CARD DATA TERMINAL BRIG-015-T001

Terminal information unit in explosion-proof design.

Operation manual

32050732.465275.003 OM

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2018

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APPROVALS LIST

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Contents.

INTRODUCTION

This document contains manufacturer's data on main parameters and technical characteristics of BRIG-015-T001. Operation manual is intended to inform on the unit designation and unit operating principles, and that are necessary for correct and safe operation of the unit its proper use, technical maintenance, operation maintenance, storage and transporting.

Only staff that have studied the operations manual and have no less than III group on electrical safety in accordance with Guidance on job safety during usage of electronic equipment for units up to 1000V are allowed to perform works on installation, mounting and service of the unit.

Manufacturer reserves the right to make review and changes in operation manual and unit's design related to its technical characteristics improvement.

1. DESCRIPTION AND FUNCTIONING

1.1. Product designation.

1.1.1 The unit is designed to display information in alpha-numeric mode, entering information from on-board keyboard, as well as reading and writing information on contactless Mifare Classic standard cards. It is possible to install and run the unit in explosion hazardous zones in accordance with the marking that is engraved on the housing of the unit.

1.1.2. The unit has explosion proofing for electrical equipment marking type 1ExdIIBT3 in accordance with GOST R 51330.0 and is designed for usage in explosion hazardous zones of 1st and 2nd classes installed on stationary objects in accordance with GOST R 51330.0, GOST R 51330.13

1.1.3. Unit functions under control of a master device (for example PC) in dialogue mode according to MODBUS RTU exchange protocol. EIA-485 interface is used for data exchange with master device.

1.1.4. The unit is designed for long-term continuous operation.

1.1.5. Range of application.

The unit is designed to be used as a user terminal at oil-loading posts, access monitoring systems and other objects located in explosion hazardous zones

1.1.6. Unit operation conditions

1.1.6.1. on degree of protection from environmental impact IP65 in accordance with GOST;

1.1.6.2. on endurance and durability to sinusoidal vibrations impact – in accordance with GOST R 52931-2008 meets N3;

1.1.6.3. on durability to ambient air temperature and humidity impact in accordance with GOST 15150-69 meets U1.

1.1.7. During purchasing and for other products' documentation the unit must be indicated as follows: "Card data terminal BRIG-015-T001".

1.2. Technical characteristics.

Product design is shown in picture 1.

Picture 1. Card data terminal BRIG-015-T001.

Main technical characteristics of the unit are as follows:

Supply voltage:	12V+10%.
Power supply type:	DC
Power consumption, no more than:	20 W
Indicator type:	Alpha-numeric, 4 lines, 20 symbols each
Keyboard type:	Optical (contactless)
Number of keys:	4
Type of cards used:	Mifare Classic
Communication with plastic cards:	In accordance with ISO/IEC 14443A/B
Communications interface with master device:	EIA-485
Communication protocol to master device:	Modbus RTU
Cable entries	1 or 2
Working mode:	Continuous, twenty-four-hour
Degree of protection from environmental impact:	IP 65
Explosion proofing marking:	1ExdIIBT3
Ambient temperature during operation:	-40..+50°C
Relative air humidity during operation, no more than:	90%
Weight, no more than:	2 kg.
Dimensions, WxHxD:	265x216x86 mm.

1.3. Unit and package contents

1.3.1. Unit delivery set includes:
- Indicator BRIG-015-T001.
- operation documentation: 1 set;
- configurational software (compact disk): 1 pcs.
- transport packaging: 1 set;

1.3.2. Operation documentation includes:
- Operations manual;
- Passport.

1.4. Unit design

1.4.1. Design.

Design of the unit includes metal case with glass front panel, electronic components boards are located inside the housing of the unit.

Power supply and interface cable glands are located on the side of the unit.

Grounding device with corresponding marking is located on the outer side of the unit.

Functionally the device consists of the following elements:
- indicator;
- keyboard;
- card reader.

1.4.2. Indicator.

LED alpha-numeric display has 4 lines, 20 symbols each. It can show both Cyrillic and Latin alphabetic symbols. The indicator has backlight.

1.4.3. Keyboard.

Keyboard – optical, consists of 4 keys. Reading of a key is performed in accordance with principle of optical beam reflection from a non-transparent object. Bouncing protection provided. Keys perform function of movement in menu items, entering information in fields (see description of the function in exchange protocol), choosing and cancelling.

1.4.4. Card reader.

Card reader provides encrypted data exchange (reading, writing) with contactless Mifare Classic standard cards. For successful data exchange the card should be put against card reading element (on the front panel of the unit) parallel frontal plane at a maximum distance of 15 mm.

1.5. Marking.

An engraved marking on the housing of the unit contains the following information:

- Type of explosion proofing;

- Degree of protection from environmental impact;

- Manufacturer's name;

- Serial number.

1.6. Packing.

The unit is wrapped in paper and then packed into polyethylene bag. Documentation and compact disk with software are packed into polyethylene bag. Then the package is packed into cardboard box. Hollow space is filled with corrugated cardboard.

1.7. Provision of explosion proofing.

Explosion proofing type «d» (explosion-proof cover) in accordance with GOST R 51330.8.

Categories and groups of explosion hazardous zones environment where the unit is to be installed should correspond or be less dangerous than categories and groups of explosion proofing stated in explosion proofing marking of the unit

Installing and energy supply should be performed in accordance with current operation manual, "Rules of electrical facilities maintenance" (ПУЭ) chapters 7.3, 7.4 and "Rules of electrical facilities maintenance" (ПУЭ) chapter Э3.4, ПТЭ, ПТБ, other executive directives that regulate installation of electrical equipment in explosion hazardous zones.

Connection of the unit should be done via cable. Cable must not have any failures both of isolation and separate wires.

Reparation of the unit should be performed in accordance with GOST R 51330.18 "Electrical apparatus for explosive gas atmospheres. Repair and overhaul".

