

## DC Ammeter

# SMD 101

*Firmware v. 1.0*

## *Operating Manual*



# LIST OF CONTENTS

- 1. DESCRIPTION.....4**
  - 1.1 History of Firmware Versions..... 4
- 2. LIST OF MODELS.....4**
- 3. INSTALLATION.....5**
  - 3.1 Physical..... 5
  - 3.2 Connection..... 5
    - 3.2.1 Power Supply Voltage Connection..... 5
      - 3.2.1.1 Protection..... 5
    - 3.2.2 Communication Link Connection..... 5
      - 3.2.2.1 RS-485 Communication Interface..... 5
      - 3.2.2.2 RS-232 Communication Interface..... 5
    - 3.2.3 Digital Output..... 6
    - 3.2.4 Current..... 6
  - 3.3 Setup..... 6
    - 3.3.1 Setup PC Connecting to the Modem with RS-485 Interface..... 6
    - 3.3.2 Setup PC Connecting to the Modem with RS-232 Interface..... 6
    - 3.3.3 Instrument Setup..... 7
      - 3.3.3.1 Installation Setup..... 8
      - 3.3.3.2 Outputs Setup..... 9
    - 3.3.4 Instrument Functionality Check..... 11
- 4. FUNCTIONAL DESCRIPTION.....12**
  - 4.1 Hardware..... 12
  - 4.2 Setup..... 12
  - 4.3 Method of Measurement and Evaluation..... 12
    - 4.3.1 Current..... 12
    - 4.3.2 Temperature..... 13
  - 4.4 Digital Outputs Function..... 13
    - 4.4.1 Level Triggered Output Behaviour..... 14
    - 4.4.2 Slope Triggered Output Behaviour..... 15
    - 4.4.3 Fast Response Output Mode Behaviour..... 16
      - 4.4.3.1 Fast Response – DC Current..... 16
      - 4.4.3.2 Fast Response – AC Current..... 16
  - 4.5 Communication..... 18
    - 4.5.1 Communication Protocol..... 18
    - 4.5.2 Modbus-RTU Protocol..... 18
      - 4.5.2.1 Identification..... 19
      - 4.5.2.2 Installation Setting..... 19

4.5.2.3 Output Setting..... 20  
4.5.2.4 Status..... 22  
4.5.2.5 Remote Output Control & Extremes Clear ..... 23

**5. CONNECTION DIAGRAM.....24**

**6. TECHNICAL SPECIFICATIONS.....25**

**7. MAINTENANCE, TROUBLESHOOTING.....26**

# 1. Description

SMD 101 is direct current ammeter with serial interface for remote monitoring of direct current networks such like photovoltaic solar cell strings, power battery chargers etc. Connection to measured wire is contactless with built-in through hole Hall sensor. In addition to the DC-current component, it measures AC-component of the current too. Furthermore, it can be equipped with built-in temperature sensor.

The instrument has electrically isolated RS-485 or RS-232 communication link. In connection with a remote computer it can be monitored with the Envis.Online program or with any application using the Modbus-RTU protocol.

For limit state indication, the instrument is equipped with both *ALARM* LED and semiconductor output switch with programmable functions. It can be used as a very fast overcurrent relay with response time in milliseconds.

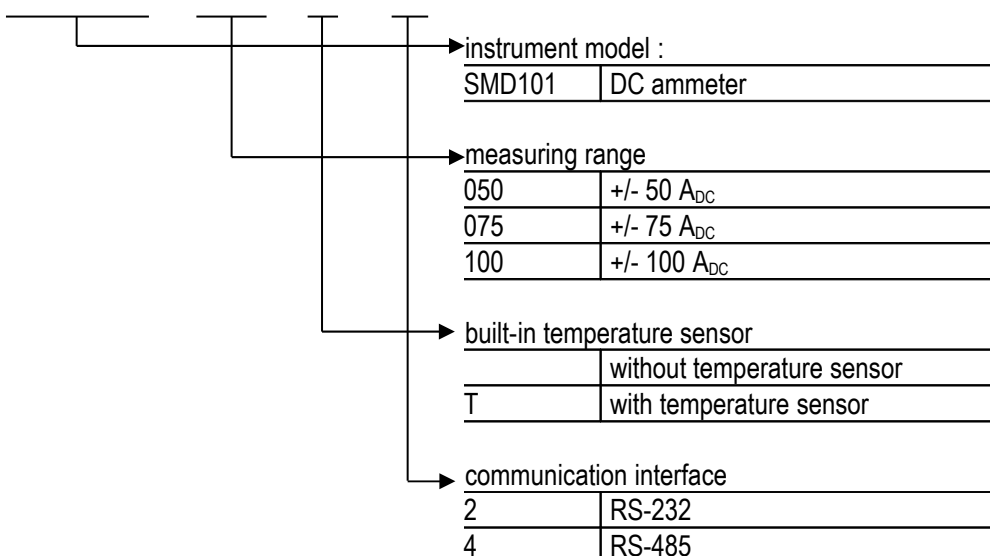
The instrument is designed for mounting on DIN-35 rail.

## 1.1 History of Firmware Versions

version	date of release	note
1.0	1.5.2011	- basic version

# 2. List of Models

## SMD101 – 075 T / 4



## 3. Installation

### 3.1 Physical

Instrument is designed for mounting on a DIN-35 bar.

If ambient temperature will be monitored, natural air circulation should be provided inside the distribution board cabinet, and in the instrument's neighbourhood, especially underneath the instrument, no other instrumentation that is source of heat should be installed or the temperature value measured may be false.

### 3.2 Connection

To connect the instrument there are connectors with screw-on terminals. Maximum cross section area of connection wires is 2.5 square millimetres.

#### 3.2.1 Power Supply Voltage Connection

Connect the power supply voltage (in range according the technical parameters, see below) to terminals + ( 6) and - ( 7) ( this polarity is recommended only, in fact it is free). The supply voltage must be secured with a 1 A breaker or with a fuse of rating T 0.5 L. If connected properly, the LED-diode *MODEM* starts flashing after the supply voltage is applied.

##### 3.2.1.1 Protection

Article 6.12.2.1 in the EN 61010-1 standard requires that instrument must have a disconnecting device in the power supply circuit (a switch — see installation diagram). It must be located at the instrument's immediate proximity and easily accessible by the operator. The disconnecting device must be marked as such. A circuit breaker for nominal current of 1 amp makes a suitable disconnecting device, its function and working positions, however, must be clearly marked (symbols "0" for power off and "I" for power on in accordance with EN 61010-1).

#### 3.2.2 Communication Link Connection

For interconnection with remote PC, the instrument is equipped with a communication interface according to the standard RS-485 or RS-232.

##### 3.2.2.1 RS-485 Communication Interface

The interface consists of terminals **A** (1), **B** (2) and **GND** (3). It allows connecting up to 32 instruments at a distance up to about 1 kilometre. Recommended cable is shielded twisted metallic double pair - use one pair for **A** and **B** signals and the second pair for **GND** signal interconnection.

RS-485 line requires impedance termination of the final nodes by installing terminating resistors for communication distances of a few tens of metres and longer. Terminating resistors matching the cable's wave impedance should be connected between terminals **A** and **B**.

If the communication cable is hundreds of meters long and in environments with electromagnetic noise it is suitable to use shielded cable. The shielding connects to the **PE** (protection earth) wire at one end of the cable.

##### 3.2.2.2 RS-232 Communication Interface

The interface consists of terminals **RxD** (1), **TxD** (2) and **GND** (3).

The communication interface complies with CCITT V.28 (RS-232) recommendations, that is  $\pm 12$  V with minimum internal impedance load 3 k $\Omega$ . Signals in accordance with CCITT V.24 are used, that is 102 (**GND**=common wire), 103 (**TxD**=transmission data) and 104 (**RxD**=reception data).

