

PLC411.1

embedded hard- and software platform

TECHNICAL DESCRIPTION

1.0.0
2023

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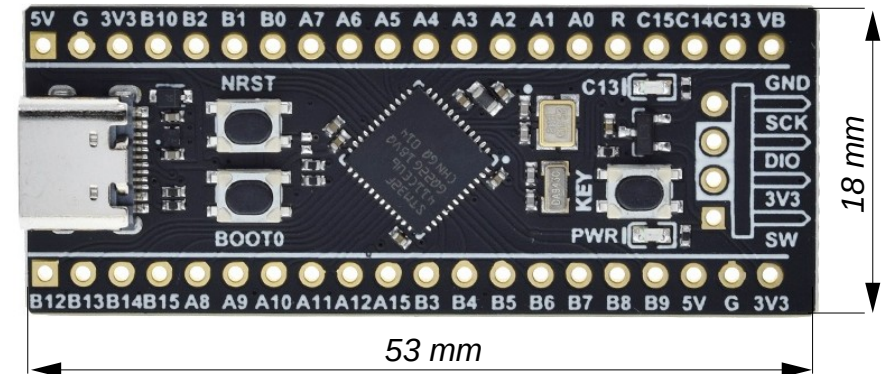
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HARDWARE PLATFORM

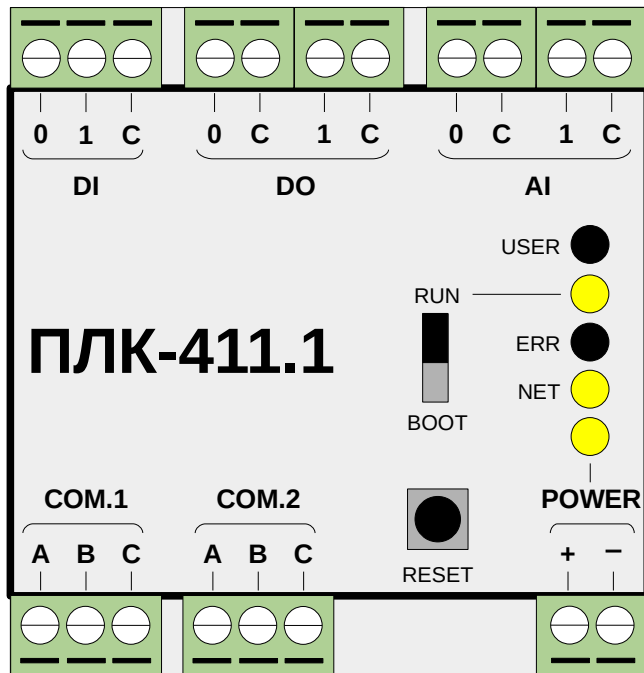
STM32F411 BLACK PILL v3.0

MCU	STM32F411CE
CORE	ARM Cortex-M4 32-bit RISC + <i>floating point unit (FPU)</i> + <i>adaptive real-time accelerator (ART)</i>
CLOCK FREQUENCY	100 MHz + <i>used external resonator on 25 MHz</i>
POWER	3,3 V DC
FLASH	512 kB
SRAM	128 kB
GPIO	36
ADC	1x 12bit (16-channels)
DAC	no
DMA	1x DMA (16-channels)
INTERFACES	3x USART 5x SPI 3x I2C 1x USB 1x SDIO
RTC	1x RTC + <i>used external resonator on 32,768 kHz</i>
JTAG/SWD	1x SWDIO



