No response from USP	

In general case, each of HART devices described in USP can correspond to a different TEKON-20 module. By the principle of their operation, TEKON-20 modules do not require such tight synchronization which is given in the HART protocol description; therefore, upon the acceptance of the broadcast command 141d, synchronization shall be carried out only once per hour at the moment when the value of the set minutes is within the range from 30 to 34 inclusively. At this moment, USP performs the following operations in CAN BUS for each of the described HART devices:

Date and time are read from the module with the specified network address.

- If the current date differs from the set one, then a new date shall be entered into the module. The day of the week is required to record the date to the modules, it is calculated in USP based on the given date. Before recording the date, the access level to the module is updated to value ‘2’.
- If the current time is behind the set time by more than 2 seconds or is ahead of it by more than 10 seconds, the new time is entered into the module. Before that, if the access level has not yet been changed, it is updated to value ‘2’.
- If the date or time has been recorded, the access level is decreased to value ‘1’ again.
- The next described HART device shall be selected. If another module corresponds to it, i.e. its network address differs from the previous one, the described sequence of actions is repeated; otherwise, select the next device.

Further, the signs ‘information is not ready’ are recorded into bytes of information reliability prepared for command 142d. Then, information is read from CAN BUS modules for all devices from the described parameters ‘from the beginning of the month’ and bit parameters of the failures, connected with them and it is stored in USP RAM. Bytes of reliability are formed; reliable information has a reliability code

00. When this code differs from zero it means that various failures occur in accordance with Table 2.38.

Table 2.38 – Structure of the reliability byte

Bit position	Failure marker (bit value)
0	No response from TEKON for main parameter
1	
2	The device-related module failure is present
3	No response from TEKON for the failure parameter
4	
5	
6	
7	Information for the main parameter is not ready

‘1’ is entered in the 4th bit position of the second byte of ‘Status-2’, it indicates for the following commands that the broadcast command is successfully executed. Command 141d is completely executed.

According to HART protocol requirements, USP counts the inquiries for the broadcast command 141d performance. If there is no command within the period of time exceeding the value specified through the system parameter 0105 (the recommended value is 304 seconds for 5 minute query period is,), USP reads the information from the modules of all defined devices separately; synchronization is not performed.

2.3.7.11 Command 141d address. Repeated query of TEKON parameters

Table 2.39

Value	Description
Query	
FFh FFh FFh	Preamble (not less than 3 bytes)
82h	Start byte
	Long 5-byte network address **Slave** USP
141d	Command code
00	Number of data bytes
	Check sum
Response	
FFh FFh FFh	Preamble (3 bytes)
86h	Start byte
	Long 5-byte network address **Slave** USP
141d	Command code
2	Number of data bytes
00	Status-1
	Status-2
	Check sum

The command is used by the Master in those cases when there were signs of a connection failure in one or several of the parameters, during the execution of command 142d following the broadcast command 141d. Then, address command 141d is sent, forcing USP to re-read all required parameters.

In 0.5-1 seconds, the command 142d may be sent again, and USP will transmit the correct information. If necessary, a pair of commands 141d and 142d may be repeated several times.

The response to the address command, in contrast to the broadcast command, is always given according to Table 2.39. The second status byte is transferred as equals to zero if there are available parameters with connection failures, and equals to code 08 if there are no such parameters.

2.3.7.12 Command 142d. Query of the heat meter measurement information

The command does not generate query to TEKON. Values and reliability bytes for all devices are copied to the response message from USP RAM, prepared by command 141d. The execution of the command in USP does not reset any signs except the 4th byte position of 'Status-2', so, if required, it is possible to send command 142d several times.

Table 2.40

Value	Description
	Query
FFh FFh FFh	Preamble (not less than 3 bytes)
82h	Start byte
	Long 5-byte network address **Slave** USP
142d	Command code
00	Number of data bytes
	Check sum
	Response
FFh FFh FFh	Preamble (3 bytes)
86h	Start byte
	Long 5-byte network address **Slave** USP
142d	Command code
2+n*5	Number of data bytes (decimal)
00	Status-1
	Status-2
	Reliability according to Table 2.38 } 'n' times for devices in the order of their setting in USP settings
	4 bytes of the parameter value }
	Check sum

2.3.7.13 Command 143d. Preliminary query of heat meter archives

Type of an archive requested: code 00 – hourly, 01 – daily, 02 – monthly. The command response is issued immediately, without analyzing the archive type correctness and the archive date correct setting.

Then, the sign 'information is not ready' is entered preliminarily into the authenticity byte prepared for the 144d command. Then, the correctness of the archive

query set date is analyzed, with regard of the principles of archiving in the TEKON-19:

- for monthly archives, ‘month’ should be within the limits from 1 to 12, the day and hour values are of no significance;
- for daily archives, ‘day’ should be within the range from 1 to 31, month from 1 to 12, the hour value is of no significance;
- for hourly archives, the moment of query ‘hour’, ‘day’, ‘month’ should be within the limits of the beginning of the last today's passed hour to the maximum specified archive depth in the device, defined through parameter 080A (i), i.e. 16, 32, 64 days ago.

If the query date is incorrect, the corresponding sign is entered into the authenticity byte, and the command execution is completed.

Table 2.41

Value	Description
	Query
FFh FFh FFh	Preamble (not less than 3 bytes)
82h	Start byte
	Long 5-byte network address **Slave** USP
143d	Command code
04	Number of data bytes
	Query month
	Query day
	Query hour
	Type of the requested archive
	Check sum
	Response
FFh FFh FFh	Preamble (3 bytes)
86h	Start byte
	Long 5-byte network address **Slave** USP
143d	Command code
2	Number of data bytes
00	Status-1
	Status-2
	Check sum

If the date is correct, information on all the archives of this type is read from the CAN BUS modules for a few tenths of a second, in the order in which they are described using the parameter settings. The information is stored in USP RAM. The authenticity byte is reformed according to the exchange results. Normally read information has a confidence code 00; if there is a connection failure for at least one archive, a sign of connection failure for all archives of the given type is set according to Table 2.42.

Table 2.42 – Structure of the archive reliability byte

Bit position	Failure marker (bit value)
0	No response from the module (communication failure)
1	
2	
3	Archive query date is incorrect
4	
5	
6	
7	Information is not ready

2.3.7.14 Command 144d. Output the prepared heat meter archives

The command does not generate query to TEKON. The reliability byte and the contents of all the archives are copied to the response message from USP RAM, prepared by command 143d. The execution of the command in USP does not reset any signs except the 4th byte position of 'Status-2', so, if required, it is possible to send command several times.

