

## AMB Smart Alternating-current Bus Bar Monitor

Installation and Operation Instruction V1.3

## **Declaration**

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## 1. Overview

AMB Smart Alternating-current Bus Bar Monitor is a new development to cater for smart power bus bar. It consists of a feeding detection module and a tapping detection module and integrates functions of conventional power measurements, electricity monitoring, consumption assessment and control. It also boasts the online alarm function and enables the independent off-line operation. It monitors the bus bar interface temperature in real time.

By virtue of 2 RJ45 communication ports (1 in and 1 out) and MODBUS-RTU protocol, it is easy and reliable to upload the monitoring data to the touch screen of the main controller for centralized monitoring, ensuring safe and reliable operation of the system. The smart bus bar monitor has several benefits such as flexible and convenient wiring so that it is a good substitution of the traditional centralized array cabinet.

## 2. Product models

Model	Standard functions	Optional functions
AMB100-A	(1) Full electrical measurements of three-phase AC circuit, 2 <sup>nd</sup> to 63 <sup>rd</sup> harmonic measurements, 1 leakage current, 8-way temperature, 1-way humidity, maximum demand measurement, neutral current, potential difference measurement between the null line and the ground line, 2 digital inputs, 2 digital outputs	/W(LORA)
AMB100-A-P1	(2) Full electrical measurements of three-phase AC circuit, 2 <sup>nd</sup> to 63 <sup>rd</sup> harmonic measurements, 1 leakage current, 8-way temperature, 1-way humidity, maximum demand measurement, neutral current measurement, 2 digital inputs, 2 digital outputs, discrete auxiliary power supply	
AMB110-A	(1) Full electrical measurements of three-phase AC circuit, 2 <sup>nd</sup> to 63 <sup>rd</sup> harmonic measurements, 1 leakage current, 8-way temperature, 1-way humidity, maximum demand measurement, neutral current measurement, potential difference measurement between the null line and the ground line, 2 digital inputs, 2 digital outputs	
AMB110-A-P1	(2) Full electrical measurements of three-phase AC circuit, 2 <sup>nd</sup> to 63 <sup>rd</sup> harmonic measurements, 1 leakage current, 8-way temperature, 1-way humidity, maximum demand measurement, neutral current measurement, 2 digital inputs, 2 digital outputs, discrete auxiliary power supply	
AMB120	8-way temperature	

Note 1. AMB: bus bar series; 100: for feeding cabinet; 110: for tapping cabinet; 120: for temperature detection; A: for alternating-current system; P1: discrete auxiliary power supply

Note 2. AMB10 display is optional. There are two variants, i.e. AMB10(F) with the front port and AMB10(B&DZ) with the rear port. It shows the voltage and the current in an automatic cycle.

Note 3. For optional LORA function, an external magnetic antenna is equipped. The standard length is 2 m.

Note 4. For temperature sensors, there are two round-hole variants, namely 12mm-hole variant and 8mm-hole variant, and one 6mm-cylindrical variant. Each variant includes yellow, green, red and black sensors.

## 3. Technical parameters

AMB100-A-□/AMB110-A-□

Measured parameters		Voltage, current, frequency, active power, inactive power, power factor, active energy, inactive energy, 2 <sup>nd</sup> -63 <sup>rd</sup> harmonic, temperature, leakage
Voltage	Rated value	3x220/380VAC
	Range	±20%
	Overloading	1.2 times than the rated voltage value continuously or 2 times than the rated voltage value instantaneously per second
Current	CT	AMB100-A : 5A/2.5mA, 100A/20mA, 400A/100mA, 600A/100mA AMB110-A: 100A/20mA
	Range	1%-120%
	Overloading	1.2 times than the rated current value continuously or 10 times than the rated current value instantaneously per second
Input frequency		45-65Hz
Measurement accuracy		Voltage/current: grade 0.2; active power/energy: grade 0.5; inactive power/energy: grade 1; temperature: ±1℃

Auxiliary power supply		AMB100/110-A(/W) : triggered upon receipt of request signal AMB100/110-A(/W)-P1: follow the bus bar voltage
functions	Temperature detection	-20-150°C
	Leakage	0-1A
	Digital input	2 dry-contact inputs
	Digital output	2 relay outputs; contact capacity : 3A/30VDC, 3A/250VAC
	Communication	Via RS485/Modbus-RTU or LORA antenna
Installation		Use DIN35mm rail
Protection		IP20
Pollution level		2
Environment	Temperature/ humidity/ altitude	Working temperature: -20-60°C Storage temperature: -25-70°C Relative humidity: ≤93% Altitude: ≤2500m
Safety	Insulation	The minimum insulation resistance between all terminals and conductive components of the shell is 100MΩ.
	Withstanding voltage	When a voltage of 2kV AC is applied between the voltage/ current input, relay output, RS485 port, auxiliary power supply and digital inputs, the leakage shall be less than 2mA and no breakdown or flashover shall occur in 1min..
Electromagnetic immunity	Electrostatic discharge immunity	Class 4
	Radio frequency electromagnetic immunity	Class 3
	Transient burst immunity	Class 4
	Surge immunity	Class 4

#### AMB120

Measurement accuracy		Temperature: ±1°C
Auxiliary power supply		220VAC, discrete
functions	Temperature detection	-20-150°C
	Communication	Via RS485/Modbus-RTU or LORA antenna
Installation		Use DIN35mm rail
Protection		IP20
Pollution level		2
Environment	Temperature/ humidity/ altitude	Working temperature: -20-60°C Storage temperature: -25-70°C Relative humidity: ≤93% Altitude: ≤2500m
Safety	Insulation	The minimum insulation resistance between all terminals and conductive components of the shell is 100MΩ.
	Withstanding voltage	When a voltage of 2kV AC is applied between the auxiliary power supply and temperature sensors, the leakage shall be less than 2mA and no breakdown or flashover shall occur in 1min..
Electromagnetic	Electrostatic	Class 4

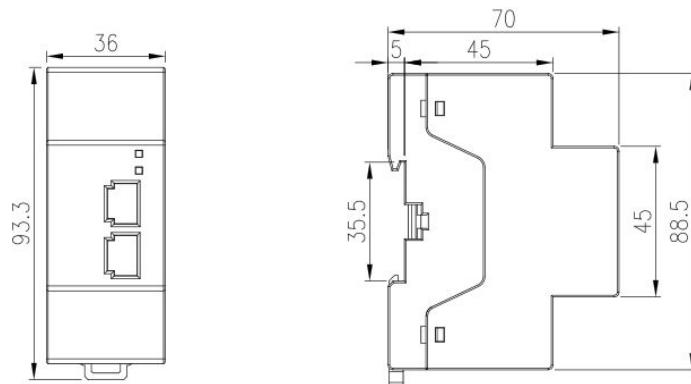
immunity	discharge immunity	
	Radio frequency electromagnetic immunity	Class 3
	Transient burst immunity	Class 4
	Surge immunity	Class 4

#### 4. Overall structure and dimensions

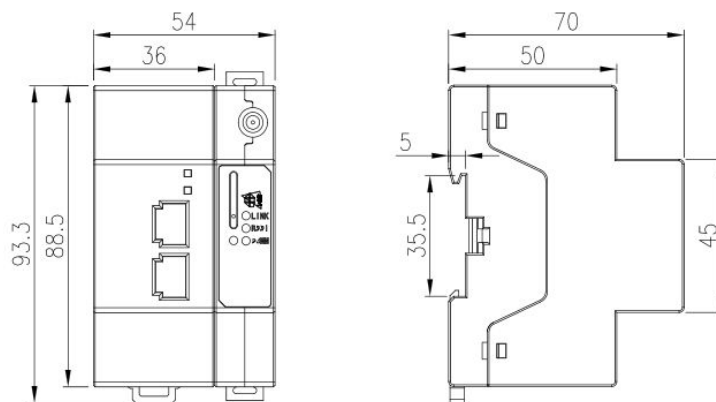
##### 4.1 Overall dimensions

###### 1) AMB smart bus bar detection module

Unit: mm



RS485/Modbus-RTU Communication

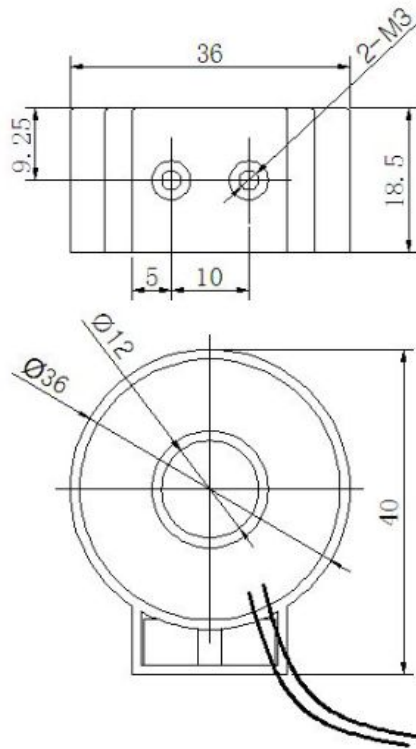


LORA Communication

Note 1. For LORA communication, the space shall be reserved for antenna.