The interface can be used to connect one instrument only to a remote computer. Communication cable maximum length is about 30 meters (shielded cable, such as 3 x AWG24, recommended).

### 3.2.3 Digital Output

The digital output is created with electrically isolated MOSFET transistor, connected to terminals **OA** (4) and **OB** (5). The output is bipolar, for maximum load see technical specifications further below.

### 3.2.4 Current

Thread the measured wire through the instrument in the way the current flows from top to bottom at positive values.

By default, use of insulated measured wire is assumed. When using bare wire it is necessary to take into account the insulation strength of the through hole (see instrument technical specifications).

For small currents measurement you can increase the measurement accuracy by multiple wire turns (if the wire thickness allows). Then enter the number of turns while device settings ( **D** parameter ).

## 3.3 Setup

To set the instrument, a class PC computer (usually portable) running Microsoft Windows XP or later and *the Envis.Daq* setup program are needed. *The Envis.Daq* program can be freely downloaded from the manufacturer's website [www.kmbsystems.eu](http://www.kmbsystems.eu). After unpacking the installation file, run the program *setup.exe* and follow instructions of the installation program.

Instrument setup is carried out via the communication interface. Usually it is necessary adequate interface converter ( see below ).

### 3.3.1 Setup PC Connecting to the Modem with RS-485 Interface

It is required to connect the setup PC to the instrument RS-485 interface through a suitable converter, usually of USB/485 type. We recommend to use the SB-485 converter from *The PaPouch* company ([www.papouch.com](http://www.papouch.com)). It is sufficient to connect the converter to the instrument interface terminals **A** and **B** only, the **GND** terminal can be left usually unconnected for the setup. You need not to disconnect any other devices connected to the interface by their connectors pulling out.

If the setup PC is equipped with a RS-232 interface, a 232/485-type converter can be used too; but note that it must support automatic data flow direction control according transmitted data and its flow direction timer shall be set to the appropriate speed transmission (baud rate).

These converters can be ordered from the modem supplier as an optional accessory.

### 3.3.2 Setup PC Connecting to the Modem with RS-232 Interface

If the setup PC is equipped with an RS-232 interface, it can be connected to the instrument directly ( without any converter). For this only so-called "cross connected" or „null modem“ cable (3-wire, the signal RxD of the PC to the TxD of the modem and vice versa, and GND to GND) is required.

Otherwise, you must use an "USB/232" converter, which is commonly available in computer shops.

### 3.3.3 Instrument Setup

The instrument must be connected to a setup PC according previous chapters. Before the instrument power up, start the *Envis.Daq* program.

The program entry window appears. Before turning on the instrument, preset communication parameters : select the *COM* tab and then select serial interface port number to which the modem is connected (e.g. *COM1*) :

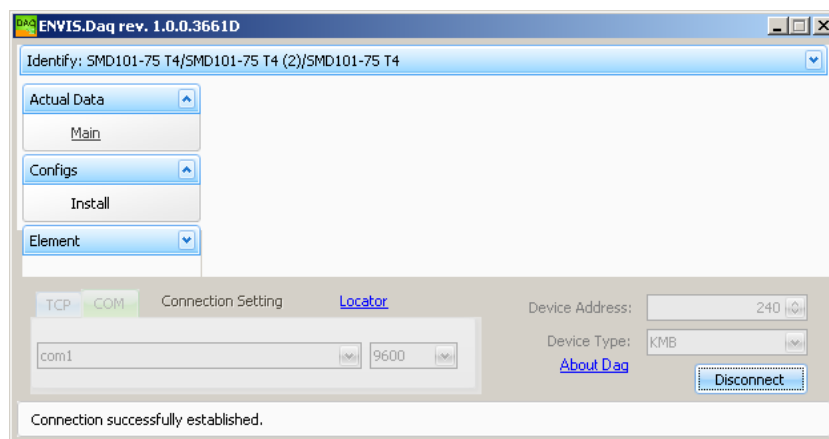


Next, set communication speed of this interface to 9600 Bd and communication address of the instrument (*Device Address*) to value of 250 ( corresponding to the default communication parameters of the instrument in *the setup state* ).

Now turn the power on the instrument. The instrument enters *the setup state* ( *STATE-LED* flashes quickly - about 4 times per second ). At this point, press the *Connect* button.

Note : This choice must be accomplished during 10 seconds, when the instrument is in *the setup state*, otherwise it switches to *the ready state* and the setting is not possible – in such case you must turn the instrument off and start the procedure again.

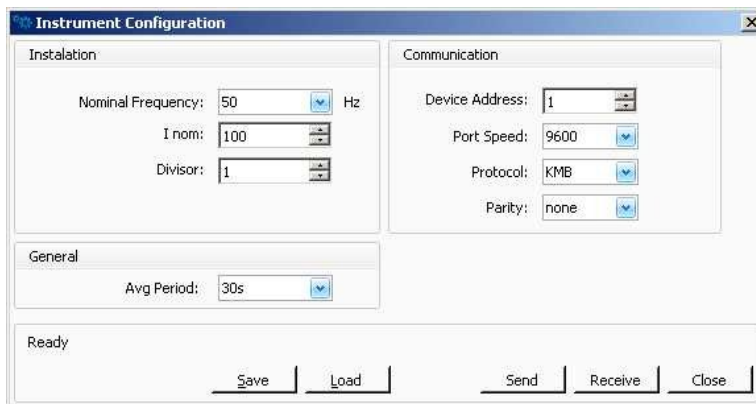
After the *Connect* button pushed the program identifies the instrument model and displays it the program main window :



In the *Identify* section heading the connected instrument model specification ( SMD101-75T/4 ) and its serial number (2) is displayed. Except of this, so called object name and record name (which is preset same as the model specification as default) can be viewed; these parameters are determined for eventual record archiving in the *Envis.Online* program in future and not relevant for now.

### 3.3.3.1 Installation Setup

For instrument basic parameters setup, choose the **Install** option in the **Configs** section. The **Instrument Configuration** window appears :



Parameters are arranged in sections:

- **Installation section :**

It comprises information of measured network properties and method of connection :

- **Nominal Frequency** - Nominal frequency of *AC-network* in site, either 50 or 60 Hz. The setting is essential for correct measurement of AC-component of the current, but it can influence accuracy of DC-component measurement too if not set properly.
- **Inom** – Nominal current in amps. It is necessary for *ALARM* LED and digital output operation setting only, because its limits are defined in percents of the **Inom** . Otherwise it has no influence on instrument function.
- **Divisor ( D )**– Dividing ratio of measured current, range 1 ÷ 250. At default value of 1, measured value corresponds to the wire current. For currents of significantly lower sizes than the instrument measuring range, relative precision of measurement can be increased by multiple turns of measured wire through the instrument hole - in such case set parameter value to number of turns.

- **General section :**

- **Avg Period** - Time constant of average current value ( **lavg** ) processing. Thermal function method is used for averaging.