Table 2.43

Value	Description
	Query
FFh FFh FFh	Preamble (not less than 3 bytes)
82h	Start byte
	Long 5-byte network address **Slave** USP
144d	Command code
00	Number of data bytes
	Check sum
	Response
FFh FFh FFh	Preamble (3 bytes)
86h	Start byte
	Long 5-byte network address **Slave** USP
142d	Command code
3+n*4	Number of data bytes (decimal)
00	Status-1
	Status-2
	Reliability byte under Table 2.42 } 'n' times for archives in the order of setting the devices in USP settings
	4 bytes of archive value }
	Check sum

2.3.8 Operation (ver.2 'Energiya')

2.3.8.1 After powering on, USP main software is started. The CAN BUS channel is configured under the entered configuration constants, the current channel is configured under the software constants. The internal timers, counting the specified time intervals, are started, and the software enters the main operation mode with a cycle of 15 seconds.

2.3.8.2 USP cyclically, with a constant period of 15 seconds, reads from the modules connected to CAN BUS, all the settings-required parameters for the 'comb busbar' and the telesignalization. In the internal buffer, the next original message for the complex 'Energiya' is formed. After 2.5 seconds from the next cycle start, USP starts issuing a message to the simplex line of communication with 'Energiya'. The transfer frequency is 100 Baud. Each byte is transferred by low-order bits forward (D0 - low bit, D7 - high bit) and is framed with a zero start bit, odd parity check bit and a single stop bit. The start byte has addition to evenness, other bytes – to oddness. The message bytes are transferred in a row, with no intervals between them. The message shall be issued twice, with 0.15 seconds between the end of the first issue and the beginning of the second. All intervals are counted by an internal 200 Hz timer with the accuracy up to 0.005 s. The message structure fully meets the Data Acquisition Device protocol in 16SC+16TS' mode.

2.3.8.3 Each assigned parameter included into the comb busbar is transferred by a code as an integer single-byte number without a sign in the range from 0 to 250 units. The code zero corresponds to the value of the parameter equals to the configured constant 'scale beginning' (SB). The maximal code value '250' corresponds to the value of the parameter equals to the configured constant 'scale end' (SE). The least significant digit (LD) of the transferred byte is calculated in USP by formula:

$$LD = (SE – SB)/250.$$

2.3.8.4 The TS bit parameters are transferred directly or inversevely depending on the configuration of each parameter.

2.3.8.5 The LED indicators on the front panel display the condition of the exchange channels and USP proper operation:

- The yellow indicator 'Tx' lights up at the start of the first byte of the message transfer to the line and is off after the last byte of the message is sent.
- The red indicator 'CAN' lights up when the CAN-BUS controller is initialized for transfer and is off after receiving a response.
- The green indicator 'Rx' flashes with a period of 1 Hz in the normal operation mode. If USP internal self-control detects hardware failures, the indicator is constantly on.

2.3.8.6 In versions 1 and 3, calls to CAN BUS are made only if the module number in the bus and the full number of a required parameter are set correctly. The term 'correct' shall mean:

- module number is within the range from 01 to FEh;
- parameter full umber differs from FFxxh (parameter type differs from FFh).

The other parameters are not controlled for correctness, and tracking the access level by reading the parameter is not carried out, and no reading will be performed at the configuration errors. Visually, this is expressed by a long (over 0.5 second) activation of the red LED indicator.

2.3.8.7 Structure of each of two messages is given in Table 2.44

Table 2.44

Byte number	Description	Note
0	Start byte	Heading
1	Comb busbar 1	
2	Comb busbar 2	
3..18	Data for comb busbars	From 0 to 16 bytes
19,20	Telesignalization	0 or 2 bytes
21	Check sum	

2.3.8.8 Structure of each byte in message is given in Table 2.45

Table 2.45

Byte	Bit	Bit description	Note
Start	D0	Sign of two TS bytes availability	1 present, 0 absent
	D1	Message cyclic number	From 0 to 7
	D2		
	D3		
	D4	Check sum of the low order part of a byte	If the sum of the bits D0..D3 is even, then D4..D7 repeats it, otherwise the lower part inversion occurs
	D5		
	D6		
	D7		
Comb busbar 1	D0	Comb busbar 8 data byte	The data byte is transferred if the bit is set to ‘1’, otherwise the byte is absent. For the transferred byte value, see 2.3.8.3
	D1	Comb busbar 7 data byte	
	D2	Comb busbar 6 data byte	
	D3	Comb busbar 5 data byte	
	D4	Comb busbar 4 data byte	
	D5	Comb busbar 3 data byte	
	D6	Comb busbar 2 data byte	
	D7	Comb busbar 1 data byte	
Comb busbar 2	D0	Comb busbar 16 data byte	
	D1	Comb busbar 15 data byte	
	D2	Comb busbar 14 data byte	
	D3	Comb busbar 13 data byte	
	D4	Comb busbar 12 data byte	
	D5	Comb busbar 11 data byte	
	D6	Comb busbar 10 data byte	
	D7	Comb busbar 9 data byte	

Table 2.45 continued

Byte	Bit	Bit description	Note
Telesignal byte 1	D0	Telesignal 1	For the positional code of the telesignals (including the inversion, possibly set during the configuration), see 2.3.8.4. Both bytes are transferred if the start-byte bit D0 is set to '1'
	D1	Telesignal 2	
	D2	Telesignal 3	
	D3	Telesignal 4	
	D4	Telesignal 5	
	D5	Telesignal 6	
	D6	Telesignal 7	
	D7	Telesignal 8	
Telesignal byte 2	D0	Telesignal 9	
	D1	Telesignal 10	
	D2	Telesignal 11	
	D3	Telesignal 12	
	D4	Telesignal 13	
	D5	Telesignal 14	
	D6	Telesignal 15	
	D7	Telesignal 16	
Check sum	To be calculated for all bytes of the message, excluding start-byte. The initial sum value is 0. The current sum value is added by the operation 'exclusive OR' with the next byte, the result is cyclically shifted right by 1 place. If a transfer occurs, the result is added by the operation 'exclusive OR' with number 1Eh. After processing the last byte, the result is added by operation 'exclusive OR' with number EBh.		

2.4 Scope of supply

USP scope of supply is given in Table 2.46.