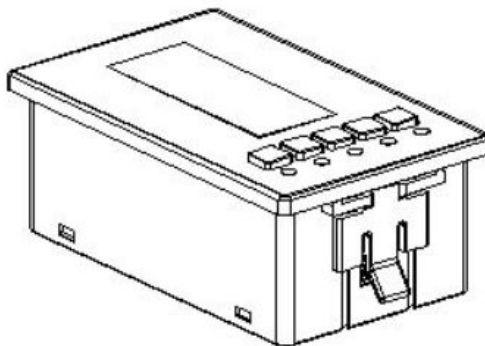
Note 2. An external auxiliary power supply is not required for LORA module.

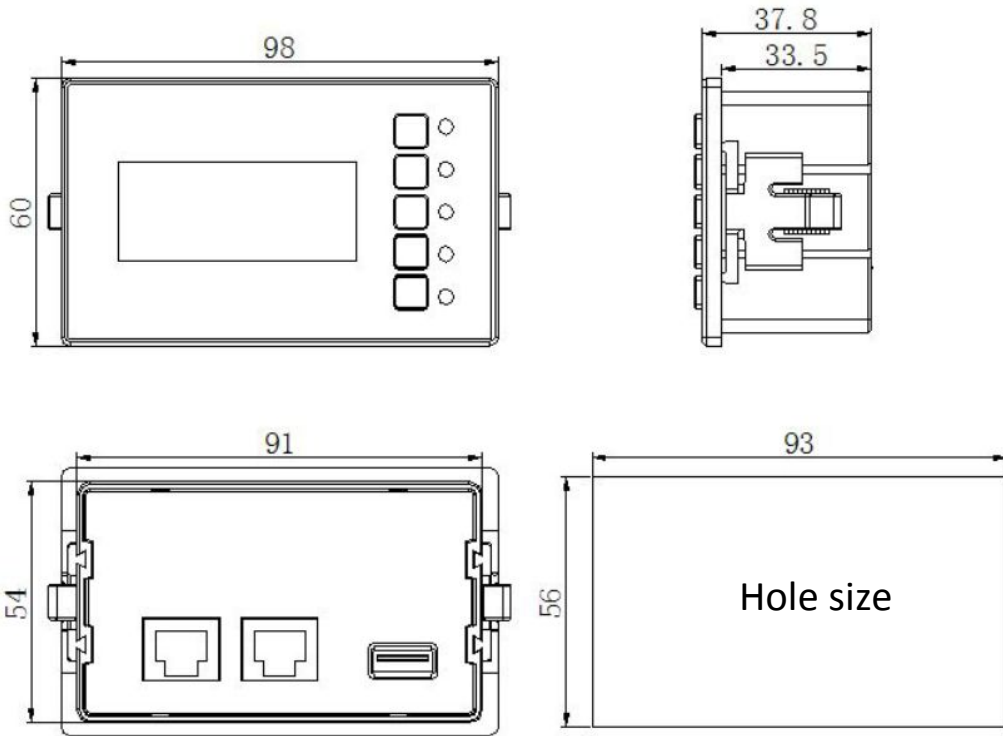
2) Ancillary transformer (unit: mm)



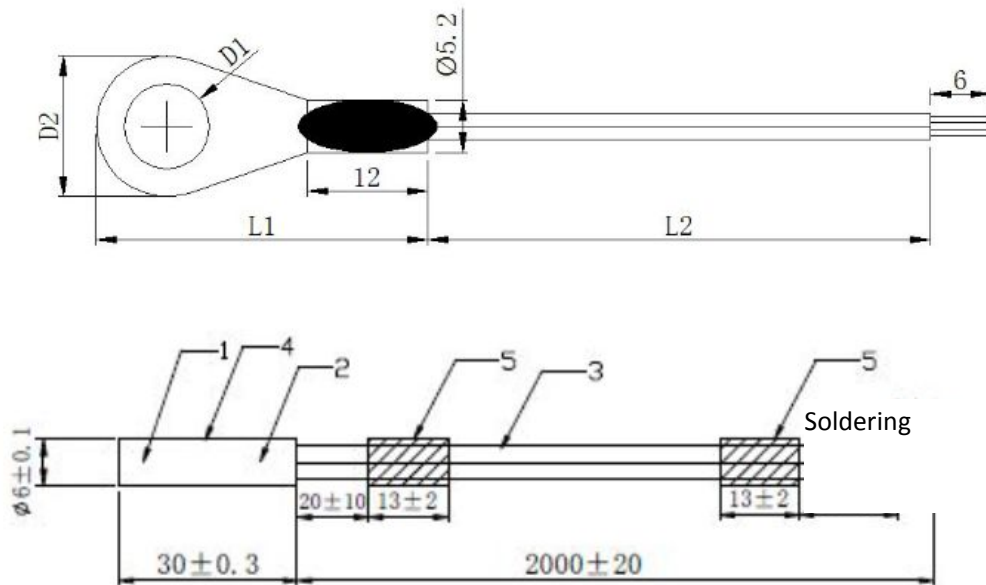
Model	Ancillary transformer	Remark
AMB100-A-□	AKH-0.66/W-12NY 5A/2.5mA, grade 0.2	(incl. 3 transformers)
	AKH-0.66/W-12NY 100A/20mA, grade 0.2	(incl. 3 transformers)
	AKH-0.66/W-45NY 400A/100mA, grade 0.2	(incl. 3 transformers)
	AKH-0.66/W-45NY 600A/100mA, grade 0.2	(incl. 3 transformers)
AMB110-A-□	AKH-0.66/W-12NY 100A/20mA, grade 0.2	(incl. 3 transformers)

3) AMB display (unit: mm)





4) Temperature sensor (unit: mm)



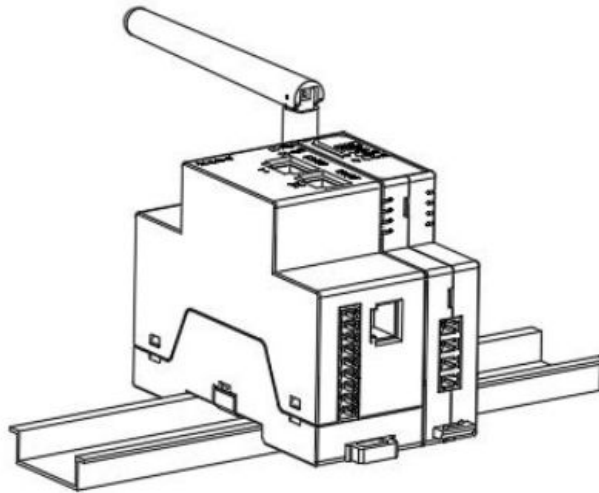


Temperature sensor	End			Wire length	Suggested use
	D1	D2	L1	L2	
12mm hole	12.5	18	35	2000 or 4000	With M10 and M12 screws
8mm hole	8.5	14	33		With M6 and M8 screws
6mm diameter	6.5	12	30	2000	Insert in the connection gap

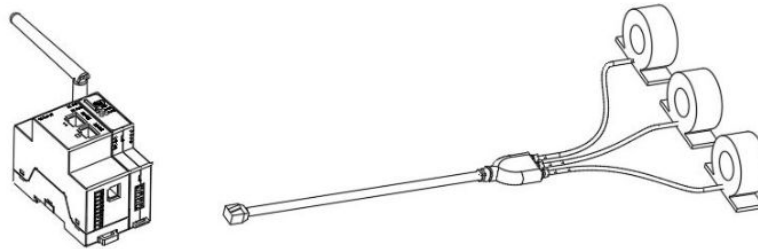
Note: For each temperature sensor variant, there are yellow, green, red and black types, corresponding to phases A, B, C and N.