2. INTENDED USE

2.1. Preparing unit to operation.

2.1.1. Unpacking.

Upon receiving the unit integrity of packing should be checked. After the box is opened the unit should be taken out of package material and wiped. Package contents should be checked against paragraph 1.3.

2.1.2. Safety precautions.

Only staff that have studied current manual and possess necessary qualifications should have access to installing, operation, technical maintenance and service of the unit.

Installing, operation, technical maintenance and service of the unit should be performed in accordance with requirements of "Users rules on electrical devices technical maintenance" and "Users safety measures during electrical devices operation", as well as other department and sectoral norms that are implemented on the operation facility.

Installing, operation, technical maintenance, troubleshooting and cables connection are allowed to

perform only if the unit is disconnected from power supply.

The unit shall be grounded, this should be done before other cables are connected. Ground loop is connected to the grounding device that is located on the outer side of the unit's housing and is marked correspondently.

2.1.3. Installation of the unit.

Fastening of the unit is performed with fastening brackets that are located on the flanks of the unit.

Overall and connection dimensions are shown on the sketch in Appendix 1.

To connect cables in it is necessary to take of the front panel by unscrewing studs that are located along its perimeter.

Cables are to be entered through cable glands, after they are terminated cable glands should be tightened.

Before termination of the cables ensure they are de-energized and protection grounding has been arranged.

Cables should be connected in accordance with connection table (Appendix 2).

EIA-485 net interconnection should be performed in accordance with requirements of this standard.

After termination the front panel must be closed and studs that are located along its perimeter must be screwed. Front panel should be car sealed.

Installation and termination must be performed in accordance with safety requirements (paragraph 2.1.2).

2.2. Precommissioning.

After installation works are finished and the unit is powered the unit is ready to work. Using the unit as a part of automated systems may require changing Modbus address. This should be done with configurational software that is included in package set. Instruction manual to the software is provided in Appendix 3.

2.3. Maintenance check.

Maintenance check provides visual examination that is performed to make sure there cables do not have any breakages or damages, all connections are safe, there have been no mechanical damages to the housing of the unit and that plates with explosion proofing marking are provided. Safety of grounding should also be checked. Operation the device with deviations from requirements listed above is prohibited.

2.4. Technical maintenance.

Technical maintenance is conducted in order to provide normal operation and maintenance of operational and technical characteristics of the unit during service life.

Technical maintenance consists of periodical control of technical state and of emerging malfunctions repair.

During conducting all kinds of technical maintenance safety measures listed in paragraph 2.1.2 must be followed.

Technical maintenance should be conducted no less than once a quarter. During the maintenance requirements in paragraph 2.3 should be followed.

During technical maintenance it is necessary to remove contaminations from surface of the housing; it is prohibited to use corrosive fluids of solvents.

Maintenance (as well as warranty repairs) is performed by manufacturer.

2.5. Unit operation.

In normal mode the unit works as ancillary device in accordance with Modbus RTU protocol. Master device initiates information output to the indicator, reading keyboard codes, data exchange with contactless cards.

EIA-485 interface is used for connection to master device.

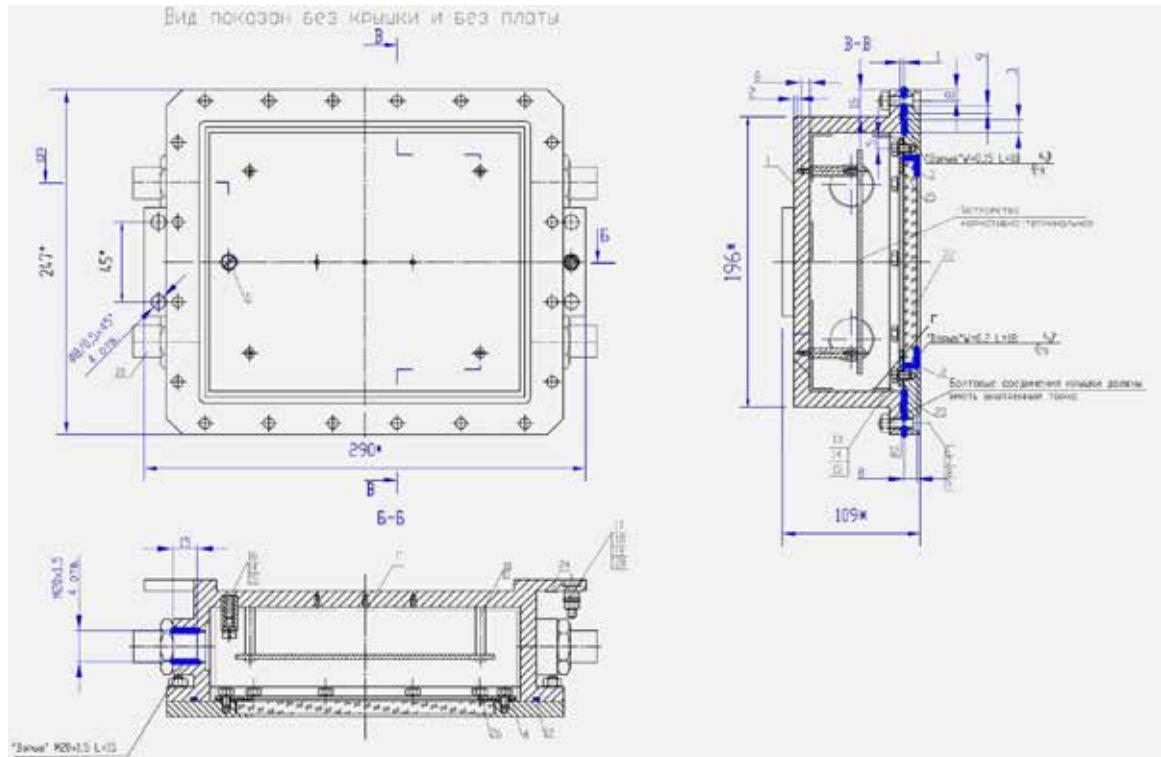Unit in special design works as slave device in accordance with special interface and protocol.

Description of communication parameters that are used by Modbus, connection principles and register map are provided in Appendix 4.