Table 2.46 – USP scope of supply

Name	Designation	Amount	
		According to the Technical Specifications	Actual
Protocol converter USP78	T10.00.78	1	1
Certificate	T10.00.78 ПС	1	1
Software and documentation CD	T10.06.295	1	1

NOTE: the power source and connecting cables are not included into USP scope of supply, they could be either supplied separately under agreement with the customer, or purchased by the customer independently in other companies.

2.5 Factory default settings

Factory default settings are given in Table 2.47. The status of other parameters is not specified.

Table 2.47

Parameter	Name	Value
General settings		
F000	Module type	0640 (versions 1,3) 0646 (version 2)
0100	Operation variant (for versions 1 and 3)	0 (not set)
CAN-BUS interface settings		
0001	Main network number	01
0002	Main mask	FF
0003	Additional network number	00
0004	Additional mask	00
0005	Configuration and rate	41E0 (300 kbps)

2.6 Package

2.6.1 The device shall be packed into a corrugated cardboard box.

2.6.2 Prior to packing into a box, the device is packed into a polyethylene film bag.

2.6.3 Accessories packed into the polyethylene film bag and documentation in accordance with Section ‘Scope of Supply’ are placed into the packaging box together with the device.

2.6.4 After packing the device into the packing box, packing with auxiliary materials was carried out.

2.6.5 The packing box is marked with the handling signs ‘FRAGILE’ and ‘DO NOT DROP’.

2.7 Marking and Sealing

2.7.1 The controller has the following marking on the front panel:

- logo of KREIT company ;
- the device short name: ‘USP 78’;

2.7.2 The controller has the following marking on the rear panel:

- product factory cipher;
- product serial number.

2.7.3 The device is not sealed.

3 INSTALLATION

3.1 Connection

3.1.1 The RS-232 port in version 1 has a DB9M connector located on USP top end panel (see Figure 2.2c). It is connected to the external system equipment by a standard cable (DB9F – DB9M, DB9F – DB25M COM port extension cable, or DB9F – DB9F, DB9F – DB25F ***null***-modem cable), depending on the type of the equipment connector and the number of pins in it. The description of USP pins is standard and is given in Table 3.1 for reference.

Table 3.1 – description of the DB9M pins

Pin	Name	Description	Note
1	DCD	Carrier detector	Not used
2	RxD	Receive data	
3	TxD	Transmit data	
4	DTR	Data Terminal Ready	Not used
5	GND	Signal Ground/Common	
6	DSR	Data Set Ready	Not used
7	RTS	Request to Send	
8	CTS	Clear to Send	Not used
9	RI	Ring Indicator	Not used

3.1.2 The current interface in version 2 has screw terminals located on USP top end panel. The location of the terminals is given in Figure 2.2g, their numbering and description – in Table 3.2. Generally USP version 2 is implemented according to a universal scheme and allows arranging both two-wire and four-wire current loop connection circuits, configuring separately active or passive transmitter and receiver (the term ‘active’ here shall mean ‘current generator in the loop’). Configuration shall be carried out by installing jumpers which are located inside the device case on the circuit board near the current interface terminals. ‘Energiya’ variant provides only a two-wire active transmitter in USP. The required USP configuration (factory configuration) is given in Figure 3.1 (the jumpers are shaded).

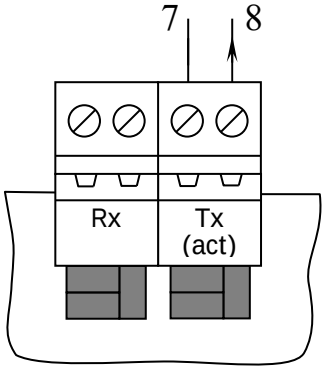

Figure 3.1 – Current interface configuration

3.1.3 The RS-485 port in version 3 has screw terminals located on USP top end panel. The location of the terminals is given in Figure 2.2d, their numbering and description – in Table 3.2.

Table 3.2

Connector number	Name	Circuit description	Note
For all versions			
1	CAN L	CAN BUS	
2	CAN H		
3	–U	External power supply 15–24 V	
4	+U		
–	TRM	CAN BUS terminator jumper	
Only for version 2			
5	Rx1	Current interface receiver loop	Not used
6	Rx2		
7	Tx1	Transmitter loop	
8	Tx2		
Only for version 3			
5	B	RS-485 interface line ‘B’	
6	A	RS-485 interface line ‘A’	
–	TRM1	RS-485 interface terminator jumper	

3.1.4 CAN-BUS and power supply in any version shall be connected to screw terminals located below on USP end panel. The location of the terminals is shown in Figure 2.2, their description – in Table 3.2.

3.1.5 Connection to CAN-BUS is performed by CAN L and CAN H circuits with the corresponding buses. If USP is connected to the extreme remote point of the bus, the TRM jumper should be installed. In other cases, the jumper should not be installed.

3.1.6 Power – DC voltage from the external supply 15-24V is connected to the terminals ‘–U’ and ‘+ U’ taking into consideration polarity after all other circuits are connected.

3.2 Configuration

3.2.1 The computer is used to configure USP. The configuration software T10.06.187, supplied with USP, is installed on PC. The universal software TELEPORT T10.06.131, performing exchanges with any modules of the TEKON-20 system, could also be used. In any case, the configuration shall be carried out only through CAN BUS. Moreover, the computer should have a TEKON-20 database (DB) for USP and for those modules with USP will work. The module database should include the description of specific projects and contain at least the numbers of all module parameters and network addresses of the modules.

NOTE: starting from USP software 06 version, the Modbus mode may be configured via RS-232 interface (see 2.3.3.1 and 2.3.3.8) if configuration software of the version not lower than 08 is used.

3.2.2 CAN BUS is connected to PC COM port via additional RS232–CAN BUS adapter, e.g. of T10.00.54 type, purchased separately. For connection to PC USB port, it is required to purchase AI-89 T10.00.89 USB-CAN adapter for USP configuration via CAN or any USB-COM adapter (for example, T20) for configuration via RS-232.

3.2.3 For configuration, connect the adapter to the computer, for example, as shown in Figure 3.2, and run the exchange and settings software. It is not described in the operation manual how to work with software. The user can read software HELP section. The access level at the configuration should be set to ‘2’ (‘service engineer’).