#### 4.2 Installation instructions

The AMB detection module is installed on DIN35mm rails and equipped with thru-hole transformer. The side with the connector is connected to Current directly.



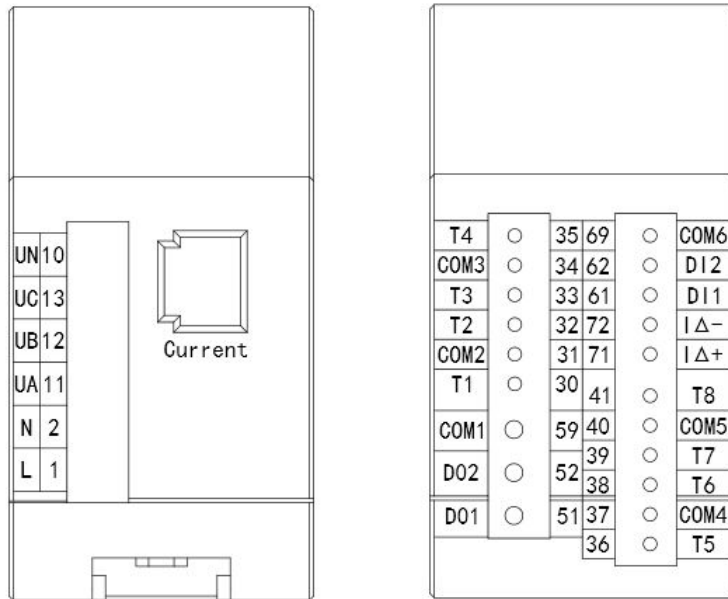
#### Rail-installed Type



#### Installation of Ancillary Transformer

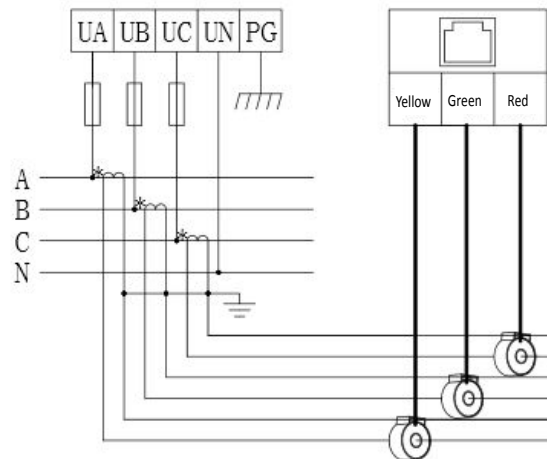
AMB display is flush-mounted. Align the display with the mounting holes, insert clips and secure the display.



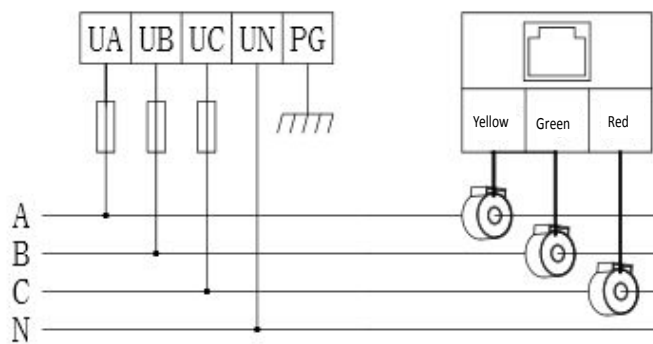


AMB1X0-A(W)-P1 Discrete Auxiliary Power Supply

### 5.1 Voltage and current connection



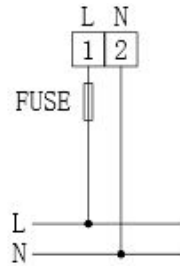
Current > 630A



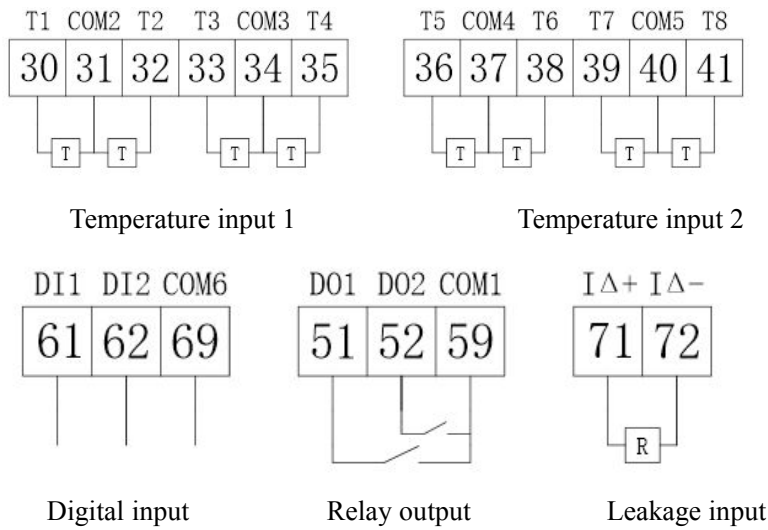
Current < 630A

Note: The direction of current shall be as indicated by arrow on the transformer.

## 5.2 Mains and auxiliary power supply connections



AMB1X0-A(/W)-P1 Auxiliary Power Supply



### 5.2.1 Temperature sensor connection

Temperature sensors shall be used to measure temperatures T1 to T8. They are NTC R25=50k (4150) thermistors. They send the monitoring signals for temperature between -20°C and 150°C and monitor the cable temperature.

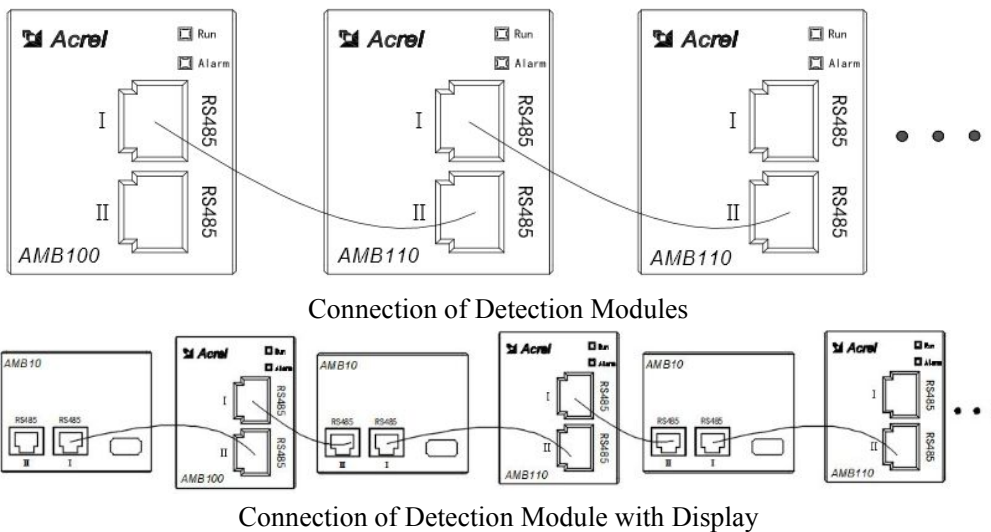
Note: Temperature sensors shall be secured firmly to prevent it from short circuiting after fall.

### 5.2.2 Network shielded wire connection

The communication port shall be connected with RJ45 network shielded wire. To connect different detection modules, it is necessary to connect RS485(I) of a module to RS485(II) of the other module. To connect a detection module with a display, RS485(II) of the module shall be connected to RS485(I) of the display. For RJ45, two wires are adequate since MODBUS-RTU protocol is applied. Keep the copper strips of connector upward. These copper strips are numbered 1 to 8 from left to right. B is presented as 1 while A is presented as 2.



Note: It is not available if LORA is activated.



## 6. Operation guide

### 6.1 Meaning of LED indications

On an AMB smart monitor are two LEDs, Run and Alarm, indicating the monitor status. When Run turns green, it indicates that the monitor works normally. This LED flashes every 0.5 second. When Alarm turns red, it indicates that the monitor fails. This LED flashes every 0.5 second.

### 6.2 Buzzer

#### 6.2.1 Buzzer activation/ deactivation

The buzzer is activated or deactivated according to the communication parameter setting. Refer to 7.5, Communication Parameter Address List.

Set “1” to activate the buzzer and “0” to deactivate the buzzer.