2.6. Rules of storing and transporting

Transporting and storing should be performed in accordance with GOST 15150-69 (terms of storing 3). Before being put into operation unit should be stored in a warehouse in factory packing at temperature -40...50 °C and relative humidity up to 90% (at temperature 25 °C).

Transportation of the unit should be performed in its factory packing. Keeping time for the unit in factory packing in warehouse, including time of transportation, is 3 years.

APPENDIX №1

Overall and connection dimensions.

Picture 2. Overall and connection dimensions.

APPENDIX №2

Unit connections.

Terminal BRIG-015-T001

X3

Cont.	Circuit
6	Com.
5	Usup.+ 12V
4	EIA-485 B
3	EIA-485 B
2.	EIA-485 A
1	EIA-485 A
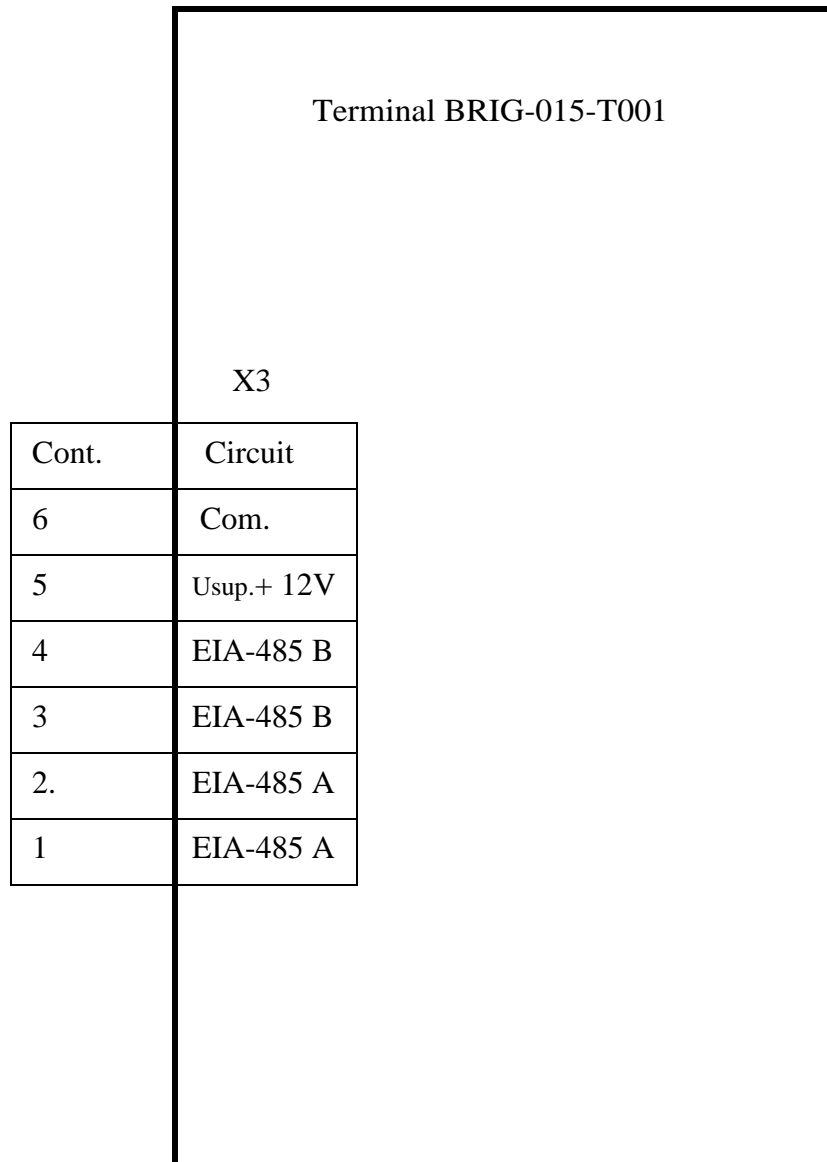
Picture 3. Unit connections.

APPENDIX №3

Configuration software. Operating instructions.

1. Introduction

Testing software "Program for terminal operation" allows conducting full control of the terminal, setting up its non-volatile memory, displaying information, performing full range of operations with Mifare Classic card, entering data from the keyboard, perform control of main registers of BRIG-015-T001. For program operation a PC with COM-port is necessary.

2. Working with the program

Testing program is shown in Picture 4. Working with the program starts from choosing COM-port that is connected to the terminal and pressing *Open*.
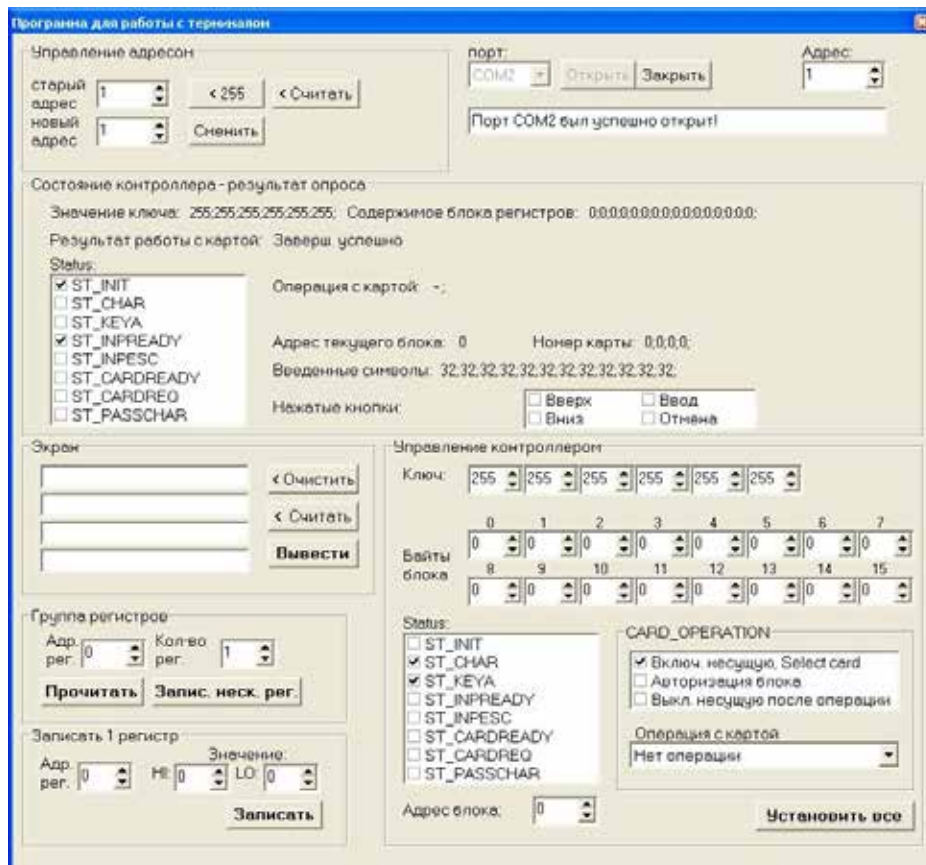
Picture 4. Main window of testing program.