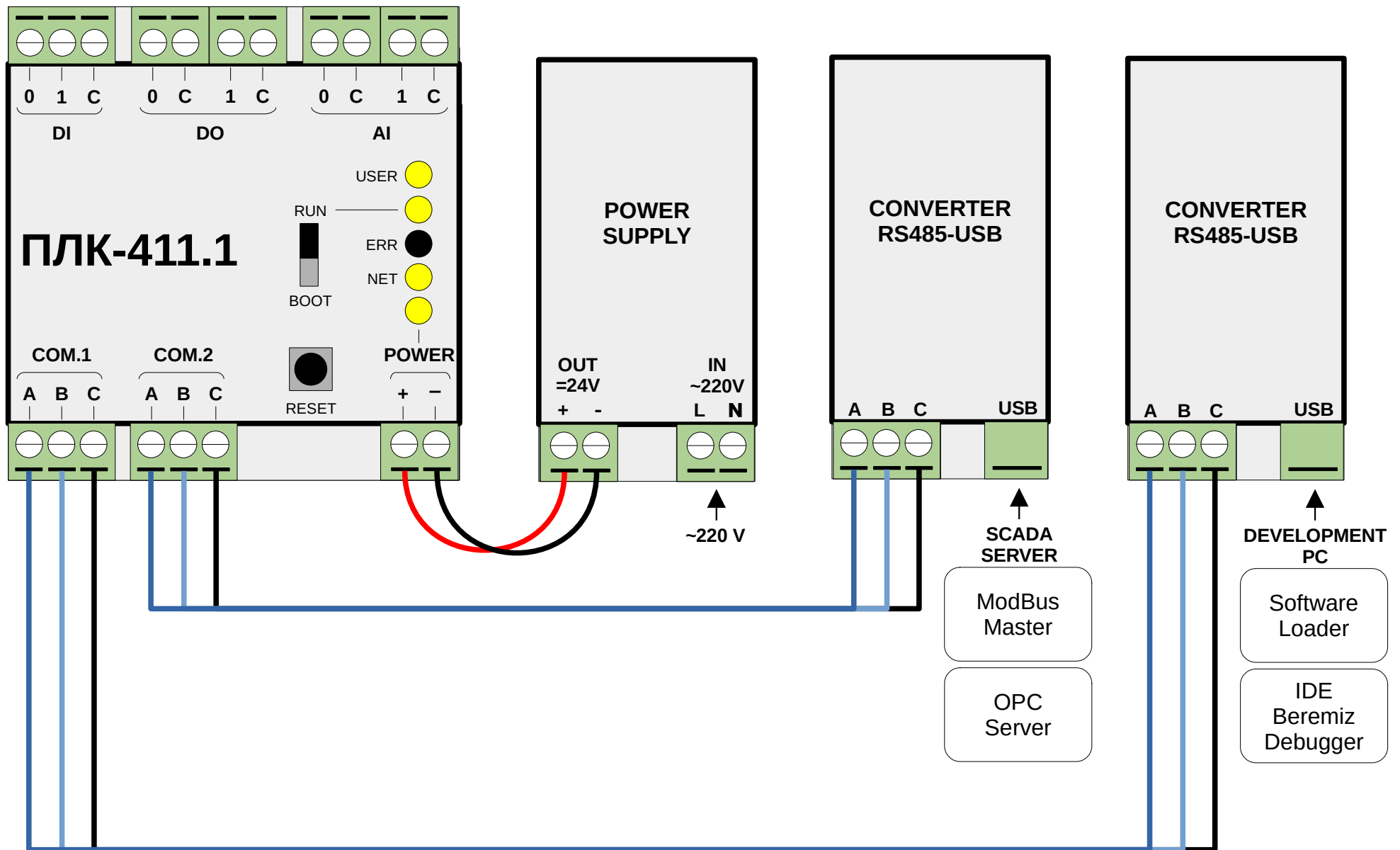
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HOUSING VARIANT