The buzzer is activated by default.

#### 6.2.2 Buzzer setting

After being activated, the buzzer alarm can be cleared according to the communication parameter setting. Refer to 7.5, Communication Parameter Address List.

Set “0x8801” to clear the current alarm. The buzzer alarm will be activated again if another alarm status occurs.

### 6.3 Alarm setting

AMB smart monitor boasts the online alarm function. Provide DO output and 2-stage over-current alarm by one buzzer. Enable the discrete running beyond the system. There is an on/off fault alarm (activated in 1s after the monitor is switched on or off) and an over-temperature alarm. It can also record the alarm time.

Set the specific alarm threshold according to the communication parameter setting. Refer to 7.5, Communication Parameter Address List.

Read the specific alarm status according to the communication parameter setting. Refer to the column “Alarm status” in 7.5, Communication Parameter Address List.

### 6.4 Centralized monitoring

Centrally acquire and monitor the data of 80-tap tapping cabinet. Acquire and show the electric parameters of each tap. Upload all acquired data to the power environment monitoring system.

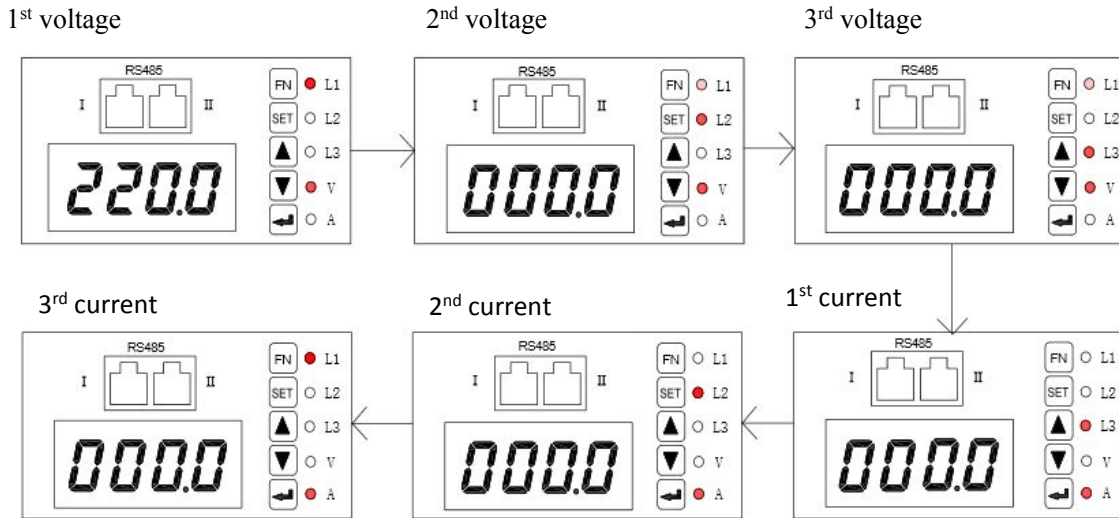
Furthermore, monitor the temperature at the bus bar connection in a real-time manner. By virtue of 2 RJ45 communication connectors (1 in and 1 out) and MODBUS-RTU protocol, it is easy and secure to upload the monitored data to the main controller and the background system, ensuring the safe and reliable running of the system.

### 6.5 Functions of control buttons

Symbol	Designation	Functions
FN	FN	Unavailable
SET	SET	Select a function, switch over to another function or save the selected function, or back to the last menu
▲	Up	Submenu parameters -
▼	Down	Submenu parameters +
←	Enter	Enter the next menu or confirm the selection

### 6.6 Display screens

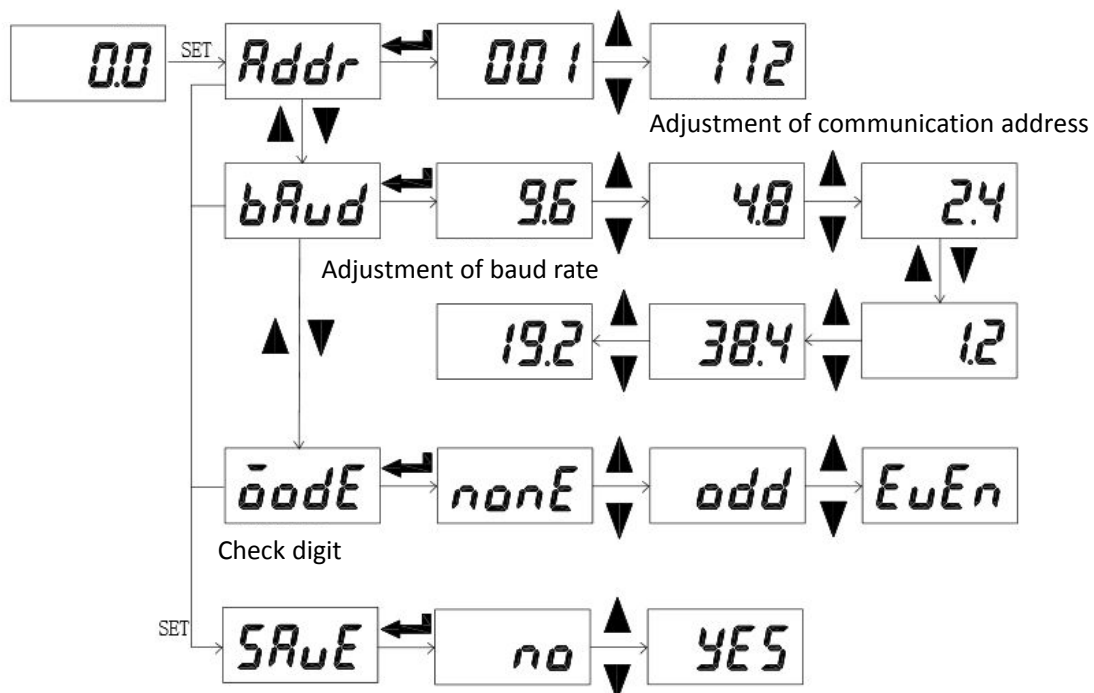
Measurement screens. After being powered, the display will show the voltage and the current in an automatic cycle. These screens change in the following order:


















For this alternating-current instrument, there are three voltages and three currents. L1, L2 and L3 correspond to the phase A, B and C. It is known from these figures that the phase-A voltage is 220V. The current is 0A by default if not being matched.

Control screens:




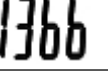

Voltage/ current screens



To adjust the communication address, press SET under any item on the screen, enter “Addr” and then press  and  or . To adjust the baud rate, press  to return to “Addr” and then press  or . To look over the check digit, press  to return to “Baud rate” and then press  or . Press SET to enter “Save”. Press  to enter “NO”. Press  or  to enter “YES”. Press  to return to the main screen. For adjustment of the communication address, press  to adjust unit parameters and  for switchover of various parameters.

## 6.7 Data setting on the display

Following menus can be set on display screens:

Function screen	Description
	RS485 communication address
	RS485 and RS645 communication baud rate
	RS485 and RS645 communication modes (no parity, odd parity, even parity)
	Software No.
	Software version

## 7. Communication guide

### 7.1 General information

AMB smart monitor implements Modbus-RTU protocol “9600, 8, 1, n”. “9600” is the baud rate by default and can be changed to 2400, 4800, 19200 or others via communication. Refer to 7.5, Communication Parameter Address List. “8” indicates 8 data bits. “n” indicates no parity. “1” indicates one stop bit.

Error check: CRC16 (cyclic redundancy check)

### 7.2 Protocol

When reaching the addressed terminal unit, a data frame will enter it through a simple “port”. In this unit, the envelope of the data frame (data header) is removed and the contained data is read. If there is no error, the request of data will be executed. Then the terminal unit will generate and input its data into the removed envelope and return the data frame to the sender. The response data returned contains: the address of terminal slave unit (Address), the function executed (Function), requested data generated from the function (Data) and a CRC check digit (Check). If there is any error, no response will be made or an error indication frame will be returned.

#### 7.2.1 Data frame format

Address	Function	Data	Check
8-Bits	8-Bits	Nx8-Bits	16-Bits

#### 7.2.2 Address field

A data frame starts from address field that consists of one byte (8-Bits, 8 binary codes). It is from 0 to 255 in decimal, in which 1 to 247 is used in our system and the rest is reserved. It indicates the address of a terminal unit that user designates to receive the data from the master unit. The address of each terminal unit of one bus must be exclusive. Except for the addressed terminal unit, other terminal units will not respond to an inquiry containing its address. When the terminal unit returns a response, the master unit will identify it according to the slave address contained in the response signal.