After opening COM-port program starts to poll terminal with the address given in the field *Address* and display information in the field *State of the controller – result of the poll*. If communication is okay then registers' values will not be displayed in pale colour. *Field of the controller – result of the poll* is refreshed on performing the command of 22 registers reading (04 – Read Input Registers), starting from address 0.

Field *Address control* allows reading and changing MODBUS address of the terminal. In order to do that it has to be the only unit of the type that is connected to the PC, because a broadcast query is performed (address of requested unit is 225) to the register with address 66. Changing address of the unit is also acceptable to address 225, but if the line has a few terminals then address would be changed for all of them.

Field *Display* allows displaying information on the screen of the terminal and reading data from display memory sector. Each entry field in this area corresponds to display line.

Field *Register group* is designed to perform reading and writing groups of registers. Registers data are taken (during writing) from subregion *Bytes of the field PC control*, at the same time byte of 0 block – lower byte of starting register, byte of 1 block – upper byte of starting register etc. After reading a number of registers the result is written in subregion *Bytes of the field PC control*.

Field *Controller control* is designed for performing card operation, entry mode setup etc. It is possible to change key value here (registers with addresses 1...3), block bytes (registers with addresses 4..11), value of registers Status, CardOperation, BlockAd (see description of exchange protocol). At pressing button *Setup all* writing in terminal of 13 registers is performed, starting with address 1.

APPENDIX №4

Communication protocol.

1.Introduction.

This protocol describes communication between upper level software (master device) and terminal BRIG-015-T001 (slave device) in accordance with protocol MODBUS RTU.

Unit BRIG-015-T001 – then referred to as the terminal, - provides full functionality in working with contactless cards of Mifare Classic standard (Mifare Standard 1k and Mifare Standard 4k). It allows receiving card number, reading and writing card blocks up to 4096 bytes (corresponds to Mifare Standard 4k) is provided as well as performing such commands like Increment block, Decrement block, Transfer block and Restore block, that are generally used for transport cards (card block can contain number of remaining trips).

Terminal screen displays 4 lines, 20 symbols each. Symbols are displayed on the matrix 5x8 dots. Between symbols there are intervals one dot widths. Display is LED with backlight. Each cell on the display corresponds to 1 byte from MODBUD map register that contains a code in accordance with Windows 1251 coding (there are insignificant discrepancies from the standard in the beginning of the table). Symbols table is provided in picture 5. A cursor can also be displayed on the screen.

Terminal keyboard consists of four optical keys: Up, Down, Enter and Cancel. During terminal operation in symbols enter mode, codes of pressed keys are put into a buffer, cursor is not displayed. Data from buffer can be read in accordance with MODBUS protocol.

During terminal operation in symbols enter mode, by fields, terminal works in the following order:

For example the following information is written into display memory: Enter product data, Density {{{.{{ and Temperature{{{.{. In this case symbol "{" (code 7B hex) is a service digit and continuous sequence of such symbols forms a field (field can begin on one line and end on the other). In the example above there are 4 fields 3, 2, 3 and 1 symbol correspondently. Maximum number of symbols in the field to be processed by the terminal – 12, if the memory of the display has more "{" symbols than 12, extra symbols are not displayed and ignored.

The field is a place for entering symbols from keyboard, cursor is located here, keys Up and Down select symbol for entering in the place where cursor is located, choice is made between a number of symbols (space,'0','1','2','3','4','5','6','7','8','9' and '-' (if the position of symbol is first in the field)). At pressing Enter if the on the cursor's position there is no symbol (not a space symbol) and there is a space for entering a symbol, the cursor moves to the next position of the field, otherwise – it moves to the first position of the next field. If next field is absent cursor switches off and in Status register flag ST_INPREADY is set (enter is completed correctly). At pressing Cancel current symbol is cleared and cursor moves back. If a cursor has no place to move back to (it was located on the 1st position of 1st field)

it switches off and in Status register flag ST_INPESC is settled (enter is completed by ESC or enter is cancelled).

Picture 5.   Symbols table.

2. Connection parameters.

Settings parameters for Com-port see in table 2.1.

Table 2.1 – Connection parameters

Parameter	Value
Connection speed, baud	9600
Quantity of bit data	8
Parity control	none
Stop bit quantity	2
Operation mode	asynchronous

3. MODBUS registers map.

List of registers available to external unit is provided in table 3.1 In register description first (upper) byte is upper byte.