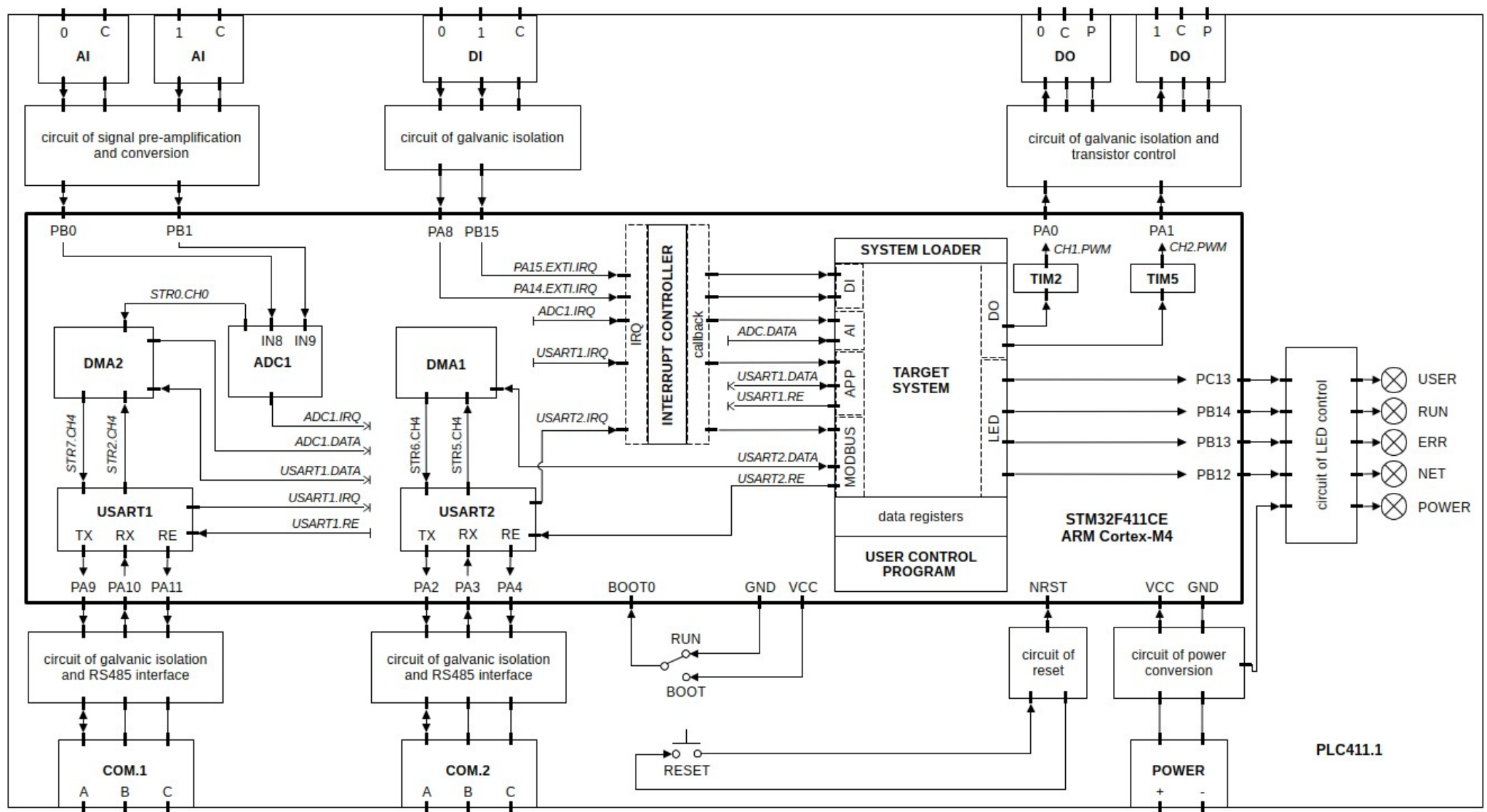
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EXTERNAL FUNCTIONAL SCHEME



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INTERNAL FUNCTIONAL SCHEME



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TECHNICAL SPECIFICATION

periphery	description
DI quantity functions PLATFORM.GPIO	Digital input channels = 2 = off, normal input, pulse counter, tachometer, 1- or 2-channel incremental encoder = 3.3 V DC, max 20 mA <i>* Pulse Tmin=1 kHz</i>
DO quantity functions PLATFORM.GPIO	Digital output channels = 2 = off, normal output, fast output, PWM = 3.3 V DC, max 20 mA <i>* PWM Tmin=100 kHz</i>
AI quantity functions PLATFORM.GPIO	Analog input channels = 2 = off, survey = 3.3 V DC, max 20 mA
COM.1 quantity functions PLATFORM.UART	Serial network interface = 1 = software loader (firmware, user control program), IDE Beremiz debugger (user control program) = 57600 8 N 1, net.address = 1
COM.2 quantity functions PLATFORM.UART	Serial network interface = 1 = ModBus RTU Slave (read/write) = 115200 8 N 1, net.address = 1 <i>* ModBus protocol specificatopn v.1.1b</i>
POWER quantity functions PLATFORM.PWR	Power input and led = 1 = electrical power of the device and power status indication = 5.0 V DC (or 3.3 V DC)