### 7.2.3 Function field

The function field indicates the function to be executed by the addressed terminal unit. The following list gives all function codes used by AMB series as well as the meaning and role.

Code (hexadecimal system)	Meaning	Behavior
03H	Read the holding register	Acquire the current binary value from one or several holding registers
10H	Preset multiple registers	Load a specific binary value into a series of holding registers

### 7.2.4 Data field

The data field contains the data that is required for a terminal unit to execute a specific function or acquired by a terminal unit in response to inquiries. The data may be values, parameter addresses or set values.

When the function field requests a terminal unit to read a register, for example, the data field shall indicate the first register and the size of data to read. Content of the embedded address and the data depends on the type and the slave unit.

### 7.2.5 Error check (Check) field

The check field employs CRC16 check and enables both master unit and terminal unit to check transmission errors. When being transmitted from one unit to another unit, a set of data may change partly because of electrical noise or other interferences. In such case, the error check ensures that neither master unit nor slave unit responds to such change, improving the system safety, reliability and efficiency.

### 7.3 Error check methods

The error check (CRC) field occupies two bytes and contains one 16-bits binary value. A CRC value is calculated in the transmitting unit and loaded to the data frame. After receiving the data, the receiving unit will make a calculation again and compare the calculated CRC value with the received one. If they are different, it indicates that there is an error.

For CRC calculation, preset 1 at all bits of a 16-bits register and then operate 8 bits of each byte in the data frame and the current value of the register continuously. It is only 8 data bits of each byte to participate in CRC generation. The start bit, stop bit or parity bit, if any used, will not have an influence on CRC. After such 8 bits and the register content are operated by XOR for CRC generation, move the result to the lower bits and fill the higher bits with 0. Shift out and detect the lowest bit (LSB). If the lowest bit is 1, operate the register and a preset fixed value (0A001H) by XOR. If it is 0, no processing is required.

CRC generation process:

1. Preset a 16-bits register to be 0FFFFH (1 at all bits) and name it CRC register.
2. Operate 8 bits of the first byte in the data frame and lower bits of CRC register by XOR and return the result to CRC register.
3. Move CRC register right by one bit. Fill the highest bit with 0. Shift out and detect the lowest bit.
4. If the lowest bit is 0, repeat step 3 (further movement). If the lowest bit is 1, operate the register and a preset fixed value (0A001H) by XOR.
5. Repeat steps 3 and 4 until eight movements complete. By then, all of 8 bits are processed.
6. Repeat steps 2 to 5 for the next 8 bits until all bytes are processed.
7. The final CRC register value is CRC value.

In addition, CRC value can be calculated by looking up table. This method is mainly characterized by quick calculation. However, a big memory is required. Please consult relevant data for more details.

### 7.4 Communication application

All examples in this section are basically in the following form (hexadecimal data).

Addr	Fun	Data start		Data # of		CRC16	
		reg	reg Lo	reg	reg Lo	Lo	Hi



		Hi		Hi			
01H	03H	00H	00H	00H	06H	C5H	C8H
Address	Function code	Data start address		Number of data read		Cyclic redundancy check digit	

#### 7.4.1 Data reading

Example 1. Read the phase-A voltage

Inquiry data frame	01 03 00 30 00 02 65 cb
Return data frame	01 03 04 <u>43 5c 00 00</u> 2f a5

Keys:

01: slave address

03: function code

04: hexadecimal system. It is 4 in decimal. Indicate that 4-bytes data is followed.

2f a5: cyclic redundancy check digit

Data processing method:

If the data is integral, such as 08 98 for hi-voltage alarm, convert the data into a decimal value in the following formula:  $(8*256+9*16+8)/10$ .

If the data is floating, such as 43 5c 00 00 for phase-A voltage, convert the data into a decimal value by using the floating conversion tool.

Read other information inquiry frame in the same way. For information address, please refer to 6.4, Communication Parameter Addresses of Single-phase Meter.

#### 7.4.2 Data writing

Example 1. Edit the meter address

Read-in data frame	01 10 00 00 00 01 02 <u>00 05</u> 66 53 (address changed to 5)
Return data frame	01 10 00 00 00 01 01 c9 (fail, no data frame returned)

Example 2. Control the buzzer alarm function

Read-in data frame	01 10 00 27 00 01 02 00 00 A0 87 (buzzer alarm deactivated) 01 10 00 27 00 01 02 00 01 61 47 (buzzer alarm activated)
Return data frame	01 10 00 28 00 01 81 c1 (fail, no data frame returned)

#### 7.5 Communication protocol

Address	Content	Data type	Bytes	Read/write	Remark
0	Address	uint16_t	2	R/W	1-247
1	Baud rate	uint16_t	2	R/W	0: 1200; 1: 2400; 2:4800; 3: 9600 4: 19200; 5: 38400
2	Check method	uint16_t	2	R/W	0:8 N 1; 1:8 E 1; 2:8 0 1; 3:8 N 2
3	Wiring method	uint16_t	2	R/W	0: 3-phase 4-wire; 2: 3-phase 3-wire
4	Voltage ratio	uint16_t	2	R/W	1-9999
5	Current ratio	uint16_t	2	R/W	1-9999
6	Over-voltage alarm on/off	uint16_t	2	R/W	0: off; 1: on
7	Over-voltage alarm setting	uint16_t	2	R/W	V
8	Under-voltage alarm on/off	uint16_t	2	R/W	0: off; 1: on
9	Under-voltage alarm setting	uint16_t	2	R/W	V
A	Stage-1 over-current	uint16_t	2	R/W	0: off; 1: on

	alarm on/off				
B	Stage-1 over-current alarm setting	uint16_t	2	R/W	0.1A
C	Stage-1 under-current alarm on/off	uint16_t	2	R/W	0: off; 1: on
D	Stage-1 under-current alarm setting	uint16_t	2	R/W	0.1A
E	Stage-2 over-current alarm on/off	uint16_t	2	R/W	0: off; 1: on
F	Stage-2 over-current alarm setting	uint16_t	2	R/W	0.1A
10	Stage-2 under-current alarm on/off	uint16_t	2	R/W	0: off; 1: on
11	Stage-2 under-current alarm setting	uint16_t	2	R/W	0.1A
12	Over-power alarm on/off	uint16_t	2	R/W	0: off; 1: on
13	Over-power alarm setting	uint16_t	2	R/W	0.1kW
14	Over-frequency alarm on/off	uint16_t	2	R/W	0: off; 1: on
15	Over-frequency alarm setting	uint16_t	2	R/W	0.1Hz
16	Under-frequency alarm on/off	uint16_t	2	R/W	0: off; 1: on
17	Under-frequency alarm setting	uint16_t	2	R/W	0.1Hz
18	Over-temperature alarm on/off	uint16_t	2	R/W	0: off; 1: on
19	Over-temperature alarm setting	int16_t	2	R/W	0.1°C
1A	Under-temperature alarm on/off	uint16_t	2	R/W	0: off; 1: on
1B	Under-temperature alarm setting	int16_t	2	R/W	0.1°C
1C	Humidity alarm on/off	uint16_t	2	R/W	0: off; 1: on
1D	Humidity alarm setting	uint16_t	2	R/W	0.10%
1E	Leakage alarm on/off	uint16_t	2	R/W	0: off; 1: on
1F	Leakage alarm setting	uint16_t	2	R/W	1mA
20	Null-ground potential difference alarm on/off	uint16_t	2	R/W	0: off; 1: on
21	Null-ground potential difference alarm setting	uint16_t	2	R/W	V
22	Neutral current alarm on/off	uint16_t	2	R/W	0: off; 1: on

