Multifunctional measuring transducer



# M1000

# Manual

M1000.411187.001 Rev. 05.2022

# Table of contents

# Introduction

The Manual contains information about functions, recommendations for use, technical support, maintenance, packing, transportation, storage, as well as wiring diagrams to electrical grid, digital interfaces, digital I/O.

Read this manual carefully before using the device.

**Typical users**

Engineers, personnel involved in setting, operation and maintenance of the devices.

**Validity range**

This manual applies to all M1000 modifications.

**Support**

If you have any questions about the device, please, do not hesitate to contact technical support of TOO “Institute of Automation”:


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**ATTENTION:**

- When using M1000, follow the rules and information set in this manual;
- Only qualified personnel are supposed to install, operate and maintain M1000;
- Do not use any cleaners except recommended by manufacturer;
- M1000 must be kept from impact;
- Before connecting M1000 to power supply, you must ensure that power supply’s voltage corresponds to the voltage set in the label on M1000.

**NOTICE:**

- Our software is being constantly developed and implemented with new functions and features;
- New features may be added to the devices and software without announcing.

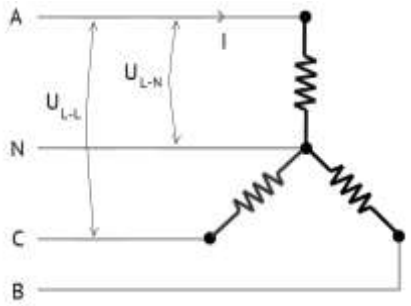
# Glossary and symbols

- AC – Alternating current
- ADC – Analog-to-digital converter
- DC – Direct current
- DI – Digital (binary) input
- DIO – Digital (binary) signal
- DO – Digital (binary) output
- EMC – Electromagnetic compatibility;
- PE – Protective earth;
- PC – personal computer;
- RTU – Remote Terminal Unit;
- SCADA –Supervisory Control and Data Acquisition
- SSR – Solid-state relay

$U_{L-L}$($U_{AB}$, $U_{BC}$, $U_{CA}$) – line-to-line voltage

$U_{L-N}$($U_A$, $U_B$, $U_C$) - line-to-neutral voltage

I ($I_A$, $I_B$, $I_C$) – phase current



# 1 General information

M1000 measures the full set of three-phase electrical grid parameters. It includes RMS of waveform combinations as well as the 1st harmonic parameters, e.g., effective voltage and current (each phase and line to line), active, reactive and apparent power (each phase and total), active and reactive energy import and export, power quality parameters. Digital input-output and programmable logic functionality enables it to play major role in automation systems. M1000 is able to exchange data via RS-485 (Modbus and IEC 60870-5-101 protocols) communication port.

M1000 is designed for use in SCADA and supervisory control centers of substations, power stations, ships, industrial mills, oil and gas production. It can transmit data directly to higher level of controlling system or through remote terminal unit (RTU), e.g., CM100.

M1000 is designed for continuous operation in industrial conditions.

M1000 is configured by ConfigTool software. ConfigTool allows to set required parameters for available interfaces and protocols and defining I/O configuration.

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## Conformity

The following table contains standards and certification of device.

| **Safety** | | | |
|---|---|---|---|
| | IEC 61010-1 | | |
| **EMC** | | | |
| **№** | Standard | Level | Class |
| **1** | IEC 61000-6-5 | - | - |
| **2** | IEC 61000-4-2 | 3 | A |
| **3** | IEC 61000-4-3 | 3 | A |
| **4** | IEC 61000-4-4 | 4 | A |
| **5** | IEC 61000-4-5 | 4 | A |
| **6** | IEC 61000-4-6 | 3 | A |
| **7** | IEC 1000-4-8 | 5 | A |
| **8** | IEC 1000-4-9 | 5 | A |
| **9** | IEC 1000-4-10 | 5 | A |
| **10** | IEC 61000-4-11 | - | A |
| **11** | IEC 61000-4-29 | - | A |
| **12** | IEC 61000-4-12 | 3*/4** | A |
| **13** | IEC 61000-4-13 | 3 | A |
| **14** | IEC 61000-4-14 | X (Special)*** | A |
| **15** | IEC 61000-4-16 | 4 | A |
| **16** | IEC 61000-4-17 | 3 | A |
| **17** | IEC 61000-4-28 | 4 | A |
| **18** | CISPR 22 | - | A |
| **19** | CISPR 11 | - | A-1 |
| **20** | IEC 60255-5 | - | - |
| *** Periodic interference 0.1 and 1 MHz;**<br>**** Solitary interference 0.1 MHz;**<br>***** $\Delta U=\pm 0.2U_n$, $U_n$ – nominal voltage.** | | | |

# 2 Design, dimensions, product identification system

M1000 has plastic case housing for DIN-rail mounting.

Interfaces: 2 x RS-485, USB

Terminals: measuring inputs, power inputs, two RS-485, 8 digital inputs, or set of 4 digital inputs and 3 outputs.


4 digital inputs, 3 digital outputs


8 digital inputs


Single phase, 4 digital inputs, 2 digital outputs

Figure 2.1 – M1000 modifications front view

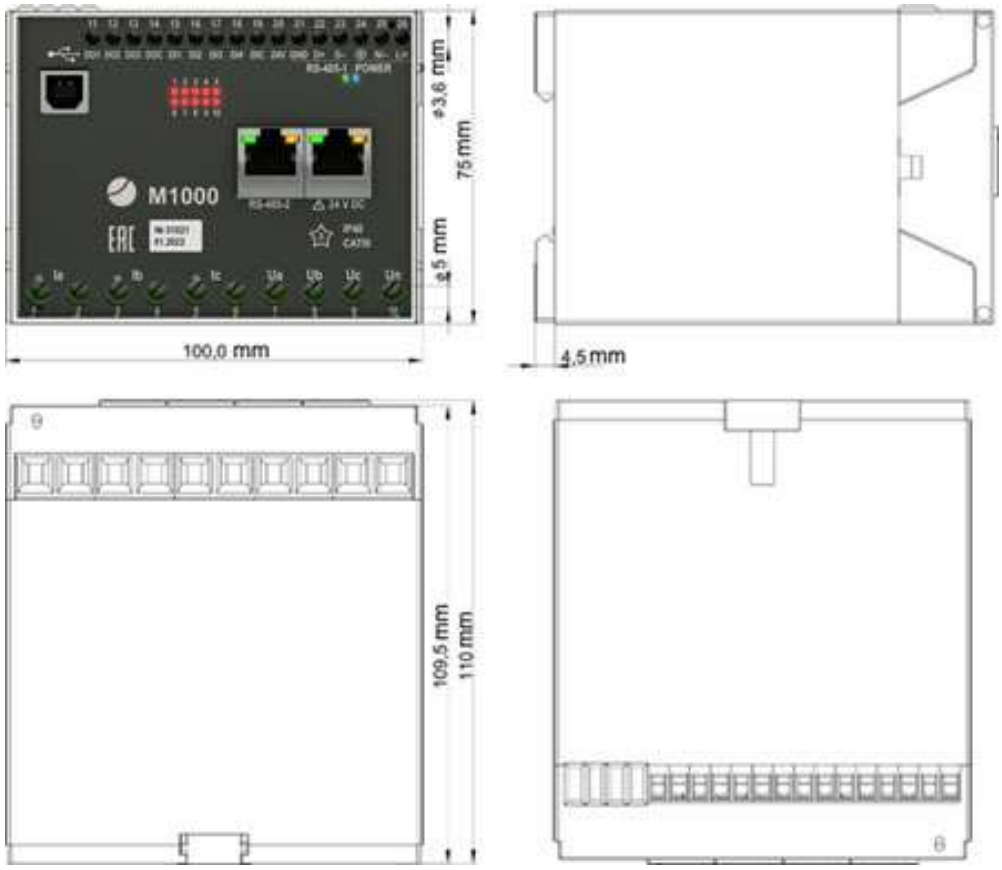



Figure 2.2. Dimensions of M1000

Please use product identification system below to make an order.

M1000-_-_-_-_-_(_)

Rated current
1 — 1 A
5 — 5 A

Rated voltage
100 — 57.7 (100) V
400 — 230 (400) V
690 — 400 (690) V
0 — without measuring inputs voltage

Features
11 — three-phase, 4 × DI, 3 × DO
21 — three-phase, 8 × DI
51 — single-phase, 4 × DI, 2 × DO

DI voltage
(220) — 220 V DC
(110) — 110 V DC
if not specified — 24 V DC

Interfaces
C1 — 1 × RS-485
C2 — 2 × RS-485

Power supply
220 — 120-370 V DC, 100-265 V AC (50 Hz)
110 — 40...160 V DC
24 — 18...36 V DC

Sample: M1000-5-100-220-C2-21

# 3 Features

## 3.1 General information

Analog current and voltage inputs are converted into analog voltage signals of lower scale. These signals go to ADC. ADC performs analog-to digital conversion of instantaneous values of measured signals (40 measures per each period of industrial frequency (50/60 Hz)). Measuring data is further passed on to microcontroller (MCU).

MCU performs:

- Electrical grid parameters calculation (using 50 ms “sliding window” measurement calculation method) – instant measurements;
- Averaging of both measured and calculated parameters through “sliding window” method (possible averaging time is 200, 500, 1000, 1500, 2000 ms) – averaged measurements;
- Digital I/O processing;
- Data exchanging;
- Real-time clocking.

M1000 supports 3- or 4-wire electrical grid and connects to measuring line through transformers or directly. All wiring diagrams see in Appendix A1.

The current range is setting up with ConfigTool software.

| Current range (% of nominal) | Description |
|---|---|
| **1…200%** | It’s recommended range. For maximal accuracy M1000 measure in two ranges - 1…70% and 70…200%. Switching between ranges is accompanied by a delay about 200 ms. |
| **2…200%** | Fast range. Measurement is provided without switching. |
| **8…800%** | Fault current range. Accuracy for low current is does not match the stated accuracy. |

## 3.2 Measured parameters

3.2.1 M1000 provides real-time “Instant” (50 ms) and averaged measurements. Averaging time is settable using ConfigTool software.

Averaging time, ms: 200, 500, 1000, 1500, 2000.

Table 3.1. Available parameters

| Parameter | Symbol | 3-wire connection* | 4-wire connection |
|---|---|---|---|
| **RMS** | | | |
| Effective voltage | $U_A$, $U_B$, $U_C$ | - | + |
| Average effective voltage | $U_{L-N}$ | - | + |
| Effective line-to-line voltage | $U_{AB}$, $U_{BC}$, $U_{CA}$ | + | + |
| Average effective line-to-line voltage | $U_{L-L}$ | + | + |
| Effective current | $I_A$, $I_B$, $I_C$ | + | + |
| Average effective current | I | + | + |
| Active power | $P_A$, $P_B$, $P_C$, | - | + |
| Total active power | P | + | + |
| Reactive power | $Q_A$, $Q_B$, $Q_C$ | - | + |
| Total reactive power | Q | + | + |
| Apparent power | $S_A$, $S_B$, $S_C$ | - | + |
| Total apparent power | S | + | + |
| Active energy import | WP+ | + | + |
| Active energy export | WP- | + | + |
| Reactive energy import | WQ+ | + | + |
| Reactive energy export | WQ- | + | + |
| **1st harmonic** | | | |
| Effective voltage** | $U_{A1}$, $U_{B1}$, $U_{C1}$ | - | + |
| Average effective voltage | $U_{L-N1}$ | - | + |
| Effective line-to-line voltage | $U_{AB1}$, $U_{BC1}$, $U_{CA1}$ | + | + |
| Average effective line-to-line voltage | $U_{L-L1}$ | + | + |
| Effective current | $I_{A1}$, $I_{B1}$, $I_{C1}$ | + | + |
| Average effective current | I1 | + | + |
| Active power | $P_{A1}$, $P_{B1}$, $P_{C1}$, | - | + |
| Total active power | P1 | + | + |
| Reactive power | $Q_{A1}$, $Q_{B1}$, $Q_{C1}$ | - | + |
| Total reactive power | Q1 | + | + |
| Apparent power | $S_{A1}$, $S_{B1}$, $S_{C1}$ | - | + |
| Total apparent power | S1 | + | + |
| Frequency | F | + | + |
| Phase angle φ phase A | cos/tg/$\varphi_A$ | + | + |
| Phase angle φ phase B | cos/tg/$\varphi_B$ | + | + |
| Phase angle φ phase C | cos/tg/$\varphi_C$ | + | + |
| Phase angle φ total | cos/tg/φ | + | + |
| Voltage zero sequence | $U_0$ | - | + |
| Voltage positive sequence | $U_1$ | - | + |

| Parameter | Symbol | 3-wire connection* | 4-wire connection |
|---|---|---|---|
| Voltage negative sequence | $U_2$ | - | + |
| Voltage unbalance of the negative sequence $K_{2U}=\frac{U_2}{U_1}$ | $K_{2U}$ | - | + |
| Voltage distortion $K_U=\frac{\sqrt{U^2-U_{1h}{}^2}}{U_{1h}}$ | $K_U$ | - | + |
| Current zero sequence | $I_0$ | - | + |
| Current positive sequence | $I_1$ | - | + |
| Current negative sequence | $I_2$ | - | + |
| Current unbalance of negative sequence $K_{2I}=\frac{I_2}{I_1}$ | $K_{2I}$ | - | + |
| Current distortion $K_I=\frac{\sqrt{I^2-I_{1h}{}^2}}{I_{1h}}$ | $K_I$ | - | + |
| Total harmonic distortion THD=(P-$P_1$)/$P_1$ | THD | - | + |
| Active power zero sequence | $P_0$ | - | + |
| Reactive power zero sequence | $Q_0$ | - | + |

* «+» means that parameter available for the this connection type (Connection type is configured by ConfigTool);

M1000 measures and saves active and reactive energy in both forward and reverse directions. Maximum energy value is 99999999.9 Wh (varh). In case of overflow, it starts counting from zero.