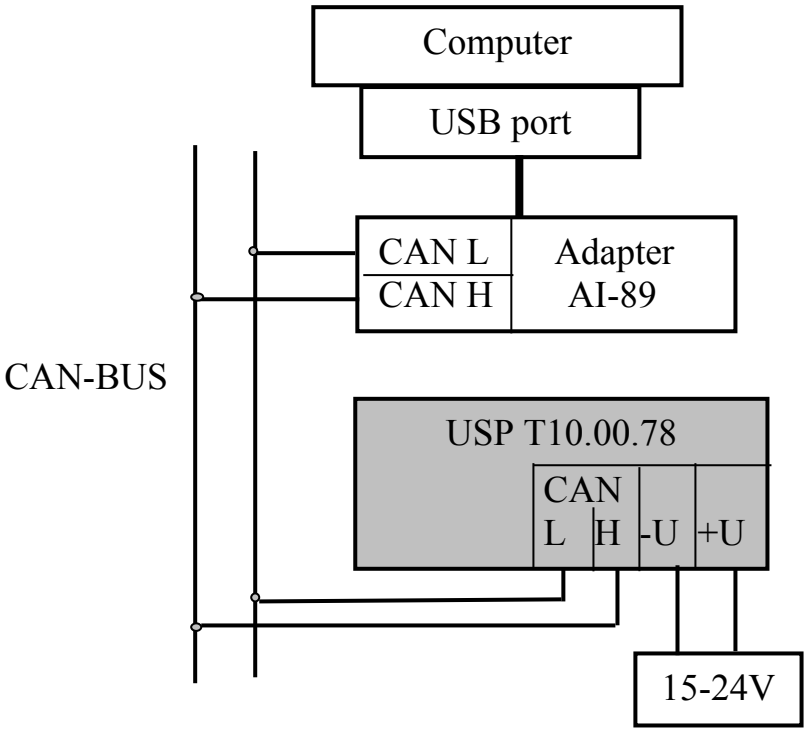

Figure 3.2- Diagram of USP connection to PC during configuration

3.2.4 To enable the connection between PC and USP via CAN BUS, its network number and rate should be known. The manufacturing company supplies USP with the bus characteristics according to Table 10.1. If attempts to establish communication with USP remain unsuccessful, then, provided the connection circuits are operating properly, the most possible reason of failure is the difference between the real and the expected characteristics of USP exchange channel. In this case, when the power is off, remove the upper part of USP case, the access to the circuit board with LED indicators is provided. Install a jumper on two pins marked as 'T' (test jumper), and turn USP power on again. In this configuration, USP software ignores CAN BUS configuration parameters, the network number 00 and the exchange constant 41E0 (rate 300 kBaud) are accepted compulsory.

Run exchange software again with the specified USP module characteristics. If there is connection between devices, then the parameters from 0001 to 0005, setting the exchange via the backbone were distorted. The configuration may be continued, and the parameters may be adjusted at the stage of final configuration of exchange via CAN BUS. If the jumper setting does not help, please contact USP manufacturer.

NOTES:

1) If a test jumper has been installed, remove it upon the configuration is completed with the power off, and, after turning the power on again, check the connection with the newly set channel characteristics.

2) If the configuration was carried out via the RS-232 interface, the exchange with USP in the configuration software should be started not later than in 20 seconds after powering on USP (see 2.3.3.1).

3.2.5 In the process of setting, the following steps should be performed:

- Select USP operationvariant (for versions 1 and 3).
- Set the exchange with external system (for versions 1 and 3).
- Set USP characteristics at CAN BUS channel.
- Set the compliance between the parameters in the external line and the module parameters in TEKON-20.

3.2.6 For versions 1 and 3, start the configuration by setting the system parameter to 0100 'operation variant'. Its value should be entered according to Table 2.2. The manufacturer supplies USP with the random value of this parameter (as a rule, it is 02, i.e. Modbus). If the configuration is carried out via CAN BUS, then, after the required value is set, turn the power at USP off and on in order to set the software for the selected operation variant. If the TELEPORT software is used for the configuration, restart it as well to select a set of algorithms (tasks) corresponding to the selected variant from the database for USP (see Table 2.6).

3.2.7 At the second step of USP configuration of version 1 or 3, enter the external exchange general characteristics in the task ‘set the external exchange’ using parameters 0103-0107. It is recommended to set parameter 0105 ‘TEKON request period’ for all systems except HART, in the range from 5 to 20 seconds; for HART variant, see instructions in 2.3.7.10. Record the remaining parameters in accordance with the applied equipment characteristics, using for parameter 0103 ‘external rate constant’ instructions from 2.3.2.11, and for parameter 0104 ‘transfer and reception formats’, instructions from 2.3.2.12. For version 3, the value of the parameter 010A ‘RTS delay time’ is not significant.

3.2.8 During configuration the characteristics of USP as a CAN BUS module:

- Set parameter 0001 ‘network number’ in the range from 01h to FEh, it shall be different from the numbers of other modules on the bus, in which USP will operate.
- Set parameter 0005 ‘configuration and rate’ according to instructions from 2.3.7.10.
- It is not recommended to change values of parameters 0002, 0003, 0004 with respect to the factory settings indicated in Table 2.7. It is only possible to restore their default values in case of damage.
- If the value of at least one parameter is changed in the process of configuration, it is recommended to restart USP and the configuration software to coordinate the new values.

3.2.9 How to set the matching between the parameters in the external line and the module parameter in the TEKON-20.

3.2.9.1 The configuration method for each variant is described in the following subsections. The following designation ‘TT NN MM’ for the parameter with the full number ‘TTNN’ (type TT, number NN) from the module with the address ‘MM’ in bus is used in the following subsections. Information about parameters is taken from the database.

3.2.9.2 In versions 1 and 3, all configuration parameters are located in software memory (Program ROM) of USP microcontroller. For the additional protection against their accidental distortion, correction is allowed only if USP is previously shifted to the special STOP mode. The configuration software T10.06.187 automatically performs this transfer and exit from it. With the use of the TELEPORT software, the following steps should be performed:

- Read the system parameter F01A ‘operation mode’ and ensure that its value is 0 (the OPERATION mode).
- Record the code 01h into it and, after reading the parameter several times, wait until the code 81h appears (the STOP mode).
- Perform all the configuration operations, enter the required values for all parameters.

- Set USP to the OPERATION mode, either by recording the code 0 into the system parameter F01A ‘operation mode’, or simply by turning USP power off and on again.

3.2.9.3 In USP version 2, the setting parameters, placed in program ROM, are absent, and the STOP mode is not used in it.