Table 3.1 – Terminal register map

Address	Name	Access	Description
0	Inp (hi)	R/W*	Upper register byte is not used.
	Inp (lo)		Indicator of pressed buttons. Bit 0 – Up key, bit 1 – Down key, bit 2 – Enter key, bit 3 – Cancel key. Other bits are not defined
1	Key_B1	R/W	1 and 0 bytes of the key used for card authorization.
	Key_B0		
2	Key_B3	R/W	3 and 2 bytes of the key used for card authorization
	Key_B2		
3	Key_B5	R/W	5 and 4 bytes of the key used for card authorization.
	Key_B4		
4	BlockBytes1	R/W	16-bytes block that is used for card operations READ_BLOCK and WRITE_BLOCK. During reading this card data value of 16-byte block is written in this field. During data writing 16-byte value from this field is written onto the card. Registers 4 and 5 (BlockBytes0, BlockBytes1, BlockBytes2, BlockBytes3) are also used in such operations as INCREMENT_BLOCK and DECREMENT_BLOCK. This field can also be used for fine adjustment of CLRC632 microchip as a 16-byte input/output buffer in accordance with SPI. During that BlockBytes1 is first buffer byte, BlockBytes0 – second, BlockBytes3 – third,…, BlockBytes14 – sixteenth. Number of bytes that should be transferred through SPI interface to CLRC632 are in BlockAd.
	BlockBytes0		
5	BlockBytes3	R/W	
	BlockBytes2		
6	BlockBytes5	R/W	
	BlockBytes4		
7	BlockBytes7	R/W	
	BlockBytes6		
8	BlockBytes9	R/W	
	BlockBytes8		
9	BlockBytes11	R/W	
	BlockBytes10		
10	BlockBytes13	R/W	
	BlockBytes12		
11	BlockBytes15	R/W	
	BlockBytes14		
12	CardResult	R/W*	Code of result during performing card operations, see table 3.2. Can be changed a few times before card finishes operation, showing result of the stage. After finishing card operation CardResult does not change and saves its result.

Address	Name	Access	Description
	Status		State of the terminal, see table 3.3
13	CardOperation	R/W	Batch command set for a card that terminal should perform at activating card reading, see table 3.6.
	BlockAd		Address of authorized 16-byte block. During sending data to CLRC632 microchip through SPI it saves value of batch length (2..16 byte).
14	CardUID1	R	Bytes 1 and 0 of card's unique number. Is set after successful choice (Select, connection) of the card.
	CardUID0		
15	CardUID3	R	Bytes 3 and 2 of card's unique number..
	CardUID2		
16	KeyInput1	R	1st and 2nd symbols entered from keyboard. 1st symbol is in upper register byte. For symbols codes description see tables 3.4 and 3.5.
	KeyInput2		
		-/-	
21	KeyInput11	R	11th and 12th symbols entered from keyboard. 11th symbol is in upper register byte.
	KeyInput12		
22	LcdBuf1	R/W	1st and 2nd symbols' codes that are displayed in accordance with table 1.1. Code of 1st symbol is in upper register byte.
	LcdBuf2		
		-/-	
61	LcdBuf79	R/W	79th and 80th symbols' codes that are displayer in accordance with table 1.1. Code of 79th symbol is in upper register byte.
	LcdBuf80		
	Registers in non-volatile terminal memory		
62	StatusF	R/W	Has impact over starting Status setting.
	CardOperationF		Has impact over starting CardOperation setting.
63	Key_B1F	R/W	Value of this register is copied into register with address 1 during loading of the terminal.
	Key_B0F		
64	Key_B3F	R/W	Value of this register is copied into register with address 2 during loading of the terminal.
	Key_B2F		
65	Key_B5F	R/W	Value of this register is copied into register with address 3 during loading of the terminal.
	Key_B4F		
66	Not used	R/W	
	Address		Terminal MODBUS address.
	Access registers to card blocks for MODBUS commands with codes 03,04 and 16 (register address in HEX format)		
1000h	CardB1	R/W*	1st and 0th byte of 0th card block
	CardB0		
		-/-	
17FFh	CardB4095	R/W*	Last and second to last byte of 255 card block. Available only for Mifare Standard 4k cards.
	CardB4094		

Table 3.2 – CardResult values description

Code	Description
0	No result.
1	Processing.
2	Completed successfully.
3	No card.
4	No reply.
5	Collision error
6	Parity error.
7	Frame error.
8	Format is not supported.
9	Unknown protocol.
10	CRC error.
11	Block authorization error.
12	Key error.
13	Crypto is not on.
14	No permission.
15	Transfer error.
16	Card reply: NACK, not allowed.
17	Card reply: NACK, transmission error.

Table 3.3 – Status description

Bit	Name	Notes
0	ST_PASSCHAR	When this flag is set and the controller is in field entry mode, all data entered by user via keyboard are shown as asterisks, with exception of the symbol that is being currently entered.
1	ST_CARDREQ	This flag indicates that a card operation is in process. Setting this flag initiates start of card operation in accordance with CardOperation and reset the flag ST_CARDREADY. If there was another card operation in progress it will be aborted and new one will begin. Writing 0 in this flag does not interrupt and does not cancel current car operation, in this case 0 will not be written into ST_CARDREQ flag.
2	ST_CARDREADY	This flag is set after completion of an operation result of which can be read in CardResult. Writing 1 in this flag interrupts current card operation and reset the flag ST_CARDREQ (flags ST_ CARDREQ=0, ST_CARDREADY=1 will be set up), 0 is written into CardResult. In case 1 will be written simultaneously into ST_CARDREQ and ST_CARDREADY flags the following chain of events would follow: if there is an operation in progress it will be interrupted (ST_ CARDREQ=0, ST_CARDREADY=1), if not – it will begin (ST_ CARDREQ=1, ST_CARDREADY=0). It is not recommended to use such combination of flags. Writing 0 in this flag will not have any effect, flag value will not change.