M1000 is not certificated as energy meter, nevertheless, its accuracy class is 0.2S (energy measurement error for $0.01I_{rated}$ is 0.35%, and for $I_{rated}$ – 0.001%).

## 3.3 Digital signals

The maximum number of digital signals (called «DIO») for M1000 is 32. These include DI, DO, configurable set-points, logical expressions, diagnostics (table 3.2). Every DIO is configured independently.

Table 3.2

| DIO | Description |
|---|---|
| **Digital output** | Built-in or external DO |
| **Digital input** | Built-in or external DI |
| **Setpoints** | Configurable setpoints for any parameters. |
| **Logical expressions** | Use any DIO for switchgear interlocking protection. |
| **Diagnostic** | Errors monitoring |

### 3.3.1 Digital outputs

M1000 Standard and Compact provides switchgear equipment control using built-in digital outputs or using extension IO100 modules, which are connected to RS-485-2 of M1000.

Table 3.3

| | M1000 | Extension module IO100 |
|---|---|---|
| **Type** | 3 SSR output | electromagnetic relay or SSR output |
| **Maximum voltage** | 300 V DC<br>250 V AC | 250 V AC |
| **Maximum current** | 100 mA DC/AC | 100 mA DC/AC (SSR) 7 A AC (EMR) |

For built-in DO shall using external relays if load is more than 100 mA.

Up to four IO100 modules can be connected via RS-485-2 and communicates via Modbus RTU protocol.

M1000 supports Single command (<45>), Double command (<46>) over IEC 60870-5-101 and Force Single Coil (the function code 5) over Modbus.

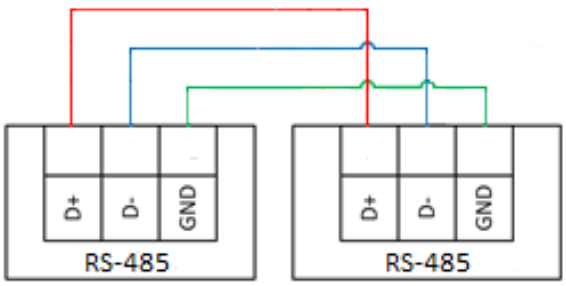



Figure 3.1. Connection of M1000 and IO100

### 3.3.2 Digital inputs

M1000 is equipped with 4 or 8 built-in digital inputs with debounce filter. Contacts for digital inputs can be wet or dry (fig. 3.2-3.5). Dry contacts are powered by built-in 24 V DC supply.

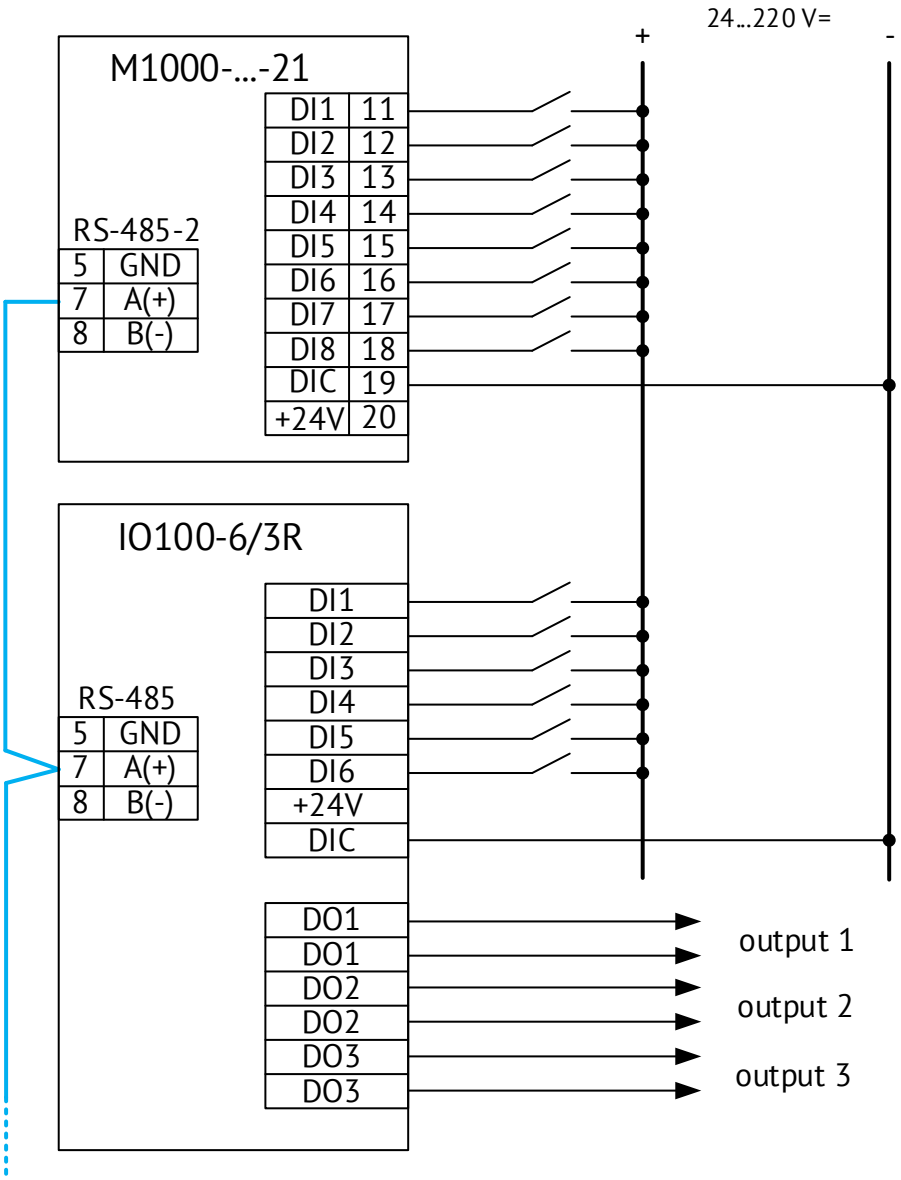



Figure 3.2. M1000-...-21 with IO100-1-6/3R connection diagram (wet contact).

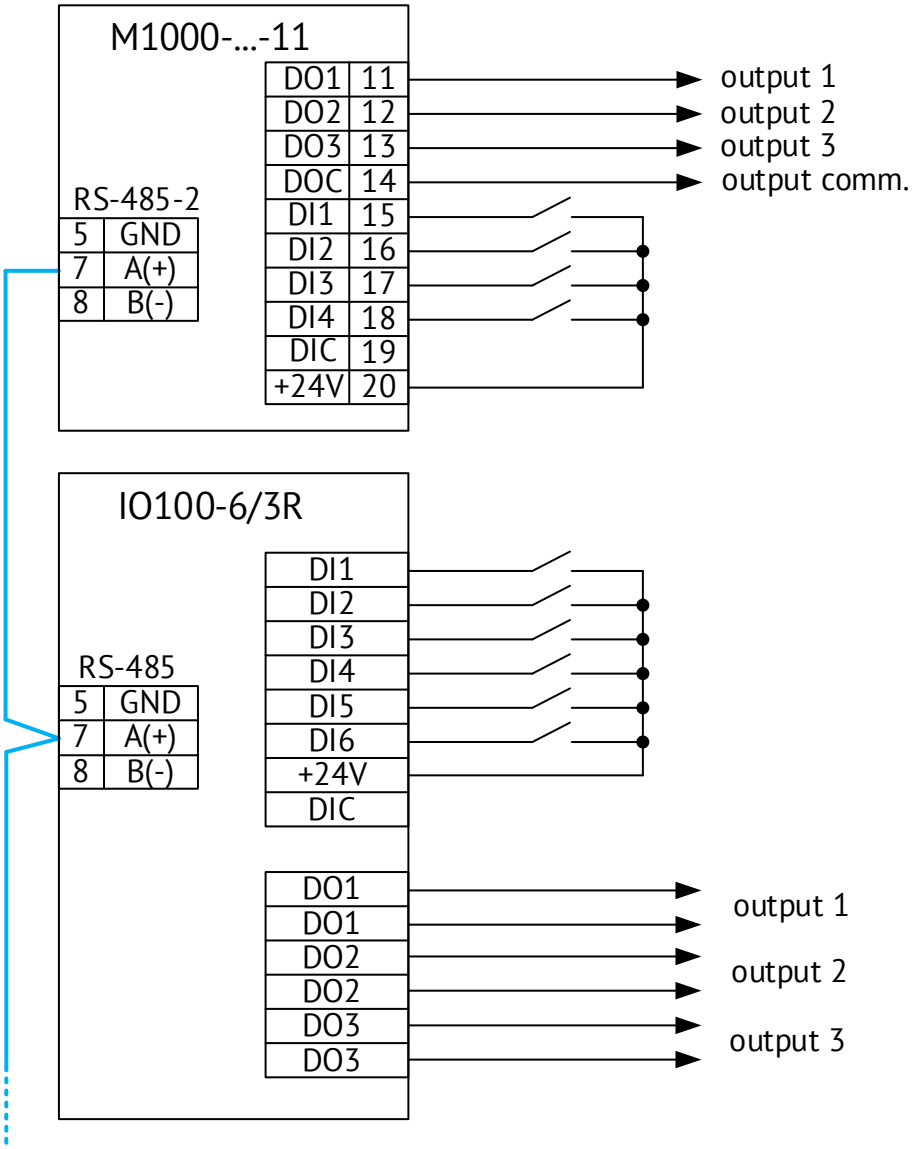



Figure 3.3. M1000-...-11 with IO100-6/3R connection diagram (dry contact).

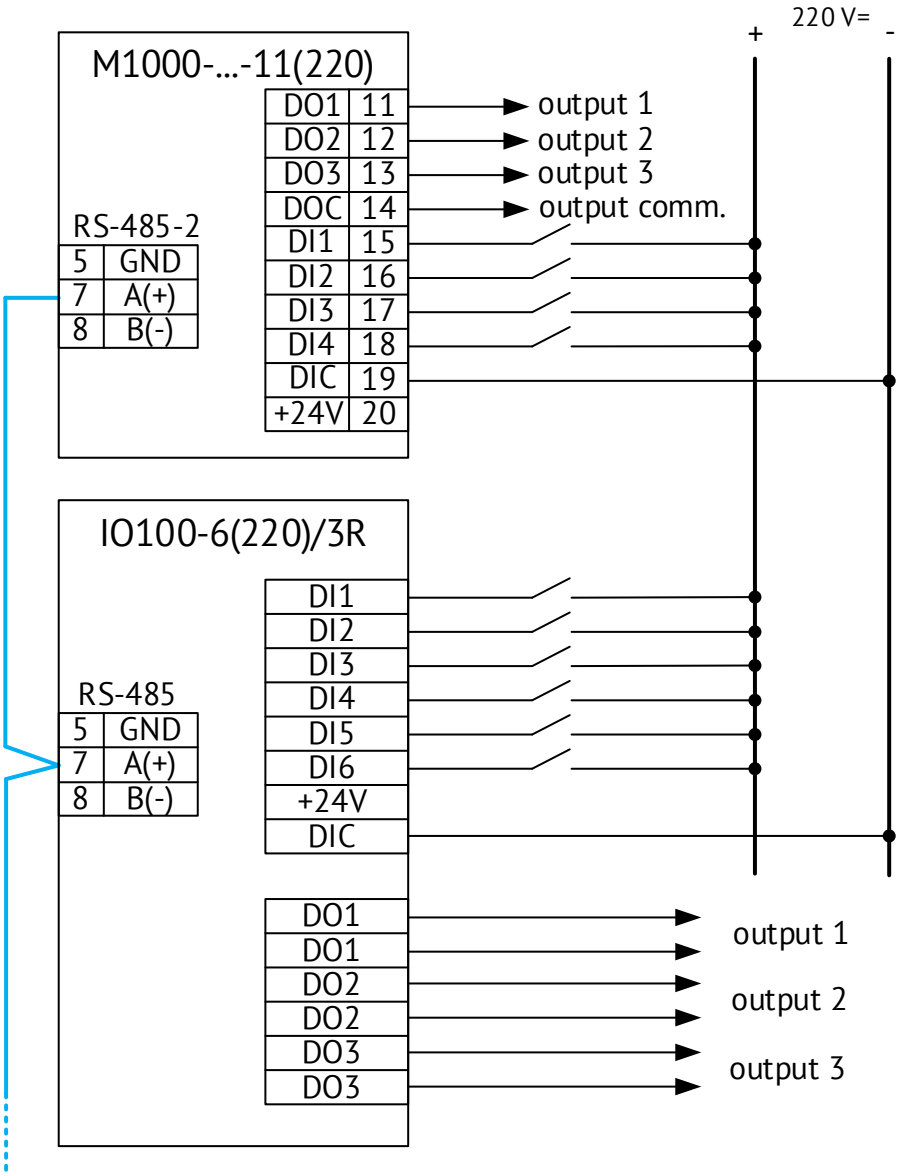



Figure 3.4. M1000-…-11(220) with IO100-6/3R connection diagram. Built-in +24V power supply (terminal 20) is disabled.

