200

AIM-T500 Insulation Monitor

User Manual V1.7

Acrel Co., Ltd.

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CONTENTS

1 Introduction 1
2 Functional Characteristic 1
3 Model Description 2
4 Technical Parameters 2
5 Reference Standards 3
6 Installation and Connection 3
    6.1 Shape and Size 3
    6.2 Method of Installation 3
    6.3 Wiring Method 4
7 Program and Usage 6
    7.1 Display Panel 6
    7.2 LED Instructions 6
    7.3 Function Description of Buttons 7
    7.4 Operation Instructions of Buttons 7
8 Communication Instruction 9
    8.1 Modbus-RTU Communication Protocol 9
    8.2 Introduction to Function Code 10
    8.3 Register Address Table 11
9 Typical Applications 12

AIM-T500 Insulation Monitor

1 Introduction

With the development of industry, in order to improve the continuity, reliability and safety of power supply, many critical production sites have adopted un-earthed systems (unearthed a.c. IT systems or unearthed d.c. IT systems, as described in IEC 61557-8; hereinafter referred to as IT systems). As earth fault currents are low, standard switching devices are unable to detect faults and trip; therefore, it is necessary to install an insulation monitoring device (IMD) to monitor the insulation resistance to earth of the IT system.

The AIM-T500 Insulation Monitor can be applied to AC, DC, and AC/DC hybrid IT systems. The device features insulation monitoring, early warning alarms, open-circuit alarms, and event logging. It is characterized by a wide measurement range, fast response time, and high tolerance for system leakage capacitance. The device can monitor the insulation status of the IT system relative to ground in real time and promptly issue an alarm when an insulation fault occurs, alerting personnel to investigate the issue.

The device injects a low-frequency AC signal into the IT system and adjusts the signal frequency based on the measured system-to-earth capacitance, ultimately determining the insulation resistance to the required accuracy. This method minimises the influence of system-to-earth capacitance, significantly enhancing the measurement accuracy and reliability of insulation resistance.

The device is suitable for use in IT systems within industrial settings such as mines, glassworks, steelworks, metallurgical plants, chemical plants, electric furnaces and test equipment, ships, offshore platforms, port shore power systems, explosion-hazardous areas, computer centres and emergency power supplies.

2 Functional Characteristic

■ Insulation resistance monitoring function. The device can monitor the insulation resistance to earth of AC, DC and AC/DC hybrid IT systems;

■ Leakage capacitance monitoring function. The device can monitor the leakage capacitance to earth of IT systems;

■ Open-circuit monitoring function. The device can monitor the connection status between the PE and KE terminals and the on-site earthing busbar in real time;

■ Early warning and alarm function. The device features early warning and alarm functions; when the insulation resistance falls below the set threshold, the device issues a corresponding alarm;

■ Alarm indication function. The device features an LCD display and LED indicators; when an alarm is triggered, the LCD displays specific alarm information and the LED indicator flashes continuously;

■ Alarm output function. The device features three relay outputs, corresponding respectively to device error, insulation alarm and insulation early warning;

■ Fault recording function. The device features a fault recording function (SOE), capable of recording the time and type of fault, facilitating operators' analysis of system operation and enabling timely fault

rectification;

■ Remote communication function. The device is equipped with one RS485 interface, allowing data to be read remotely via a host computer;

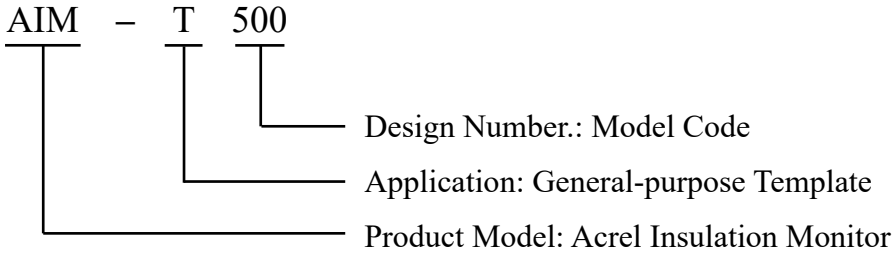
■ Self-test function. The device can perform a self-test on its hardware circuitry and software via the "Test / ESC", button and self-test terminals;

■ Reset function. The device supports manual or automatic reset, which can be selected according to on-site conditions;

■ Interlock function. The device can perform insulation monitoring in dual-busbar interconnection scenarios via the bus interlock terminal;

■ Panel mounting. The device is designed for panel mounting with pluggable terminals, facilitating installation and wiring by on-site personnel.