3.3 Configuration. ‘Magistral-1’.

3.3.1 Intelligent remote stations (IRS)

3.3.1.1 Using parameter 0101 ‘IRS address’, set the required value of the intelligent RS address.

3.3.1.2 Through the index parameters '4 IRS parameters n' 020N (i), where N = 0..Bh for subunit numbers 'n' from 0 to 11, i = 0..3 for operation numbers inside each subunit from 1 to 4, set the description of all 48 floating-point parameters that can be read from TEKON-20 modules or recorded into them. Each parameter descriptor shall have the form DD TT NN MM, where

- DD – access specification. Code 80h and higher (FFh is recommended) indicates at the parameter absence; this value should be **obligatorily** specified for all unused parameters. For the parameters intended solely for reading from USP, any specification code in the range from 0 to 7Fh (0 is recommended) may be set. For the parameters to be recorded, the code value of ‘1’ (free recording without increasing of access level) or ‘2’ (the recommended value, recording with access level 2’) should be set. If the parameter in the module has a real access level exceeding the specified one, recording is impossible.
- TT NN MM – the full ‘TTNN’ number of readable or recordable floating-point parameter from the module with the ‘MM’ address in the bus.

3.3.2 Common RS

3.3.2.1 Using parameter 0102 ‘common RS address’, set the required value of common RS address.

3.3.2.2 Through the index parameters ‘description of common RS’ 020C (i), where i=0..Dh for subunit numbers from 0 to 13, set the description of types for all possible 14 subunits:

- code 01 – subunit of TS type;
- code 02 – subunit of TC type;
- any other code (0 or FFh is recommended) – subunit is absent, to be **obligatorily** recorded for all unused subunits.

3.3.2.3 Through the index parameters ‘description of group parameters’ 020D(i), where i=0..3 for parameter groups with numbers 0-3, set the description of each of these 4 groups in the form CC TT NN MM. Here, CC is the specification; its code, equals 80h and higher (FFh is recommended) indicates that the group is absent;

this value should be **obligatorily** specified for all unused groups. The code from 0 to 7Fh (0 is recommended) indicates that the group is present, and the 32-position bit array as the parameter ‘TTNN’ is read into it from the ‘MM’ module.

3.3.2.4 Through the index parameters ‘TS 1-8 TOm RSn signals’ with numbers from 0210(i) to 0248(i), where the index value i=0..7 corresponds to the telesignal number from 1 to 8, and the distribution of the parameter numbers by the numbers of the subunits 'n' and teleoperations 'm' is given in Table 2.7, set the description of each possible telesignal in the form of CC TT NN MM or SS GG BB XX. Here, CC is the signal specification. Its code ‘0’ indicates that the bit parameter with the number ‘TTNN’ is read from the module with the address ‘MM’. The code ‘1’ indicates that the bit parameter is in the group with the ‘GG’ number (from 0 to 3) as a bit position with a number ‘BB’ (from 0 to 31) value ‘XX’ is not significant. Other specification codes indicate that the signal is absent; the recommended FFh value should be **obligatorily** specified for all unused signals.

NOTE: It is permitted to leave the setting parameters not related to the TC-type subunits in any condition.

3.3.2.5 Through the index parameters ‘TC 1-6 RSn signals’ with numbers from 0248(i) to 0255(i), where index value i=0..5 corresponds to the telecommand number from 1 to 6, and the distribution of the parameter numbers by the numbers of the subunits 'n' is given in Table 2.7, set the description of each possible control signal in the form DD TT NN MM.

Here, DD is the access specification by recording to the bit parameter ‘TTNN’ (control output signal) in the module with the address ‘MM’. The code ‘1’ allows free recording into the parameter (without the access level increase); the code ‘2’ (the recommended value) provides recording with the preliminary access level increase. If the parameter in module has the actual access level exceeding the specified one, telecommand is impossible. Any other DD codes also prohibit the telecommand under this signal; the recommended FFh value should be **obligatorily** recorded in the access specification of all unused control signals of the ‘TC’ type.

NOTE: It is permitted to leave the setting parameters not related to the TC-type subunits in any condition.

3.3.2.6 Through the index parameters ‘1-6 RSn TC duration’ with numbers from 0256(i) to 0263(i), where the index value i = 0..5 corresponds to the control signal number from 1 to 6, and the distribution of the parameter numbers by the numbers of the subunits 'n' is given in Table 2.7, set the pulse duration of each of the assigned telecommand signals as an integer in the range from 1 to 255 seconds in accordance with the equipment used. For signals, not described according to 3.3.2.5 as the used TC signals, the value of the duration parameters is not significant.

3.4 Configuration. ‘Modbus’.

3.4.1 General settings

3.4.1.1 Using parameter 0101 ‘Slave-address’, set the required Slave-address value in the Modbus line.

3.4.1.2 Using parameter 0108 ‘CRC generator polynomial’ set the required value of a generator polynomial, used in control algorithm CRC-16, in sexadecimal form. At the polynomial value $X^{16} + X^{15} + X^2 + X^0$, standard for Modbus, code of the parameter 0108 should be equal to A001h.

3.4.2 Floating-point operations

3.4.2.1 Through the index parameter ‘description of floating parameters’ 0301(i), where i=0..63, set the description of all 64 floating-point parameters which may be read from TEKON-20 modules, or recorded into them. Each parameter descriptor has the form DD TT NN MM where

- DD – access specification. Code 80h and higher (FFh is recommended) indicates at the parameter absence; this value should be **obligatorily** specified for all unused parameters. For the parameters intended solely for reading from USP, any specification code in the range from 0 to 7Fh (0 is recommended) may be set. For the parameters to be recorded, the code value of ‘1’ (free recording without increasing access level) or ‘2’ (the recommended value, recording with access level 2’) should be set. If the parameter in the module has a real access level exceeding the specified one, recording is impossible.
- TT NN MM – the full ‘TTNN’ number of readable or recordable floating-point parameter from the module with the ‘MM’ address in bus.

3.4.2.2 Through the index parameter ‘Modbus address of floating parameters’ 0300(i), where i=0..63, for floating-point parameters intended for use, assign the Modbus address (‘Holding Registers’) as a decimal number in the range from 0 to 65535. The specific value of the address is determined based on the characteristics of the Modbus controller at the dispatching station. For several parameters with consecutive Modbus addresses that can be read or recorded by one floating-point command, the step of the addresses should be two. Unused parameters can have any address value.

3.4.2.3 For operation in ‘Magistral-2’, assign zero values to parameters 010B and 010C, which determine the sequence of bytes in the floating-point number; for operation in ‘Inkomsystems’, assign the single value to the parameter 010V and zero value to the parameter 010C.