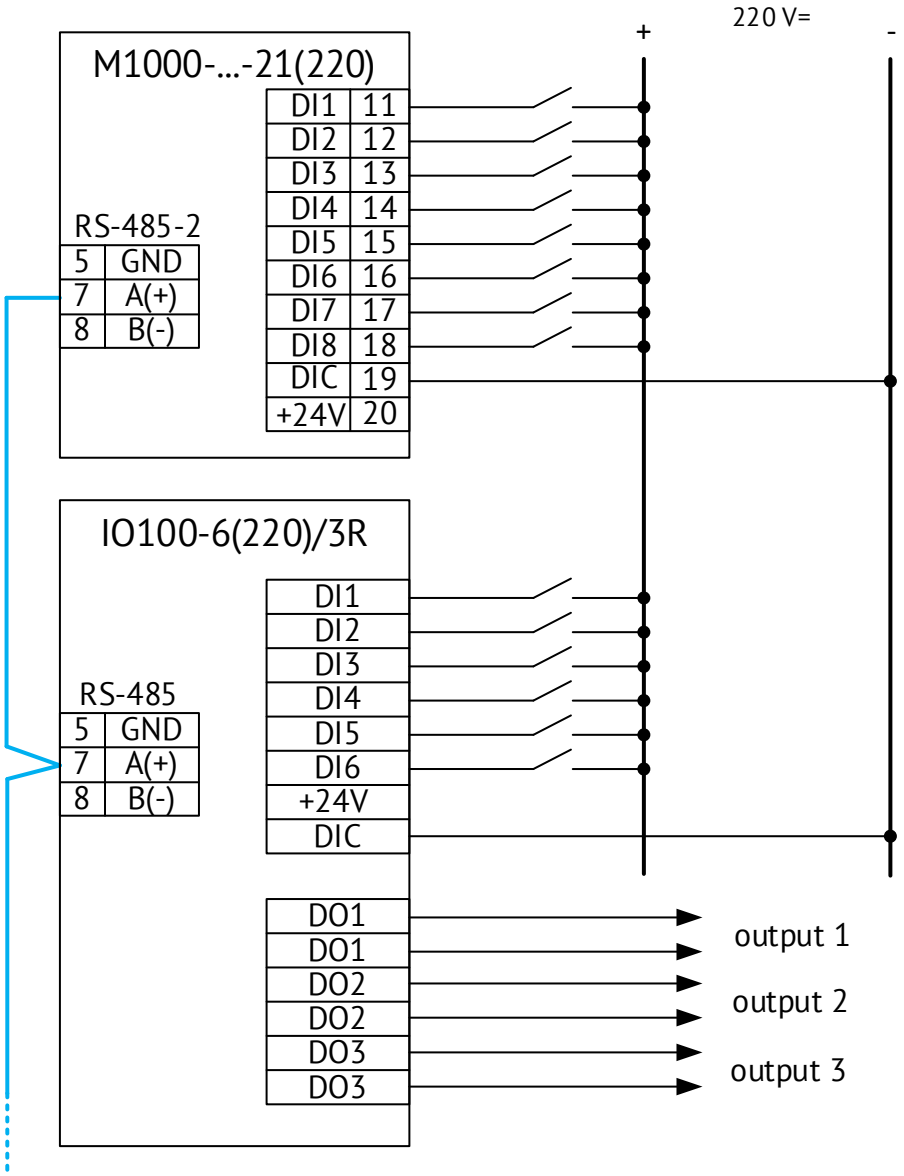



Figure 3.5. M1000-...-21(220) with IO100-6/3R connection diagram. Built-in +24V power supply (terminal 20) is disabled.

M1000 can handle up to 32 digital signals. The event log stores DI statuses. Each record of event log is marked with the time stamp with 1 ms resolution. M1000 sends DI statuses using IEC 60870-5-101 (Single or Double point).

Table 3.4

| | M1000-..-X1(24) | M1000-..-X1(220) |
|---|---|---|
| **Type** | 4 or 8 wet contact | 4 or 8 wet contact |
| **Voltage** | 20...250 V DC | 200...250 V AC |
| **Current** | 2 mA | 2 mA |

## 3.4 Interfaces and protocols

### 3.4.1 RS-485

M1000 has two RS-485 galvanically isolated interface ports.

Each port's configuration is supposed to be defined independently (for example, RS-485-1 - IEC 60870-5-101, RS-485-2 – Modbus RTU).

The Modbus protocol description see in appendix B.

IEC 60870-5-101 is described in Appendix C.

**RS-485 parameters**

| | |
|---|---|
| **Type** | 2-wire (D+, D-, GND) |
| **Baud rate** | 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200 bps |
| **Parity** | none, odd, even |
| **Stop bits** | 1, 2 |
| **Response delay** | 0…25.5 ms |
| **Protocols** | Modbus RTU, IEC-60870-5-101 |
| **RS-485-1 default settings:** | IEC 60870-5-101, 19200 bps, address ASDU 1 |
| **RS-485-2 default settings:** | Modbus RTU, 19200 bps, slave address 1, master mode is activated |

«RS-485-2» consists of two RJ45. First one has only digital pins, second one has both digital pins and power pins 24 V DC. RS-485-2 can serve as a source of power supply for external devices (if the cable length does not exceed 20 meters).

Data map for each protocol see in corresponding appendix.

### 3.4.2 USB

USB port allows to set configuration, to read data and logs, to update firmware, or utilize M1—as a USB-COM converter (When M1000 switched to virtual COM-port mode).

## 3.5 Real-time clock

M1000 has real-time clock. It allows to save event logging and to transmit data with timestamp over IEC 60870-5-101 or Modbus.

Time sync may be UTC or local time. Timestamp over IEC 60870-5-101 may transmit with UTC or local time (with summer/winter time).

All settings, including time source, validity checking and time zone are available for configuration.

Time accuracy with synchronization is up to 1 ms. Without synchronization M1000 has up to 3 seconds error per day.

## 3.6 Event logging

M1000 saves in non-volatile memory the following log files:

- Event log (software update, configuration change, power supply on/off, diagnostic messages); up to 40 last events with timestamp are available.
- Digital signals log (status of internal and external digital inputs and outputs, thresholds); 200 last events with timestamp are available.

# 4 Specification

## 4.1 Measuring input

Nominal current, voltage and power see in table 4.1.

Table 4.1

| M1000 modifications | Nominal: | | | | |
|---|---|---|---|---|---|
| | Voltage line-to-neu-tral $U_{L-N}$, V | voltage line-to-line $U_{L-L}$, V | current I, A | power, P, W; Q, var; S, VA | total power, P, W; Q, var; S, VA |
| M1000-1-100… | 57.7, 63.5 | 100, 110 | 1 | 57.7, 63.5 | 173.1, 190.5 |
| M1000-5-100… | 57.7, 63.5 | 100, 110 | 5 | 288.5, 317.5 | 865.5, 952.5 |
| M1000-1-400… | 230 | 400 | 1 | 230 | 690 |
| M1000-5-400… | 230 | 400 | 5 | 1150 | 3450 |
| M1000-1-690… | 400 | 690 | 1 | 400 | 1200 |
| M1000-5-690… | 400 | 690 | 5 | 2000 | 6000 |

Nominal frequency: 50/60 Hz.

Nominal power factor: 1.

The maximum power consumption of current inputs is 0.1 VA, for voltage inputs - 0.1 VA. The internal resistance of voltage inputs exceeds 4 MΩ.

M1000 continues to measuring with the declared precision after influence of current/voltage overloads specified in table 4.2.

Table 4.2

| Current | Voltage | The number of overload | Overload time, s | Time between overloads, s |
|---|---|---|---|---|
| 7I | U | 2 | 15 | 60 |
| 10I | U | 1 | 15 | - |
| 40I | U | 1 | 1 | - |
| I | 2U | 1 | 60 | - |

I – nominal current, U – nominal voltage

## 4.2 Operating conditions

Table 4.3

| № | Condition | Value |
|---|---|---|
| 1 | Temperature, °C | -40…+70 |
| 2 | Relativity humanity, % | Up to 95, non-condensing |
| 3 | Operation mode | continuous |
| 4 | Turn-on time | <30 sec |
| 5 | MTBF | 100000 h |
| 6 | Device life | 20 year |
| 7 | Seismic sustainability | Up to 6 degree MSK-64 |
| 8 | Max altitude | 3500 m |
| 9 | Input frequency, Hz | 50/60±5 |
| 10 | Input current load, % of nominal | 1÷200 (2÷200; 8÷800)* |

| № | Condition | Value |
|---|---|---|
| 11 | Input voltage load, % of nominal | 5÷150 |
| 12 | Power factor | ±(0…1…0) |
| 13 | sin φ | ±(0…1…0) |
| 14 | Voltage unbalance, % | Up to 100 |
| 15 | Current unbalance, % | Up to 100 |
| * Note: ranges descriptions see in page 9. | | |

Normal conditions see in table 4.4.

Table 4.4

| Condition | Normal value (or normal range) | Variation |
|---|---|---|
| Temperature, °C | 15÷25 | |
| Relativity humanity, % | Up to 95 | |
| Atmospheric pressure, kPa (mmHg) | 65÷106.7 (487.5÷800) | |
| Position | any | |
| Supply frequency, Hz | 45÷65 | |

## 4.3 Accuracy

Precision of measuring in normal conditions corresponds to the table 4.5.

Table 4.5

| № | Parameter's range from nominal | Accuracy | | |
|---|---|---|---|---|
| | | $\gamma_x$, % | $\delta_x$, % | ΔX |
| 1. | Effective voltage | ±0.2 | | |
| | 0.2U ≤ U ≤ 1.5U* | | ±0.2 | |
| | 0.05U ≤ U < 0.2U | | ±0.75 | |
| 2. | Effective current | ±0.2 | | |
| | 0.2I ≤ I ≤ 2I | | ±0.2 | |
| | 0.05I ≤ I < 0.2I | | ±0.75 | |
| | 0.01I ≤ I < 0.05I | | ±2.0 | |
| 3. | Active power | ±0.5 | | |
| | 0.2I ≤ I ≤ 2I, 0.2U ≤ U ≤ 1.5U*, 0.8≤\|cosφ\|≤1 | | ±0.5 | |
| 4. | Total active power | ±0.5 | | |
| 5. | Reactive power | ±0.5 | | |
| | 0.2I ≤ I ≤ 2I, 0.2U ≤ U ≤ 1.5U*, 0.8≤\|sinφ\|≤1 | | ±0.5 | |
| 6. | Total reactive power | ±0.5 | | |
| 7. | Apparent power | ±0.5 | | |
| | 0.2I ≤ I ≤ 2I, 0.2U ≤ U ≤ 1.5U | | ±0.5 | |
| 8. | Total apparent power | ±0.5 | | |
| 9. | Frequency | | | ±10 mHz** |
| 10. | Power factor cos φ | | | ±0.01 |
| * For the M1000-.../690-... modification: 0.05U ≤ U ≤ 1.15U;<br>** For the M1000-.../690-... modification: ±1 mHz; | | | | |

When conditions differ from normal, M1000 gives additional measurement error according to table 4.6.