3	ST_INPESC	In field enter mode this bit will be set if key Cancel is pressed on terminal's keyboard when the cursor is on starting position of the 1st field, flag ST_INPREADY will be cleared. In symbols enter mode this flag can be set up only with flag ST_INPREADY and means that in buffer of symbols that were entered from keyboard (KeyInput1..KeyInput12) there is a symbol with code 2 (Cancel key was pressed). If 1 is written in this flag, flags ST_INPESC and ST_INPREADY are cleared as well as entry buffer ST_INPESC and ST_INPREADY. In field enter mode cursor is set into starting position of 1st field (if there are no fields then the cursor is not shown and flag ST_INPREADY is set). Writing 0 in this flag will not have any effect, flag will not be re-written.
4	ST_INPREADY	In field enter mode this flag will be set after entering symbol in the last field (if there are no field it is set at once), and the cursor is switched off. in symbols enter mode this flag is set in case in enter buffer (KeyInput1..KeyInput12) there is at least 1 symbol, but if there is a symbol with code 2 (Cancel key was pressed) the flag ST_INPESC will be set. On writing 1 in this flag flags ST_INPESC and ST_INPREADY are cleared, as well as entry buffer (KeyInput1..KeyInput12). In field enter mode cursor is located on starting position of the 1st field (if there are no fields then the cursor is not shown and flag ST_INPREADY is set). Writing 0 in this flag will not have any effect, flag will not be re-written.
5	ST_KEYA	If this bit is set then during performing card operation terminal would perform block authorization with key A, during that in the fields KeyB0..KeyB5 there should be a real value of key A. if this bit has been reset ed terminal would perform block authorization with key B, during that in the fields KeyB0..KeyB5 there should be a real value of key B.
6	ST_CHAR	If the flag is set then symbols entry is performed, thus cursor is not shown on the screen. If the flag is cleared the terminal performs field entry. On changing flag value entry buffer is cleared (KeyInput1..KeyInput12), ST_INPESC and ST_INPREADY are cleared. In field enter mode cursor is located on starting position of the 1st field (if there are no fields then the cursor is not shown and flag ST_INPREADY is set).
7	ST_INIT	This flag is set during terminal loading and can signal to the master device (upper level program) about terminal overload. to clear this flag it is necessary to write 1 into it. Writing 0 in this flag will not change its value.

Table 3.4 – Codes' values that are in enter buffer KeyInput1..KeyInput12 I symbols enter mode

Code	Decription
0	These are symbols that are in the buffer when it is cleared.
1	Enter key was pressed.
2	Cancel key was pressed.
3	Up key was pressed.
4	Down key was pressed.

Table 3.5 – Codes values that are in enter buffer KeyInput1..KeyInput12 in fields enter mode

Code	Decription
32(20h)	These are symbols that are in the buffer when it is cleared (for space code see picture 1.1)
48(30h)	Number 0, see picture 1.1.
49(31h)	Number 1, see picture 1.1.
57(39h)	Number 9, see picture 1.1.
45(2Dh)	Symbol «-», see picture 1.1. This symbol can be entered only in the 1st position of a field.

Table 3.6 – Description CardOperation

Bit	Name	Notes
7	CO_Select	At performing each card operation as a first step value of this flag is checked. If it is set then the antenna carrier signal is switched on, card is activated and chosen via anticollision algorithm (establishing connection to a card). If card operation was started via setting ST_CARDREQ flag (a record in Status register), then terminal will infinitely try to connect with the card until it succeeds (or the operation will be cancelled) and after establishing connection will go to the next step (see description for CO_AuthBlock). If card operation was started via addressing to 1000h-17FFh by reading or writing 8 register command then the terminal makes only 2 attempts on connecting with the card, in case it succeeds it will go to the next step. Otherwise master device will receive an error with code 04 – Slave Device Failure. In case this step is successfully completed regardless of the way operation was begun CardUID0..CardUID3 field would hold card's unique number.
6	CO_AuthBlock	At performing any card operation value of this flag is checked as a second step (if the previous step did not cause an error), if it is set then 1st attempt (unlike the 1st step) to authenticate (authorize) which block address is saved in BlockAd, and the key is saved in Key_B0..Key_B5. If ST_KEYA of Status register is set then block authorization will be performed via key A, otherwise – via key B. If card operation was started via addressing field 1000h- 17FFh by reading or writing 8 register command (performing card operation in such way automatically changes BlockAd and BlockBytes0.. BlockBytes15), then the next step will be READ_BLOCK or WRITE_BLOCK in case this step succeeds. Otherwise master device will receive an error with code 04 – Slave Device Failure.

| 4..0 | CO_MainOper | If card operation was started via setting ST_CARDREQ flag (a record in Status register), then third step will be performing the operation (1st attempt) (if the previous step did not cause an error), coded by 5 lower bites of CardOperation. Description of CO_MainOper values:

0: no operation, step is skipped
1: READ_BLOCK - reading block with BlockAd address from the card to field BlockBytes0.. BlockBytes15.
2: WRITE_BLOCK - writing a block with BlockAd address in the card with values from BlockBytes0.. BlockBytes15.
If card operation was started via addressing to 1000h-17FFh field by reading or writing 8 registers command and this step concluded with an error then the master device will receive an error with 04 code – Slave Device Failure
3: INCREMENT_BLOCK – increasing value of block with BlockAd address by value BlockBytes0..BlockBytes3 (4 bytes), result is saved in unit's regular (not non-volatile) memory
4: DECREMENT_BLOCK – decreasing value of block with BlockAd address by value BlockBytes0..BlockBytes3 (4 bytes), result is saved in unit's regular (not non-volatile) memory
5: TRANSFER_BLOCK – saves/transfers value of calculations that were performed with a block (operations INCREMENT_BLOCK or DECREMENT_BLOCK) from regular memory to non-volatile memory.
6: RESTORE_BLOCK – restores block value in regular card memory from non-volatile (cancelling operation INCREMENT_BLOCK and DECREMENT_BLOCK).
7: INCREMENT_BLOCK + READ_BLOCK – increasing value of block with BlockAd value by BlockBytes0..BlockBytes3 (4 bytes), result is saved in regular card memory (not non-volatile), then reading initial (non-incremented) value of the block to the field BlockBytes0.. BlockBytes15.
8: DECREMENT_BLOCK + READ_BLOCK – this operation is analogue to previouns one, but decrease is performed instead of increase.
9: INCREMENT_BLOCK + TRANSFER_BLOCK + READ_BLOCK – increasing value of block with BlockAd address by BlockBytes0..BlockBytes3 (4 bytes), saving result in non-volatile card memory, then reading block value to field BlockBytes0.. BlockBytes15 is performed.
10: DECREMENT_BLOCK + TRANSFER_BLOCK + READ_BLOCK – this operation is analogue to previouns one, but decrease is performed instead of increase.
11: Transfer to CLRC632 via SPI. FieldBlockBytes0..BlockBytes15 is used as 16-byte input/output buffer via SPI. At that BlockBytes1 – first buffer byte, BlockBytes0 – second, BlockBytes3 – third,…, BlockBytes14 – sixteenth. Number of bytes that are to be transferred via SPI interface to CLRC632 are in BlockAd (from 2 to 16). |
| 5 | CO_ShutDown | At performing every card operation value of this flag is checked as a last step (if previous steps succeeded), if it is set then antenna carrier signal is switched off. Card is deenergized. |