- **Communication section :**

In this section there is defined communication interface setting that is used during the instrument *normal state* :

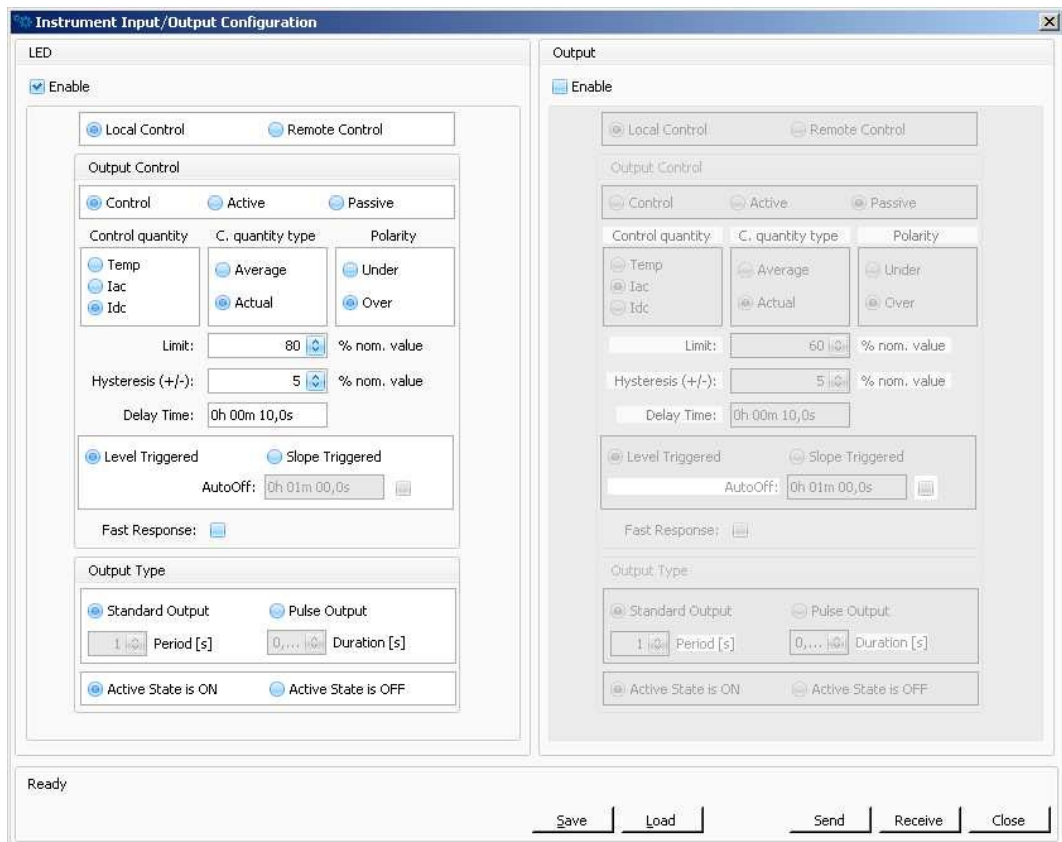
- **Device Address** - Instrument address, range 1 ÷ 250.
- **Port Speed** - Communication rate in Bauds.
- **Protocol** - The communication protocol. For cooperation with the *Envis.Daq* program, set manufacturer's proprietary **KMB** protocol. For connection to third-party monitoring systems the Modbus-RTU protocol can be used.
- **Parity** - Parity can be set as *none*, *even* or *odd*. Valid for Modbus-RTU protocol setting only.

Now send preset settings into the instrument with the **Send** button. You can save it on a disk for future use with the **Save** button too. Finally, close the window with the **Close** button.



### 3.3.3.2 Outputs Setup

With the **Input/Output** option in the **Configs** section you can set the **ALARM LED** and the digital output behaviour. Following **Instrument Input/Output Configuration** window appears :



Both the LED and the output can be set independently – the LED setting in the left part and the output in the right part of the window. Meanings of individual parameters are :

- **Enable** Global enable of the output function. Otherwise the output is permanently off
- **Local / Remote Control** You can define if the output is controlled locally by the instrument itself or remotely via serial link by commands from remote computer.

In case of *Local Control* you can define the output behaviour according to so called *control event* as follows :

- *Output Control* section :

In this section there is specified how so called output *logical state* is controlled by selected *control event*. It is necessary to set :

- **Control Event**
  - **Control** *Control quantity* size event. The selected *control quantity* size is compared with preset limit which results in the event state.
  - **Active** *Control quantity* permanently active (1)
  - **Passive** *Control quantity* permanently passive (0)

For the **Control** setting you further need to set :

- **Control Quantity** :

- **Temp** Temperature
- **Iac** AC-current
- **Idc** DC-current

If any of currents is set as *control quantity*, define :

- **Control Quantity Type** :
  - **Actual** Actual value of the current is used
  - **Average** Average value of the current is used

Next set :

- **Control Quantity Deviation Polarity** :
  - **Over** Event state gets active if control quantity over the limit
  - **Under** Event state gets active if control quantity below the limit
- **Limit** Limit value of the control quantity at which the event state changes ( in percents of the *Inom* or directly in °C )
- **Hysteresis** Defines the insensibility range of the event state(in the same units as the *Limit*)
- **Delay Time** Defines minimum duration of the event till the output *logic state* changes
- **Fast Response** Fast output reaction. When set, following settings get irrelevant : **Hysteresis** (0), **Delay Time** (0) and **Trigger** (*Level*). Can be set only for *Actual Iac* or *Idc* control quantities and the *Over* deviation polarity.
- **Trigger** :
  - **Level Triggered** The output *logical state* is continuously controlled by actual *control event* value.
  - **Slope Triggered** The output *logical state* gets active when the value of *the control event* changes from inactive (0) to active (1) state only. In such case another parameter should be set :
    - **AutoOff** Duration of the active *logical state* after being triggered. When the preset time expires the output *logical state* reverts back to inactive state automatically.

According the setting, instrument evaluates output *logical state* continuously – it can get active (1) or passive (0) and its value can be monitored in actual data window (see below).

- **Output Type** section :

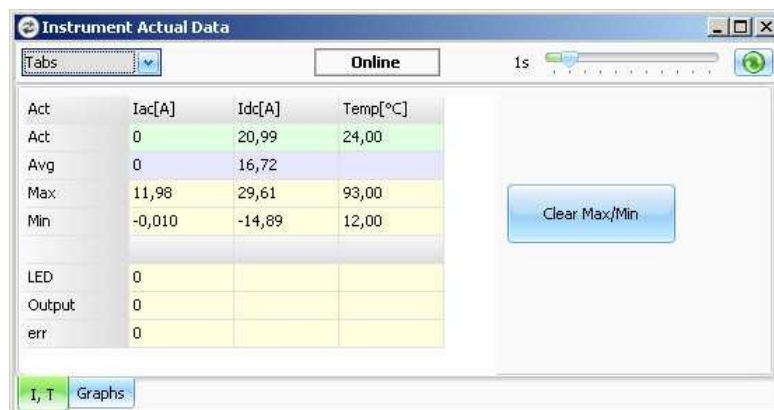
Finally, an *output type* that defines how the output *physical state* will be controlled by the output *logical state* must be set :

- **Output Character** :
  - **Standard Output** Physical output is permanently on or off
  - **Pulse Output** In such case you need to set :
    - **Pulse Signal Period** (in seconds )

- **Active Signal Duration** Duration of the active state ( defined with *the output active state* parameter ) part of the pulse signal ( duty of the signal ). The preset value must be lower than *the pulse signal period*.
- **Output Active State** Defines output *physical state* polarity when the *logical state* is 1 ( active ). Can be set either to *on* ( output switch is closed, LED is on ) or *off* (open. LED is off).