3 Model Description



4 Technical Parameters

Item		Parameter
Accessory power supply		AC 85~265V, 50/60Hz; DC100~300V
Power dissipation		< 8W
System voltage		AC 0~690V, 40~460Hz; DC 0~800V
System application		IT system (online), Other system (offline)
Insulation monitoring	Measuring range *Rf*	1k~10MΩ
	Response range *Ran*	10k~10MΩ
	Resistance accuracy	1~10k, ±1k; 10k~10M, ±10%
	Leakage Capacitance *Ce*	<500μF
	Response time (Ce=1μF)	<5s
Internal parameters	Measuring voltage	<50V
	Measuring current	<270μA
	Internal DC impedance	≥180kΩ
Relay output		Error, Alarm, Warning; 5A 250VAC/30VDC
SOE		20 records (fault type, fault value, fault time)
Alarm type		LCD, LED indicator

Communication		RS485, Modbus-RTU
Impulse voltage / Pollution Level		8kV/III
EMC/ Radiation		IEC61326-2-4
IP Rating / Device Weight		IP40 / 414.8g
Environment	Working temperature	-10 ~+65℃
	Storage temperature	-20~+70℃
	Relative humidity	<95%, without condensation
	Altitude	≤2500m

5 Reference Standards

■ Q/VDCL-26 *IT System Insulation Monitor.*

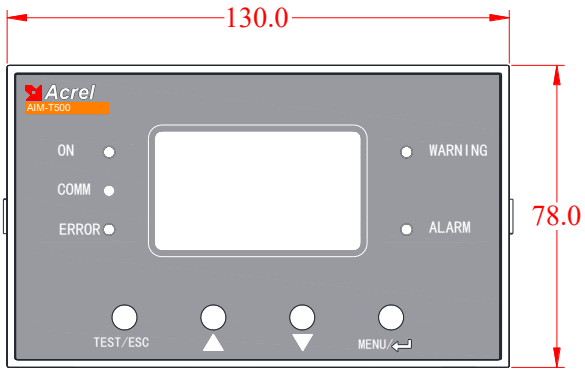
■ IEC 61557-8 *Electrical safety in low voltage distribution systems up to 1000V a.c. and 1500V d.c. - Equipment for testing, measuring or monitoring of protective measures - Part 8: Insulation monitoring devices for IT systems.*

■ IEC 61326-2-4 *Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 2-4: Particular requirements - Test configurations, operational conditions and performance criteria for insulation monitoring devices according to IEC 61557-8 and for equipment for insulation fault location according to IEC 61557-9.*

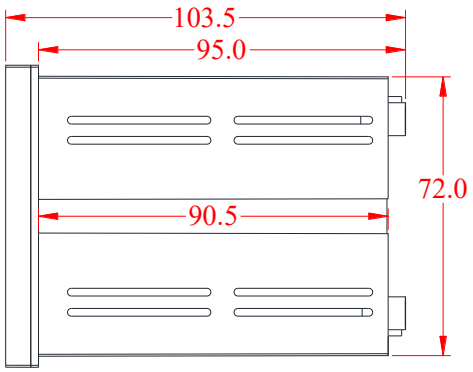
6 Installation and Connection

6.1 Shape and Size

The dimensions and installation specifications of the AIM-T500 Insulation Monitor are shown in the figure below. (Unit: mm)



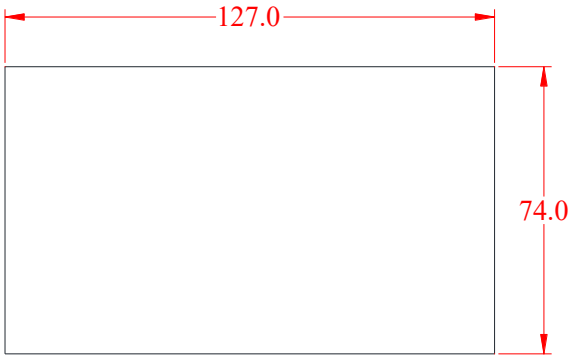
Front view



Side view

6.2 Method of Installation

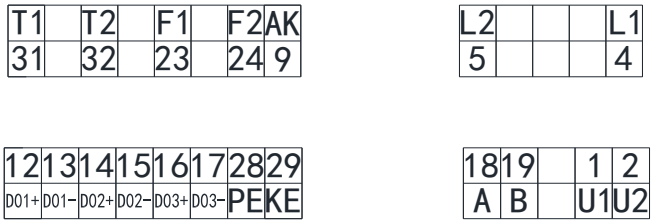
The AIM-T500 Insulation Monitor is designed for panel mounting. The cutout dimensions are shown in the figure below. (Unit: mm)



First, cut an opening in the cabinet door at the appropriate location. Then, insert the meter into the opening, take out the included plastic mounting bracket, and place it into the side slots of the meter. Finally, secure it with the included screws to complete the installation.

Note: The dimensional tolerance for external dimensions is ±0.5 mm, and the dimensional tolerance for mounting dimensions is ±0.2 mm. When designing and installation, allow sufficient space for terminal blocks and wiring.