23	Neutral current alarm setting	uint16_t	2	R/W	A
24	Alarm delay time	uint16_t	2	R/W	0.1S
25	Relay type	uint16_t	2	R/W	0: remote control; 1: alarm
26	Digital input filtering	uint16_t	2	R/W	Number is written
27	Buzzer on/off	uint16_t	2	R/W	0: off; 1: on
28	D01	uint16_t	2	R/W	0: open; 1: closed
29	D02	uint16_t	2	R/W	0: open; 1: closed
2A	Buzzer alarm cleared	uint16_t	2	R/W	0x8801
2B	Data cleared	uint16_t	2	R/W	0x6601: energy cleared 0x6602: demand record cleared 0x6603: energy record cleared
2C	Year	uint16_t	2	R/W	
2D	Month	uint16_t	2	R/W	
2E	Day	uint16_t	2	R/W	
2F	Hour	uint16_t	2	R/W	
30	Minute	uint16_t	2	R/W	
31	Second	uint16_t	2	R/W	
32	DI1 alarm on/off	uint16_t	2	R/W	0: off; 1: on
33	DI2 alarm on/off	uint16_t	2	R/W	0: off; 1: on
34	DI3 alarm on/off	uint16_t	2	R/W	Reserved
35	DI4 alarm on/off	uint16_t	2	R/W	Reserved
36	DI1 on/off status	uint16_t	2	R/W	0: NO; 1: NC
37	DI2 on/off status	uint16_t	2	R/W	0: NO; 1: NC
38	DI3 on/off status	uint16_t	2	R/W	Reserved
39	DI4 on/off status	uint16_t	2	R/W	Reserved
3A	Open-phase alarm on/off	uint16_t	2	R/W	0: off; 1: on
3B	Phase-sequence alarm on/off	uint16_t	2	R/W	0: off; 1: on
3C	Open-phase voltage setting	uint16_t	2	R/W	V
3D	Cabinet over-temperature alarm on/off	uint16_t	2	R/W	0: off; 1: on
3E	Cabinet over-temperature alarm setting	uint16_t	2	R/W	0.1°C
3F	Cabinet under-temperature alarm on/off	uint16_t	2	R/W	0: off; 1: on
40	Cabinet under-temperature alarm setting	uint16_t	2	R/W	0.1°C
41	Active switching alarm	uint16_t	2	R/W	0: off; 1: on

	1 on/off				
42	Active switching alarm 2 on/off	uint16_t	2	R/W	0: off, 1: on
43	Active switching alarm 3 on/off	uint16_t	2	R/W	0: off, 1: on
44	Active switching alarm 1 setting	uint16_t	2	R/W	V
45	Active switching alarm 2 setting	uint16_t	2	R/W	V
46	Active switching alarm 3 setting	uint16_t	2	R/W	V
47-4F	Reserved				
50	Phase voltage Ua	float	4	R	V
51					
52	Phase voltage Ub	float	4	R	V
53					
54	Phase voltage Uc	float	4	R	V
55					
56	Line voltage Uab	float	4	R	V
57					
58	Line voltage Ubc	float	4	R	V
59					
5A	Line voltage Uca	float	4	R	V
5B					
5C	Null-ground potential difference	float	4	R	V
5D					
5E	Frequency	float	4	R	Hz
5F					
60	Current Ia	float	4	R	A
61					
62	Current Ib	float	4	R	A
63					
64	urrent Ic	float	4	R	A
65					
66	Null current In	float	4	R	A
67					
68	Leakage current	float	4	R	mA
69					
6A	Zero-sequence current	float	4	R	A
6B					
6C	Active power Pa	float	4	R	W
6D					
6E	Active power Pb	float	4	R	W
6F					

70	Active power Pc	float	4	R	W
71					
72	Active power Ps	float	4	R	W
73					
74	Reactive power Qa	float	4	R	Var
75					
76	Reactive power Qb	float	4	R	Var
77					
78	Reactive power Qc	float	4	R	Var
79					
7A	Reactive power Qs	float	4	R	Var
7B					
7C	Apparent power Sa	float	4	R	VA
7D					
7E	Apparent power Sb	float	4	R	VA
7F					
80	Apparent power Sc	float	4	R	VA
81					
82	Apparent power Ss	float	4	R	VA
83					
84	Phase-A power factor pfa	float	4	R	
85					
86	Phase-B power factor pfb	float	4	R	
87					
88	Phase-C power factor pfc	float	4	R	
89					
8A	Total power factor pfs	float	4	R	
8B					
8C	Active energy Epa	uint32_t	4	R	0.01kWh
8D					
8E	Active energy Epb	uint32_t	4	R	0.01kWh
8F					
90	Active energy Epc	uint32_t	4	R	0.01kWh
91					
92	Active energy Eps	uint32_t	4	R	0.01kWh
93					
94	Reactive energy Eqa	uint32_t	4	R	0.01kWh
95					
96	Reactive energy Eqb	uint32_t	4	R	0.01kWh
97					
98	Reactive energy Eqc	uint32_t	4	R	0.01kWh
99					
9A	Reactive energy Eqs	uint32_t	4	R	0.01kWh

9B					
9C	Total harmonic distortion of phase-A voltage	uint16_t	2	R	0.01%
9D	Total harmonic distortion of phase-B voltage	uint16_t	2	R	0.01%
9E	Total harmonic distortion of phase-C voltage	uint16_t	2	R	0.01%
9F	Total harmonic distortion of phase-A current	uint16_t	2	R	0.01%
A0	Total harmonic distortion of phase-B current	uint16_t	2	R	0.01%
A1	Total harmonic distortion of phase-C current	uint16_t	2	R	0.01%
A2	1 <sup>st</sup> -channel temperature	int16_t	2	R	0.1°C
A3	2 <sup>nd</sup> -channel temperature	int16_t	2	R	0.1°C
A4	3 <sup>rd</sup> -channel temperature	int16_t	2	R	0.1°C
A5	4 <sup>th</sup> -channel temperature	int16_t	2	R	0.1°C
A6	5 <sup>th</sup> -channel temperature	int16_t	2	R	0.1°C
A7	6 <sup>th</sup> -channel temperature	int16_t	2	R	0.1°C
A8	7 <sup>th</sup> -channel temperature	int16_t	2	R	0.1°C
A9	8 <sup>th</sup> -channel temperature	int16_t	2	R	0.1°C
AA	Cabinet humidity	uint16_t	2	R	0.10%
AB	Cabinet temperature	int16_t	2	R	0.1°C
AC	Digital input 1	uint16_t	2	R	
AD	Digital input 2	uint16_t	2	R	
AE	Digital input 3	uint16_t	2	R	
AF	Digital input 4	uint16_t	2	R	
B0	Alarm status 1	uint16_t	2	R	
B1	Alarm status 2	uint16_t	2	R	
B2	Alarm status 3	uint16_t	2	R	
B3	Alarm status 4	uint16_t	2	R	
B4	Active DI1	uint16_t	2	R	
B5	Active DI2	uint16_t	2	R	
B6	Active DI3	uint16_t	2	R	
B7-BD	Reserved				
BE	Maximum phase-A	float	4	R	V
BF	voltage demand				

C0	Time: year/month	uint16_t	2	R	
C1	Day/hour	uint16_t	2	R	
C2	Minute/bank	uint16_t	2	R	
C3	Maximum phase-B	float	4	R	V
C4	voltage demand				
C5	Time: year/month	uint16_t	2	R	
C6	Day/hour	uint16_t	2	R	
C7	Minute/bank	uint16_t	2	R	
C8	Maximum phase-C	float	4	R	V
C9	voltage demand				
CA	Time: year/month	uint16_t	2	R	
CB	Day/hour	uint16_t	2	R	
CC	Minute/bank	uint16_t	2	R	
CD	Maximum phase-A	float	4	R	A
CE	current demand				
CF	Time: year/month	uint16_t	2	R	
D0	Day/hour	uint16_t	2	R	
D1	Minute/bank	uint16_t	2	R	
D2	Maximum phase-B	float	4	R	A
D3	current demand				
D4	Time: year/month	uint16_t	2	R	
D5	Day/hour	uint16_t	2	R	
D6	Minute/bank	uint16_t	2	R	
D7	Maximum phase-C	float	4	R	A
D8	current demand				
D9	Time: year/month	uint16_t	2	R	
DA	Day/hour	uint16_t	2	R	
DB	Minute/bank	uint16_t	2	R	
DC	Maximum phase-A	float	4	R	W
DD	active demand				
DE	Time: year/month	uint16_t	2	R	
DF	Day/hour	uint16_t	2	R	
E0	Minute/bank	uint16_t	2	R	
E1	Maximum phase-B	float	4	R	W
E2	active demand				
E3	Time: year/month	uint16_t	2	R	
E4	Day/hour	uint16_t	2	R	
E5	Minute/bank	uint16_t	2	R	
E6	Maximum phase-C	float	4	R	W
E7	active demand				
E8	Time: year/month	uint16_t	2	R	
E9	Day/hour	uint16_t	2	R	
EA	Minute/bank	uint16_t	2	R	
EB	Maximum total active	float	4	R	W