### 3.3.4 Instrument Functionality Check

To check instrument function, choose **Main** option in **Actual Data** section. **Actual Data** window appears :

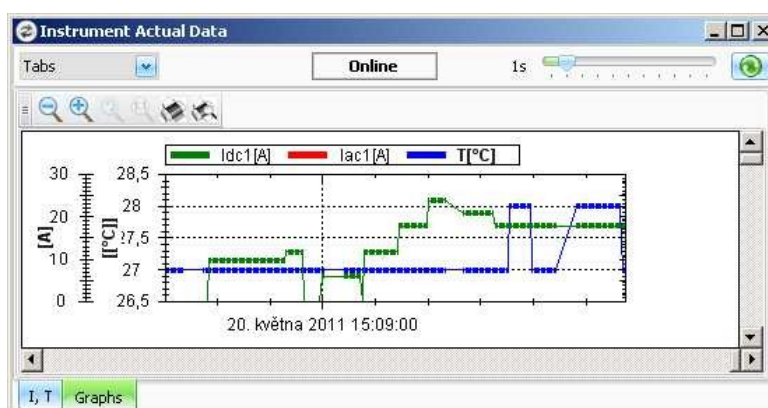


The program reads measured data from the instrument and views them in numeric format periodically. Besides actual and average data the instrument registers minimums and maximums of average current values and actual temperature; these extreme values can be cleared with the **Clear Max/Min** .button.

Next, actual *logic state* of the ALARM LED and digital output are displayed. If any of the outputs are set as *remotely controlled* , you can switch their state with the **Toggle** button. If an output is controlled *locally* and slope triggered you can deactivate its *logical state* if it is active.

In the **Err** field so called *instrument error state* can be checked. Its value should be zero if the instrument is without defects.

In the **Graphs U,I** folder you can check time traces of individual measured quantities.



## 4. Functional Description

### 4.1 Hardware

There are three LED-diodes on the instrument front panel :

*STATE* ... indicates that the instrument is powered; in the *setup state* it flashes

*RxTx* ... indicates serial link traffic; received bytes with green, sent bytes in red

*ALARM* ... freely programmable, see output setting

### 4.2 Setup

After the instrument being power up, the LED-diode *STATE* starts flashing quickly (approx. 4 times per second) signalling the instrument has entered the *setup state*. Regardless of the instrument current setting, in the *setup state* the instrument uses following fixed communication parameters :

- *address* 250
- *port speed* 9600 Bd
- *protocol* KMB

In this state it is possible to set the instrument using the communication parameters above with the *Envis.Daq* program.

As default, *the setup state* lasts approx. 10 seconds. If the instrument receives at least one valid command during this time, *the setup state* time is prolonged to approx. 10 minutes; then you can set the instrument as desired (see *Installation* chapter).

If no valid command comes from communication interface into the instrument during the default setup time, the instrument gets into *the normal state*. This state is indicated with permanently lit *STATE* LED. Since this the instrument starts to use preset communication parameters.

Generally, the instrument can be set in both setup state and normal state; but communication parameters can be set in the setup state only via address 250.

### 4.3 Method of Measurement and Evaluation

#### 4.3.1 Current

Current signal is evaluated continuously, without any gaps. Although the instrument is primarily determined for DC current measurement, the measurement cycle is tailored to nominal frequency of AC network (can be set either to 50 or 60 Hz) for optimal interference suppression.

The unitary evaluation interval, a *measurement cycle*, is a twenty / twenty four ( value behind slash is valid for  $f_{\text{NOM}} = 60 \text{ Hz}$  ) *mains cycles* long period, i.e. 400 ms at frequency equal to preset  $f_{\text{NOM}}$  .

The current is sampled with rate 32 samples per AC mains cycle. From sampled values following quantities are calculated :

$I_{\text{DC}}$  actual DC-current value. It corresponds to mean value of current samples during the last *measurement cycle* (400 ms). It can be either positive or negative.

$I_{AC}$  AC-component of the current. It is evaluated as mean value of current samples during the last *measurement cycle* after subtraction of DC- current component and recalculated to corresponding effective value ( multiplied by  $\pi/(2*\sqrt{2})$  ).

From measurement cycle values, average values  $I_{DCAVG}$  and  $I_{ACAVG}$  are evaluated using so called *thermal function* averaging method. An exponential function simulation is used to get thermal-like dependence. Unit step time response depends on the preset averaging period (*Avg Period*) – during this period, an average value reaches about 90 % of unit step amplitude. Average values are refreshed with period equal to square root of preset average period (*Avg Period*).

The instrument registers minimum and maximum values of average current values :

- $I_{DCAVGMAX}$  maximum of average DC- current since last clearing
- $I_{DCAVGMIN}$  minimum of average DC- current since last clearing
- $I_{ACAVGMAX}$  maximum of average AC-component of current since last clearing
- $I_{ACAVGMIN}$  minimum of average AC-component of current since last clearing

The values are registered in a non-volatile memory so they are kept even in case of power outage. They can be cleared with appropriate command.

### 4.3.2 Temperature

Instruments with built-in temperature sensor measure actual temperature **Temp** too. Period of measurement is approx. each 12 seconds. Maximum and minimum values **Temp<sub>MAX</sub>** and **Temp<sub>MIN</sub>** are registered too.

As the temperature sensor is built inside the instrument, it measures internal temperature in fact. But measure value is calibrated ( after internal temperature stabilisation, i.e. approx. 20 minutes after power-up ) to ambient temperature. It is supposed that natural air circulation is provided and in the instrument's neighbourhood, especially underneath the instrument, no other instrumentation that is source of heat is installed. Otherwise, the temperature value measured may be false.

## 4.4 Digital Outputs Function

Behaviour of both *ALARM* LED and digital output can be set individually. In this chapter you can find detailed description.

If *local control* of an output and *control quantity event* are set, output value is controlled by control quantity size compared to preset *limit* .

If *fast response* is not set, the outputs are evaluated each *measurement cycle* period, i.e. each 400 ms. As control quantity either actual or average current ( $I_{DC}$ ,  $I_{AC}$ ,  $I_{DCAVG}$ ,  $I_{ACAVG}$ ) or actual temperature (**Temp**) can be used.

If *the fast response* is set, the output state is controlled by values of individual current signal samples directly (see below).

The *limit* and *hysteresis* are defined either in percents of nominal current ( $I_{NOM}$ ) or in °C if the control quantity is temperature. If the control quantity is current the nominal current value  $I_{NOM}$  must be properly set too.

In case of AC-current control quantity *the limit* must be set as **positive DC-current** value ! That means the *the limit* must be set as amplitude of desired AC-current limit which is for sinus signal effective current value multiplied by coefficient  $\sqrt{2} = 1.41$ .

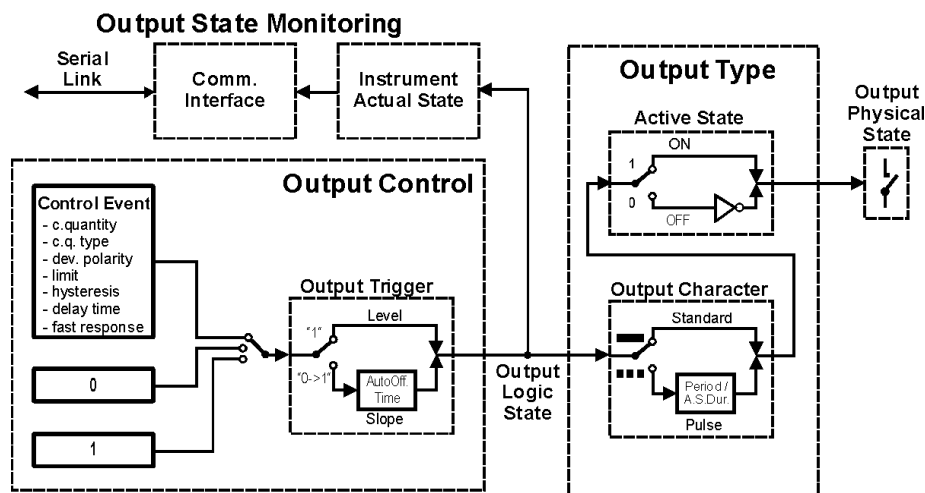
In case control quantity is DC-current or temperature *the limit* can be set both positive and negative. These quantities are compared with *the limit* including their signs.