Table 4.6

| Condition | Value | Added error | |
|---|---|---|---|
| | | $\delta_{X1}/\gamma_{X1}$, % | $\Delta X_1$ |
| **Temperature, °C** | -40…+70* | | |
| Current, voltage, depending on the modification | | ±0.025/5 °C | - |
| Power, depending on the modification | | ±0.05/5 °C | - |
| Frequency | | - | ±0.005/10°C |
| **Strength of the magnetic field, mT** | 0.5 | | |
| Current, voltage | | ±0.1% | |
| Power | | ±0,25% | |
| Frequency | | - | ±0.005 Hz |
| **Power factor cos φ (sin φ)** | ±(0.5 – 0.8) | | |
| Power | | ±0.4% | |

## 4.4 Power supply

Table 4.7

| Voltage range | Power consumption |
|---|---|
| 120...370 V DC or<br>100...265 V AC, 45…55 Hz | (3 to 11) VA<br>up to 19 VA (with ENMI) |
| 18...36 V DC | (3 to 11) W<br>up to 19 W (with ENMI) |

## 4.5 Isolation

Table 4.8

| Isolation to ground | 1 min voltage, VAC |
|---|---|
| **Digital interfaces** | 500 |
| **Input voltage** | 2000 |
| **Input current** | 2000 |
| **Input power** | 2000 |
| **DI** | 2000 |
| **DO** | 2000 |

# 5 Operation

M1000 might be installed in the middle voltage switchgear cells, at control panels and cabinets. M1000 works at wide operating temperature range in unattended and non-heated facilities.

To connect M1000 properly to power supply use wiring diagrams in the Appendix A3.

## 5.1 Package contents

Intelligent electronic device M1000 - 1

All documentation and software updates see on ains.kz

## 5.2 Before installation

Make sure that packing has no defects. Unpacking M1000, check the package contents.

Before configuring, installing, and operating CM1000, read and follow the guide rules of the manual.

Before connecting/disconnecting M1000 to digital interfaces or measuring inputs make sure that all sources of power supply are disconnected.

M1000 is supposed to be connected straight to instrument transformers or power lines.

When connecting M1000 to RTU (or SCADA) follow the manual of RTU (SCADA).

Do not use M1000 in an explosive or corrosive environment.

Save M1000 from heating above 70 °C, large temperature variations and strong electro-magnetic fields.

## 5.3 Mounting

For safety, you must read the instructions in this manual before performing mounting and operation. Only qualified personnel should be allowed for installation.

M1000 is mounted on panel, cabinet or 35mm DIN-rail.

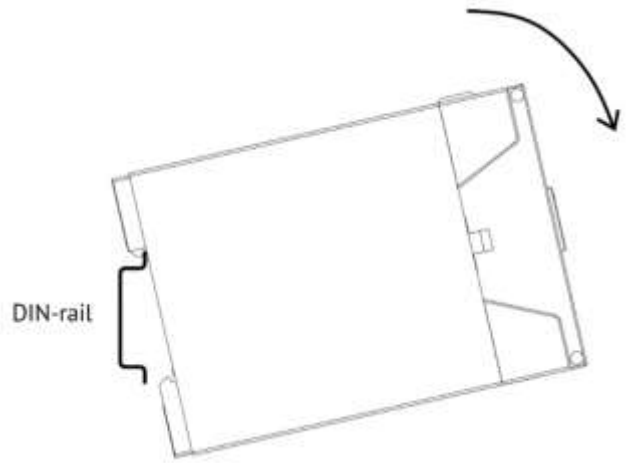



Figure 5.1. M1000 Standard installation to 35 mm DIN-rail.

Pull down the clip in bottom to remove M1000 from DIN-rail.

## 5.4 Connection

### 5.4.1 Wires

Table 5.1

| | M1000-…-X1 | M1000-…-32 (Compact) |
|---|---|---|
| **Power supply** | 2.5 $mm^2$ wires (AWG 14) | 1.5 $mm^2$ wires (AWG 16) |
| **Current input**<br>**Voltage input** | 4 $mm^2$ wires (AWG 12) | 4 $mm^2$ wires (AWG 12)<br>2.5 $mm^2$ wires (AWG 14) |
| **Digital I/O** | 2.5 $mm^2$ wires (AWG 14) | 2.5 $mm^2$ wires (AWG 14) |
| **Digital interface** | 0.25 $mm^2$ wires (AWG 24)<br>or shielded patch cord Cat5 cables using 8P8C (RJ-45) | 0.25 $mm^2$ wires (AWG 24) |

Connections diagrams see in appendix A.

Tightening torque for current and voltage terminals is 0.5 to 0.6 N·m.

### 5.4.2 Function of terminals and connectors

Points of connection for measuring circuits, discrete signals circuits and power supply are listed in the tables below.

Table 5.2

| terminal | symbol | description |
|---|---|---|
| **1** | II1 | I1 input |
| **2** | | I1 output |
| **3** | II2 | I2 input |
| **4** | | I2 output |
| **5** | II3 | I3 input |
| **6** | | I3 output |
| **7** | L1 | U1 input |
| **8** | L2 | U2 input |
| **9** | L3 | U3 input |
| **10** | N | UN input |

Table 5.3

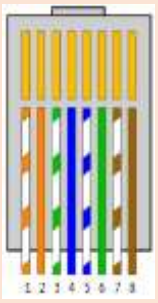
| terminal | M1000-X-X-X-C2-**21** | | M1000-X-X-X-C2-**11** | |
|---|---|---|---|---|
| | symbol | description | symbol | description |
| **11** | DI1 | Digital input 1 | DO1 | Digital output 1 |
| **12** | DI2 | Digital input 2 | DO2 | Digital output 2 |
| **13** | DI3 | Digital input 3 | DO3 | Digital output 3 |
| **14** | DI4 | Digital input 4 | DO4 | Digital output 4 |
| **15** | DI5 | Digital input 5 | DI1 | Digital input 1 |
| **16** | DI6 | Digital input 6 | DI2 | Digital input 2 |
| **17** | DI7 | Digital input 7 | DI3 | Digital input 3 |
| **18** | DI8 | Digital input 8 | DI4 | Digital input 4 |
| **19** | DIC | Digital input com | DIC | Digital input com |
| **20** | +24 | Digital input power | +24 | Digital input power |
| **21** | GND | RS-485-1 ground | GND | RS-485-1 ground |
| **22** | D+ | RS-485-1 data + | D+ | RS-485-1 data + |
| **23** | D- | RS-485-1 data - | D- | RS-485-1 data - |
| **24** | - | Power supply PE conductor | - | Power supply PE conductor |
| **25** | N/- | Power supply N/- | N/- | Power supply N/- |
| **26** | L/+ | Power supply L/+ | L/+ | Power supply L/+ |


Figure 5.2 Analog inputs for M1000

### 5.4.3 RJ-45 pinouts

Digital interfaces pinouts for M1000 given in Table 5.4.

Table 5.4

| Interface | RJ-45 pinout | |
|---|---|---|
| **RS-485-1, RS-485-3** | 5 – GND<br>7 – A (data+)<br>8 – B (data-) |  |
| **RS-485-2 with 24VDC** | 1,2 –power supply for ENMI (+24 V DC)<br>3,4 –power supply for ENMI (0 V)<br>5 – GND<br>7 – A (data+)<br>8 – B (data-) | |

# 6 Configuring and Updating

To configure M1000 use the ConfigTool software.

System requirements: Windows XP or newer and .NET Framework 4. (Download .NET Framework 4 distributive from the official site here: www.microsoft.com/downloads)

The configuration process of M1000 implies setting up parameters for communication ports, data format and data sets, connection types, sync time, DIO and etc.

To update firmware of M1000 please contact for details our tech support team.

# 7 Maintenance

When performing the maintenance, follow the rules set in the manual. Maintenance is supposed to be performed by qualified personnel only.

Do not open the housing during operation. Opening the M1000 voids the warranty.

M1000 doesn’t need special maintenance operations.

For cleaning use non-abrasive detergent or 70% ethanol-water solution.

# 8 Transportation, packing and storage

Transport conditions temperature is –50…+70°C, relative humidity is 95 % at 30°C. Save M1000 from impact during the transportation.

M1000 is delivered in packaging case. Package contents is according to page 21.

Max net weight - 0.55 kg, Max gross weight, 0.70 kg

Store the device in dry and clean location. Essential storage conditions are listed in the following table:

Table 8.1

| Condition | Device in manufacturer packing | Device without manufacturer packing |
|---|---|---|
| **Temperature** | 5-40 °C | 10-35 °C |
| **Relative humidity** | 80% (at 25 °C) | 80% (at 25 °C) |

# 9 Self-diagnostics

Errors codes of M1000

| Error code | Description |
|---|---|
| **0x0001** | ADC failure/ no power supply |
| **0x0002** | No connection with Ethernet |
| **0x0004** | Clock error |
| **0x0008** | Low battery voltage |
| **0x0010** | Authorization error |
| **0x0020** | Internal communications error of M1000 with 2 Ethernet ports |
| **0x0040** | Sync time error |
| **0x0080** | Extension device error |
| **0x0100** | DO error |

When necessary, diagnostic information can be transmitted via interfaces. There is an option of receiving an error code register using Modbus RTU, IEC 60870-101 protocols. This register contains current set of diagnosed states. It is also possible to transmit the self-diagnostic information in form of DI, choosing which specific parameter or error to pass on.

Self-diagnostics also includes temperature measuring inside the device. This could be transmitted by an additional register.

# Appendix A1. Wiring diagrams

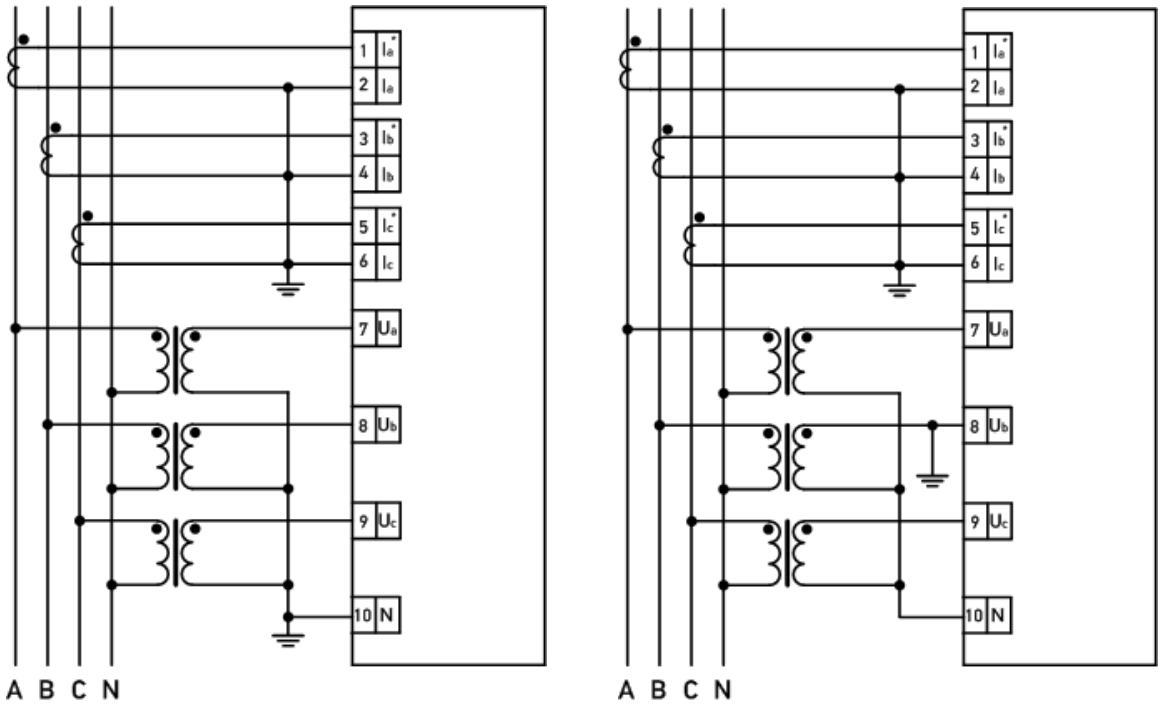



Figure A1.1. M1000-1-100-… and M1000-5-100-… for 4-wire three-phase grid (4-wire measurement mode must be activated)