6.3 Wiring Method

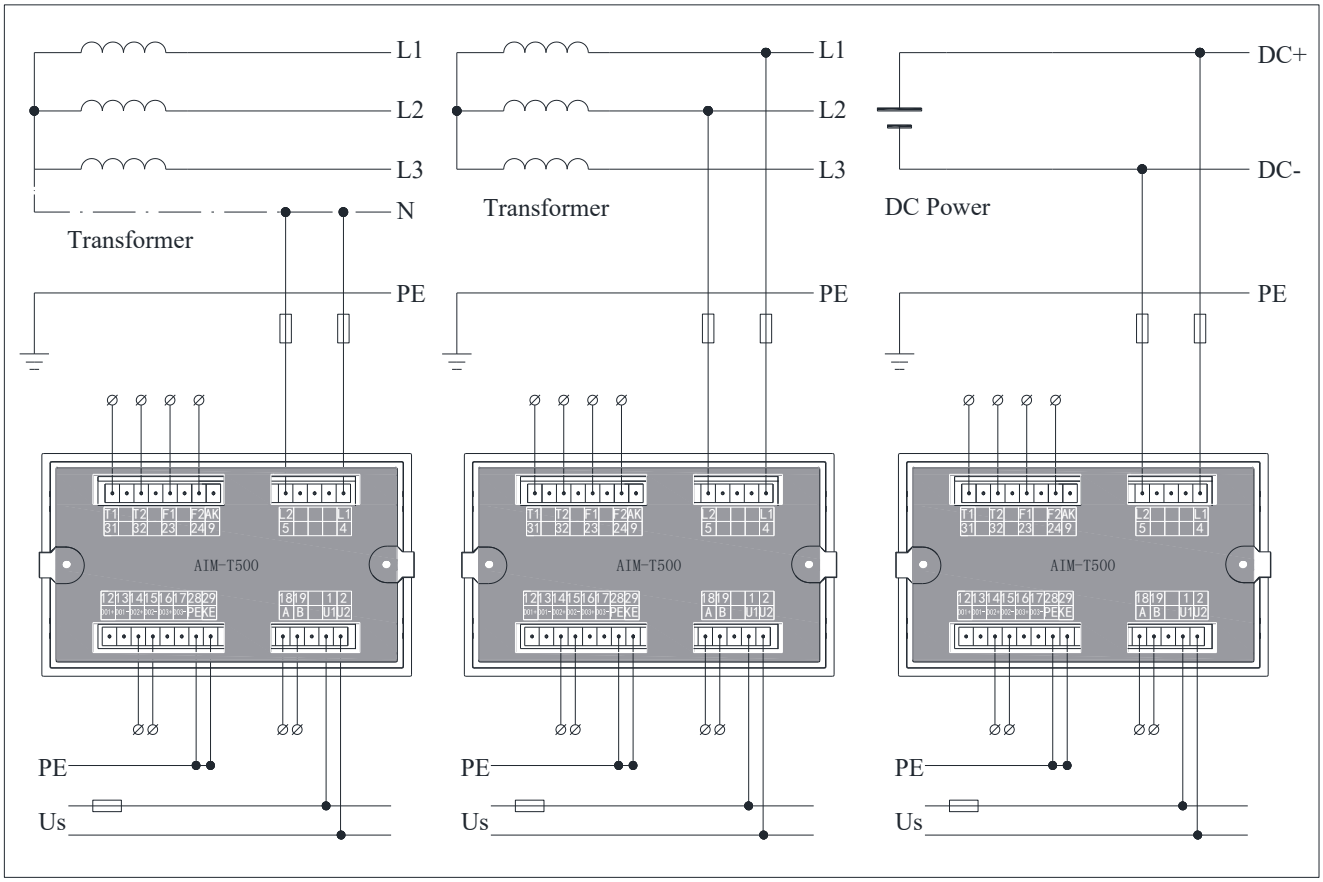


Upper row terminals: T1 and T2 (31, 32) are self-test terminals used to verify the accuracy of the device's resistance measurements. This function must be used whilst the device is disconnected from the DC system; short-circuiting T1 and T2 will display the device's measurement results. F1 and F2 (23, 24) are interlock terminals. When two unearthed systems are connected via a switch, the device with F1 and F2 short-circuited will cease operation, with monitoring performed by the other device alone. This is commonly used in scenarios with two busbar sections connected by a bus tie. The normally open auxiliary contacts of the bus tie switch can be connected to F1 and F2. After short-circuiting PE and KE, connect the normally closed auxiliary contacts to the earthing bar. When the bus tie switch is closed, short-circuiting F1 and F2 causes the corresponding device to exit monitoring mode, displaying "measure shut down!!!", and the device becomes inoperable; the PE and KE terminals are disconnected from the earthing bar. AK (9) is an expansion terminal used for insulation monitoring in IT systems with voltages of 690 V AC / 800 V DC or higher; please refer to the '290 ACPD Series… Manual' for details. L1 and L2 (4, 5) are the device's insulation monitoring terminals, which must be connected to the IT system under monitoring.