	demand				
EC					
ED	Time: year/month	uint16_t	2	R	
EE	Day/hour	uint16_t	2	R	
EF	Minute/bank	uint16_t	2	R	
C8	Maximum phase-C voltage demand	float	4	R	V
C9					
CA	Time: year/month	uint16_t	2	R	
CB	Day/hour	uint16_t	2	R	
CC	Minute/bank	uint16_t	2	R	
CD	Maximum phase-A current demand	float	4	R	A
CE					
CF	Time: year/month	uint16_t	2	R	
D0	Day/hour	uint16_t	2	R	
D1	Minute/bank	uint16_t	2	R	
D2	Maximum phase-B current demand	float	4	R	A
D3					
D4	Time: year/month	uint16_t	2	R	
D5	Day/hour	uint16_t	2	R	
D6	Minute/bank	uint16_t	2	R	
D7	Maximum phase-C current demand	float	4	R	A
D8					
D9	Time: year/month	uint16_t	2	R	
DA	Day/hour	uint16_t	2	R	
DB	Minute/bank	uint16_t	2	R	
DC	Maximum phase-A active demand	float	4	R	W
DD					
DE	Time: year/month	uint16_t	2	R	
DF	Day/hour	uint16_t	2	R	
E0	Minute/bank	uint16_t	2	R	
E1	Maximum phase-B active demand	float	4	R	W
E2					
E3	Time: year/month	uint16_t	2	R	
E4	Day/hour	uint16_t	2	R	
E5	Minute/bank	uint16_t	2	R	
E6	Maximum phase-C active demand	float	4	R	W
E7					
E8	Time: year/month	uint16_t	2	R	
E9	Day/hour	uint16_t	2	R	
EA	Minute/bank	uint16_t	2	R	
EB	Maximum total active demand	float	4	R	W
EC					
ED	Time: year/month	uint16_t	2	R	
EE	Day/hour	uint16_t	2	R	



EF	Minute/bank	uint16_t	2	R	
F0-F1	Phase-A energy of this month	uint32_t	4	R	0.01kWh
F2-F3	Phase-B energy of this month	uint32_t	4	R	0.01kWh
F4-F5	Phase-C energy of this month	uint32_t	4	R	0.01kWh
F6-F7	Phase-A energy of last month	uint32_t	4	R	0.01kWh
F8-F9	Phase-B energy of last month	uint32_t	4	R	0.01kWh
FA-FB	Phase-C energy of last month	uint32_t	4	R	0.01kWh
FC-FD	Phase-A energy of last two months	uint32_t	4	R	0.01kWh
FE-FF	Phase-B energy of last two months	uint32_t	4	R	0.01kWh
100-101	Phase-C energy of last two months	uint32_t	4	R	0.01kWh
102-103	Phase-A energy of last three months	uint32_t	4	R	0.01kWh
104-105	Phase-B energy of last three months	uint32_t	4	R	0.01kWh
106-107	Phase-C energy of last three months	uint32_t	4	R	0.01kWh
108-109	Phase-A energy of last four months	uint32_t	4	R	0.01kWh
10A-10B	Phase-B energy of last four months	uint32_t	4	R	0.01kWh
10C-10D	Phase-C energy of last four months	uint32_t	4	R	0.01kWh
10E-10F	Phase-A energy of last five months	uint32_t	4	R	0.01kWh
110-111	Phase-B energy of last five months	uint32_t	4	R	0.01kWh
112-113	Phase-C energy of last five months	uint32_t	4	R	0.01kWh
114-115	Phase-A energy of last six months	uint32_t	4	R	0.01kWh
116-117	Phase-B energy of last six months	uint32_t	4	R	0.01kWh
118-119	Phase-C energy of last six months	uint32_t	4	R	0.01kWh
11A-11B	Phase-A energy of last seven months	uint32_t	4	R	0.01kWh

11C-11D	Phase-B energy of last seven months	uint32_t	4	R	0.01kWh
11E-11F	Phase-C energy of last seven months	uint32_t	4	R	0.01kWh
120-121	Phase-A energy of last eight months	uint32_t	4	R	0.01kWh
122-123	Phase-B energy of last eight months	uint32_t	4	R	0.01kWh
124-125	Phase-C energy of last eight months	uint32_t	4	R	0.01kWh
126-127	Phase-A energy of last nine months	uint32_t	4	R	0.01kWh
128-129	Phase-B energy of last nine months	uint32_t	4	R	0.01kWh
12A-12B	Phase-C energy of last nine months	uint32_t	4	R	0.01kWh
12C-12D	Phase-A energy of last ten months	uint32_t	4	R	0.01kWh
12E-12F	Phase-B energy of last ten months	uint32_t	4	R	0.01kWh
130-131	Phase-C energy of last ten months	uint32_t	4	R	0.01kWh
132-133	Phase-A energy of last eleven months	uint32_t	4	R	0.01kWh
134-135	Phase-B energy of last eleven months	uint32_t	4	R	0.01kWh
136-137	Phase-C energy of last eleven months	uint32_t	4	R	0.01kWh
138-139	Phase-A energy of last twelve months	uint32_t	4	R	0.01kWh
13A-13B	Phase-B energy of last twelve months	uint32_t	4	R	0.01kWh
13C-13D	Phase-C energy of last twelve months	uint32_t	4	R	0.01kWh
13E-13F	Phase-A energy of this year	uint32_t	4	R	0.01kWh
140-141	Phase-B energy of this year	uint32_t	4	R	0.01kWh
142-143	Phase-C energy of this year	uint32_t	4	R	0.01kWh
144-145	Phase-A energy of last year	uint32_t	4	R	0.01kWh
146-147	Phase-B energy of last year	uint32_t	4	R	0.01kWh
148-149	Phase-C energy of last year	uint32_t	4	R	0.01kWh

	last year				
14A	2 <sup>nd</sup> harmonic ratio of phase-A voltage	uint16_t	2	R	0.01%
14B	2 <sup>nd</sup> harmonic ratio of phase-B voltage	uint16_t	2	R	0.01%
14C	2 <sup>nd</sup> harmonic ratio of phase-C voltage	uint16_t	2	R	0.01%
14D	2 <sup>nd</sup> harmonic ratio of phase-A current	uint16_t	2	R	0.01%
14E	2 <sup>nd</sup> harmonic ratio of phase-B current	uint16_t	2	R	0.01%
14F	2 <sup>nd</sup> harmonic ratio of phase-C current	uint16_t	2	R	0.01%
150-155	3 <sup>rd</sup> harmonic ratio	uint16_t	6*2	R	0.01%
156-15B	4 <sup>th</sup> harmonic ratio	uint16_t	6*2	R	0.01%
15C-161	5 <sup>th</sup> harmonic ratio	uint16_t	6*2	R	0.01%
162-167	6 <sup>th</sup> harmonic ratio	uint16_t	6*2	R	0.01%
168-16D	7 <sup>th</sup> harmonic ratio	uint16_t	6*2	R	0.01%
16E-173	8 <sup>th</sup> harmonic ratio	uint16_t	6*2	R	0.01%
174-179	9 <sup>th</sup> harmonic ratio	uint16_t	6*2	R	0.01%
17A-17F	10 <sup>th</sup> harmonic ratio	uint16_t	6*2	R	0.01%
180-185	11 <sup>th</sup> harmonic ratio	uint16_t	6*2	R	0.01%
186-18B	12 <sup>th</sup> harmonic ratio	uint16_t	6*2	R	0.01%
18C-191	13 <sup>th</sup> harmonic ratio	uint16_t	6*2	R	0.01%
192-197	14 <sup>th</sup> harmonic ratio	uint16_t	6*2	R	0.01%
198-19D	15 <sup>th</sup> harmonic ratio	uint16_t	6*2	R	0.01%
19E-1A3	16 <sup>th</sup> harmonic ratio	uint16_t	6*2	R	0.01%
1A4-1A9	17 <sup>th</sup> harmonic ratio	uint16_t	6*2	R	0.01%
1AA-1A9	18 <sup>th</sup> harmonic ratio	uint16_t	6*2	R	0.01%
1B0-1B5	19 <sup>th</sup> harmonic ratio	uint16_t	6*2	R	0.01%
1B6-1BB	20 <sup>th</sup> harmonic ratio	uint16_t	6*2	R	0.01%
1BC-1C1	21 <sup>st</sup> harmonic ratio	uint16_t	6*2	R	0.01%
1C2-1C7	22 <sup>nd</sup> harmonic ratio	uint16_t	6*2	R	0.01%
1C8-1CD	23 <sup>rd</sup> harmonic ratio	uint16_t	6*2	R	0.01%
1CE-1D3	24 <sup>th</sup> harmonic ratio	uint16_t	6*2	R	0.01%
1D4-1D9	25 <sup>th</sup> harmonic ratio	uint16_t	6*2	R	0.01%
1DA-1DF	26 <sup>th</sup> harmonic ratio	uint16_t	6*2	R	0.01%
1E0-1E5	27 <sup>th</sup> harmonic ratio	uint16_t	6*2	R	0.01%
1E6-1EB	28 <sup>th</sup> harmonic ratio	uint16_t	6*2	R	0.01%
1EC-1F1	29 <sup>th</sup> harmonic ratio	uint16_t	6*2	R	0.01%
1F2-1F7	30 <sup>th</sup> harmonic ratio	uint16_t	6*2	R	0.01%
1F8-1FD	31 <sup>st</sup> harmonic ratio	uint16_t	6*2	R	0.01%
1FE-203	32 <sup>nd</sup> harmonic ratio	uint16_t	6*2	R	0.01%
204-209	33 <sup>rd</sup> harmonic ratio	uint16_t	6*2	R	0.01%