3.4.3 Telesignalization

3.4.3.1 Through the index parameters ‘groups of TS bit parameters’ 030B (i), where i=0..3 for parameter groups 0-3, set the description of each of 4 groups in the form CC TT NN MM. Here, CC is the specification; its code, equaling 80h and higher (FFh is recommended), indicates that the group is absent; this value should be **obligatorily** specified for all unused groups. The code from 0 to 7Fh (0 is recommended) indicates that the group is present, and the 32-position bit array as the parameter ‘TTNN’ is read into it from the ‘MM’ module.

3.4.3.2 Through the index parameter ‘description of TS signals’ 0303(i), where i=0..127, set the description of all 128 bit parameters, which may be used as TS signals. Each parameter descriptor has the form CC TT NN MM or SS GG BB XX, where CC is the signal specification. Its ‘0’ indicates that the bit parameter with the number ‘TTNN’ is read from the module with the ‘MM’ address. The code ‘1’ indicates that the bit parameter is in the group with the ‘GG’ number (from 0 to 3) as a bit position with a number ‘BB’ (from 0 to 31) value ‘XX’ is not significant. Other specification codes indicate that the signal is absent; the recommended FFh value should be **obligatorily** specified for all unused signals.

3.4.3.3 Through the index parameter ‘Modbus address of TS signals’ 0302(i), where i=0..127, for the TS bit parameters intended for use, assign the Modbus address (‘Discret Inputs’) as a decimal number in the range from 0 to 65535. The specific value of the address is determined based on the characteristics of the Modbus controller at the dispatching station. For several parameters with consecutive Modbus addresses that can be read by one command, the step of the addresses should be equal to 1. The unused parameters may have an arbitrary address value.

3.4.4 Telecommand

3.4.4.1 Setting shall be carried out by setting the line of index parameters with indices i=0..15, corresponding to numbers of TC signals from 1 to 16.

3.4.4.2 Through the index parameter ‘Modbus address of TC signals’ 0304(i) for assigned TC signals, assign the Modbus address (‘Coils’) as a decimal number in the range from 0 to 65534, **obligatorily** even. The specific value of the address is determined based on the characteristics of the Modbus controller at the dispatching station. The unused signals may have any address values.

3.4.4.3 Through the index parameters ‘TC signal type’ 0307(i) set the type of each control signal described according to 3.4.4.2 in the form of a two-digit number of PQ form:

The digit ‘P’ defines the number of stages in the control command:

- P=0 single-stage;
- P≠0 two-stage with preliminary and executive commands.

The digit ‘Q’ defines the type of the output control signal:

- Q=0 pulse signal, i.e. recording of the value ‘1’ into the control parameter, an delay with control of the return signal control, then recording of the value ‘0’ into the parameter. The numbers of the control and return parameters, and the delay value are determined by the TC1 or TC0 value transferred in the TC command.
- Q≠0 potential signal, i.e. the value set in the TC command is simply recorded in the parameter.

The type value for the parameters with indices not described as TC signals is not significant.

3.4.4.4 Through the index parameters ‘description of signals for TC1’ 0305(i) and ‘description of signals for TC0’ 030C (i) set the description of each of possible control signals in the form DD TT NN MM. Here DD is the access specification by recording to the bit parameter with the number ‘TTNN’ (as a rule, the control output signal) in the module with address ‘MM’. The code ‘1’ allows free recording into the parameter (without the access level increase); the code ‘2’ (the recommended value) provides recording with the preliminary access level increase. If the parameter in the module has the actual access level exceeding the specified one, telecommand is impossible. Any other DD codes also prohibit the telecommand under this signal; the recommended FFh value should be **obligatorily** recorded in the access specification of all unused control signals.

NOTES:

- If TC signal with index ‘i’ is described as potential, only the parameter 0305(i) is used, and the value of the parameter 030C (i) is not significant.
- If TC signal with index ‘i’ is described as pulse, the parameter 0305(i) is used in TC1, i.e., in those TC commands which are accompanied by control code FF 00, and parameter 030C(i) in TC0, i.e. in those TC commands which are accompanied by control code 00 00.

3.4.4.5 Through the index parameters ‘description of the proper operation signal TC1’ 030F (i) and ‘description of the proper operation signal TC0’ 0310(i) for each control signal, specify the description of the desired control signal in the form of CC TT NN MM. Here, CC is a specification of the presence and the sign of the signal being used as the bit parameter with number ‘TTNN’ from module with the address ‘MM’. The specification code ‘0’ specifies the circuit proper operation when the read bit parameter value is ‘0’. The specification code ‘1’ specifies the circuit proper operation when the value of this parameter is ‘1’. The remaining specification codes indicate that the proper operation signal is not used. The recommended FFh code should be recorded for all TC signals which do not use proper functionality or readiness signals in their operation.

NOTES:

- If TC signal with index ‘i’ is described as potential, only the parameter 030F (i) is used, and the value of the parameter 0310(i) is not significant
- If TC signal with index ‘i’ is described as pulse, the parameter 030F(i) is used in TC1, i.e., in those TC commands which are accompanied by the control code FF 00, and parameter 0310(i) in TC0, i.e. in those TC commands which are accompanied by the control code 00 00.

3.4.4.6 Through the index parameters ‘description of RS TC1 signal’ 0308(i) and‘ description of RS TC0 signal’ ’030E (i) specify the description of the return signal, in the form of CC TT NN MM to each of the control signals, described as pulsed,. Here CC is a specification of the presence and sign of the signal used as a bit parameter with the number ‘TTNN’ from the module with the address ‘MM’.

The specification code ‘0’ sets the end of the TC pulse when the return parameter takes the value ‘0’. The specification code ‘1’ sets the end of the TC pulse when the return parameter takes the value ‘1’. The remaining specification codes indicate that the return signal is not used in the TC; the recommended FFh value should be recorded for all TC pulse signals which do not use return signals in operation.

3.4.4.7 Through the index parameters 'pulse TC1 duration' 0306 (i) and 'pulse T01 duration' 030D (i) set the pulse duration to each of the control signals described as pulsed, as an integer in the range from 1 to 255 seconds in accordance with the characteristics of the equipment used.

NOTES:

- Parameter 0306(i) is used in pulsed TC1, i.e. in those TC commands, which are accompanied by the control code FF 00, and parameter 030D (i) in TC0, i.e. in those TC commands, which are accompanied by control code 00 00.
- If TC signal with index ‘i’ is described as potential or not described at all, the values of both parameters are not significant.