Lower row of terminals: DO1+ and DO1- (12, 13), DO2+ and DO2- (14, 15), and DO3+ and DO3- (16, 17) are three sets of relay output terminals, corresponding respectively to device error, insulation alarm and insulation warning fault outputs. PE and KE (28, 29) are the device's functional earth terminals, which must be connected to the on-site equipotential bonding terminal block. A and B (18,

19) are the device's RS485 interface terminals, used for communication with the host computer. U1 and U2 (1, 2) are the device's auxiliary power supply terminals.

The typical wiring diagram for the AIM-T500 insulation monitor is shown below.



(a) (b) (c)

Wiring Instructions:

(1) Figure (a) shows a three-phase distribution system with a neutral conductor (ITn), where L1 and L2 are connected to the neutral conductor; Figure (b) shows a three-phase distribution system without a neutral conductor (IT), where L1 and L2 are connected to any two phases; Figure (c) shows a DC ungrounded system, where L1 is connected to the positive terminal (DC+), and L2 is connected to the negative terminal (DC-);

(2) PE and KE (28, 29) use two separate cables to connect to the on-site grounding busbar (PE).

(3) U1 and U2 (4, 5) are auxiliary power terminals that must be connected to the Us auxiliary power supply; they can be connected to either AC 220V or DC 220V power.

(4) Other terminals may be wired according to on-site requirements.

6.4 Matters Attention

(1) When designing and installing the insulation monitor, note that only one unit should be installed and used per independent IT system. If multiple insulation monitors are installed at different locations, a control strategy should be employed for insulation resistance monitoring.

(2) The insulation monitor may be installed inside a distribution panel, provided the installation

location is free from dripping water, corrosive chemical gases, and sediment.

(3) When wiring the insulation monitor, follow the wiring diagram strictly. It is best to crimp the pin-type connectors before inserting them into the terminals and tightening the screws, to prevent the device from malfunctioning due to poor contact. Please ensure that you use cables suitable for the voltage rating; cables are selected with 1~2.5 mm² are recommended. The tightening torque for the terminals should not exceed 0.6 N·M. The fuse shown in diagram should be selected with a 6A rating.

(4) When establishing a communication connection between the insulation monitor and the host computer, it is recommended to use shielded twisted-pair cable, connecting to terminals A and B respectively. Ensure the polarity is correct, and route the cable away from high-voltage cables or other strong electric field environments. In case of communication abnormalities, connect a 120Ω matching resistor in parallel at both the beginning and end of the bus.

(5) The relay output of the insulation monitor is a dry contact and does not include a power supply; connecting it to an alarm light or an audible and visual alarm requires an external power source.

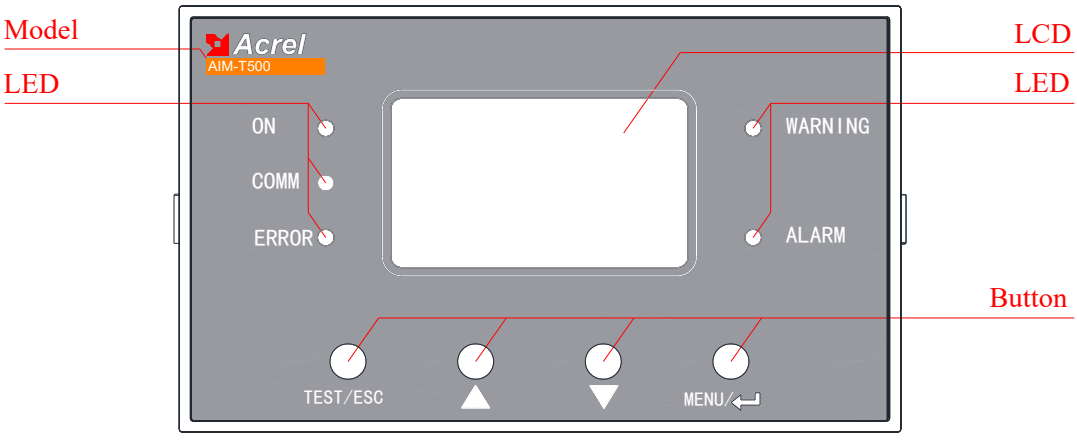
(6) The insulation monitor must be reliably connected to the IT system being monitored to ensure the effectiveness of insulation monitoring; As the insulation monitor is a measuring device, the connection between the monitor and the IT system must be disconnected during line or load withstand voltage tests.

(7) Non-professionals are strictly prohibited from opening the product housing without authorization to avoid affecting product functionality.

7 Program and Usage

7.1 Display Panel

Each part of the AIM-T500 panel is shown below.