20A-20F	34 <sup>th</sup> harmonic ratio	uint16_t	6*2	R	0.01%
210-215	35 <sup>th</sup> harmonic ratio	uint16_t	6*2	R	0.01%
216-21B	36 <sup>th</sup> harmonic ratio	uint16_t	6*2	R	0.01%
21C-221	37 <sup>th</sup> harmonic ratio	uint16_t	6*2	R	0.01%
222-227	38 <sup>th</sup> harmonic ratio	uint16_t	6*2	R	0.01%
228-22D	39 <sup>th</sup> harmonic ratio	uint16_t	6*2	R	0.01%
22E-233	40 <sup>th</sup> harmonic ratio	uint16_t	6*2	R	0.01%
234-239	41 <sup>st</sup> harmonic ratio	uint16_t	6*2	R	0.01%
23A-23F	42 <sup>nd</sup> harmonic ratio	uint16_t	6*2	R	0.01%
240-245	43 <sup>rd</sup> harmonic ratio	uint16_t	6*2	R	0.01%
246-24B	44 <sup>th</sup> harmonic ratio	uint16_t	6*2	R	0.01%
24C-251	45 <sup>th</sup> harmonic ratio	uint16_t	6*2	R	0.01%
252-257	46 <sup>th</sup> harmonic ratio	uint16_t	6*2	R	0.01%
258-25D	47 <sup>th</sup> harmonic ratio	uint16_t	6*2	R	0.01%
25E-263	48 <sup>th</sup> harmonic ratio	uint16_t	6*2	R	0.01%
264-269	49 <sup>th</sup> harmonic ratio	uint16_t	6*2	R	0.01%
26A-26F	50 <sup>th</sup> harmonic ratio	uint16_t	6*2	R	0.01%
270-275	51 <sup>st</sup> harmonic ratio	uint16_t	6*2	R	0.01%
276-27B	52 <sup>nd</sup> harmonic ratio	uint16_t	6*2	R	0.01%
27C-281	53 <sup>rd</sup> harmonic ratio	uint16_t	6*2	R	0.01%
282-287	54 <sup>th</sup> harmonic ratio	uint16_t	6*2	R	0.01%
288-28D	55 <sup>th</sup> harmonic ratio	uint16_t	6*2	R	0.01%
28E-293	56 <sup>th</sup> harmonic ratio	uint16_t	6*2	R	0.01%
294-299	57 <sup>th</sup> harmonic ratio	uint16_t	6*2	R	0.01%
29A-29F	58 <sup>th</sup> harmonic ratio	uint16_t	6*2	R	0.01%
2A0-2A5	59 <sup>th</sup> harmonic ratio	uint16_t	6*2	R	0.01%
2A6-2AB	60 <sup>th</sup> harmonic ratio	uint16_t	6*2	R	0.01%
2AC-2B1	61 <sup>st</sup> harmonic ratio	uint16_t	6*2	R	0.01%
2B2-2B7	62 <sup>nd</sup> harmonic ratio	uint16_t	6*2	R	0.01%
2B8-2BD	63 <sup>rd</sup> harmonic ratio	uint16_t	6*2	R	0.01%

Remark: Actual energy value= energy reading \* current ratio

Alarm status 1	bit0	Phase-A over-voltage alarm
	bit1	Phase-B over-voltage alarm
	bit2	Phase-C over-voltage alarm
	bit3	Phase-A under-voltage alarm
	bit4	Phase-B under-voltage alarm
	bit5	Phase-C under-voltage alarm
	bit6	Voltage open-phase alarm
	bit7	Phase-A stage-1 over-current alarm
	bit8	Phase-B stage-1 over-current alarm
	bit9	Phase-C stage-1 over-current alarm
	bit10	Phase-A stage-2 over-current alarm
	bit11	Phase-B stage-2 over-current alarm
	bit12	Phase-C stage-2 over-current alarm

	bit13	Phase-A stage-1 under-current alarm
	bit14	Phase-B stage-1 under-current alarm
	bit15	Phase-C stage-1 under-current alarm

Alarm status 2	bit0	Phase-A stage-2 under-current alarm
	bit1	Phase-B stage-2 under-current alarm
	bit2	Phase-C stage-2 under-current alarm
	bit3	Phase-A over-power alarm
	bit4	Phase-B over-power alarm
	bit5	Phase-C over-power alarm
	bit6	
	bit7	Humidity alarm
	bit8	Leakage 1 alarm
	bit9	Null-ground potential difference alarm
	bit10	Neutral current alarm
	bit11	Phase sequence alarm
	bit12	Digital input 1 alarm
	bit13	Digital input 2 alarm
	bit14	Cabinet over-temperature alarm
	bit15	Cabinet under-temperature alarm

Alarm status 3	bit0	1 <sup>st</sup> -channel over-temperature alarm
	bit1	2 <sup>nd</sup> -channel over-temperature alarm
	bit2	3 <sup>rd</sup> - channel over-temperature alarm
	bit3	4 <sup>th</sup> - channel over-temperature alarm
	bit4	5 <sup>th</sup> - channel over-temperature alarm
	bit5	6 <sup>th</sup> - channel over-temperature alarm
	bit6	7 <sup>th</sup> - channel over-temperature alarm
	bit7	8 <sup>th</sup> - channel over-temperature alarm
	bit8	1 <sup>st</sup> -channel under-temperature alarm
	bit9	2 <sup>nd</sup> -channel under -temperature alarm
	bit10	3 <sup>rd</sup> - channel under -temperature alarm
	bit11	4 <sup>th</sup> - channel under -temperature alarm
	bit12	5 <sup>th</sup> - channel under -temperature alarm
	bit13	6 <sup>th</sup> - channel under -temperature alarm
	bit14	7 <sup>th</sup> - channel under -temperature alarm
	bit15	8 <sup>th</sup> - channel under -temperature alarm

Alarm status 4	bit0	Digital input alarm 3 (none)
	bit1	Digital input alarm 4 (none)
	bit2	Active DI1 alarm
	bit3	Active DI2 alarm
	bit4	Active DI3 alarm
	bit5	

	bit6	
	bit7	Over-frequency alarm
	bit8	Under-frequency alarm
	bit9	
	bit10	
	bit11	
	bit12	
	bit13	
	bit14	
	bit15	

## 8. Precautions

8.1 The monitor shall be installed at a place without direct exposure to rain, snow, corrosive gases or violent vibration.

8.2 The monitor shall be installed with the surrounding temperature between -20°C and +60°C.

8.3 The monitor shall be installed with the surrounding relative humidity not exceeding 95%.

## 9. Diagnostics and troubleshooting of common faults

9.1 Incorrect measurements

\* Check if the voltage and current connection is correct.

9.2 Correct voltage and current measurements and incorrect power measurement

\* Check if the direction of current is correct.

\* Check if each current circuit corresponds to the correct phase.

9.3 Communication failure

\* Check if the communication connection is normal.

\* Check if the address setting and the communication baud rate are correct.

\* Check the communication of one monitor in a series of monitors with communication failure