4.   Terminal registers description.

Register Inp is designed for reading information on keys that are currently pressed. Only last 4 lower bits are documented. At attempt of writing in this register there would be no error, writing would influence only value of upper byte register.

Registers with addresses 1..3 (Key_B0..Key_B5) contain 6-byte value of the key that is used in block authorization operation. During terminal loading registers Key_B0F..Key_B5F are copied into Key_B0..Key_B5. In case flag ST_KEYA of Status register is set then this value is used as key A, otherwise - at key B. It is possible to read or write this field.

Registers with addresses 4..11 (BlockBytes0.. BlockBytes15) are used as buffer for exchanging information with the card (regardless of the way the card operation was begun). Registers 4,5 (BlockBytes0, BlockBytes1) are used as operand in operations NCREMENT_BLOCK and DECREMENT_BLOCK. The field can also be used as 16-byte buffer for information exchange with CLRC632 via SPI. It is possible to read or write this field.

CardResult register is an upper byte of MODBUS register with address 12. Attempt of writing in this register would cause neither any effect, nor error. This register can change its value many times at performing card operation, showing its intermediate states. for example, during attempts to connect to the card (card operation was started by setting ST_CARDREQ flag of Status register) that is not in card reading panel, this register will have value 4 - no reply (see table 3.2), after card is put against card reading panel and all other steps are successfully completed in Status register flag ST_CARDREADY and CardResult register writes final value 2 - completed successfully. After setting ST_CARDREADY flag CardResult value will not change and via table 3.2 it is possible to define what was a result of card operation.

Status register is MODBUS register lower byte with address 12. This register is the main mean of terminal control and monitoring. After writing in this register its value may not correspond with the written one.

During initial loading of the terminal flag ST_INIT is set and flags ST_CARDREQ, ST_CARDREADY, ST_INPREADY, ST_INPESC are cleared, bit 6 of StatusF register is copied into ST_CHAR Status register, bit 5 - into ST_KEYA, bit 0 - into ST_PASSCHAR. For additional information on this register see table 3.3.

Register CardOperation is upper byte of MODBUS register with address 13. At terminal loading value of CardOperationF register is copied in register CardOperation without checking card operation code compatibility, which can lead to performing the next stage with an error. At the beginning of card operation value of this register is saved in non-accessible field, thus if master device (program of upper level) would change value of this register prior to card operation completion, this change would not have any effect on current card operation.

This register describes starting actions of card operation: switching on carrying wave, choosing card, block authorization; main action: no operation, READ_BLOCK, WRITE_BLOCK, …, transition via STI; concluding action: switching off carrying wave. In case card operation was started by addressing 1000h-17FFh field with reading or writing 8 register command, then main action (READ_BLOCK, WRITE_BLOCK) is defined by the command, not value of the register, other bits of this register in this case are also taken into account. For more detailed information on CardOperation register see table 3.6.

BlockAd register is a lower byte of MODBUS register with address 13. this register contains address of operation block in card operations. In case card operation was started by addressing 1000h-17FFh field with reading or writing 8 register command the value of this register is automatically changed for address of that block in the card that is being addressed to. Also this register can contain a number of bytes (from 2 to 16) that are to be transferred to microchip CLRC632 via SPI. It is not recommended to rewrite this register before card operation is over.

Registers with addresses 14 and 15 contain CardUID0..CardUID3 - card's unique number. This field is written after successful connection with the card (see description for CO_Select in table 3.6). This field is available only for reading.

Registers with addresses 16..21 (KeyInput1..KeyInput12) are keyboard enter buffer, where in each of these registers upper byte has a previously entered number. This field is available only for reading.

Registers with addresses 22..61 (LcdBuf1..LcdBuf80) are memory area that is displayed. Each memory element contains a code of a symbol which picture can be found on picture 1.1. Upper register byte in this area contain a code of a symbol which is displayed earlier (more on the left or higher) that the symbol in lower register. At writing even 1st register in this area screen contents is immediately updated and KeyInput1..KeyInput12 are cleared.

Register StatusF is an upper byte of MODBUS register with address 62 that is stored in non-volatile unit memory. Purpose of this register – initial initialization of Status register. During loading of the terminal bit 6 of StatusF register is copied into ST_CHAR of Status register, bit 5 – into ST_KEYA, bit 0 – into ST_PASSCHAR. This register is available both for reading and writing.

CardOperationF register is lower byte of MODBUS register with address 62, it is located in non-volatile memory of the terminal and its purpose is initial initialization of CardOperation register. During loading of the terminal value of CardOperationF register is copied into CardOperation register without card operation code validation that can lead to an error in the following card operation. This register is available both for reading and writing.

Registers with addresses 63..65 (Key_B0F..Key_B5F) are located in non-volatile memory of the terminal and contain values for registers 1..3 (Key_B0..Key_B5) initialization. During loading of the terminal registers Key_B0F..Key_B5F are copied into Key_B0..Key_B5. These registers are available both for reading and writing.

Address register is lower byte of the register with address 66 that is located in non-volatile memory of the terminal and contains MODBUS address of the terminal. At writing in this register terminal address

changed without terminal restart.