7.2 LED Instructions

5 LED indicators are used to indicate the status of the insulation monitor:

LED indicators	Instructions
ON	when the device is working normally, the indicator light flickers, and the scintillation frequency is about once a second
COMM	when the device has communication data to receive or send, the indicator light flickers

ERROR	when the device PE, KE breaks, the indicator light flickers
WARNING	When the insulation resistance of the monitoring is less than the warning value, the warning indicator light flickers
ALARM	when the insulation resistance of the monitoring is less than the alarm value, the alarm indicator light flickers

7.3 Function Description of Buttons

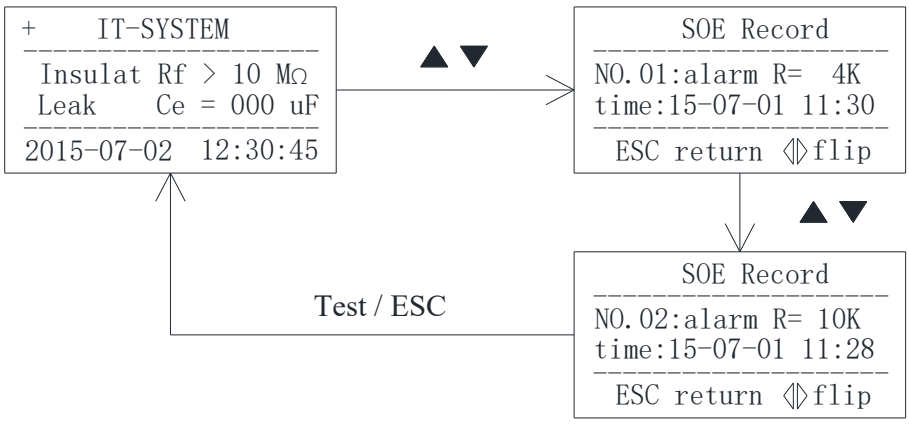
There are four Buttons in the device. They are "Test / ESC", "▲", "▼", "Menu/↵ ".

Button	Button Function
Test / ESC	In the non-programming mode, it is used to start the self-checking; In programming mode, it is used to exit.
▲ ▼	In the non-programming mode, it is used to read the alarm record; In programming mode, it is used to increase or decrease the figure.
Menu/↵	In non-programming mode, press button to enter programming mode; In programming mode, they are used as Backspace confirmation or selection Button.

7.4 Operation Instructions of Buttons

7.4.1 Button operation under the main interface

(1) When starting up, enter the main interface by default. If there is no other Button operation, the system will go into the main interface and work. The insulation resistance value, the leakage capacitance value and the current system time are showed on the main interface.



(2) Check the alarm record. In the main interface, one can enter the event record query interface by pressing the "▲" or "▼" to turn the page to successively query the most recent 20 fault records. The first one is the latest record, and the twentieth record is the oldest one.

(3) Device self-test. Press the "Test / ESC" button to initiate the self-test procedure. All five LEDs will light up simultaneously, and the self-test result will be displayed after approximately 2 seconds, confirming that the device's alarm and other functions are operating correctly.

7.4.2 Parameter setting

(1) Enter the menu

Under normal operation, enter the password input page by pressing "Menu/↵ ". Set the size of number by "▲" or "▼", press "Menu/↵ " to enter the menu after inputting the correct password. Otherwise, the

password error will be displayed and automatically returned after 1s.

(2) LCD Settings

After entering the menu, select "LCD Set" and press "▲" or "▼" to adjust the LCD contrast (long press is supported). You can adjust the LCD backlight time. After the modification is complete, press the "Test / ESC" Button to exit. At this time, you can choose whether to save the setting and press "Menu/↵ " to confirm and exit.

(3) Security Settings

Enter the menu and select "AlarmSet". Press "▲" or "▼" to adjust the warning and alarm values (long press is supported). Press The "Test / ESC" Button to exit. At this time, you can choose whether to save the settings. Press "Menu/↵ " to confirm and exit. The default alarm value is 38K and the early warning value is 60K. The warning threshold is higher than the alarm threshold. The warning and alarm thresholds can use the default values or be adjusted based on actual conditions.