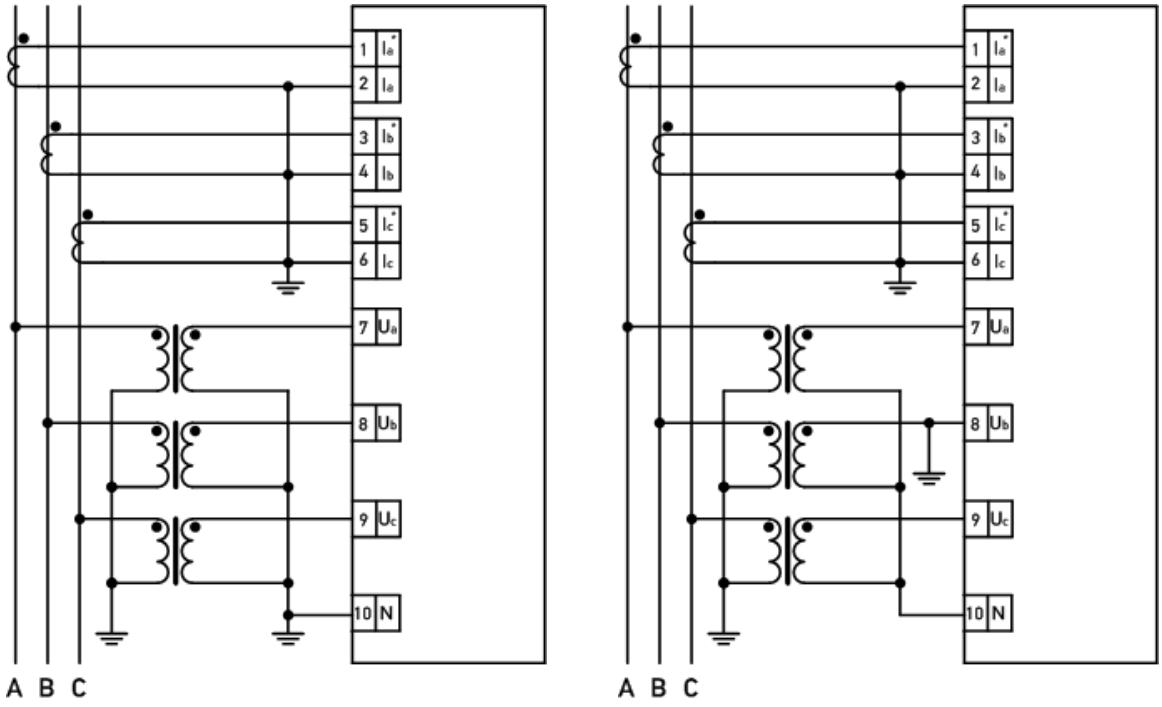



Figure A1.2. M1000-1-100-… and M1000-5-100-… for 3-wire three-phase grid (4-wire measurement mode must be activated)

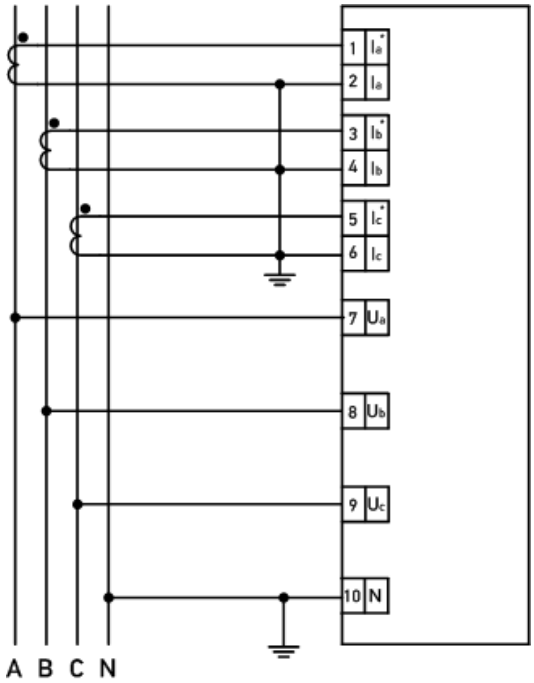



Figure A1.3. M1000-1-100-… and M1000-5-100-… for 4-wire three-phase grid 230(400) V (4-wire measurement mode must be activated)

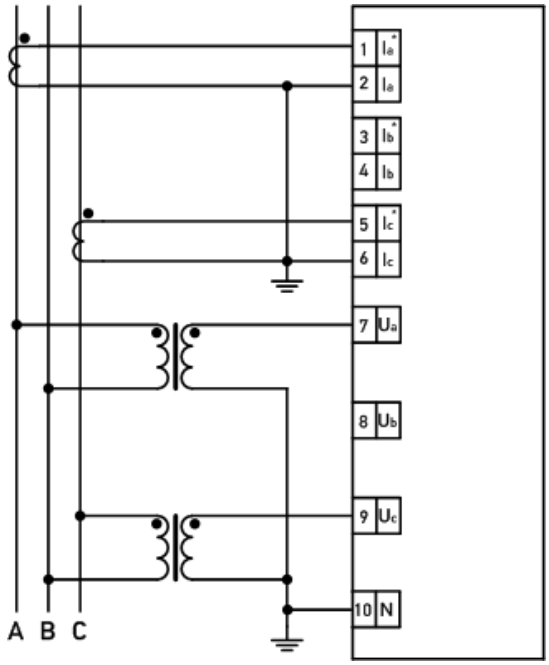
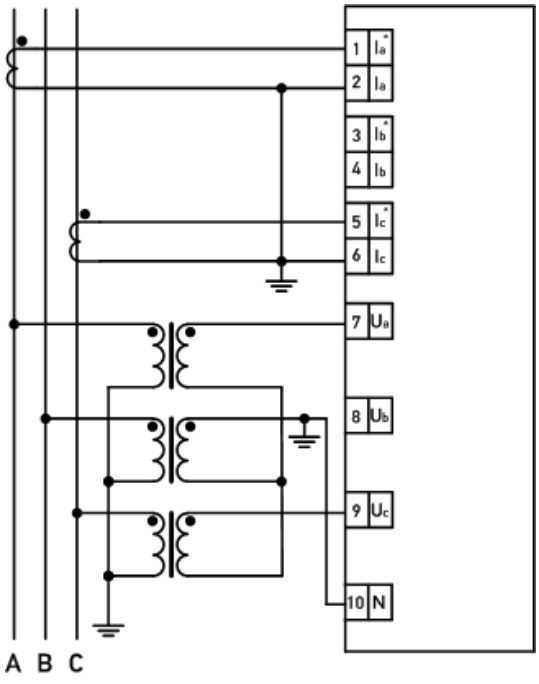
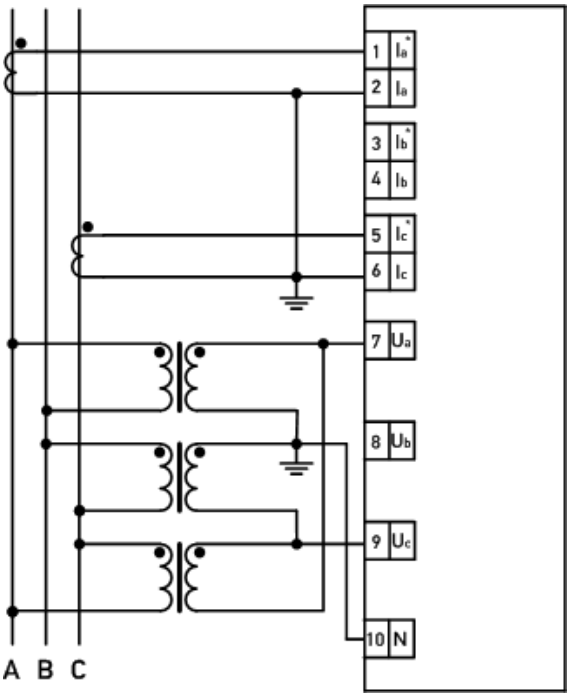



Figure A1.4. M1000-1-100-… and M1000-5-100-… for 3-wire three-phase grid with two PT (3-wire measurement mode must be activated)




PT connection is Y




PT connection is Δ

Figure A1.5. M1000-1-100-… and M1000-5-100-… for 3-wire three-phase grid with three PT (3-wire measurement mode must be activated)

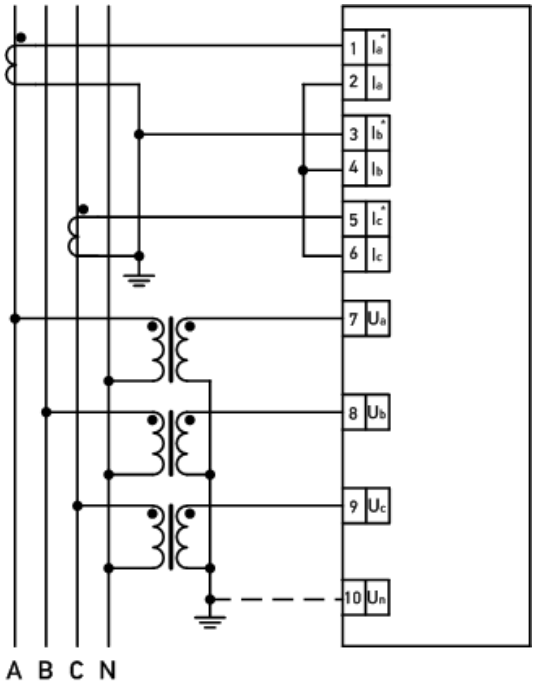



Figure A1.6. M1000-1-100-… and M1000-5-100-… for 3-wire three-phase grid with three PT without neutral wire and two CT (3-wire measurement mode must be activated)

Last diagram is not recommended! Power measurement errors may occur.

# Appendix A2. Wiring diagrams for extension devices

## Connection via RS-485:

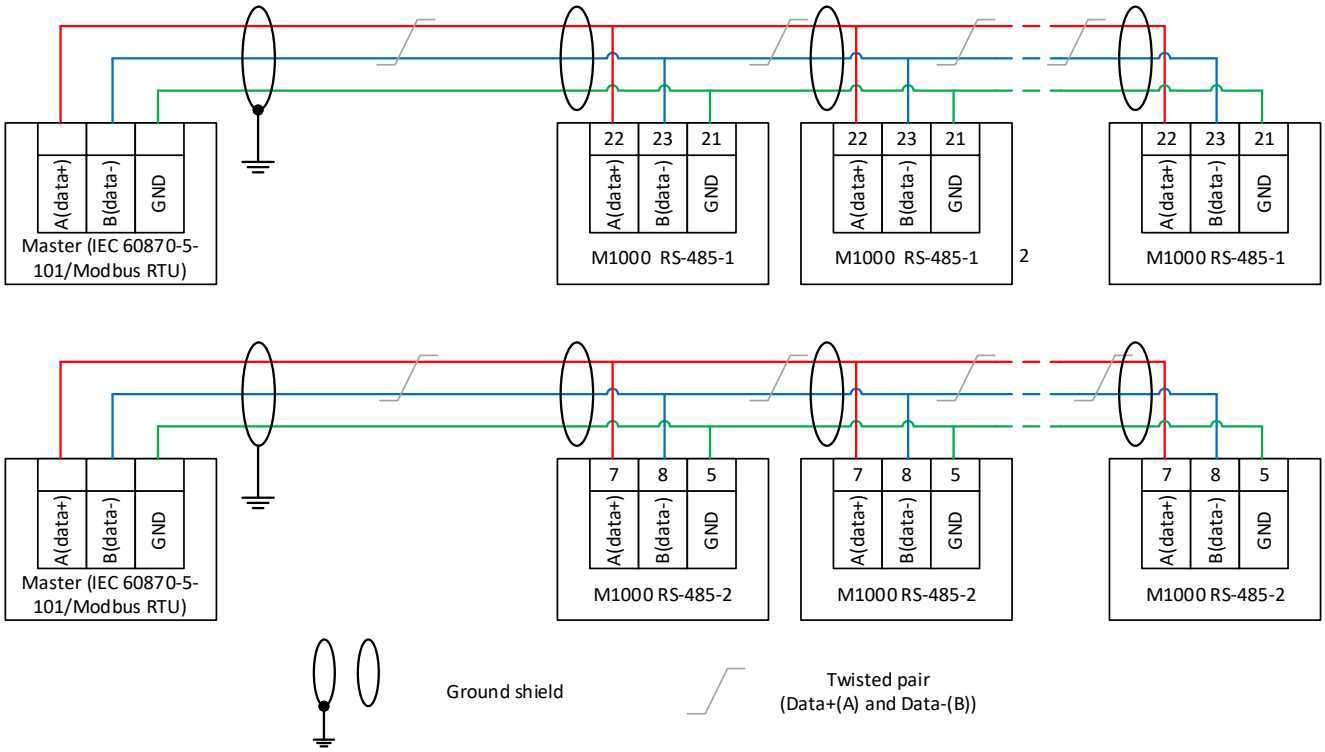



Figure A2.1. RS-485 connection

## Power supply:

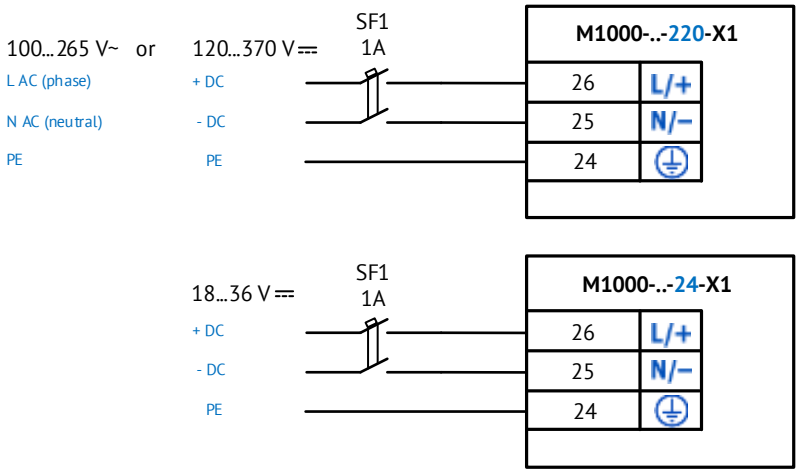



Figure A3.3. Power supply connection diagram

# Appendix B. M1000: Modbus

## About Modbus

Modbus (Schneider Electric trademark) is a serial communication protocol. Full description see on www.modbus.org. This protocol is used for data communication via RS-485 or Ethernet interfaces.