Registers with addresses 1000h..17FF (CardB0..CardB4095) are virtual, which means they do not possess any corresponding physical memory in terminal (RAM, ROM or EEPROM). Terminal qualifies addressing this memory as attempt to read or write information to a card of Mifare Classic standard. There are two rules on working with this memory: 1) reading or writing is allowed only for 8 registers, that is due to the fact that data exchange with the card is performed by 16-byte blocks (8 registers); 2) address if initial register should conform the formula addr_reg_start=8*block_address+1000h where block_address – address of necessary block in Mifare Classic card (for Mifare Standard 4k it is block_addres=0..255). At addressing this memory of the following positions takes place: register BlockAd (value (addr_reg_start-1000h)/8), BlockBytes0..BlockBytes15, CardUID0..CardUID3, CardResult fields, ST_CARDREADY flag of Status register.

5. Entry of information to the terminal from the keyboard.

Terminal has 4 keys (Up, Down, Enter, Cancel) to perform entry. Current state of keys can be read in Inp. register.

Symbols that were entered by user (see tables 3.4 and 3.5) are entered in KeyInput1..KeyInput12 fields. In symbols enter mode (see description of ST_CHAR bit in table 3.3) KeyInput1 contains code of first pressed button, KeyInput2 - of the second, etc. In field enter mode (ST_CHAR=0) (description of this regime see in Introduction) KeyInput1 contains symbol that was entered for first curly brace (symbol "{" (code 7B hex) in display memory LcdBuf1..LcdBuf80), KeyInput2 for the second etc. Enter buffer it automatically cleared (as well as flags ST_INPREADY and ST_INPESC) in the following cases:

  · during writing in display memory LcdBuf1..LcdBuf80;

  · at changing enter mode (when value of ST_CHAR bit changes);

  · at writing 1 into ST_INPREADY or ST_INPESC flag (1 will not be written, entry buffer and these flags will be cleared).

In field enter mode after entry buffer is cleared (as well as ST_INPREADY and ST_INPESC) cursor on the display of the terminal will be set to starting position of the 1st field, in case there are no fields (in display memory LcdBuf1..LcdBuf80 there is not any symbol "{" (code 7B hex)) cursor will switch off and flag ST_INPREADY will be set.

In symbols enter mode (ST_CHAR=1) ST_INPREADY flag is set as soon there is at least 1 symbol in enter buffer, ST_INPESC flag is set (only with the ST_INPREADY flag) if in the entered sequence there is at least one symbol with code 2 - Cancel key was pressed.

In field enter mode only one of two flags can be set - either ST_INPREADY or ST_INPESC - and cursor on display switches off.

6. Working with Milfare card.

There are two ways to start card operation:

1 – setting ST_CARDREQ bit in Status register, at this if a CO_Select flag of CardOperation register is set terminal will wait infinitely for a card to be put against reading zone. This method of card operation performing allows conducting full range of card operations including INCREMENT_BLOCK, DECREMENT_BLOCK, TRANSFER_BLOCK and RESTORE_BLOCK

2 - Through addressing 1000h-17FFh field by reading or writing 8 registers command. At that for the moment of performing the operation card should be in reading zone, otherwise master device will receive an error with code 04 – Slave Device Failure. Operations INCREMENT_BLOCK, DECREMENT_BLOCK, TRANSFER_BLOCK and RESTORE_BLOCK are not available for this method.

At any method of card operation start, flags CO_Select and CO_AuthBlock (CardOperation register) affects the beginning of card operation, and CO_ShutDown affects its end (in case previous steps did not cause an error).

Important! If card operation caused an error (register CardResult received a result different from 2), the next card operation should be performed with a set CO_Select flag of CardOperation register.

Important! After performing inner card operation, step that corresponds with CO_Select (activation of inner anticollision) authorization of the block that has been previously authorized is cancelled.

Important! For block authorization BlockAd register should be in its address, but if authorization was successful (card operation spet that corresponds with the flag CO_AuthBlock) not only this block will be authorized, but whole sector where it is located. For example: after authorization of block with address 6 you can read or write information in block with addresses 4, 5, 6, 7, thus in the following reading of block with address 4 CO_AuthBlock bit can be cleared (which means that bit CO_Select must obligatorily be cleared because processing this step cancels all authorization).

During working with a card the following registers are used: Status (ST_CARDREQ, ST_CARDREADY, ST_KEYA), Key_B0..Key_B5, BlockBytes0..BlockBytes15, CardResult, CardOperation, BlockAd, CardUID0..CardUID3, CardB0.. CardB4095.

7.   Using MODBUS protocol.

Table 3.1 has a list of registers that are available to access by using functions of MODBUS protocol. If a register has an R accessibility (derived from Read) then in accordance with MODBUS protocol this register is available only for reading, at attempt of writing this register master device (upper level software) would receive an error with code 02 – ILLEGAL DATA ADDRESS. If the

register has R/W accessibility (derived from Read/Write) both reading and writing this register are allowed. If the register has R/W accessibility but is not in the field CardB0..CardB4095 this means that on attempts of writing this register there will be no mistake but value of the register after writing may not correspond with the value that was written into it.

During working with terminal in accordance with MODBUS protocol functions with the following codes are available:

03, 04 – Read Holding Registers, Read Input Registers. Maximum number of registers that master device can read with one command. - 22. At attempts of reading larger registers master device would receive an error with code 02 – ILLEGAL DATA ADDRESS.

 06 – Write Single Register.

16 (10h) – Write Multiple Registers. Maximum number of registers that can be written with one command - 20. At attempts of writing larger registers master device would receive an error with code 02 – ILLEGAL DATA ADDRESS. One such command can change Key_B0..Key_b5, BlockBytes0..BlockBytes15, CardOperation, BlockAd, start a card operation by setting ST_CARDREQ flag and clear keyboard entry buffer (terminal keys) by writing 1 into flags ST_INPREADY or ST_INPESC (1 will not be written, entry buffer and these flags will be cleared).

The terminal does not support other MODBUS functions, at attempt of performing function with another code master device will receive an error with code 01 – ILLEGAL FUNCTION.