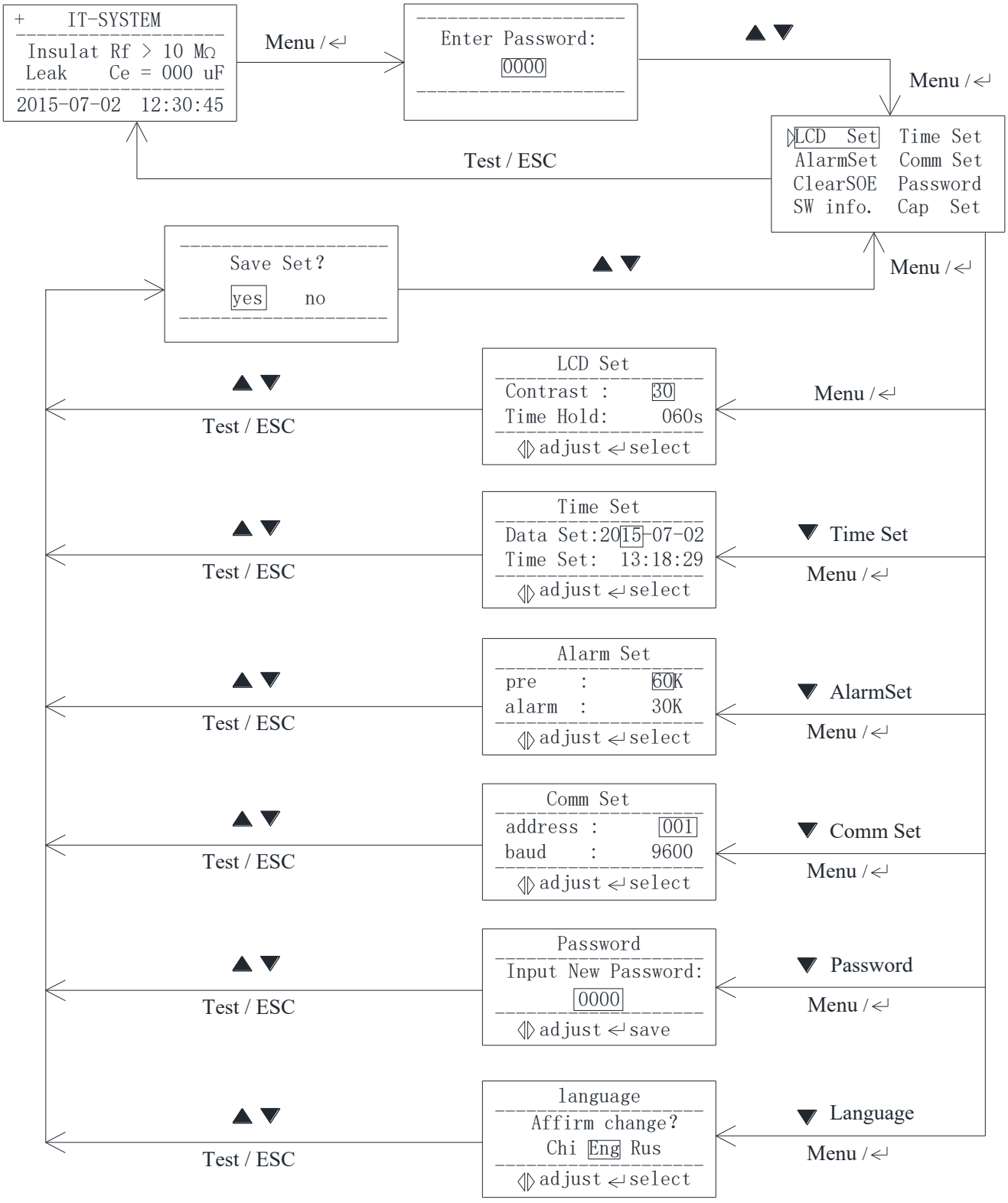
The pre-alarm threshold can be set at 1 kΩ/1V, and the alarm threshold at 0.1 kΩ/1V; in humid or saline environments, the pre-alarm threshold can be set at 0.5 kΩ/1 V, and the alarm threshold at 0.05 kΩ/1 V. For example, for an IT system operating at 690 V AC in a humid environment, the pre-alarm threshold can be set to 350 kΩ and the alarm threshold to 35 kΩ.

(4) Communication Settings

After entering the menu, select "Comm Set" and press "▲" or "▼" to adjust system communication parameters (hold down is supported). Press "Test / ESC" Button to exit. At this time, you can choose whether to save the settings. Press "Menu/↵ " to confirm and exit. The default communication address is 1 and baud rate is 9600.

(5) Setting of other information

The insulation monitor also provides the functions of Clearing Records, Password Setting, Software Information, and Capacitor Setting. The settings of these parameters are similar to those described in the preceding steps.



8 Communication Instruction

8.1 Modbus-RTU Communication Protocol

Meter RS485 interface adopts Modbus-RTU communication protocol, which defines the address, function code, data, check code in detail. It is the necessary content to complete the data exchange between the host and slave machine.

8.2 Introduction to Function Code

8.2.1 Function code 03H or 04H: Read the registers

This function allows to acquire the data by equipment and the system parameters. The number of data requested by hosts has no limit, but cannot exceed the defined address range.

The following example shows how to read a measured insulation resistance value from No.01 slave computer, with the address of the value of 0008H.

The Host Computer Sends		Send Message
Address code		01H
Function code		03H
Start address	High byte	00H
	Low byte	08H
Number of registers	High byte	00H
	Low byte	01H
CRC Code	Low byte	05H
	High byte	C8H

The Slave Computer Returns		Return Message
Address code		01H
Function code		03H
Bytes		02H
Register data	High byte	00H
	Low byte	50H
CRC Code	Low byte	B8H
	High byte	78H

8.2.2 Function code 10H: Write the registers

The function code 10H allows the user to change the contents of multiple registers, which can write the time and date in this meter. The host can write up to 16 (32 bytes) data at a time.

The following example shows a preset address of 01 with an installation date and time of 12:00, Friday, December 1, 2009.