### Address

Available slave addresses of M1000 are from 01 to 254 (01-hFE). h00 and hFF are multicast addresses. Any device in network responds to the request if it's address is h00. Any device in network executes a command if the request address is hFF.

## Available function codes

h01 read coil;

h02 read discrete inputs;

h03 read holding registers;

h04 read input registers;

h05 write single coil;

h06 write single register (reset, fixing data, delete event log);

h14 read file record;

h2B read ID.

## Service function codes

h64 service read;

h65 service write.

### Exception codes

01 – illegal function

02 – illegal data address

03 – illegal data value

04 – slave device failure

### Analog registers

Register addresses range is 0 to 59999. You can change the addresses of values using ConfigTool. Values in registers are saved in integer and float formats.

Available data type:

- Integer

M1000 integer is little-endian order.

For the data conversion obtained use the following formulas (x – register's value, y – real value):

| Value | M1000-5-100 | M1000-1-100 | M1000-5-400 |
|---|---|---|---|
| Current | x/1000 | y= x/5000 | x/1000 |

| | | | |
|---|---|---|---|
| Voltage | x/100 | x/100 | y= x/25 |
| Power | y= x/10 | y= x/50 | y= x/2,5 |
| Energy | y= x/10 | y= x/50 | y= x/2,5 |
| cos(φ), tg (φ) | y= x/1000 | y= x/1000 | y= x/1000 |
| φ | y= x/100 | y= x/100 | y= x/100 |
| f (3 decimal places) | x/1000 | x/1000 | x/1000 |
| f (2 decimal places) | x/100 | x/100 | x/100 |
| THD | y= x/1000 | y= x/1000 | y= x/1000 |

- Float

M1000 float corresponds to IEEE 754.

## Default addresses

| Address | | Quantity of registers | Value | Type |
|---|---|---|---|---|
| Dec | hex | | | |
| Integer RMS | | | | |
| 0 | 0x00 | 1 | Ua | unsigned short |
| 1 | 0x01 | 1 | Ub | unsigned short |
| 2 | 0x02 | 1 | Uc | unsigned short |
| 3 | 0x03 | 1 | Average U | unsigned short |
| 4 | 0x04 | 1 | Uab | unsigned short |
| 5 | 0x05 | 1 | Ubc | unsigned short |
| 6 | 0x06 | 1 | Uca | unsigned short |
| 7 | 0x07 | 1 | Average line-to-line U | unsigned short |
| 8 | 0x08 | 1 | Ia | unsigned short |
| 9 | 0x09 | 1 | Ib | unsigned short |
| 10 | 0x0A | 1 | Ic | unsigned short |
| 11 | 0x0B | 1 | Average I | unsigned short |
| 12 | 0x0C | 1 | Pa | short |
| 13 | 0x0D | 1 | Pb | short |
| 14 | 0x0E | 1 | Pc | short |
| 15 | 0x0F | 1 | Total P | short |
| 16 | 0x10 | 1 | Qa | short |
| 17 | 0x11 | 1 | Qb | short |
| 18 | 0x12 | 1 | Qc | short |
| 19 | 0x13 | 1 | Total Q | short |
| 20 | 0x14 | 1 | Sa | unsigned short |
| 21 | 0x15 | 1 | Sb | unsigned short |
| 22 | 0x16 | 1 | Sc | unsigned short |
| 23 | 0x17 | 1 | Total S | unsigned short |
| Integer first harmonic | | | | |
| 24 | 0x18 | 1 | Ua1 | unsigned short |
| 25 | 0x19 | 1 | Ub1 | unsigned short |
| 26 | 0x1A | 1 | Uc1 | unsigned short |
| 27 | 0x1B | 1 | Average U1 | unsigned short |
| 28 | 0x1C | 1 | Uab1 | unsigned short |
| 29 | 0x1D | 1 | Ubc1 | unsigned short |
| 30 | 0x1E | 1 | Uca1 | unsigned short |
| 31 | 0x1F | 1 | Average line-to-line U1 | unsigned short |
| 32 | 0x20 | 1 | Ia1 | unsigned short |
| 33 | 0x21 | 1 | Ib1 | unsigned short |
| 34 | 0x22 | 1 | Ic1 | unsigned short |
| 35 | 0x23 | 1 | Average I1 | unsigned short |
| 36 | 0x24 | 1 | Pa1 | short |

| Address | | Quantity of registers | Value | Type |
|---|---|---|---|---|
| Dec | hex | | | |
| 37 | 0x25 | 1 | Pb1 | short |
| 38 | 0x26 | 1 | Pc1 | short |
| 39 | 0x27 | 1 | Total P1 | short |
| 40 | 0x28 | 1 | Qa1 | short |
| 41 | 0x29 | 1 | Qb1 | short |
| 42 | 0x2A | 1 | Qc1 | short |
| 43 | 0x2B | 1 | Total Q1 | short |
| 44 | 0x2C | 1 | Sa1 | unsigned short |
| 45 | 0x2D | 1 | Sb1 | unsigned short |
| 46 | 0x2E | 1 | Sc1 | unsigned short |
| 47 | 0x2F | 1 | Total S1 | unsigned short |

cos, frequency, power quality parameters, energy, quantums, CT/PT ratio, temperature, DIO, timestamp, reserve

| | | | | |
|---|---|---|---|---|
| 48 | 0x30 | 1 | cos φ, phase A | short |
| 49 | 0x31 | 1 | cos φ, phase B | short |
| 50 | 0x32 | 1 | cos φ, phase C | short |
| 51 | 0x33 | 1 | cos φ, total | short |
| 52 | 0x34 | 1 | F | unsigned short |
| 53 | 0x35 | 1 | U0 – voltage zero sequence | unsigned short |
| 54 | 0x36 | 1 | U1 - voltage positive sequence | unsigned short |
| 55 | 0x37 | 1 | U2 – voltage negative sequence | unsigned short |
| 56 | 0x38 | 1 | KuU – voltage unbalance | unsigned short |
| 57 | 0x39 | 1 | KdU – voltage distortion | unsigned short |
| 58 | 0x3A | 1 | I0 - current zero sequence | unsigned short |
| 59 | 0x3B | 1 | I1 - ток positive sequence | unsigned short |
| 60 | 0x3C | 1 | I2 - ток negative sequence | unsigned short |
| 61 | 0x3D | 1 | KuI – current unbalance | unsigned short |
| 62 | 0x3E | 1 | KdI – current distortion | unsigned short |
| 63 | 0x3F | 1 | THD - total harmonic distortion | short |
| 64 | 0x40 | 2 | WP+ active energy, forward direction | unsigned long |
| 66 | 0x42 | 2 | WP- active energy, reverse direction | unsigned long |
| 68 | 0x44 | 2 | WQ+ reactive energy, forward direction | unsigned long |
| 70 | 0x46 | 2 | WQ- reactive energy, reverse direction | unsigned long |
| 72 | 0x48 | 2 | DIO – DI/DO status | unsigned long |
| 74 | 0x4A | 2 | Time - timestamp UTC, seconds | unsigned long |
| 76 | 0x4C | 1 | Time - timestamp UTC, milliseconds | unsigned short |
| 77 | 0x4D | 1 | T – inside temperature | short |
| 78 | 0x4E | 1 | KU – PT ratio | unsigned short |
| 79 | 0x4F | 1 | KI – CT ratio | unsigned short |
| 80 | 0x50 | 1 | QU – voltage quantum | unsigned short |
| 81 | 0x51 | 1 | QI – current quantum | unsigned short |
| 82 | 0x52 | 1 | reserve | |
| 83 | 0x53 | 1 | reserve | |

Float RMS

| | | | | |
|---|---|---|---|---|
| 92 | 0x5C | 2 | Ua | float |
| 94 | 0x5E | 2 | Ub | float |
| 96 | 0x60 | 2 | Uc | float |
| 98 | 0x62 | 2 | Average U | float |
| 100 | 0x64 | 2 | Uab | float |
| 102 | 0x66 | 2 | Ubc | float |
| 104 | 0x68 | 2 | Uca | float |
| 106 | 0x6A | 2 | Average line-to-line U | float |
| 108 | 0x6C | 2 | Ia | float |
| 110 | 0x6E | 2 | Ib | float |

| Address | | Quantity of registers | Value | Type |
|---|---|---|---|---|
| Dec | hex | | | |
| 112 | 0x70 | 2 | Ic | float |
| 114 | 0x72 | 2 | Average I | float |
| 116 | 0x74 | 2 | Pa | float |
| 118 | 0x76 | 2 | Pb | float |
| 120 | 0x78 | 2 | Pc | float |
| 122 | 0x7A | 2 | Total P | float |
| 124 | 0x7C | 2 | Qa | float |
| 126 | 0x7E | 2 | Qb | float |
| 128 | 0x80 | 2 | Qc | float |
| 130 | 0x82 | 2 | Total Q | float |
| 132 | 0x84 | 2 | Sa | float |
| 134 | 0x86 | 2 | Sb | float |
| 136 | 0x88 | 2 | Sc | float |
| 138 | 0x8A | 2 | Total S | float |

Float first harmonic

| | | | | |
|---|---|---|---|---|
| 140 | 0x8C | 2 | Ua1 | float |
| 142 | 0x8E | 2 | Ub1 | float |
| 144 | 0x90 | 2 | Uc1 | float |
| 146 | 0x92 | 2 | Average U1 | float |
| 148 | 0x94 | 2 | Uab1 | float |
| 150 | 0x96 | 2 | Ubc1 | float |
| 152 | 0x98 | 2 | Uca1 | float |
| 154 | 0x9A | 2 | Average line-to-line U1 | float |
| 156 | 0x9C | 2 | Ia1 | float |
| 158 | 0x9E | 2 | Ib1 | float |
| 160 | 0xA0 | 2 | Ic1 | float |
| 162 | 0xA2 | 2 | Average I1 | float |
| 164 | 0xA4 | 2 | Pa1 | float |
| 166 | 0xA6 | 2 | Pb1 | float |
| 168 | 0xA8 | 2 | Pc1 | float |
| 170 | 0xAA | 2 | Total P1 | float |
| 172 | 0xAC | 2 | Qa1 | float |
| 174 | 0xAE | 2 | Qb1 | float |
| 176 | 0xB0 | 2 | Qc1 | float |
| 178 | 0xB2 | 2 | Total Q1 | float |
| 180 | 0xB4 | 2 | Sa1 | float |
| 182 | 0xB6 | 2 | Sb1 | float |
| 184 | 0xB8 | 2 | Sc1 | float |
| 186 | 0xBA | 2 | Total S1 | float |

cos, frequency, power quality parameters

| | | | | |
|---|---|---|---|---|
| 188 | 0xBC | 2 | cos φ, phase A | float |
| 190 | 0xBE | 2 | cos φ, phase B | float |
| 192 | 0xC0 | 2 | cos φ, phase C | float |
| 194 | 0xC2 | 2 | cos φ, total | float |
| 196 | 0xC4 | 2 | F | float |
| 198 | 0xC6 | 2 | U0 – voltage zero sequence | float |
| 200 | 0xC8 | 2 | U1 - voltage positive sequence | float |
| 202 | 0xCA | 2 | U2 – voltage negative sequence | float |
| 204 | 0xCC | 2 | KuU – voltage unbalance | float |
| 206 | 0xCE | 2 | KdU – voltage distortion | float |
| 208 | 0xD0 | 2 | I0 - current zero sequence | float |
| 210 | 0xD2 | 2 | I1 - ток positive sequence | float |
| 212 | 0xD4 | 2 | I2 - ток negative sequence | float |
| 214 | 0xD6 | 2 | KuI – current unbalance | float |

| Address | | Quantity of registers | Value | Type |
|---|---|---|---|---|
| Dec | hex | | | |
| 216 | 0xD8 | 2 | KdI – current distortion | float |
| 218 | 0xDA | 2 | THD - total harmonic distortion | float |

## Discrete information

Any DIO is configured independently. Available function for DIO are in the Table 3.3.