3.4.5 Telemetering of two-byte parameters

3.4.5.1 Through the index parameters ‘TM signals description’ 030A (i), where i=0..15 for 0-15 TM signals, set the description of each signal in the form of CC TT NN MM. Here, CC is the specification; its code, equaling 80h and higher (FFh is recommended) indicates that the parameter is absent; this value should be **obligatorily** specified for all unused signals. The code from 0 to 7Fh (0 is recommended) indicates that the two-byte parameter ‘TTNN’ from the ‘MM’ module is used.

3.4.5.2 Through the index parameter ‘Modbus address of the two-byte TM’ 0309(i), where i=0..15, for TM assigned to the use of two-byte parameters, specify the Modbus address (‘Holding Registers’) as a decimal number in the range from 0 to 65535. The specific value of the address is determined based on the characteristics of the Modbus controller at the dispatching station. For several parameters with consec-

utive Modbus addresses which can be read by one command, the step of the addresses should be equal to 1. The unused parameters may have any address value.

3.5 Configuration. 'UNK TM'

3.5.1 General settings

3.5.1.1 Using parameter 0101 'USP address in line' assign the required address value as a flow meter in UNK TM line.

3.5.1.2 Using parameter 0400 'number of threads (pipelines)', set the number of Superflo calculator pipelines, simulated by USP with TEKON-20 modules, within the range from 1 to 3.

3.5.1.3 Through the index parameter 'time and date recording password' 0401 (i), where i = 0..15, enter the required 16-character password for time and date recording, which is used in the command 30 (see 2.3.6.9).

3.5.2 Setting of each pipeline

3.5.2.1 The numbers of the parameters for each pipeline configuration are given further as 0Nxx, where 'N' value is 5 for the 1st pipeline, 6 for the 2nd pipeline, 7 for the 3rd pipeline. For each of the existing pipelines, perform the actions described in subclauses 3.5.2.2 - 3.5.2.10. Pipelines with numbers higher than a specified number of threads are not obligatory configured, and their parameters may have any value.

3.5.2.2 Through index parameter 'pipeline name' 0N00 (i), where i = 0..15, enter the pipeline name in the form of a 16-character sequence. The name does not affect the operation of USP, it is read in commands 01 and 02.

3.5.2.3 Through index parameter 'time and date recording password' 0N0C (i), where i = 0..15, enter the required 16-character password for storing the pipeline static parameters used in command 03 (see 2.3.6.6).

3.5.2.4 Using parameters 0N01 'flow measurement type', 0N02 'selection method', enter codes for the flow measurement type and pressure differential selection method in accordance with the requirements of UNK TM controller. The parameters do not affect USP performance, their values are simply read in commands 01 and 02.

3.5.2.5 Using parameter 0N03 'CAN-address of pipeline module ', enter the 'MM' address in CAN-BUS of that TEKON-20 module, which 'represents' this pipeline. All parameters related to this pipeline will be taken from this module.

3.5.2.6 Using parameters 0N04 'gas density', 0N05 'CO2 percentage', 0N06 'nitrogen percentage', enter the full numbers of the module parameters containing the data specified in the names in the form 'TTNN'.

3.5.2.7 Using parameters 0N07 'pipeline diameter', 0N08 'orifice diameter', 0N09 'atmospheric pressure', 0N0A 'minimal drop', enter the full numbers of the module parameters containing the data specified in the names in the form 'TTNN'.

NOTE: If any parameter is absent in the module, specify its full number in the form of FFxxh code, where ‘xx’ is an arbitrary code. USP will not execute a query to the module under such number, and when USP responds to an external command, the parameter value field in response message will be reserved, but its status will be undefined.

3.5.2.8 Through parameters 0N0D ‘flow archive by days’, 0N0E 'backup archive by days', 0N0F ‘drop archive by days’, 0N10 ‘pressure archive by days', 0N11 ‘temperature archive by days’, 0N12 ‘auxiliary archive by days’, enter the full numbers of the parameters, which contain in the module the archived data specified in the names, in the form of 'TTNN'. USP does not check the purpose of the archive, and generally it is possible to assign the parameters with other daily data as well. See also the note to subclause 3.5.2.7.

3.5.2.9 Through parameters 0N13 'archive flow rate by hour', 0N14 'backup archive by hour', 0N15 'drop archive by hour', 0N16 'pressure archive by hour', 0N17 ‘temperature archive by hour', 0N18 'backup archive by hour’, enter the full numbers of the parameters, which contain in the module the archived data specified in the names, in the form of 'TTNN'. USP does not check the purpose of the archive, and generally it is possible to assign the parameters with other hourly data as well. See also the note to subclause 3.5.2.7.

3.5.2.10 Using parameter 0N19 ‘depth of hourly archives’, enter the real depth of hourly archives, expressed in days. Only numbers 16, 32 or 64 can be set, depending on the actual depth of the hourly archives in the module. The remaining numbers will cause an error when reading the parameters of hourly archives.

3.6 Configuration. ‘HART’.

3.6.1 General settings

3.6.1.1 Using parameter 0101 ‘short address’, assign the required short address value to USP as a single-byte hexadecimal number.

3.6.1.2 Using parameters 0800 '2nd byte of long address', 0801 '3rd byte of a long address', 0802 '4th byte of a long address', assign to USP the required values of the last three bytes of a long address as hexadecimal numbers. The first two bytes of a long address are set in the rigid form in USP program as 00 02.

3.6.1.3 Using parameter 0803 ‘number of HART devices’, specify the number of ‘N’ devices in terms of HART protocol, implemented in USP together with TEKON-20 module, from 1 to 16.

3.6.1.4 Using parameters 010B and 010C to specify the required sequence of byte transfer in floating-point numbers.

3.6.2 Setting of each HART device

3.6.2.1 The numbers of the parameter settings for each device are indices, the index value ‘i’ varies from 0 to 15. For each of the assigned devices with indices i ’from 0 to N-1, perform the steps described in subclauses from 3.6.2.2 to 3.6.2.6. De-

vices with indices N and more are not configured, and their parameters may have any value.

3.6.2.2 Through the index parameters 0804(i) ‘device type’ and 0805(i) ‘device number’, enter the device type and number codes in accordance with HART protocol requirements. The parameters do not affect USP performance, their values are simply read by command 130d.

3.6.2.3 Through index parameter 0806(i) ‘module number in CAN’, enter the ‘MM’ address in CAN-BUS of TEKON-20 module representing this device. All the parameters related to this device will be taken from this module.