The Host Computer Sends		Send Message
Address code		01H
Function code		10H
Start address	High byte	00H
	Low byte	04H
Number of registers	High byte	00H
	Low byte	03H
Number of registers		06H
0004H data	High byte	09H
	Low byte	0CH
0005H data	High byte	01H
	Low byte	05H
0006H data	High byte	0CH
	Low byte	00H
CRC Code	Low byte	A3H
	High byte	30H

The Slave Computer Returns		Return Message
Address code		01H
Function code		10H
Start address	High byte	00H
	Low byte	04H
Number of registers	High byte	00H
	Low byte	03H
CRC Code	Low byte	C1H
	High byte	C9H

Note: The above data is for reference only, see address table for register definition

8.3 Register Address Table

No.	Address	Parameter		R/W	Value range	Data Type
0	0000H	Password		R	0000-9999 (default 0000)	UINT16
1	0001H high	Address		R	1~247 (default 1)	UINT16
	0001H low	Baud rate		R	1~4: 4800, 9600, 19200, 38400 (unit: bps) (default 9600)	
2	0002H high	Contrast ratio		R	15-60 (default 30)	UINT16
	0002H low	Display time		R	15~250 (unit: second) (default 60, 15 light)	
3	0003H high	Year		R/W	0~99; Read value +2000	UINT16
	0003H low	Month		R/W	1~12	
4	0004H high	Day		R/W	0~31	UINT16
	0004H low	Warning mark		R	0: none 1: warning 2: warning and alarm	
5	0005H high	Hour		R/W	0~23	UINT16
	0005H low	Minute		R/W	0~59	
6	0006H high	Second		R/W	0~59	UINT16
	0006H low	Data stable		R	0 or 1 (0 invalid, 1 stable)	
7	0007H	Warning value		R/W	10~10 000 (unit: kΩ) (default 60)	UINT16
8	0008H	Alarm value		R/W	10~10 000 (unit: kΩ) (default 30)	UINT16
9	0009H	Resistance value		R	1~10001 (unit: kΩ)	UINT16
10	000AH	SN (high 16 bits)		R	SN is UINT32 value, Default 0000000000	UINT16
11	000BH	SN (low 16 bits)		R		UINT16
12	000CH	Reserved		R		UINT16
13	000DH	Leakage capacity		R	0~500 (unit: μF)	UINT16
14	000EH high	Symbol of broken line		R	0: none 4:PE/KE broken	UINT16
	000EH low	Current period			2~200 (unit: second)	
15	000FH high	Access system or not		R	0: no access system 1: access system	UINT16
	000FH low	Reserved				
16	0010H high	SOE1	Fault info.	R	The sequence number of incident record	UINT16
	0010H low			R	SOE1 content: 0~2 0: no record 1: warning 2: alarm	
17	0011H		Resistance value	R	SOE 1 insulation resistance	UINT16

18	0012H high		Year1	R	SOE 1 time -year	UINT16
	0012H low		Month	R	SOE 1 time -month	
19	0013H high		Day	R	SOE 1 time -day	UINT16
	0013H low		Hour	R	SOE 1 time -hour	
20	0014H high		Minute	R	SOE 1 time -minute	UINT16
	0014H low		Second	R	SOE 1 time -second	
21~115	0015H~0073H	SOE 2~20 information		R	The data format is the same as SOE1	UINT16 *95

9 Typical Applications

When referring to inspecting the insulation condition or insulation level of an IT system, this typically involves checking the insulation between phases, between phases and ground, between windings and the enclosure, and between windings and ground while the system is offline (de-energized). The standard procedure is to use a megohmmeter (either manual or digital) to test the insulation between phases and between phases and ground. If the test results do not meet the standards, corrective measures are implemented.

Insulation monitoring for IT systems generally refers to online monitoring, which measures the overall insulation resistance of the IT system to ground. The first instance of metallic grounding and multi-phase non-metallic grounding are considered serious insulation fault alarms.

Insulation monitoring devices cannot be used for online monitoring in TN-S, TT, and similar systems. To assess insulation status in these systems, residual current monitoring products are typically employed; refer to RCM and RCD-related products. Offline monitoring can also be used, with a method similar to that of a megohmmeter, though different test signals are employed.

The following points should be noted when using insulation monitors:

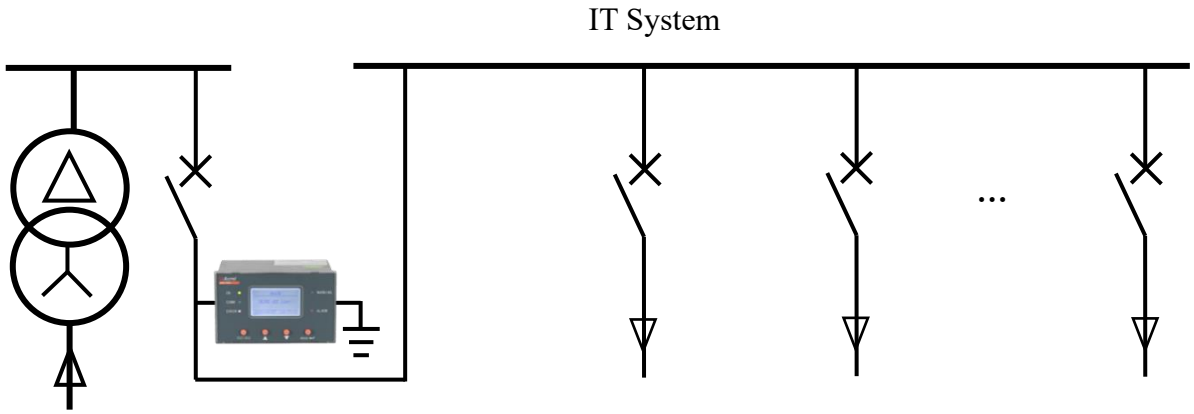
(1) A standalone IT system typically uses a single insulation monitor; using multiple insulation monitors simultaneously can cause signal interference. To determine whether a system is a standalone IT system, check whether it uses a transformer or isolation equipment to divide the power distribution system into separate sections.