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TECHNICAL SPECIFICATION

periphery	description
RUN/BOOT quantity functions	Switcher and led = 1 = set operating mode of the target system and indication of the user control program status <i>* RUN — work of the target system and user control program</i> <i>* BOOT — work of the MCU system loader (to update the firmware and user program)</i>
RESET quantity functions	Button = 1 = reset of the platform
USER quantity functions	Led = 1 = user indication <i>* control from ModBus or from the user program</i> <i>* works in RUN mode</i>
ERR quantity functions	Led = 1 = <i>indication of the target system errors</i> <i>* works in RUN mode</i>
NET quantity functions	Led = 1 = indication of data transfer over COM.1 or COM.2 <i>* works in RUN mode</i>

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MEMORY ALLOCATION

Memory	Segment		
	alias	size	start address
SRAM	RAM <i>(target system)</i>	100 kB	0x20000000
	RAM_APP <i>(user program)</i>	28 kB	0x20019000
FLASH	FLASH <i>(target system)</i>	256 kB	0x08000000
	FLASH_APP <i>(target system)</i>	256 kB	0x08040000

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TARGET SYSTEM

RTOS	FreeRTOS 10.3.1
Runtime system	RTE 1.0.0, 14.04.2023 <i>* C-language, CMSYS ARM CORTEX-M, HAL STM32F4</i>

REG	Data register tables <i>* addressing for Beremiz and ModBus</i>
DI_Task	DI task = execution of operating modes and synchronization with data registers <i>* the task is running in blocking mode (waiting for data from EXT.IRQ or DATA manager)</i>
DO_Task	DO task = execution of operating modes and synchronization with data registers <i>* the task is running in blocking mode (waiting for data from DATA manager)</i>
AI_Task	AI task = execution of operating modes and synchronization with data registers <i>* the task is running in blocking mode (waiting for data from ADC.DMA.IRQ or DATA manager)</i>
COM1_Task	COM1 task = execution of Beremiz YAPLC debug protocol <i>* the task is running in blocking mode (waiting for data from UART.DMA.IRQ)</i>
COM2_Task	COM2 task = execution of ModBus RTU Slave protocol <i>* the task is running in blocking mode (waiting for data from UART.DMA.IRQ)</i>
LED_Task	LED task = control of led: USER, RUN, ERR, NET <i>* the task is running in blocking mode (waiting for data from COM1_Task, COM2_Task, APP_Task, DATA_Task)</i>
APP_Task	APP task = execution of user program and debug protocol <i>* the task is running in non-blocking mode</i>
DATA_Task	DATA task = data manager <i>* the task is running in non-blocking mode</i>

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USER CONTROL PROGRAM

IDE	Beremiz YAPLC 1.2-e521602 * IEC-61131-3
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system libraries

PLC411_MAIN	Inc, Dec, GetBit, SetBit, ScaleAna, PIDtun, PID, FLRtun, FLR
PLC411_SYS	SoftReset, LedUser
PLC411_DI	DIMode, DINorm, DITach, DICntr, DICntrRst, DIEnc
PLC411_DO	DOMode, DONorm, DOFast, DOPwm
PLC411_AI	AIMode, AINorm

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ADDRESSING OF DATA REGISTERS

Access	Interface
local	User control program
network	COM2 / ModBus RTU Slave

Local addressing

%[code of **Memory zone**][code of **Data type**][**address**]

Mem zone	description	
I	input	value of input channel
M	memory	settings, commands, other data
Q	output	value of output channel

address						
code of register group	.	number of channel	.	code of register subgroup	.	code of data

Data type	associated by languages		size	
	IEC	C	Byte	bit
X	BOOL	uint8_t	1	8
B	BYTE, USINT SINT	uint8_t int8_t	1	8
W	WORD, UINT INT	uint16_t int16_t	2	16
D	DWORD, UDINT DINT REAL	uint32_t int32_t float	4	32
L	LWORD, ULINT LINT LREAL	uint64_t int64_t double	48	64

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ADDRESSING OF DATA REGISTERS

Register	Data type	Access				EEPROM
		Beremiz	ModBus			
		address	address	table	byte order	
DI.0 Normal: Value	BOOL	%IX1.0.1.1	0	DISC.INPUTS		
DI.1 Normal: Value	BOOL	%IX1.1.1.1	1	DISC.INPUTS		
DI.0 Tachometer: Value (pulses/sec)	WORD	%IW1.0.2.1	0	INPUTS	1-0	
DI.1 Tachometer: Value (pulses/sec)	WORD	%IW1.1.2.1	1	INPUTS	1-0	
DI.0 Tachometer: Setpoint (pulses/sec)	WORD	%MW1.0.2.2	0	HOLDINGS	1-0	
DI.1 Tachometer: Setpoint (pulses/sec)	WORD	%MW1.1.2.2	1	HOLDINGS	1-0	
DI.0 Tachometer: Allow to work by setpoint	BOOL	%MX1.0.2.3	0	COILS		
DI.1 Tachometer: Allow to work by setpoint	BOOL	%MX1.1.2.3	1	COILS		
DI.0 Tachometer: Flag of setpoint reached	BOOL	%MX1.0.2.4	2	DISC.INPUTS		
DI.1 Tachometer: Flag of setpoint reached	BOOL	%MX1.1.2.4	3	DISC.INPUTS		
DI.0 Counter: Value (pulses)	DWORD	%ID1.0.3.1	2	INPUTS	1-0 3-2	
DI.1 Counter: Value (pulses)	DWORD	%ID1.1.3.1	4	INPUTS	1-0 3-2	
DI.0 Counter: Setpoint (pulses)	DWORD	%MD1.0.3.2	2	HOLDINGS	1-0 3-2	
DI.1 Counter: Setpoint (pulses)	DWORD	%MD1.1.3.2	4	HOLDINGS	1-0 3-2	
DI.0 Counter: Allow to work by setpoint	BOOL	%MX1.0.3.3	2	COILS		
DI.1 Counter: Allow to work by setpoint	BOOL	%MX1.1.3.3	3	COILS		
DI.0 Counter: Flag of setpoint reached	BOOL	%MX1.0.3.4	4	DISC.INPUTS		
DI.1 Counter: Flag of setpoint reached	BOOL	%MX1.1.3.4	5	DISC.INPUTS		
DI.0 Mode	BYTE	%MB1.0.4	6	HOLDINGS	1-0	
DI.1 Mode	BYTE	%MB1.1.4	7	HOLDINGS	1-0	

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ADDRESSING OF DATA REGISTERS

Register	Data type	Access				EEPROM
		Beremiz	ModBus			
		address	address	table	byte order	
DI.0 Command to reset counter	BOOL	%MX1.0.5	4	COILS		
DI.1 Command to reset counter	BOOL	%MX1.1.5	5	COILS		
DI.0 Status code	BYTE	%MB1.0.6	6	INPUTS	1-0	
DI.1 Status code	BYTE	%MB1.1.6	7	INPUTS	1-0	
DI.0 Anti-aliasing filter (delay, msec)	DWORD	%MD1.0.7	8	HOLDINGS	1-0 3-2	
DI.1 Anti-aliasing filter (delay, msec)	DWORD	%MD1.1.7	10	HOLDINGS	1-0 3-2	
DO.0 Normal: Value	BOOL	%QX2.0.1.1	6	COILS		
DO.1 Normal: Value	BOOL	%QX2.1.1.1	7	COILS		
DO.0 Fast: Value	BOOL	%QX2.0.2.1	8	COILS		
DO.1 Fast: Value	BOOL	%QX2.1.2.1	9	COILS		
DO.0 PWM: Value (fill factor, % from period)	REAL	%QD2.0.3.1	12	HOLDINGS	1-0 3-2	
DO.1 PWM: Value (fill factor, % from period)	REAL	%QD2.1.3.1	14	HOLDINGS	1-0 3-2	
DO.0 PWM: Allow to work	BOOL	%MX2.0.3.2	10	COILS		
DO.1 PWM: Allow to work	BOOL	%MX2.1.3.2	11	COILS		
DO.0 PWM: Period (msec)	REAL	%MD2.0.3.3	16	HOLDINGS	1-0 3-2	
DO.1 PWM: Period (msec)	REAL	%MD2.1.3.3	18	HOLDINGS	1-0 3-2	
DO.0 Mode	BYTE	%MB2.0.4	20	HOLDINGS	1-0	
DO.1 Mode	BYTE	%MB2.1.4	21	HOLDINGS	1-0	
DO.0 Status code	BYTE	%MB2.0.5	8	INPUTS	1-0	
DO.1 Status code	BYTE	%MB2.1.5	9	INPUTS	1-0	

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ADDRESSING OF DATA REGISTERS

Register	Data type	Access				EEPROM
		Beremiz	ModBus			
		address	address	table	byte order	
AI.0 Normal: Value	REAL	%ID3.0.1	10	INPUTS	1-0 3-2	
AI.1 Normal: Value	REAL	%ID3.1.1	12	INPUTS	1-0 3-2	
AI.2 Normal: Value (MCU_TEMP)	REAL	%ID3.2.1	13	INPUTS	1-0 3-2	
AI.0 Mode	BYTE	%MB3.0.2	22	HOLDINGS	1-0	
AI.1 Mode	BYTE	%MB3.1.2	23	HOLDINGS	1-0	
AI.2 Mode	BYTE	%MB3.2.2	24	HOLDINGS	1-0	
AI.0 Status code	BYTE	%MB3.0.3	16	INPUTS	1-0	
AI.1 Status code	BYTE	%MB3.1.3	17	INPUTS	1-0	
AI.2 Status code	BYTE	%MB3.2.3	18	INPUTS	1-0	
AI.0 Scale factor (Ka)	REAL	%MD3.0.4	25	HOLDINGS	1-0 3-2	
AI.1 Scale factor (Ka)	REAL	%MD3.1.4	27	HOLDINGS	1-0 3-2	
AI.2 Scale factor (Ka)	REAL	%MD3.2.4	29	HOLDINGS	1-0 3-2	
AI.0 Scale factor (Kb)	REAL	%MD3.0.5	31	HOLDINGS	1-0 3-2	
AI.1 Scale factor (Kb)	REAL	%MD3.1.5	33	HOLDINGS	1-0 3-2	
AI.2 Scale factor (Kb)	REAL	%MD3.2.5	35	HOLDINGS	1-0 3-2	
PLC hardware code [411]	WORD	%MW7.1.0	19	INPUTS	1-0	
PLC hardware variant [1]	WORD	%MW7.1.1	20	INPUTS	1-0	
RTE version (bitfield: 8-11:Patch 5-7:Minor 4-0:Major) [1.0.0]	WORD	%MW7.1.2	21	INPUTS	1-0	
RTE version (year) [2023]	WORD	%MW7.1.3	22	INPUTS	1-0	
RTE version (day, month; bitfield: 6-10:MM 0-5:DD) [14.04]	WORD	%MW7.1.4	23	INPUTS	1-0	

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ADDRESSING OF DATA REGISTERS

Register	Data type	Access				EEPROM
		Beremiz	ModBus			
		address	address	table	byte order	
System statuses 1 (bitfield, see end of the table)	WORD	%MW7.1.5	24	INPUTS	1-0	
System statuses 2 (bitfield, see end of the table)	WORD	%MW7.1.6	25	INPUTS	1-0	
Safety timer of output channels: Time (sec)	WORD	%MW7.2.0	37	HOLDINGS	1-0 3-2	
MCU.WD timer: Time (sec)	WORD	%MW7.2.1	38	HOLDINGS	1-0 3-2	
LED_USER: Control command	BOOL	%MX7.3.0	12	COILS		
Safety timer of output channels: Command to reset	BOOL	%MX7.3.1	13	COILS		
MCU.WD timer: Command to reset	BOOL	%MX7.3.2	14	COILS		
User data: Booleans (0)	BOOL	%MX8.1.0	15	COILS		
...
User data: Booleans (31)	BOOL	%MX8.1.31	46	COILS		
User data: Numbers (0)	WORD	%MW8.2.0	39	HOLDINGS	1-0	
...
User data: Numbers (63)	WORD	%MW8.2.63	102	HOLDINGS	1-0	