*The hysteresis* defines the insensibility range. If control quantity value is inside  $[(limit - hysteresis), (limit + hysteresis)]$  range the control event state doesn't change. It is defined in the same units as the *limit*.

*Control quantity deviation polarity* valid for active event state can be set to *over limit* or *under limit*.

Next you can set insensitivity of control event against fast changes of control quantity with the *delay time* parameter. Then the event value will change only when the control quantity keeps over or under *the limit* for preset *delay time*.

Fig. 4.1 : Output Local Control Scheme



The outputs function is illustrated on the scheme. Selected quantity size is compared with preset limit which results in the control event state and the output *logic state*. This state can be monitored via serial link as part of the instrument actual state.

The output *physical state* is set according the *logic state* and *the output type* setting.

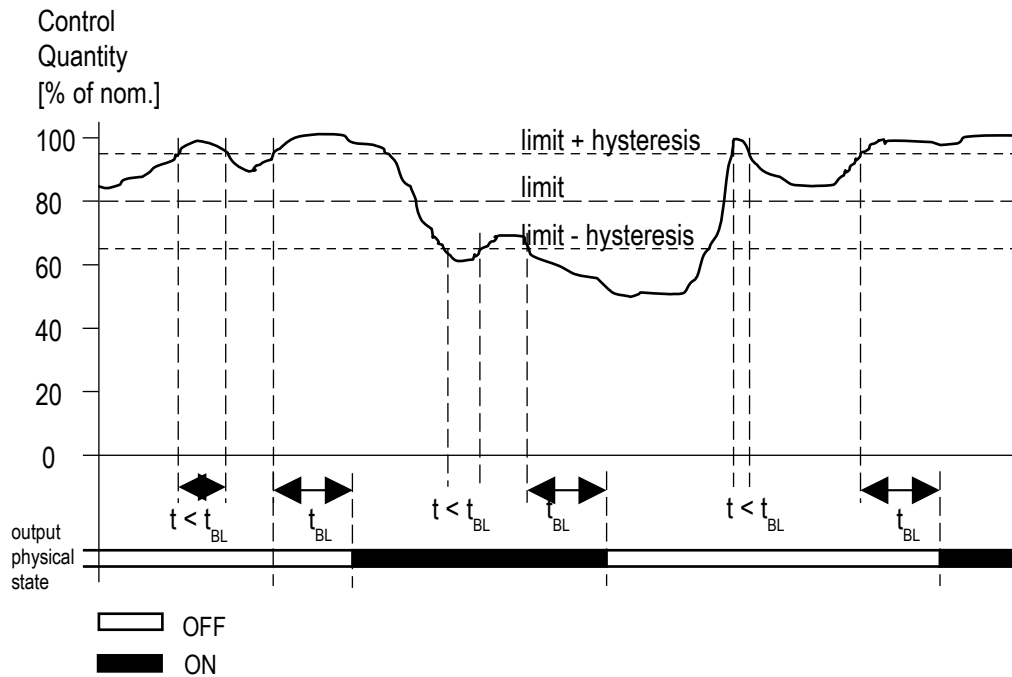
#### 4.4.1 Level Triggered Output Behaviour

If *the fast response* is not set, the output functionality is as described on picture below.

In the example the output was set :

- *the limit* to 80 % of nominal value with 15% *hysteresis*
- *the control quantity deviation polarity* to *over*
- *level* triggered
- output type :
  - *standard output character*
  - *output active state* to *ON*

Fig. 4.2 : Level Triggered Output Behaviour



The output physical state gets ON if control quantity exceeds 95 % of preset nominal value and keeps on for preset delay time ( $t_{BL}$ ).

Similarly, the output physical state gets OFF after control quantity drops below 65 % of preset nominal value and remains there for the delay time.

In other cases the output state doesn't change.

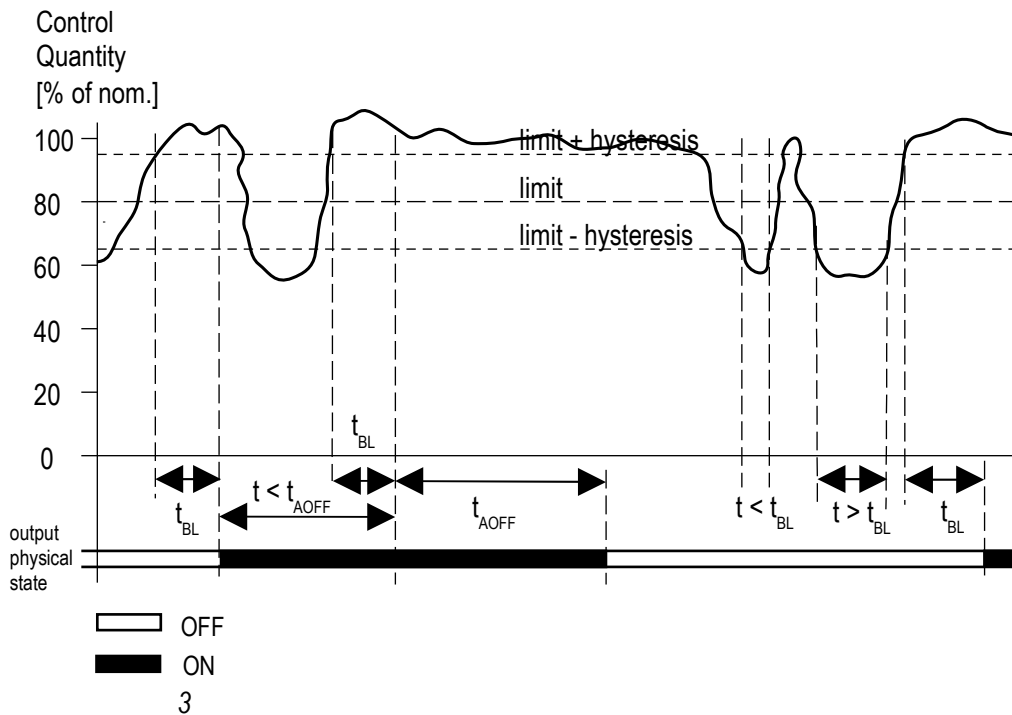
#### 4.4.2 Slope Triggered Output Behaviour

When set as *slope triggered* (i.e. by level change) the output *logic state* gets active only when control event state passes from passive to active state. Back to passive state it gets automatically after preset *auto-off time* ( $t_{AOFF}$ ) expires.

If this *auto-off time* is set as *never*, the logic state stays activated permanently ( its value is saved in non-volatile memory so it is restored even after instrument power up ). In such case, the only possibility to return its value back to passive is by appropriate command from supervising system via the communication link (in the same way as remotely controlled outputs).

At the discussed output setting, the output physical state will follow its logic state.

Fig. 4.3 : Slope Triggered Output Behaviour



### 4.4.3 Fast Response Output Mode Behaviour

At the fast response mode, quantity actual level is evaluated after each scanned sample, i.e. 32 times per AC mains cycle with sampling frequency 1600 Hz at  $f_{NOM} = 50$  Hz or 1920 Hz at  $f_{NOM} = 60$  Hz. That corresponds to sampling period of  $t_{SCAN} = 0.625$  ms ( 50 Hz ) or  $t_{SCAN} = 0.52$  ms ( 60 Hz ).

The fast response mode can be set for actual current (both DC and AC) control quantities and for deviation polarity at over position only. The output behaviour is different for DC- and AC-current.

Against the standard mode, following parameters setting is irrelevant for the fast response mode : hysteresis (fixed 0), delay time, trigger (fixed level), and character (fixed standard).