Default configuration:

| **Address** | | **Value** |
|---|---|---|
| **dec** | **hex** | |
| 0 | 0x00 | DIO1 |
| 1 | 0x01 | DIO2 |
| 2 | 0x02 | DIO3 |
| 3 | 0x03 | DIO4 |
| 4 | 0x04 | DIO5 |
| 5 | 0x05 | DIO6 |
| 6 | 0x06 | DIO7 |
| 7 | 0x07 | DIO8 |
| 8 | 0x08 | DIO9 (DI1) |
| 9 | 0x09 | DIO10 (DI2) |
| 10 | 0x0A | DIO11 (DI3) |
| 11 | 0x0B | DIO12 (DI4) |
| 12 | 0x0C | DIO13 (DI5) |
| 13 | 0x0D | DIO14 (DI6) |
| 14 | 0x0E | DIO15 (DI7) |
| 15 | 0x0F | DIO16 (DI8) |
| 16 | 0x10 | DIO17 |
| 17 | 0x11 | DIO18 |
| 18 | 0x12 | DIO19 |
| 19 | 0x13 | DIO20 |
| 20 | 0x14 | DIO21 |
| 21 | 0x15 | DIO22 |
| 22 | 0x16 | DIO23 |
| 23 | 0x17 | DIO24 |
| 24 | 0x18 | DIO25 |
| 25 | 0x19 | DIO26 |
| 26 | 0x1A | DIO27 |
| 27 | 0x1B | DIO28 |
| 28 | 0x1C | DIO29 |
| 29 | 0x1D | DIO30 |
| 30 | 0x1E | DIO31 |
| 31 | 0x1F | DIO32 |

Here is an example of request with function code 01 if M1000 has slave address 01, DIO requested from 2 to 13

| Slave address | Function code | Data address of the first coil | | Number of coil | | CRC | |
|---|---|---|---|---|---|---|---|
| 01 | 01 | 00 | 01 | 00 | 0C | 9D | CF |

And this is the response to previous request

| | | | | | |
|---|---|---|---|---|---|
| 01 | 01 | 02 | 00 | 51 | 78 |

Second and third byte describe DIO status

| byte | 02 | | | | | | | | 00 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| bit | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DIO | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | | | | | 13 | 12 | 11 | 10 |

# Appendix C. M1000: IEC 60870-5-101

Available ASDU

| Value | ASDU | | Description |
|---|---|---|---|
| Digital signals | 1 | M_SP_NA_1 | Single-point information |
| | 3 | M_DP_NA_1 | Double-point information |
| | 30 | M_SP_TB_1 | Single-point information with time tag CP56 |
| | 31 | M_DP_TB_1 | Double-point information with time tag CP56 |
| Measured value | 11 | M_ME_NB_1 | Measured value, scaled value |
| | 13 | M_ME_NC_1 | Measured value, short floating point value |
| | 35 | M_ME_TE_1 | Measured value, scaled value with time tag CP56 |
| | 36 | M_ME_TF_1 | Measured value, short floating point value with time tag CP56 |
| Integrated totals | 15 | M_IT_NA_1 | Integrated totals |
| | 37 | M_IT_TB_1 | Integrated totals with time tag CP56 |

## Default register's addresses:

| address | Parameter | | ASDU type | | Quantum (for type 11,13,35,37) |
|---|---|---|---|---|---|
| | | **Digital signals** | | | |
| 1000 | DO1 ON | (IO100 №1) | 1/30 | 3/31 | - |
| 1001 | DO2 OFF | (IO100 №1) | 1/30 | | - |
| 1002 | DO3 ON | (IO100 №2) | 1/30 | 3/31 | - |
| 1003 | DO4 OFF | (IO100 №2) | 1/30 | | - |
| 1004 | DO5 ON | (IO100 №3) | 1/30 | 3/31 | - |
| 1005 | DO6 OFF | (IO100 №3) | 1/30 | | - |
| 1006 | DO7 ON | (IO100 №4) | 1/30 | 3/31 | - |
| 1007 | DO8 OFF | (IO100 №4) | 1/30 | | - |
| 1 | DI1 | (M1000) | 1/30 | 3/31 | - |
| 2 | DI2 | (M1000) | 1/30 | | - |
| 3 | DI3 | (M1000) | 1/30 | 3/31 | - |
| 4 | DI4 | (M1000) | 1/30 | | - |
| 5 | DI5 | (M1000) | 1/30 | 3/31 | - |
| 6 | DI6 | (M1000) | 1/30 | | - |
| 7 | DI7 | (M1000) | 1/30 | 3/31 | - |
| 8 | DI8 | (M1000) | 1/30 | | - |
| | | **RMS** | | | |
| 100 | Ua | | 11/13/35/36 | | Uquant, V |
| 101 | Ub | | 11/13/35/36 | | Uquant, V |
| 102 | Uc | | 11/13/35/36 | | Uquant, V |
| 103 | Average U | | 11/13/35/36 | | Uquant, V |
| 104 | Uab | | 11/13/35/36 | | Uquant, V |
| 105 | Ubc | | 11/13/35/36 | | Uquant, V |
| 106 | Uca | | 11/13/35/36 | | Uquant, V |
| 107 | Average line-to-line U | | 11/13/35/36 | | Uquant, V |
| 108 | Ia | | 11/13/35/36 | | Iquant, A |
| 109 | Ib | | 11/13/35/36 | | Iquant, A |
| 110 | Ic | | 11/13/35/36 | | Iquant, A |
| 111 | Average I | | 11/13/35/36 | | Iquant, A |
| 112 | Pa | | 11/13/35/36 | | Pquant, W |
| 113 | Pb | | 11/13/35/36 | | Pquant, W |
| 114 | Pc | | 11/13/35/36 | | Pquant, W |
| 115 | Total P | | 11/13/35/36 | | Pquant, W |
| 116 | Qa | | 11/13/35/36 | | Qquant, var |
| 117 | Qb | | 11/13/35/36 | | Qquant, var |

| address | Parameter | ASDU type | Quantum (for type 11,13,35,37) |
|---|---|---|---|
| 118 | Qc | 11/13/35/36 | Qquant, var |
| 119 | Total Q | 11/13/35/36 | Qquant, var |
| 120 | Sa | 11/13/35/36 | Squant, VA |
| 121 | Sb | 11/13/35/36 | Squant, VA |
| 124 | Sc | 11/13/35/36 | Squant, VA |
| 123 | Total S | 11/13/35/36 | Squant, VA |

**First harmonic**

| | | | |
|---|---|---|---|
| 0 | Ua | 11/13/35/36 | Uquant, V |
| 0 | Ub | 11/13/35/36 | Uquant, V |
| 0 | Uc | 11/13/35/36 | Uquant, V |
| 0 | Average U | 11/13/35/36 | Uquant, V |
| 0 | Uab | 11/13/35/36 | Uquant, V |
| 0 | Ubc | 11/13/35/36 | Uquant, V |
| 0 | Uca | 11/13/35/36 | Uquant, V |
| 0 | Average line-to-line U | 11/13/35/36 | Uquant, V |
| 0 | Ia | 11/13/35/36 | Iquant, A |
| 0 | Ib | 11/13/35/36 | Iquant, A |
| 0 | Ic | 11/13/35/36 | Iquant, A |
| 0 | Average I | 11/13/35/36 | Iquant, A |
| 0 | Pa | 11/13/35/36 | Pquant, W |
| 0 | Pb | 11/13/35/36 | Pquant, W |
| 0 | Pc | 11/13/35/36 | Pquant, W |
| 0 | Total P | 11/13/35/36 | Pquant, W |
| 0 | Qa | 11/13/35/36 | Qquant, var |
| 0 | Qb | 11/13/35/36 | Qquant, var |
| 0 | Qc | 11/13/35/36 | Qquant, var |
| 0 | Total Q | 11/13/35/36 | Qquant, var |
| 0 | Sa | 11/13/35/36 | Squant, VA |
| 0 | Sb | 11/13/35/36 | Squant, VA |
| 0 | Sc | 11/13/35/36 | Squant, VA |
| 0 | Total S | 11/13/35/36 | Squant, VA |

**COS, frequency, quality**

| | | | |
|---|---|---|---|
| 124 | cos φ, phase A | 11/13/35/36 | 0,001 |
| 125 | cos φ, phase B | 11/13/35/36 | 0,001 |
| 126 | cos φ, phase C | 11/13/35/36 | 0,001 |
| 127 | cos φ, total | 11/13/35/36 | 0,001 |
| 128 | F | 11/13/35/36 | 0,001 Hz |
| 0 | U0 – voltage zero sequence | 11/13/35/36 | Uquant, B |
| 0 | U1 - voltage positive sequence | 11/13/35/36 | Uquant, B |
| 0 | U2 – voltage negative sequence | 11/13/35/36 | Uquant, B |
| 0 | KuU – voltage unbalance | 11/13/35/36 | 0,1 % |
| 0 | KdU – voltage distortion | 11/13/35/36 | 0,1 % |
| 0 | I0 - current zero sequence | 11/13/35/36 | Iquant, A |
| 0 | I1 - ток positive sequence | 11/13/35/36 | Iquant, A |
| 0 | I2 - ток negative sequence | 11/13/35/36 | Iquant, A |
| 0 | KuI – current unbalance | 11/13/35/36 | 0,1 % |
| 0 | KdI – current distortion | 11/13/35/36 | 0,1 % |
| 0 | THD - total harmonic distortion | 11/13/35/36 | 0,1 % |
| 0 | T – inside temperature | 11/13/35/36 | 1 °C |

**Service registers**

| | | | |
|---|---|---|---|
| 0 | Diagnostic | 11/13/35/36 | 1 |

| address | Parameter | ASDU type | Quantum (for type 11,13,35,37) |
|---|---|---|---|
| 0 | Reserve | 11/13/35/36 | - |
| | **Energy** | | |
| 0 | WP+ active energy, forward direction | 15/37 | Wquant, Вт/ч |
| 0 | WP- active energy, reverse direction | 15/37 | Wquant, Вт/ч |
| 0 | WQ+ reactive energy, forward direction | 15/37 | Wquant, Вар/ч |
| 0 | WQ- reactive energy, reverse direction | 15/37 | Wquant, Вар/ч |
| | **Files** | | |
| 40000 | Event log, txt | - | - |
| 50000 | DI log txt | - | - |

* Addresses are marked by gray font is not available by default. You can activate them using ConfigTool software.

| quantum | Description | Quantum value | | |
|---|---|---|---|---|
| | | I = 5 A | | I = 1 A |
| | | U = 57,7 V | U = 220 V | U = 57,7 V |
| Iquant | Current quantum; A | 0,001 | | 0,0002 |
| Uquant | Voltage quantum; V | 0,01 | 0,04 | 0,01 |
| P/Q/S/Wquant | Power/Energy quantum; W, var, VA/Wh, varh | 0,1 | 0,4 | 0,02 |

## IEC 60870-5-101 Protocol Implementation Conformance Statement

This companion standard presents sets of parameters and alternatives from which subsets have to be selected to implement particular telecontrol systems. Certain parameter values, such as the number of octets in the COMMON ADDRESS of ASDUs represent mutually exclusive alternatives. This means that only one value of the defined parameters is admitted per system. Other parameters, such as the listed set of different process information in command and in monitor direction allow the specification of the complete set or subsets, as appropriate for given applications. This Clause summarizes the parameters of the previous Clauses to facilitate a suitable selection for a specific application. If a system is composed of equipment stemming from different manufacturers, it is necessary that all partners agree on the selected parameters.

**Designation:**

☐ - Function or ASDU is not used;

|×| - Function or ASDU is used as standardized (default);

|R| - Function or ASDU is used in reverse mode;

|B| - Function or ASDU is used in standard and reverse mode/

The possible selection (blank, X, R, or B) is specified for each specific Clause or parameter.