(2) The insulation monitor monitors the insulation to ground of the entire IT system, including the secondary side of transformers, busbars, cables, and all live parts of equipment. Therefore, the insulation monitor is generally installed in the feeder cabinet.

(3) When the insulation monitor triggers an alarm, it indicates that the overall insulation level of the IT system has dropped to a very low level. It is necessary to sequentially check the insulation to ground of each section. Most insulation fault alarms are caused by equipment; you can sequentially disconnect the power switches for each piece of equipment to see if the insulation monitor returns to normal. If it does, you can then inspect that specific circuit.

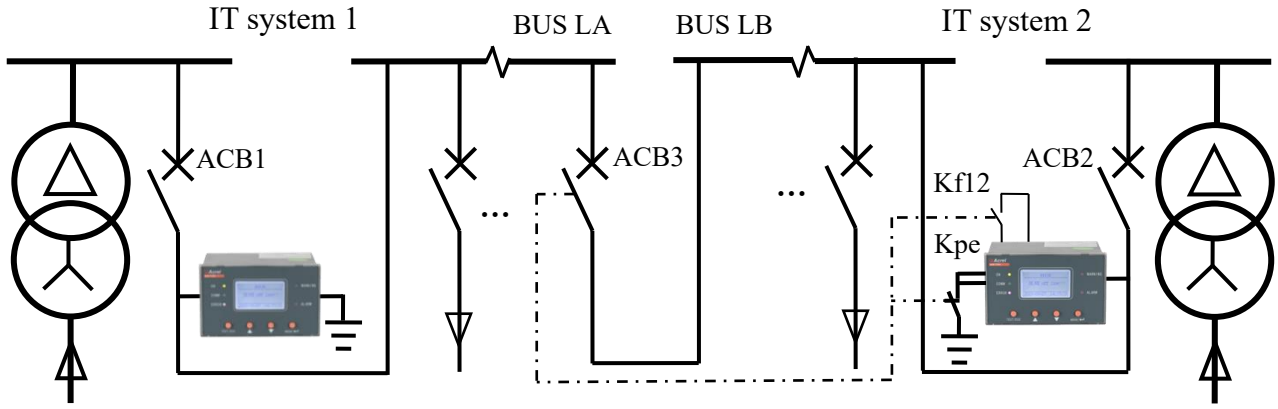
The AIM-T500 Insulation Monitor is intended for use only in ungrounded systems; it cannot be used in IT systems with high-resistance grounding, TN-S systems, or TT systems. The AIM-T500 Insulation Monitor can be used in both single-busbar IT systems and double-busbar, sectioned IT systems.

A typical application of a single-busbar IT system is shown in the figure below.



In a single-busbar IT system, the AIM-T500 insulation monitor is installed in the feeder cabinet to monitor the insulation to ground of all live circuits on the secondary side of the transformer.

A typical application of a double-busbar sectioned IT system is shown in the figure below.



In a double-busbar sectioned power distribution system, when the bus tie switch is open, the two busbar sections operate independently, forming two separate IT systems. AIM-T500 insulation monitors are installed in the two feeder cabinets to monitor the insulation status of the LA and LB sections respectively. When the bus tie switch is closed, the two busbar sections are connected, forming a single, independent IT system. At this point, the normally open contact Kf12 of the bus tie switch closes, causing the insulation monitor to cease monitoring, whilst the normally closed contact Kpe opens, disconnecting the device from the earthing bar.

Headquarters: Acrel Co., Ltd.
Trade Company: Acrel E-Business (Shanghai) Co., Ltd.
Address: No.253 Yulv Road, Jiading District, Shanghai, China
TEL.: 0086-21-69156352
Web-site: www.acrel-electric.com
E-mail: sales@acrel-electric.com
Postcode: 201801

Manufacturer: Jiangsu Acrel Electrical Manufacturing Co., Ltd.
Address: No.5 Dongmeng Road, Dongmeng industrial Park, Nanzha Street, Jiangyin City, Jiangsu Province, China
TEL./Fax: 0086-510-86179970
Web-site: www.jsacrel.com
E-mail: sales@email.acrel.cn
Postcode: 214405