#### 4.4.3.1 Fast Response – DC Current

Output *logical state* gets active as soon as two consecutive samples exceed preset limit. It gets back passive immediately after any sample (even single) drops below the limit.

Consequently, the activation time is  $2 \times t_{SCAN}$ , at maximum and deactivation time is  $t_{SCAN}$ , at maximum.

The output *physical state* follows its *logical state* according preset *active state (on or off)*.

#### 4.4.3.2 Fast Response – AC Current

Output *logical state* gets active as soon as two consecutive samples exceed preset limit. The limit must be set to the maximum (positive) value (=amplitude) of sinus signal corresponding to target effective current value limit (= effective current value multiplied by coefficient  $\sqrt{2} = 1.41$ ).

Output *logical state* gets back passive if during  $18 \times t_{SCAN}$  period the instrument doesn't detect at least two consecutive samples exceeding preset limit (in absolute value).

Consequently, both activation and deactivation time is  $2 \times t_{SCAN}$ , at maximum.

The output *physical state* follows its *logical state* according preset *active state (on or off)*.



Fig. 4.4 : Fast Response at DC-Current Control Quantity

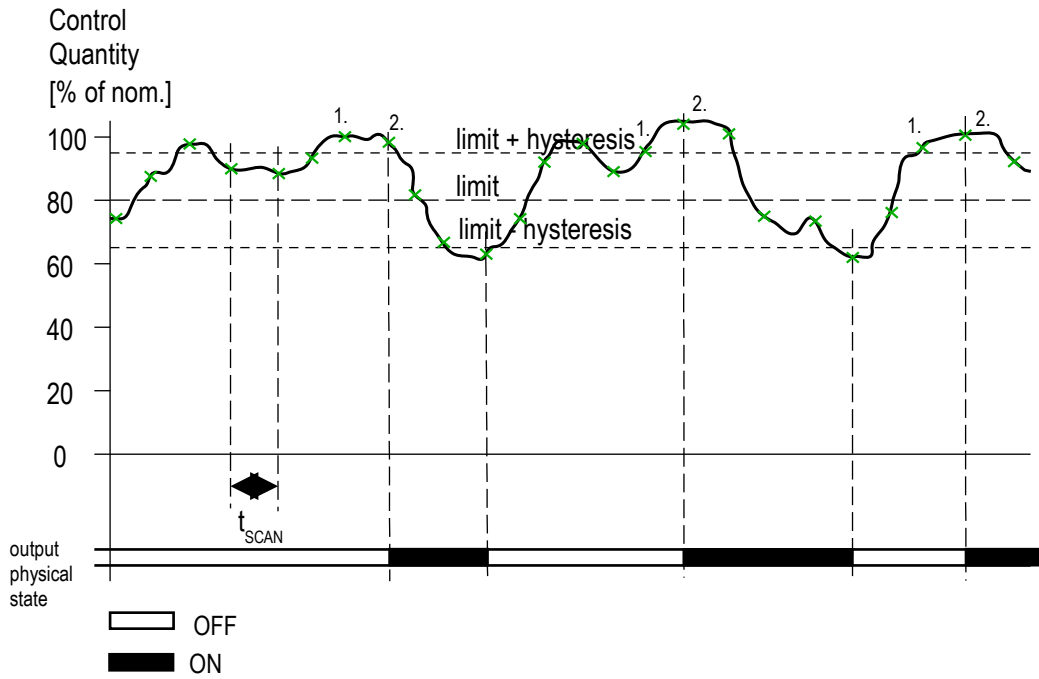
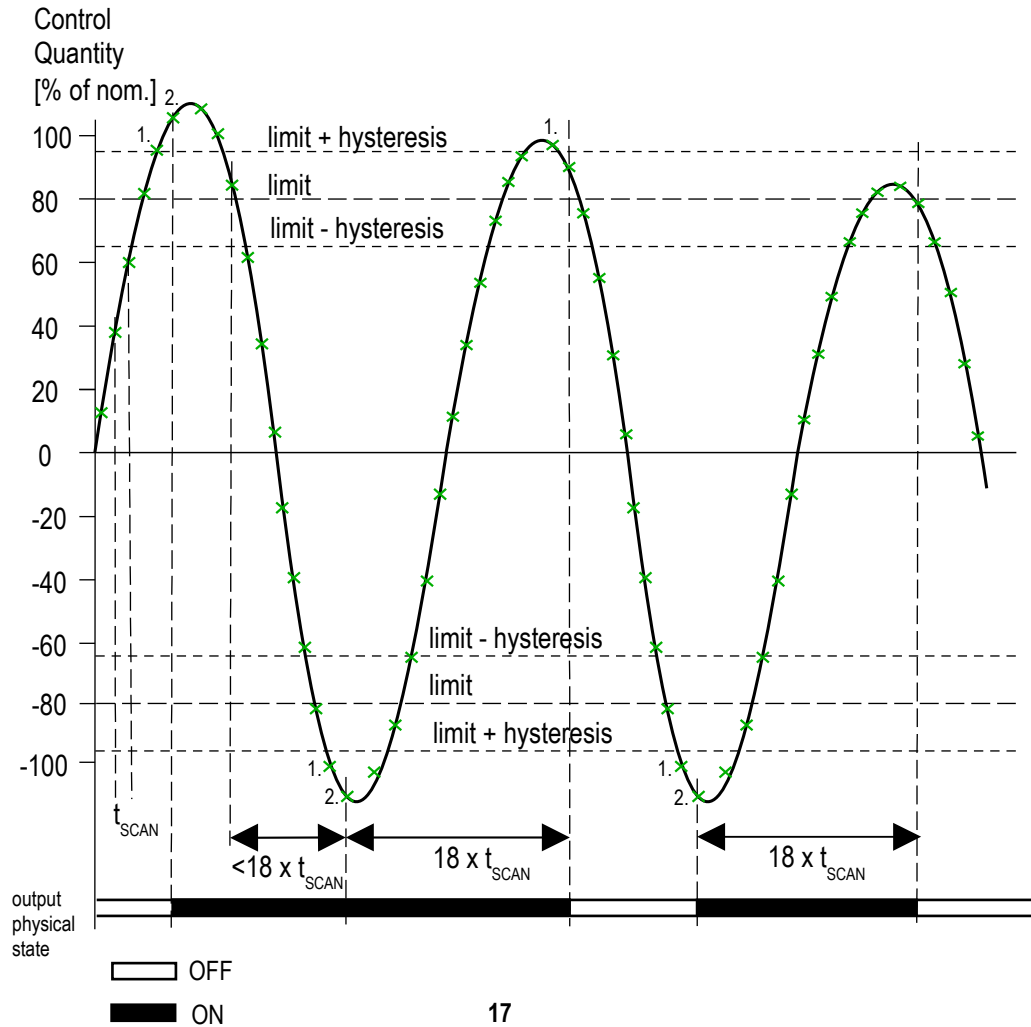


Fig. 4.5 : Fast Response at AC-Current Control Quantity



## 4.5 Communication

### 4.5.1 Communication Protocol

Data transfer between an instrument and a remote PC runs via communication link with RS-485 or RS-232 interface. Instruments support two communication protocols :

- *KMBLong* ... manufacturer's proprietary protocol. Set this protocol for cooperation with any of manufacturer's programs ( *Envis*, *Envis.Online*, *Envis.Daq* )
- *Modbus-RTU* ... widely supported communication standard. Use this protocol for interconnection with third-party applications.
- 

### 4.5.2 Modbus-RTU Protocol

Standard Modbus-RTU communication protocol can be used optionally for connection with master. Except slave address and communication rate, parity bit function can be set ( even / odd / none parity ).

The instrument answers during 600 ms after receiving a command from the master, available gap of up to 1.5 bytes transmit time between bytes during transmitting can occur.