3.6.2.4 Through index parameters 0808(i) ‘TEKON parameter for the current month’ and 0809 (i) ‘failure parameter’ enter the full numbers of the parameters containing the data specified in the names in the ‘TTNN’ form. The first parameter should be represented in the module as a floating-point number, and represent, as a rule, the value of the flow or the average value of any physical quantity for this period accumulated from the beginning of the month. The second parameter in the module should be bit and represent a sign of failure related to the formation of the first parameter. If the module does not have any special signs of failure for each parameter, it is possible, for example, in case of TEKON-19, to use its system parameter 050E ‘common failure’. USP does not provide correspondence between the floating point parameters (flow, heat, temperature, etc.) and HART device type.

3.6.2.5 Through index parameter 080A(i) ‘hour archive depth’, enter the real depth of the hourly archive expressed in days. Only numbers 16, 32 or 64 can be set, depending on the actual depth of the archive in the module. Other numbers will cause an error when reading hour archive parameters from device.

3.6.2.6 Through index parameters 080B(i) ‘hour archive’, 080C(i) ‘daily archive’, 080D(i) ‘monthly archive’, enter the full numbers of the parameter of the module, which contain the archive data belonging to this device by hour, day and month, respectively, in the form of ‘TTNN’.

3.7 Configuration. Ver.2 ‘Energiya’.

3.7.1 Comb busbar setting

3.7.1.1 Numbers of the comb busbar configuration parameters shall be indices, the value of index ‘i’ shall vary from 0 to 15 to set the comb busbar bytes from 1 to 16, respectively. For all indices from 0 to 15, perform the steps described in subclauses 3.7.1.2, 3.7.1.3.

3.7.1.2 Using index parameter 0200(i) ‘comb busbar parameter’, enter this parameter full number, which contains the required floating-point data, in the form ‘TTNN’. Using index parameter 0201(i) ‘CAN address’ enter the module address in CAN-BUS containing the required data in the form ‘MM’. If the comb busbar position is not used, **obligatorily** set the parameter number as a code ‘FFxxh’ (then the module address is not significant), or the module address as a code 00 or ‘FFh’ (then the parameter number is not significant).

3.7.1.3 Using index parameters 0202(i) ‘scale beginning’ and 0203(i) ‘scale end’ for all used comb busbar bytes, enter the scale beginning and end numbers as floating numbers. Both positive and negative numbers may be used, but for USP correct operation, the ‘scale beginning’ value should be algebraically, with regard of the sign, less than the ‘scale end’ value. For unused comb busbar bytes, the values of these parameters are not significant.

3.7.2 Telesignalization setting

3.7.2.1 Telesignal configuration parameter numbers are indices, the ‘i’ index value varies from 0 to 15 for telesignal configuration from 1 to 16, respectively. For all indices from 0 to 15, perform the steps described in subclauses 3.7.2.2, 3.7.2.3.

3.7.2.2 Using the index parameter 0204(i) ‘specification’, set the presence, location and method of use of telesignals in the form of one of the following codes:

- 0 – the Telesignal is present, it is contained in the separate bit parameter and entered in the direct form;
- 1 – the Telesignal is present, it is contained in the group parameter and entered in the direct form;
- 80h – the telesignal is present, it is contained in the separate bit parameter and entered in the inverted form;
- 81h – the telesignal is present, it is contained in the group parameter and entered in the inverted form;
- Any other codes – no telesignal. For all unused positions, enter the signal absence code **obligatorily**, FFh is recommended.

3.7.2.3 Using index parameter 0205(i) ‘TS parameter’ for all assigned telesignals, specify the telesignal receipt source:

- for signals with specification ‘0’ or ‘80h’, enter the full number of the bit parameter in the form of ‘TT NN’.
- for signals with specification ‘1’ or ‘81h’, enter GG group (from 0 to 3) and BB bit number in it (from 0 to 31) in the form ‘GG BB’.

Using index parameter 0206(i) ‘CAN address’ for signals with the specification ‘0’ or ‘80h’, enter the module address in CAN-BUS containing the parameter bit in the form ‘MM’. For signals with specification ‘1’ or ‘81h’, the value of the parameter 0206(i) is not significant.

For absent telesignals, the condition of the parameters 0205(i) and 0206(i) is not significant.

3.7.3 Auxiliary settings. Group parameters

3.7.3.1 Numbers of parameters to configure four groups of bit parameters shall be indices; the ‘i’ index values shall vary from 0 to 3. For each group, perform actions described in subclause 3.7.3.2.

3.7.3.2 Using index parameter 0207(i) ‘32-bit group parameter’, enter this parameter full number in the form ‘TTNN’. Using index parameter 0208(i) ‘CAN address’, enter the module address in CAN-BUS containing the required parameter in the form ‘MM’. If the group is not used, **obligatorily** set the parameter number as a code ‘FFxxh’ (then the module address is not significant), or the module address as a code 00 or ‘FFh’ (then the parameter number is not significant).

4 OPERATION

4.1 After USP is installed and connected in accordance with the recommendations of clause 3.1, it becomes an off-hand intermediate part of data acquisition system, and no special actions are required.

4.2 The exchange signal transmission may be visually assessed by the state of the LED indicators according to 2.3.3.8 for versions 1 and 3, or 2.3.8.5 for version 2.

4.3 For debug and repair operations, USP condition may be additionally assessed through its parameters given in Table 2.7. For this purpose, it is required to have a PC connected to CAN-BUS and equipped with the exchange software developed by KREIT, for example, TELEPORT software, and corresponding database.

5 TECHNICAL SERVICE

5.1 Maintenance

Maintenance in the process of operation is not required.

5.2 Repair

USP Repair shall be carried out at OEM.

6 TRANSPORTATION AND STORAGE

6.1 The packaged USP should be transported in covered vehicles by all means of transport, by air transport – only in sealed and heated compartments.

6.2 USP should be stored in accordance with OZh4 storage conditions according to GOST 15150.

7 DISPOSAL

7.1 USP contains no precious metals and hazardous materials.

7.2 USP shall be disposed separately by material groups: plastic elements, metal fasteners.

ANNEX A –List of regulatory and technical documents, referrenced in Operation Manual

GOST R 52931-2008 ГОСТ Р 52931-2008	Instruments for process monitoring and control. General specifications.
GOST 15150-69 ГОСТ 15150-69	Machines, instruments and other products. Modifications for different climatic regions. Categories, operation, storage conditions and transportation conditions as to environment climatic aspects 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	OSSS (Occupational safety standards system). General safety requirements.
GOST 2.601-2013 ГОСТ 2.601-2013	USDD (Unified system for design documentation). Exploitative documents
TU 4233-4233-023-44147075-12 ТУ 4233-023-44147075-12	Interface controllers of T-20 series. Technical specifications.