### 1. System / device

(system-specific parameter, indicate the definition of a system or a device by marking one of the following with an «X»)

| **IEC 60870-5-101** | |
|---|---|
| ☐ | System definition |
| ☐ | Controlling station definition (master) |
| ☒ | Controlled station definition (slave) |

## 2. Network configuration

| IEC 60870-5-101 | | | |
|---|---|---|---|
| ☒ | Point-to-point | ☐ | Multipoint-partyline |
| ☒ | Multiple point-to-point | ☐ | Multipoint-star |

## 3. Physical layer

(network-specific parameter, all interfaces and data rates that are used are to be marked with an «X»)

**Transmission speed (control direction)**

| IEC 60870-5-101 | | | | | |
|---|---|---|---|---|---|
| Unbalanced interchange circuit V.24/V.28 Standard | | Unbalanced interchange circuit V.24/V.28 recommended if >1200 bit/s | | Balanced interchange circuit X.24/X.27 | |
| ☐ | 100bit/s | ☒ | 2400bit/s | ☐ | 2400bit/s |
| ☐ | 200bit/s | ☒ | 4800bit/s | ☐ | 4800bit/s |
| ☐ | 300bit/s | ☒ | 9600bit/s | ☐ | 9600bit/s |
| ☒ | 600bit/s | ☒ | 19200bit/s | ☐ | 19200bit/s |
| ☒ | 1200bit/s | ☒ | 38400 bit/s | ☐ | 38400bit/s |
| | | ☒ | 57600 bit/s | ☐ | 56000bit/s |
| | | ☒ | 115200 bit/s | ☐ | 64000bit/s |

**Transmission speed (monitor direction)**

| IEC 60870-5-101 | | | | | |
|---|---|---|---|---|---|
| Unbalanced interchange circuit V.24/V.28 Standard | | Unbalanced interchange circuit V.24/V.28 recommended if >1200 bit/s | | Balanced interchange circuit X.24/X.27 | |
| ☐ | 100bit/s | ☒ | 2400bit/s | ☐ | 2400bit/s |
| ☐ | 200bit/s | ☒ | 4800bit/s | ☐ | 4800bit/s |
| ☐ | 300bit/s | ☒ | 9600bit/s | ☐ | 9600bit/s |
| ☒ | 600bit/s | ☒ | 19200bit/s | ☐ | 19200bit/s |
| ☒ | 1200bit/s | ☒ | 38400 bit/s | ☐ | 38400bit/s |
| | | ☒ | 57600 bit/s | ☐ | 56000bit/s |
| | | ☒ | 115200 bit/s | ☐ | 64000bit/s |

## 4. Link layer

Network-specific parameter, all options that are used are to be marked with an “×”. Specify the maximum frame length. If a non-standard assignment of class 2 messages is implemented for unbalanced transmission, indicate the type ID and COT of all messages assigned to class 2.

**IEC 60870-5-101**

Frame format FT 1.2, single character 1 and the fixed time out interval are used exclusively in this companion standard.

| Link transmission procedure | | Address field of the link | |
|---|---|---|---|
| ☐ | Balanced transmission | ☐ | Not present (balanced transmission only) |

| | |
|---|---|
| ☒ Unbalanced transmission | ☒ One octet<br>☐ Two octets<br>☐ Structured<br>☒ Unstructured |
| Frame length<br>255 Maximum length L (control direction) 255<br>Maximum length L (monitor direction)<br><br>5 - repetitions Time during which repetitions are permitted (Trp) or number of repetitions | |

When using an unbalanced link layer, the following ASDU types are returned in class 2 messages (low priority) with the indicated causes of transmission:

☐ The standard assignment of ASDUs to class 2 messages is used as follows:

| Type identification | Cause of transmission |
|---|---|
| | |

☒ A special assignment of ASDUs to class 2 messages is used as follows:

| Type identification | Cause of transmission |
|---|---|
| 1, 3, 11, 13, 15, 30, 31, 35, 36,37 | <3> |

~~NOTE: In response to a class 2 poll, a controlled station may respond with class 1 data when there is no class 2 data available.~~

## 5. Application layer

Transmission mode for application data Mode 1 (least significant octet first), as defined in 4.10 of IEC 60870-5-4, is used exclusively in this companion standard.

**Common address of ASDU**

(system-specific parameter, all configurations that are used are to be marked with an X).

| **IEC 60870-5-101** |
|---|
| ☒ One octet |
| ☒ Two octets |

**Information object address**

(system-specific parameter, all configurations that are used are to be marked with an X).

| **IEC 60870-5-101** | | | |
|---|---|---|---|
| ☐ | One octet | ☒ | Structured |
| ☒ | Two octets | ☒ | Unstructured |
| ☒ | Three octets | | |

**Cause of transmission**

(system-specific parameter, all configurations that are used are to be marked with an X).

| **IEC 60870-5-101** | | | |
|---|---|---|---|
| ☒ | One octet | ☒ | Two octets (with originator address) |

**Selection of standard ASDUs**

**Process information in monitor direction**

**Type identification and cause of transmission assignments**

((station-specific parameters).

| **IEC 60870-5-101** | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Type identification | | Cause of transmission | | | | | | | | | | | | | | |
| | | 1 | | 1 | | 1 | | 1 | | 1 | | 1 | | 1 | | 1 | |
| <1> | M_SP_NA_1 | | X | X | | | | | | | | | | | X | | |
| <2> | M_SP_TA_1 | | | | | | | | | | | | | | | | |
| <3> | M_DP_NA_1 | | X | X | | | | | | | | | | | X | | |
| <4> | M_DP_TA_1 | | | | | | | | | | | | | | | | |
| <5> | M_ST_NA_1 | | | | | | | | | | | | | | | | |
| <6> | M_ST_TA_1 | | | | | | | | | | | | | | | | |
| <7> | M_BO_NA_1 | | | | | | | | | | | | | | | | |
| <8> | M_BO_TA_1 | | | | | | | | | | | | | | | | |
| <9> | M_ME_NA_1 | | | | | | | | | | | | | | | | |
| <10> | M_ME_TA_1 | | | | | | | | | | | | | | | | |
| <11> | M_ME_NB_1 | X | X | X | | | | | | | | | | | X | | |
| <12> | M_ME_TB_1 | | | | | | | | | | | | | | | | |
| <13> | M_ME_NC_1 | X | X | X | | | | | | | | | | | X | | |
| <14> | M_ME_TC_1 | | | | | | | | | | | | | | | | |
| <15> | M_IT_NA_1 | | | X | | | | | | | | | | | | X | |

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| <16> | M_IT_TA_1 | | | | | | | | | | | | | | | | |
| <17> | M_EP_TA_1 | | | | | | | | | | | | | | | | |
| <18> | M_EP_TB_1 | | | | | | | | | | | | | | | | |
| <19> | M_EP_TC_1 | | | | | | | | | | | | | | | | |
| <20> | M_PS_NA_1 | | | | | | | | | | | | | | | | |
| <21> | M_ME_ND_1 | | | | | | | | | | | | | | | | |
| <30> | M_SP_TB_1 | | | X | | | | | | | | | | | | | |
| <31> | M_DP_TB_1 | | | X | | | | | | | | | | | | | |
| <32> | M_ST_TB_1 | | | | | | | | | | | | | | | | |
| <33> | M_BO_TB_1 | | | | | | | | | | | | | | | | |
| <34> | M_ME_TD_1 | | | | | | | | | | | | | | | | |
| <35> | M_ME_TE_1 | | | X | | | | | | | | | | | | | |
| <36> | M_ME_TF_1 | | | X | | | | | | | | | | | | | |
| <37> | M_IT_TB_1 | | | X | | | | | | | | | | | | X | |
| <38> | M_EP_TD_1 | | | | | | | | | | | | | | | | |
| <39> | M_IT_TB_1 | | | | | | | | | | | | | | | | |
| <40> | M_EP_TD_1 | | | | | | | | | | | | | | | | |
| <45> | C_SC_NA_1 | | | | | | R | R | R | R | R | | | | | | R |
| <46> | C_DC_NA_1 | | | | | | R | R | R | R | R | | | | | | R |
| <47> | C_RC_NA_1 | | | | | | R | R | R | R | R | | | | | | R |
| <48> | C_SE_NA_1 | | | | | | | | | | | | | | | | |
| <49> | C_SE_NB_1 | | | | | | | | | | | | | | | | |
| <50> | C_SE_NC_1 | | | | | | | | | | | | | | | | |
| <51> | C_BO_NA_1 | | | | | | | | | | | | | | | | |
| <70> | M_EI_NA_1 | | | | | | | | | | | | | | | | |
| <100> | C_IC_NA_1 | | | | | | R | R | R | R | R | | | | | | |
| <101> | C_CI_NA_1 | | | | | | R | R | | | R | | | | | | |
| <102> | C_RD_NA_1 | | | | | R | | | | | | | | | | | R |
| <103> | C_CS_NA_1 | | | | | | R | R | | | | | | | | | R |
| <104> | C_TS_NA_1 | | | | | | | | | | | | | | | | |
| <105> | C_RP_NA_1 | | | | | | | | | | | | | | | | |
| <106> | C_CD_NA_1 | | | | | | | | | | | | | | | | |
| <110> | P_ME_NA_1 | | | | | | | | | | | | | | | | |
| <111> | P_ME_NB_1 | | | | | | | | | | | | | | | | |
| <112> | P_ME_NC_1 | | | | | | | | | | | | | | | | |
| <113> | P_AC_NA_1 | | | | | | | | | | | | | | | | |
| <120> | F_FR_NA_1 | | | | | | | | | | | | | X | | | |
| <121> | F_SR_NA_1 | | | | | | | | | | | | | X | | | |
| <122> | F_SC_NA_1 | | | | | | | | | | | | | X | | | |
| <123> | F_LS_NA_1 | | | | | | | | | | | | | X | | | |
| <124> | F_AF_NA_1 | | | | | | | | | | | | | X | | | |
| <125> | F_CG_NA_1 | | | | | | | | | | | | | X | | | |
| <126> | F_DR_TA_1 | | | | | | | | | | | | | | | | |

## 6. Basic application functions

**Station initialization**

☐ Remote initialization

**Cyclic data transmission**

× Cyclic data transmission

**Read procedure**

☐ Read procedure

**Spontaneous transmission**

× Spontaneous transmission

**Double transmission of information objects with cause of transmission spontaneous**

(station-specific parameter, mark each information type with an “X” where both a type ID without time and corresponding type ID with time are issued in response to a single spontaneous change of a monitored object) The following type identifications may be transmitted in succession caused by a single status change of an information object. The particular information object addresses for which double transmission is enabled are defined in a project-specific list.

☐ Single-point information M_SP_NA_1, M_SP_TA_1, M_SP_TB_1,

M_PS_NA_1

☐ Double-point information M_DP_NA_1, M_DP TA 1, M_DP_TB_1

☐ Step position information M_ST_NA_1, M_ST_TA_1, M_ST_TB_1

☐ Bitstring of 32 bit M_BO_NA_1, M_BO_TA_1, M_BO_TB_1 (if defined for a specific project, see 7.2.1.1)

☐ Measured value, normalized value M_ME_NA_1, M_ME_TA_1, M_ME_ND_1, M_ME_TD_1

☐ Measured value, scaled value M_ME_NB_1, M_ME_TB_1, M_ME_TE_1

☐ Measured value, short floating point number M_ME_NC_1, M_ME_TC_1, M_ME_TF_1

**Station interrogation**

☒ – Global

☒ – Group 1
☐ – Group 2
☐ – Group 3
☐ – Group 4
☐ – Group 5
☐ – Group 6
☐ – Group 7
☐ – Group 8
☐ – Group 9
☐ – Group 10
☐ – Group 11
☐ – Group 12
☐ – Group 13
☐ – Group 14
☐ – Group 15
☐ – Group 16
☐ – Information object addresses assigned to each group are configurable

**Clock synchronization**

☒ – Clock synchronization

**Command transmission**

☒ Direct command transmission

☐ Direct set point command transmission

☒ Select and execute command

☐ Select and execute set point command

☐ C_SE ACTTERM used

☐ No additional definition

☒ Short-pulse duration (1 sec.)
☒ Long-pulse duration (1 sec.)
☒ Persistent output (255 sec.)

**Transmission of integrated totals**

☐ Mode A: local freeze with spontaneous transmission

☐ Mode B: local freeze with counter interrogation

☐ Mode C: freeze and transmit by counter interrogation commands

☐ Mode D: freeze by counter-interrogation command, frozen values reported spontaneously

☐ Counter read

☐ Counter freeze without reset

☐ Counter freeze with reset

☐ Counter reset

☒ – Clock synchronization
☒ – Request counter group 1

☐ Request counter group 2

☐ Request counter group 3

☐ Request counter group 4

**Parameter loading**

☐ Threshold value

☐ Smoothing factor

☐ Low limit for transmission of measured value

☐ High limit for transmission of measured

**Parameter activation**

☐ Act/deact of persistent cyclic or periodic transmission of the addressed object

**Test procedure**

☐ Test procedure

**File transfer**

File transfer in monitor direction

× Transparent file

☐ Transmission of disturbance data of protection equipmen

☐ Transmission of sequences of events

☐ Transmission of sequences of recorded analogue values

**File transfer in control direction**

☐ Transparent file

**Background scan**

× Background scan