Broadcast-mode is not supported.

*Note* : In compliance with the Modbus protocol definition, 9-data-bit transfer is used even if no parity bit is set; in such case the bit value is ignored. But some applications use at this setting 8-bit data transfer and then instrument doesn't reply on such commands. Setting protocol to 2 stopbits can help to solve this problem.

Implemented Modbus functions are listed in following table :

function no.	function	application
03	Read Holding Registers	<i>Identification</i> read – registers 40101-40108 ( addressed 100 – 107 ) <i>Installation Setting</i> read – registers 40201-40209 (addressed 200 – 208 ) <i>Output Setting</i> read – registers 40301-40312 (addressed 300 – 311 )
04	Read Input Registers	<i>Status</i> (measured data) read – registers 30101-30112 (addressed 100 – 111)
06	Preset Single Register	<i>Installation Setting</i> write <i>Output Setting</i> write Remote output control & extremes clear – register 40401 (address 400)
16	Preset Multiple Registers	the same as 06 - Preset Single Register

The data structure access is available by reading/writing from/to appropriate registers (see table above ). Every structure corresponds with appropriate continuous group of registers.

#### 4.5.2.1 Identification

Holding-registers. Starting register address in the command : 100.

Registers are read-only.

Offset	Parameter	Comment
0	instrument serial number	
1	instrument type	např. 0x2115 pro přístroje SMC101-50 /4
2	instrument group type	0x0058 pro přístroje řady SMC
3	firmware version	
4	hardware version	
5	firmware module version	
6	high byte : instrument address low byte : bootloader version	
7	reserve	

Example :

Instrument serial number read ( holding register on address 100=64hex), instrument address 1 supposed (hexadecimal format ):

Command :

01 03 00 64 00 01 C5 D5

Response :

01 03 02 00 05 78 47

The instrument returned serial number of 0005.

#### 4.5.2.2 Installation Setting

Holding-registers. Starting register address in the command : 200.

Registers are read/write.

Offset	Parameter	Comment
0	high byte : $f_{NOM}$ nominal frequency bit 0 : 0... 60 Hz 1... 50 Hz low byte : <b>D</b> -divisor ...dividing ratio of measured current	range 1 ÷ 250
1	high byte : <b>AvgPeriod</b> 0 ... no averaging 1 ... 4 sec 2 ... 9 sec .... 18 ... 45 min 19 ... 1 h 20 ... 1h 30 min 21 ... 2 h low byte : reserve	values over 21 invalid
2	$I_{NOM}$ nominal current [0.01A] (DC)	

3	high byte : communication address low byte : comm. speed & protocol low nibble : comm. speed : 4.....1200 Bd 5.....2400 Bd 6.....4800 Bd 7.....9600 Bd 8.....19200 Bd 9 ....38400 Bd 10.....57600 Bd 11...115200 Bd  high nibble : comm. protocol : bit 6 :    0 = KMBLong 1 = ModBus-RTU bits 5,4...parity (for ModBus-RTU only): bit5.....0=no parity 1=with parity bit4.....0=even parity 1=odd parity	range 1-250 Warning ! Comm. parameters change will be accepted in <i>the setup state</i> via address value 250 only ! Otherwise, the communication parameters will stay unchanged.
4	reserve	
5 ÷ 8	<i>object</i> – text string of 8 characters	

Example :

Parameters  $f_{NOM}$  and D-divisor (holding registr on address 200=C8hex) read, instrument address 240(=F0hex) :

Command :

F0 03 00 C8 00 01 10 D5

Response :

F0 03 02 FF 01 45 A1

Instrument returned 0xFF in the high byte, i.e. bit 0 = 1, i.e.  $f_{NOM}$  is 50 Hz. In the low byte 01 means D = 1.

### 4.5.2.3 Output Setting

Holding-registers. Starting register address in the command : 300.

Registers are read/write.

Offset	Parameter	Comment
0	ALARM LED setting: high byte : bit 0 : 0... enable 1... disable bit 1 : reserve bit 2 : 0... remote control 1... local control bit 3 : 0... pulse output 1... standard output bit 4 : 0... slope triggered 1... level triggered	

	bit 5 : 0... active state OFF 1... active state ON bit 6 : reserve bit 7 : 0... fast response 1... normal response  low byte : reserve	
1	ALARM LED setting: high byte : bit 0 : 0... control quantity size c. event 1... fixed control event bit 1 : 0... fixed control event passive 1... fixed control event active bits 4-3 : control quantity : 0X ... <b>Temp</b> 10 ... I <sub>DC</sub> 11 ... I <sub>AC</sub> bit 5 : 0... average control quantity 1... actual control quantity bit 6 : 0... deviation polarity „under“ 1... deviation polarity „over“ bit 6,7 : reserve  low byte : <b>Limit</b> [%]	
2	ALARM LED setting: high byte : <b>Hysteresis</b> [%] low byte : <b>Delay Time</b> . Coding : 0 -10 ... 0 ÷ 5 sec with 0.5sec step 11 -25 ... 6 ÷ 20 sec with 1 sec step 26 -33 ... 25 ÷ 60 sec with 5 sec step 34 -41 ... 1min.30sec ÷ 5min with 30 sec step 42 -156...6 min ÷ 120 min with 1 min step 157 and higher - invalid value	
3	ALARM LED setting: reserve	
4	ALARM LED setting: high byte : <b>AutoOff</b> time. Coded in the same way as the <i>Delay Time</i> . low byte : reserve	
5	ALARM LED setting: reserve	
6 ÷ 11	Digital Output setting: the same setting structure as the ALARM LED setting	

Example :

Digital output setting parameters (6 holding registers starting from address 306=132hex) read,  
 instrument address 1 :

Command :

01 03 01 32 00 06 65 FB

Response :

01 03 0C 7A FF F4 3C 05 0F 07 08 FF FF FF FF 62 CA

#### 4.5.2.4 Status

Input-registers. Starting register address in the command : 100.

Registers are read-only.

Offset	Parameter	Comment
0	high byte : error byte ..... 0 = no error >0 = hardware error low byte : instrument state bit 0 : 0...normal state 1...setup state	
1	high byte : reserve low byte : setting change counter	after power-up cleared to 0
2	I <sub>DC</sub> – DC-current actual value	in 0.01A units *) 32767... undefined
3	I <sub>AC</sub> – AC-current actual value	
4	high byte : <b>Temp</b> – temperature (actual) low byte : digital output & <i>ALARM LED logical state</i> : bit 0 : 0... digital output is passive 1... digital output is active bit 1 : 0... <i>ALARM LED</i> is passive 1... <i>ALARM LED</i> is active	in °C; +127...undefined value
5	I <sub>DCAVG</sub> – DC current average value	in 0.01A units *)
6	I <sub>ACAVG</sub> – AC current average value	32767... undefined
7	I <sub>DCAVGMAX</sub> – maximum of DC-current average value reached since last clearing	
8	I <sub>DCAVGMIN</sub> – minimum of DC-current average value reached since last clearing	
9	I <sub>ACAVGMAX</sub> – maximum of AC-current average value reached since last clearing	
10	I <sub>ACAVGMIN</sub> – minimum of AC-current average value reached since last clearing	
11	high byte : T <sub>MAX</sub> ....maximum of temperature value reached since last clearing low byte : T <sub>MIN</sub> ....minimum of temperature value reached since last clearing	in °C; +127...undefined value

\*) ... Current values in 0.01A units (0.01A<sub>eff</sub> for AC-current). Theoretical range –30000 ÷ +30000 (0 ÷ +30000 for AC-current), but real range is lower ; it depends on the instrument type (see technical specifications). If temporary undefined , value 32767(=7FFF hex) is given.

Example :

Actual DC- and AC-current values (2 input registers starting from address 102=66hex) read,  
instrument address 1 :

Command :

01 04 00 66 00 02 91 D4

Response :

01 04 04 FF B8 07 D1 89 D9

The instrument passed values  $I_{DC} = -0.72A$  (FFB8hex = -72) and  $I_{AC} = 20.01 A_{eff}$  (7D1hex=2001).

#### 4.5.2.5 Remote Output Control & Extremes Clear

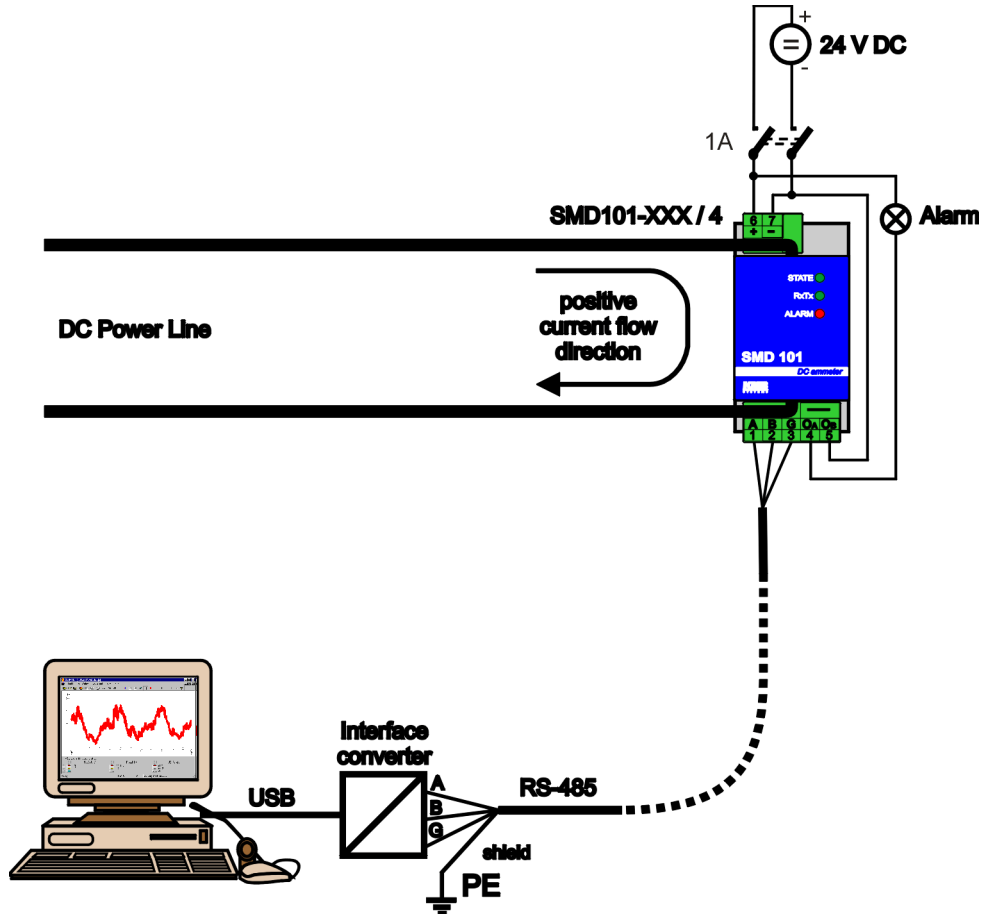
Holding-register. Starting register address in the command : 400.

Register is write-only.

Offset	Parameter	Comment
0	high byte : reserve low byte : bit 0 : 0... no extremes clear 1... clear extremes bits 1,2,3 : reserve bit 4 : 0... don't affect LED <i>ALARM logical state</i> 1... set LED <i>ALARM logical state</i> bit 5 : if bit 4 = 1 : 0... set LED <i>ALARM logical state</i> passive 1... set LED <i>ALARM logical state</i> active  bit 6 : 0... don't affect dig. output <i>logical state</i> 1... set dig. output <i>logical state</i> bit 7 : if bit 6 = 1 : 0... set dig. output <i>logical state</i> passive 1... set dig. output <i>logical state</i> active	

## 5. Connection Diagram

### SMD 101-XXX / 4 Typical Connection



### Installation Example





## 6. Technical Specifications

nominal DC-current $I_{DCNOM}$ : SMD101-050 SMD101-075 SMD101-100	50 A <sub>DC</sub> 75 A <sub>DC</sub> 100 A <sub>DC</sub>
DC-current measuring range	0 ÷ +/- 120 % $I_{DCNOM}$
DC-current measuring uncertainty excluding offset ( $t_A=23 \pm 2$ °C)	$\pm 1$ % $I_{DCNOM}$
DC-current offset ( $t_A=23 \pm 2$ °C)	$\pm 0,75$ % $I_{DCNOM}$
DC-current offset temperature drift	$\pm 0.75$ % $I_{DCNOM} / 10$ °C
DC-current offset hysteresis after current change by 1 x $I_{DCNOM}$	$\pm 0.4$ % $I_{DCNOM}$
AC-current measuring range (effective value)	0 ÷ 80 % $I_{DCNOM}$ [ A <sub>AC</sub> ]
AC-current measuring uncertainty	$\pm 1$ % $I_{DCNOM}$
through-hole dielectric strength	2,5 kV <sub>AC</sub> , 1 minute
through-hole diameter	11 mm
aux. power supply voltage, power	18 ÷ 36 V <sub>DC</sub> / V <sub>DC</sub> , 2 W
overvoltage class / pollution degree	III / 2 according to EN 61010-1
operational temperature	- 20 ÷ 60°C
storage temperature	- 40 ÷ 85°C
operational and storage humidity	< 95 % - non-condensable environment
EMC – immunity	EN 61000 – 4 - 2 EN 61000 – 4 - 3 EN 61000 – 4 - 4 EN 61000 – 4 - 5 EN 61000 – 4 - 6 EN 61000 – 4 - 11
EMC – emissions	EN 55011, class A EN 55022, class A (not for home use )
communication link type communication speed communication protocol	RS-485 or RS-232, isolated 1200 ÷ 115200 Bd KMBLong or Modbus-RTU
protection class	IP 20
dimensions / mass	91 x 36 x 58 / 0.1 kg

## 7. MAINTENANCE, TROUBLESHOOTING

SMD-101 ammeters do not require any maintenance. For reliable operation you only have to comply with the operating conditions specified and prevent mechanical damage to the instrument.

In the event of the product's breakdown, you have to return it to the supplier at their address.

supplier:

manufacturer:

KMB systems, s.r.o.

559 Dr. M. Horákové

460 06, Liberec 7

Czech Republic

website: [www.kmbsystems.eu](http://www.kmbsystems.eu)

The product must be packed properly to prevent damage in transit. Description of the problem or its symptoms must be sent along with the product. If warranty repair is claimed, the warranty certificate must be sent in too. If after-warranty repair is requested, a written order must be included.

### Warranty Certificate

Warranty period of 24 months from the date of purchase, however no later than within 30 months from the dispatch date from manufacturer's warehouse, is provided for the instrument. Problems in the warranty period, evidently caused by poor workmanship, design or inconvenient material, will be repaired free of charge by the manufacturer or an authorized servicing organization.

The warranty becomes void even within the warranty period if the user makes unauthorized modifications or changes to the instrument, connects it to out-of-range quantities if the instrument is damaged in out-of-specs impacts or from improper handling or if it has been operated in conflict with the technical specifications.

type of product: **SMD 101**.....

serial number .....

date of dispatch: .....

final quality inspection: .....

manufacturer's seal:

date of purchase: .....

supplier's seal: