LK Series

Programmable Logic Controller System Manual

Automation for Better Life

HollySys Group

Beijing HollySys Intelligent Technologies Co., Ltd.

LK Series Programmable Logic Controller

System Manual

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Chapter 1 About This Book

1.1 Document Update

Version	Description	Date
V1.0	New	2016.06.14
V1.1	Add LK234	2017.04.11
V1.2	**1.** Update temperature and humidity **2.** Update module name: LK610,LK710,LK441,LK511 **3.** Add LK410, LK510,LK620	2018.01.10

1.2 Purpose

This Manual mainly introduces the operational principle, major functions, wiring instructions, configuration settings, technical specifications and so on of LK large-scale programmable controller hardware products. It helps users to use the product properly.

1.3 Intended Audience

This Manual is applicable to the following people:

- Engineers in charge of system engineering implementation.
- Technicians in charge of system maintenance.
- Installation personnel.

1.4 Document Conventions

1.4.1 Menu

The menu commands are described as [], such as [Reset], [Download], [Add Device].

The names of window and dialog are described as bold font, such as **Device Library**, **Library**, **Device Property**.

1.4.2 Mouse

- Point to: move mouse pointer on an object.
- Press: press the left mouse button once and keep.

- Click: Press the left mouse button once and release.
- Right-click: Press the right mouse button once and release.
- Double click: quickly press the left mouse button two times and release.
- Drag: Press and hold the left mouse button while moving the mouse.

1.4.3 Keyboard

The names of keys on the keyboard are described with bold style, such as **Shift**、**Enter**、**Shift**+**F2**.

1.4.4 Important Information

- Danger icon. Indicates a potentially hazardous situation that could result in death or serious injury.

- Electric shock icon. Indicates a potentially hazardous situation that could result in electric shock accident.

- Warning icon, indicating that the operation may lead to the potential threats of failure or damage to software and hardware equipments.

- Important icon, identifies important information about the operations or functions which need to be understood.

- Operation icon. Indicates the operation method of an object.

SEE ALSO

- Reference icon. Provides additional sources of the information.

1.5 Catalog

HollySys Programmable Logic Controller PLC Instruction Manual

AutoThink V3.1 User Manual_Project Configuration

LK Series Programmable Logic Controller System Manual

1.6 Terminology

Terminology	Description
Profibus –DP	Standard bus protocol
MRAM	Magnetic random access memory, a nonvolatile memory
MODBUS	A serial interface industrial bus protocol, used for communication between electron devices
PHY	PHY refers to the physical layer, the lowest level of OSI. It is the medium access control and medium interface of the data link layer
PCIE	Peripheral Component Interface Express, a quick and peripheral interconnection standard

1.7 Abbreviations

Abbreviations	Full Name
PLC	Programmable Logical Controller
I/O	Input / Output
DC	Direct Current
FPGA	Field Programmable Gate Array
TCP/IP	Transmission Control Protocol/Internet Protocol
Profibus	Process Field Bus
AI	Analog Input
AO	Analog Output
DI	Digital Input
DO	Digital Output
TC	Thermocouple Assembly
RTD	Resistance Temperature Detector
RTC	Real-Time Clock
HMI	Human Machine Interface
STP	Shielded Twisted Pair

Chapter 2 Overview

LK220 Master Control Module act as the master control unit for the medium and large PLC system in hollysys company, which has high reliability, high performance, and fast response characteristics, can be widely used in a variety of application scenarios, such as subway, water treatment, high-end equipment, complex machines, and production line control. The redundant system is composed of the controller, IO and configuration software, which can realize the functions of data acquisition, logic calculation, output execution, human-computer interaction, data exchange and so on.

2.1 System characteristic

2.1.1 High Reliability

(1) Dual backplane redundant structure includes power redundancy, controller redundancy and network redundancy.

(2) In redundancy mode, the system can run when there is a single fault.

(3) The system is based on the TCP/IP protocol to realize safety and reliable network communication, and defense tens of thousands of zero day vulnerabilities and other undisclosed vulnerabilities or risks. System has passed Wurldtech's Achilles international certification.

(4) Support three proofing: moisture proofing, salt spray proofing and fungus proofing, satisfying GB2423 • 3/ GB2423 • 17/ GB2423 • 16.

2.1.2 Fast Response

(1) The time for redundancy switching is no more than 130ms.

(2) The minimum time of task scheduling is less than100 us.

(3) The loop response time of system is less than 200ms.

2.1.3 Large Capacity

(1) Single-DP network, 124 IO slaves can be added.

(2) The IO capacity supported by the system is more than 10,000 points.

2.1.4 Easy Maintenance

(1) Reading Log tool can record abnormal operations, faults and other information, and more than 10,000 logs.

(2) Module information and diagnostic information of each module can be obtained respectively through Module Information Instruction Library and System State Instruction Library.

(3) Each module is hot-swappable.

(4) You can update the firmware via SD card or AutoThink software.

2.2 Hardware components and structures

LK series large-scale PLC system adopt the dual backplane redundant structure, a large universal controller is mounted separately on two backplanes, respectively, A series and B series. Each redundant controller set consists of the following components:

Figure 2-1　LK Controller Components

- **1：** LK921 24V power switching module
- **2：** LK220 master control module
- **3：** LK240 redundancy communication module
- **4：** LK249 DP master station communication module
- **5：** LK130 4-slot backboard module

1. 24V power switching module

Dual 24V DC inputs are converted to single 24V DC output by redundant processing, it provides redundant 24VDC power supply for the 4 slot backboard.

2. Master control module

Master control module LK220 is redundant in configuration. Module contains two 10/100 Mbps Ethernet interface for connection to a program computer, to download the user program and upgrade controller. And also as a MODBUSTCP master/slave station to communicate with other devices. You can upgrade controller and store user files via SD card slot in panel. The controller runs in the different mode by changing the position of key switch. In redundancy mode, two controllers are in master – slave relationship, and the master switches to slave when fault occurs in master station.

3. Redundancy communication module

It is used to complete the redundant communication between A and B frame with fiber cable.

4. DP master station communication module

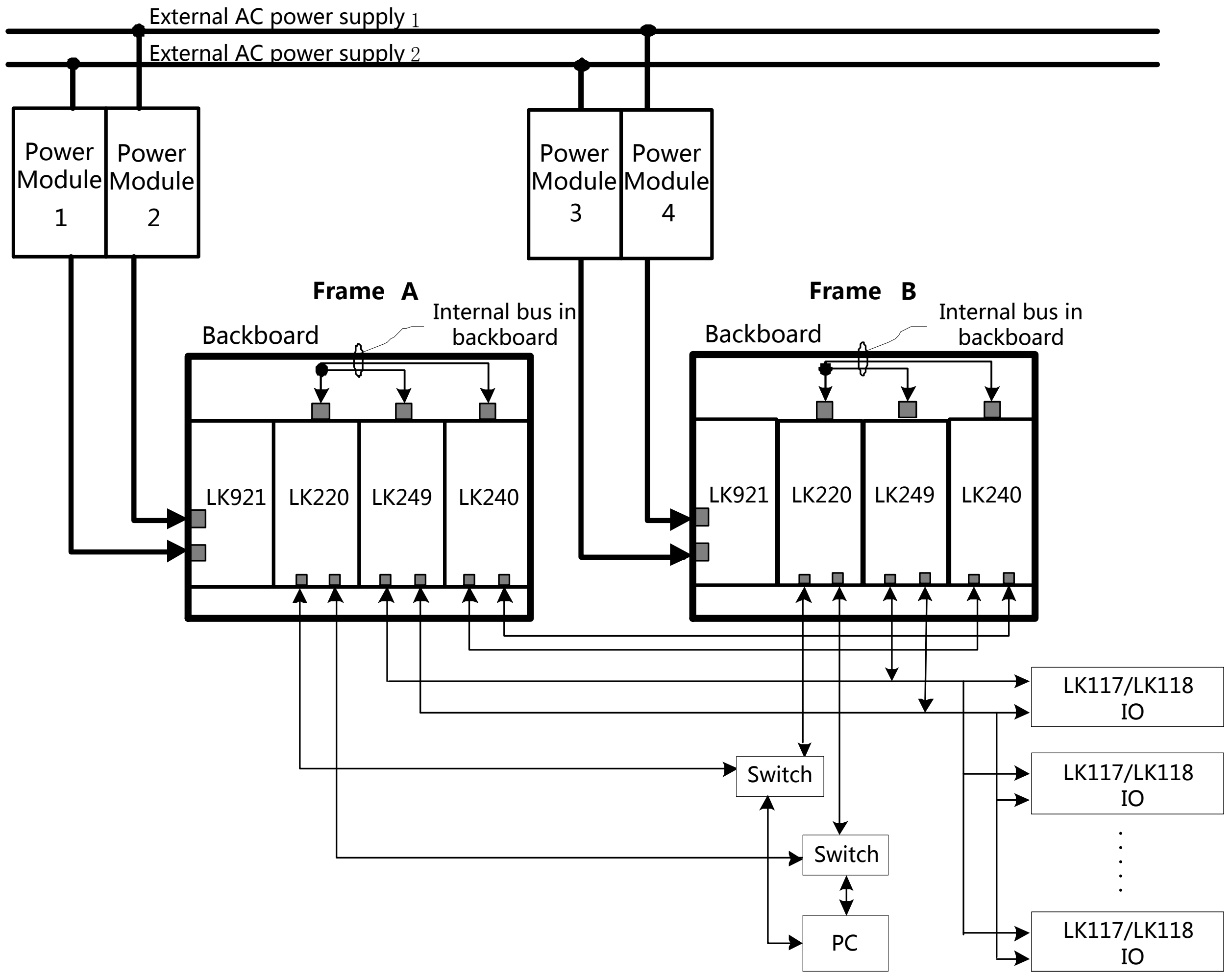
LK249 module includes two DB9 communication interface, connected to the expansion backboard LK117 / LK118 by DP bus, establish the communication connection with IO module. LK249 module exchanges data with master control module via the bus in backboard.

5. 4-slot backboard module

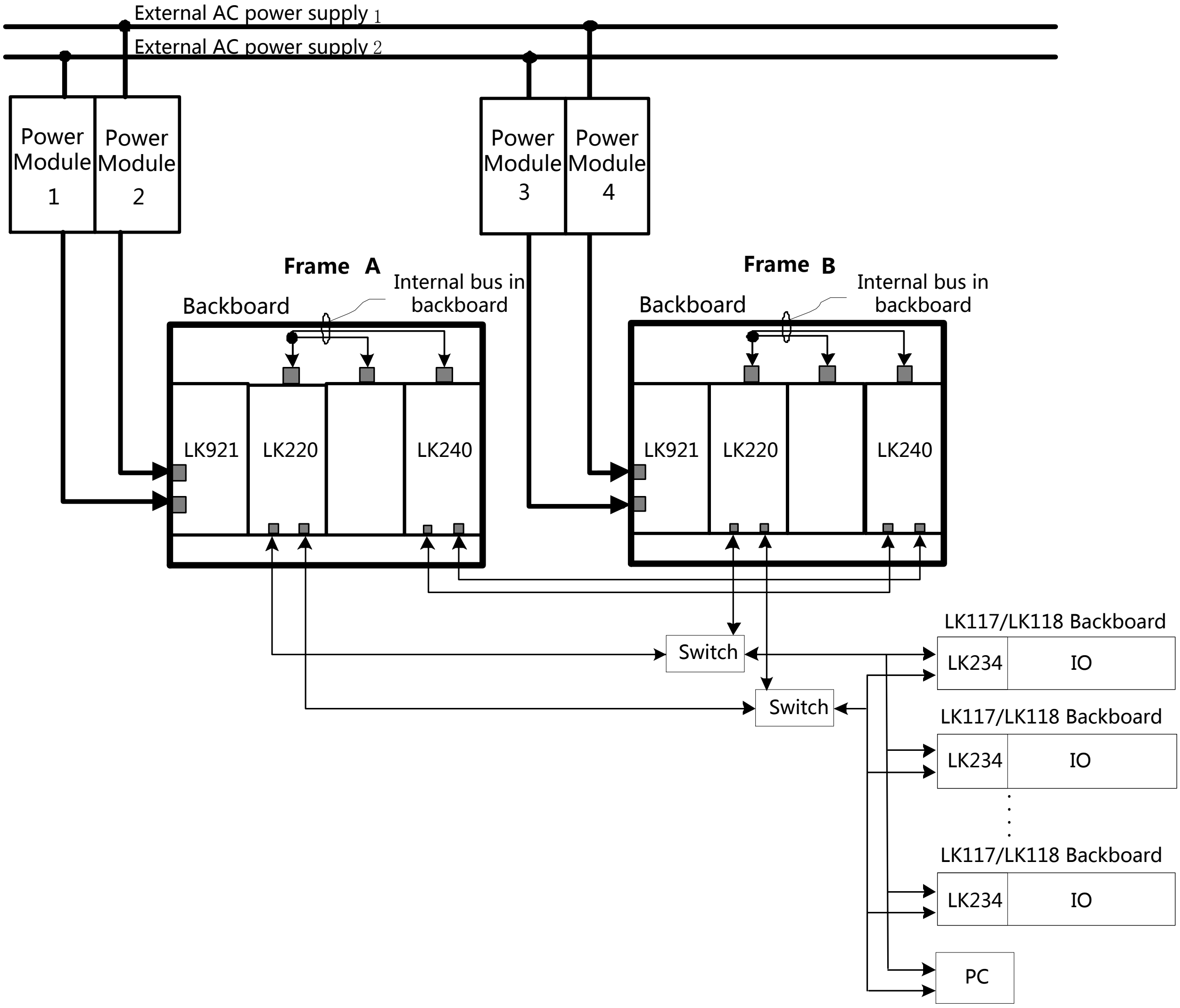
It is used to install the master control module, 24 V power switching module, redundancy communication module, DP master station communication module. It supports both high-speed local backboard bus and PROFIBUS-DP bus for data exchanging between modules.

- Please note that you can exchange the installation slot of LK240 and LK249, both of them can working normally.
- LK220, LK240, LK249, LK921 and LK130 need to be installed in the cabinet.
- LK220, LK240, LK249, LK921 and LK130 are designed for use in pollution degree 2.
- Above modules should be installed inside a metal cabinet, IP rating of the cabinet no less than IP41.

LK249 and LK234 are used respectively to extend the IO modules, topological structure schematic diagram of LK redundancy system in the two power supply ways as shown below:

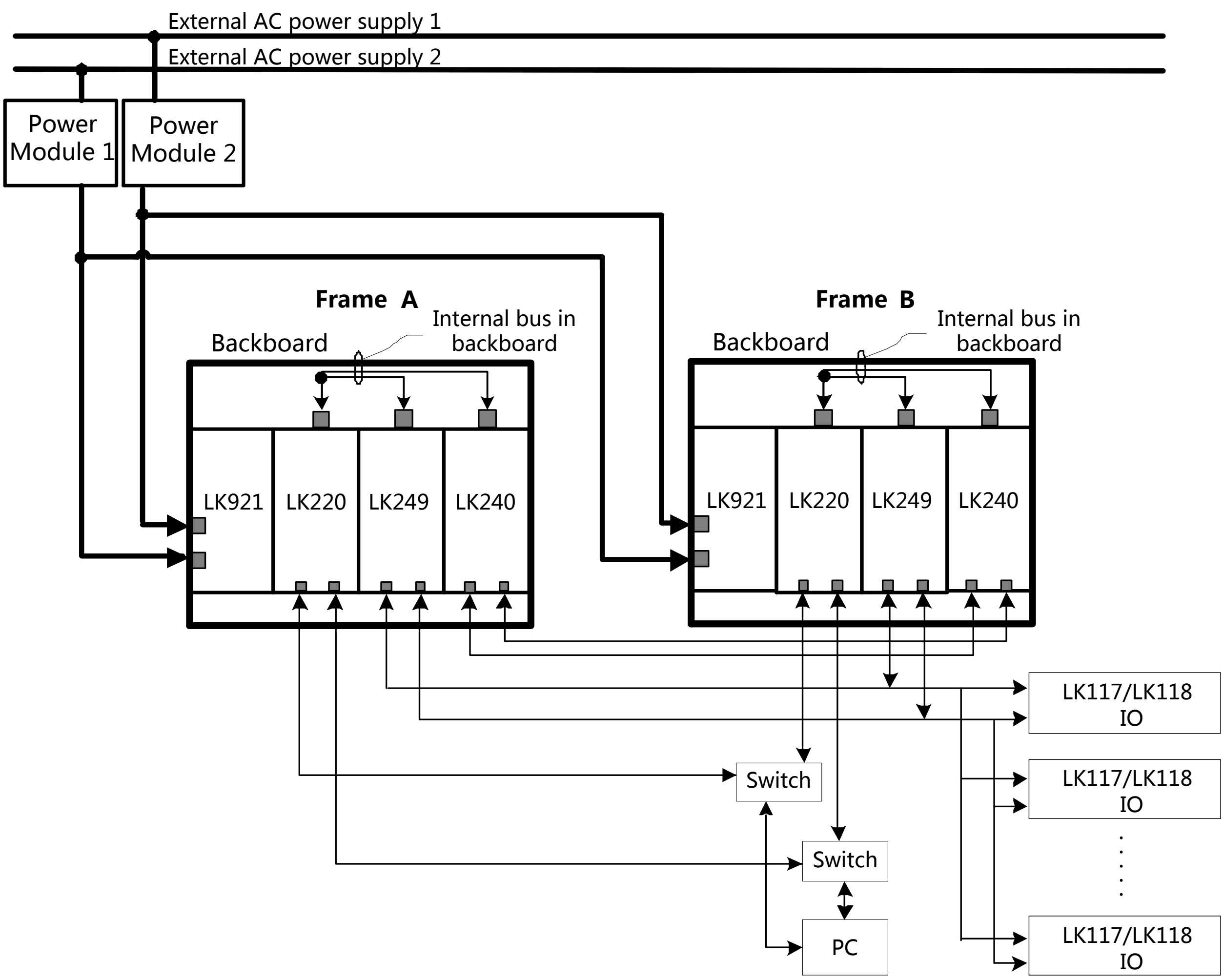

External AC power supply 1
External AC power supply 2
Power Module 1
Power Module 2
Power Module 3
Power Module 4
Frame A
Backboard
Internal bus in backboard
LK921
LK220
LK249
LK240
Frame B
Backboard
Internal bus in backboard
LK921
LK220
LK249
LK240
LK117/LK118 IO
LK117/LK118 IO
LK117/LK118 IO
Switch
Switch
PC

(a)

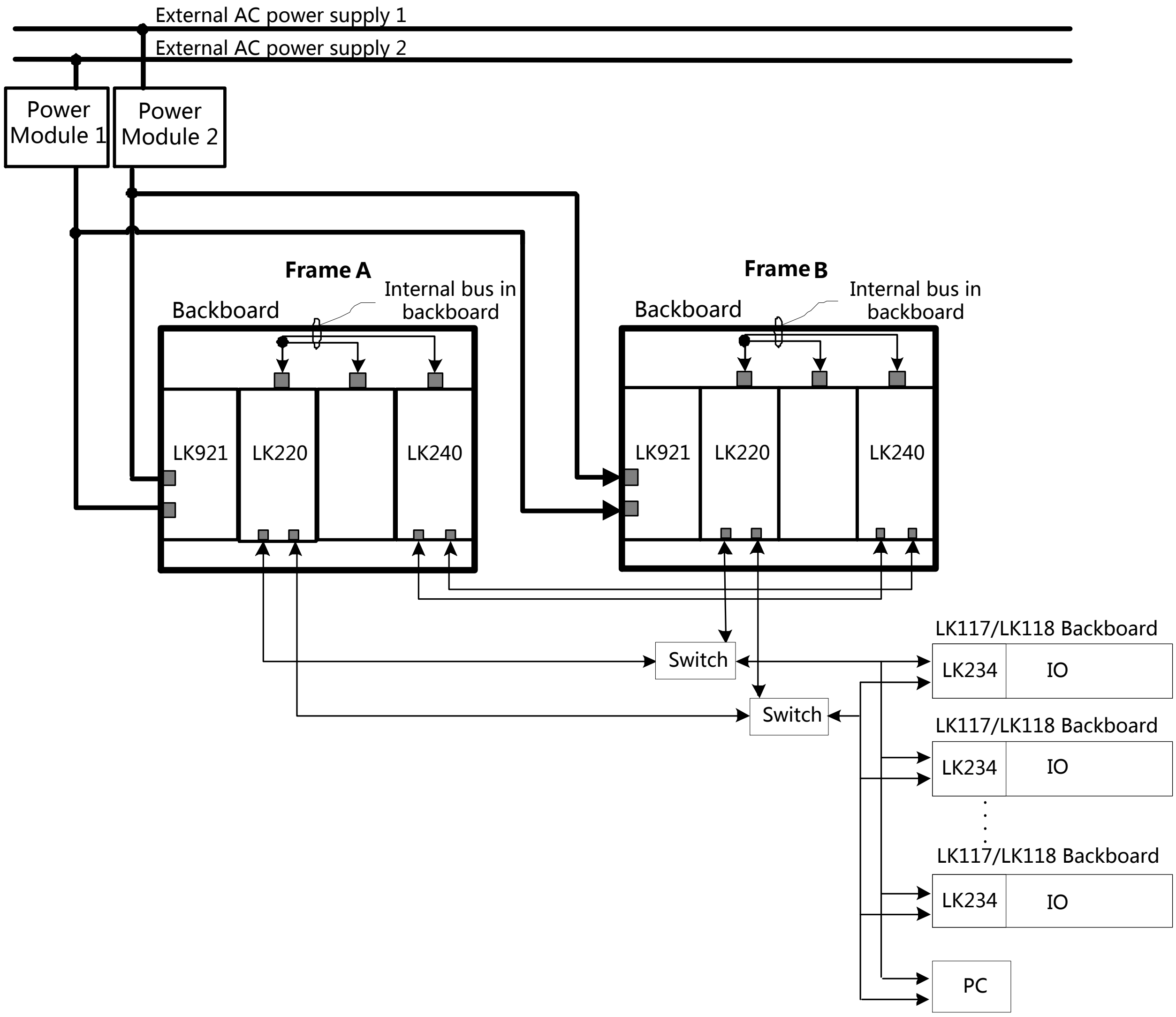


(b)

Figure 2-2 Schematic Diagram of LK Large Universal Controller Redundant System (1)


External AC power supply 1
External AC power supply 2
Power Module 1
Power Module 2
Frame A
Backboard
Internal bus in backboard
LK921
LK220
LK249
LK240
Frame B
Backboard
Internal bus in backboard
LK921
LK220
LK249
LK240
LK117/LK118 IO
LK117/LK118 IO
LK117/LK118 IO
Switch
Switch
PC

(a)



(b)

Figure 2-3 Schematic Diagram of LK Large Universal Controller Redundant System (2)

2.3 Hardware Product List

The LK series large-scale PLC hardware products mainly include master control modules, communication modules, I/O modules, backboards and power modules. Wherein, the I/O modules fall into multiple types, as shown in Table 2-1.

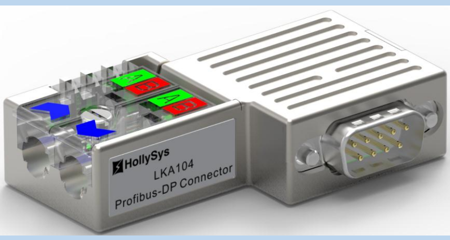
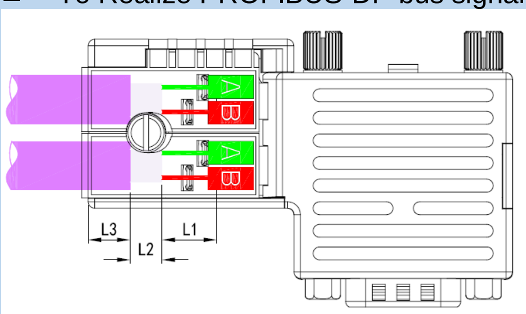
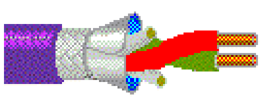
Table 2-1 LK System Hardware Product List

Module Type	Model	Specifications	Protection Key
Master controller Unit	LK130	4-slot, local backboard, 235×166×44.3 mm, with 4 CPCI pin interfaces	None
	LK921	24V power switching module, input voltage: 12~30 VDC,	None

Module Type	Model	Specifications	Protection Key
		with independently pluggable input terminals	
	LK220	667 MHz, bit instruction: 0.013ms/K, program: 10MB, 64KB retain area, supporting redundancy	None
	LK249	DP master station communication module, one double-layer DB9 receptacle, supporting hot plug	None
	LK240	Redundant communication module, dual optical fiber communication interface of LC type	None
Power supply	LK910	24 VDC power module, input voltage:110VAC/220VAC, output voltage: 24 VDC, power: 120 W, DIN rail mounting	
Backboard	LK117	Local backboard, 11-slot, 385×166×55.5 mm, with DB9 hole receptacles applied to DP interfaces, provided pluggable with I/O terminals	None
	LK118	Local backboard, 5-slot, 210×166×55.5 mm, with Type-D 9-pin receptacles applied to DP interfaces, provided with pluggable I/O terminals	None
Communication module	LK232	PROFIBUS-DP bus repeater, with terminal resistance switches	A5
	LK233	PROFIBUS-DP bus optoelectronic transceiver	A5
	LK234	Ethernet interface module	A5
	LK239	MODBUS master/slave communication extension module, RS232/RS485 interface	F1
DI	LK610	16-channel leaking type digital input module	D0
DO	LK710	16-channel source type digital output module, MOSFET output, capacity: 0.5 A, 10~30 VDC	E0
AI	LK410	8-channel voltage type analog input module, ±10V/0~5V/0~10V	A0
	LK411	8-channel current type analog input module, 0~20 mA/4~20 mA	A1
	LK412	6-channel isolation analog input module, 0~20 mA/4~20 mA/±10 V/0~5 V/0~10 V	A0
	LK430	6-channel thermal resistance analog input module, PT100/200/500/1000, Ni100/120/200/500, Cu10/50	A2

Module Type	Model	Specifications	Protection Key
	LK441	8-channel thermocouple analog input module, B/C/E/J/K/N/R/S/T type thermocouple, -12 mV~+32 mV (+78 mV)	B1
High-speed counting module	LK620	2-channel counting module, 2 counters, each one has 3-way pulse inputs and 2-way MOSFET outputs	F2
AO	LK510	4-channel inter-channel isolated voltage type analog output module, ±10.25V/0~5.125V/0~10.25V	C0
	LK511	4-channel inter-channel isolated current type analog output module, 0~21 mA/4~20 mA	C1
Attachment	LKA101	PROFIBUS-DP bus connector module	None
	LKA102	LK220 battery power box module	None
	LKA103	LK220 capacitance power box module	None
	LKA104	PROFIBUS-DP bus connector module	None
	LKA105	Optical fiber	None

Table 2-2 LK Dedicated Communication Cable

Connecting Cable	Specifications and Purposes
	LKA104 PROFIBUS-DP connector ■ D-sub 9-pin connector adapting to dual (incoming, outgoing) STP ■ Terminal matching resistance, dial switch option ■ To Realize PROFIBUS-DP bus signal transfer 
	LKX002 system dedicated PROFIBUS-DP communication extension cable ■ RS485 STP system ■ 2-core stranded and paired ■ Cable length: 3 m ■ PROBUS-DP communication connection cable

2.4 Model Selection and Planning

2.4.1 Power Capacity Calculation and Configuration

For the sake of security, it is suggested that the total power consumption of all the modules shall not exceed 70% of the selected power supply. Refer to Table 2-3 for the power consumption of the modules. The table only represents the LK system power capacity. The field power capacity of the LK Series (that is, power supply to switch, load, field devices including transmitter, etc.), shall be determined according to the specific load of each I/O channel. Refer to each I/O module section.

- To ensure electrical isolation between the field and the system, system power supply and field power supply should be configured separately; otherwise a short circuit on the field side will cause damage to the system hardware.
- Power supply module of the system must be certified by UL and meet class 2.

Table 2-3 Power Consumption of Hardware Modules

Module Type	Model	Rated Voltage	Current (max.)	Power consumption
Master control module	LK220	24 VDC	300 mA	7.2 W
AI	LK410	24VDC	100 mA	2.4 W
	LK411	24 VDC	60 mA	1.44 W
	LK412	24 VDC	150 mA	3.6 W
RTD	LK430	24 VDC	60 mA	1.44 W
TC	LK441	24 VDC	60 mA	1.44 W
AO	LK510	24VDC	125 mA	3 W
	LK511	24 VDC	180 mA	4.32 W
High-speed counting module	LK620	24VDC	80 mA	1.92W
DI	LK610	24 VDC	50 mA	1.2 W
DO	LK710	24 VDC	70 mA	1.68 W
Communication module	LK232	24 VDC	60 mA	1.44 W
	LK233	24 VDC	80 mA	1.92 W
	LK240	24 VDC	250 mA	6 W
	LK249	24 VDC	200 mA	4.8 W
	LK234	24 VDC	180 mA	4.32 W

2.4.2 Ethernet Connection

LK220 module provides dual-redundancy Ethernet interface with the communication rate of 10/100 Mbps self-adapting, using the standard RJ45 interface and unshielded twisted pair as the transmission medium. ETHERNET1 interface default as network segment 128, IP address default as

128.0.0.250. ETHERNET2 interface default as network segment 129, IP address default as 129.0.0.250. For the sake of network reliability, network segments 128 and 129 shall use different switch.

The Ethernet interface (Ethernet) can connect the master control module to the industrial Ethernet, communicating with an external device based on standard TCP/IP protocol or other protocols, thus providing an open distributed automated network platform for the user.

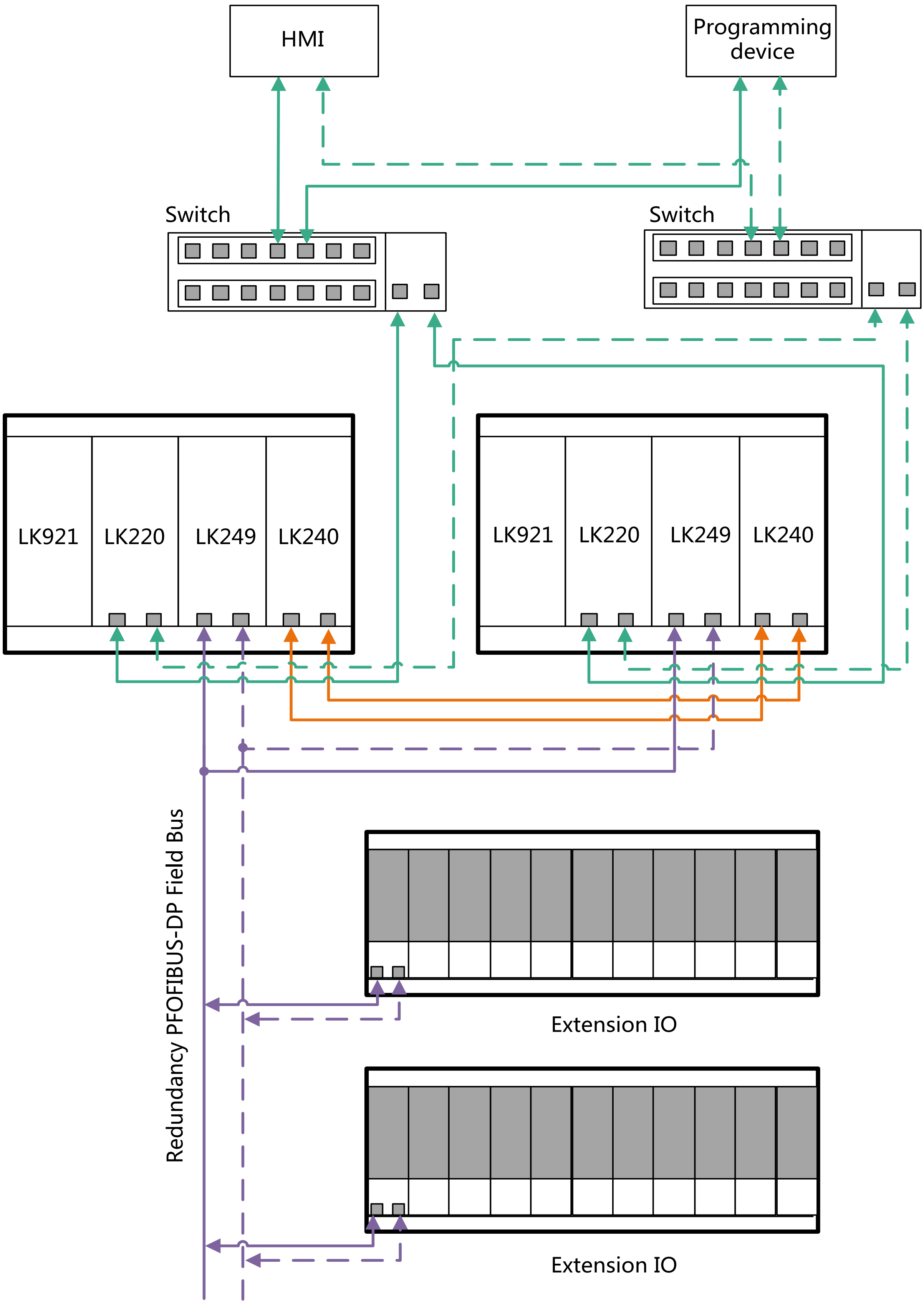


Figure 2-4 Network Connection of LK Master Controller

- The extended IO modules are connected by LK232 in the Figure 2-4, if the extended IO modules are connected by LK234, wiring way please see Chapter 6.3.3.6 Wirings.

Connecting the programming device via the Ethernet, the user can configure, download and upgrade the firmware. It can conduct remote real-time monitoring and operation of the CPU module by connecting to the HMI device.

- Internal test environment of LK series large-scale PLC system is in the case of using the switch.

2.4.3 PROFIBUS-DP Network Connection and Calculation

As shown in Figure 2-4, it can cascade multiple extension backboards to increase I/O via the redundant PROFIBUS-DP bus interface (DP1, DP2) on LK249 module. It shall adopt two LKA104 modules to connect DP interface between LK249 module and extension backboard, with the communication rate 500 kbps, 187.5 kbps, 1500 kbps optional and the transmission medium of RS485 shielded twisted pair.

For the I/O passing through PROFIBUS-DP extension backboard, it shall carefully calculate its node capacity before planning the LK series large-scale PLC system, estimating whether all the I/O bus scanning period can meet the specific project requirements.

Capacity of node: IO slave station up to 124 on PROFIBUS-DP segment, node address from 2 to 125. 1 is fixed to the address of the master controller, with 2~125 are for the I/O modules.

Calculation of bus scanning period: even when it is feasible to calculate the capacities of node, to meet the speed requirement of a specific engineering project, it finally shall still calculate the bus scanning period.

2.4.4 PROFIBUS-DP Bus Scanning Period

When configuring the DP slave scale, the entire DP polling cycle should not exceed 150ms. Refer to Table 2-4 for roughly estimating DP polling cycle in current DP scale (Note: Table 2-4 as a reference value of polling cycle for single slave station).

DP polling cycle is the total time to poll all slave stations.

Table 2-4 Polling Cycle for Single Slave Station

Baud rate	LK239 module requires time (ms, the maximum number of configured module)	Non-LK239 module requires time (ms)
187.5kbps	34	2.2
500kbps and above which	14	1

2.5 System Specification

Table 2-5 General Technical Specifications for LK Series large-scale PLC System

General Technical specifications for LK Series large-scale PLC System			
System Power	24 VDC	Supply voltage	24VDC (-15%, +20%)

General Technical specifications for LK Series large-scale PLC System			
		Ripple	<5%
		Polarity-reverse protection	Supported
Electromagnetic Compatibility	Anti noise	Electrostatic discharge	IEC61000-4-2 contact discharge 6 kV, air discharge 8 kV
		Radiated immunity of radio frequency field	IEC61000-4-3 20 V/m (80 ~1000 MHz)
		Electrical fast transient	IEC61000-4-4 2 kV
		Surge immunity	IEC61000-4-5 2 kV
		Conducted immunity of radio frequency field	IEC61000-4-6 10 V
		Power frequency magnetic field immunity	IEC61000-4-8 magnetic field strength of stable and continuous magnetic field test 30 A/m
	Electromagnetic radiation	Radiated interference	IEC61131-2 30~230 MHz, the quasi-peak value less than 40 dB (μV/m) 230~1000 MHz, the quasi-peak value less than 47 dB (μV/m) 1~3 GHz, the quasi-peak value less than 70dB(μV/m), with the average value less 56 dB(μV) 3~6 GHz, the quasi-peak value less than 80dB（μV/m）, with the average value less 60 dB（μV）
		Conducted interference	IEC61131-2 0.15~0.5 MHz, with the quasi-peak value less than 79 dB (μV), with the average value less than 66 dB (μV) 0.5~30 MHz, with the quasi-peak value less than 73 dB (μV), with the average value less than 60 dB(μV)
Environmental adaptability	Climatic environment	Operating temperature	0℃~+60℃ （Operating temperature is 0℃~+50℃ when use LKA102）
		Operating humidity	5%~95%, with no condensation
		Operating altitude	0~2000 m
		Storage temperature	-40℃~+70℃(Storage temperature of LKA102 is 0℃~+35℃)
		Storage humidity	5%~95%, with no condensation
	Mechanical environment	Vibration	IEC61131-2-4: 5≤f≤8.4, then position is 1.75 mm. 8.4≤f≤150, then gravity acceleration is 0.5
		Impact	IEC61131-2-4: 15 G, duration: 11 ms
	Enclosure protection	Enclosure protection rating	IEC60529 IP20 (preventing the entry of foreign matters with a size over 12 mm, non-watertight)

2.6 Product Storage and Transport

2.6.1 Storage

To hold the performance of the LK hardware during storage, the LK Series must be placed indoors. It is forbidden to place the devices in open air. See the following for the optimal storage environment:

1. Storage temperature: 0℃~+40℃.
2. Relative humidity: 40%~80%, without condensation.
3. It shall not allow storing various flammable, explosive, corrosive gases and articles indoors.
4. It shall be free of fierce mechanical vibration, impact and strong magnetic field indoors.
5. The packing box shall be elevated no less than 100 mm away from the ground, at least 500 mm away from the wall, heat source, cold source, window or air ventilation port.

2.6.2 Transport

It shall strictly follow the following when transporting the LK hardware products:

1. Protective measures shall be taken during transport. The packing box shall be kept away from rain, snow or drip washing of liquid substance and mechanical damage. During long-distance transport, the products shall not be loaded onto an open cabin and compartment. During transshipment, the products shall not be placed in an open warehouse.
2. The packing box shall meet the Level-II stipulations of GB9813 concerning vibration, collision and impact adaptability.
3. When handling the packing box, it shall strictly forbid strenuous vibration, collision and falloff.
4. Product weight: refer to Table 2-6.

Table 2-6 LK Hardware Module Weight List

Model	Module Name	Weight
LK117	11-slot extension backboard	1740 g
LK118	5-slot extension backboard	880 g
LK130	4-slot backboard module	933 g
LK220	Master control module (redundancy)	382 g
LK921	24V power switching module	371 g
LK910	24VDC power module	790 g
LK232	PROFIBUS-DP bus repeater module	170 g
LK233	PROFIBUS-DP bus optoelectronic transceiver	170 g
LK239	MODBUS master/slave communication extension module, RS232/RS485 interface	180 g
LK240	Redundancy Communication Module	365 g
LK249	DP Master Station Communication Module	365 g
LK234	Ethernet Interface Module	300 g
LK410	8-channel voltage type analog input module	190 g

Model	Module Name	Weight
LK411	8-channel current type analog input module	190 g
LK412	6-channel isolation analog input module	190 g
LK430	6-channel thermal resistance analog input module	180 g
LK441	8-channel thermocouple analog input module	180 g
LK510	4-channel inter-channel isolated voltage type analog output module	180 g
LK511	4-channel inter-channel isolated current type analog output module	180 g
LK620	2-channel counting module	185 g
LK610	16-channel leaking type digital input module	180 g
LK710	16-channel source type digital output module	200 g
LKA101	PROFIBUS-DP bus connector module	31 g
LKA102	LK220 battery power box module	22 g
LKA103	LK220 capacitance power box module	16 g
LKA104	PROFIBUS-DP bus connector module	30 g

Chapter 3 Installation and Wiring

3.1 Layout Planning and Installation

Based on power capacity planning, network planning and node capacity planning mentioned in the previous chapter, by giving full consideration to all factors, it can consider the layout and installation of the modules on the backboard after having determined the quantities and configurations of master control modules, I/O modules and backboards.

3.1.1 Space Layout

When placing a LK backboard, it shall consider keeping enough room for ventilation, which can also facilitate the engineering personnel in terms of successful wiring, routing and installation, etc.

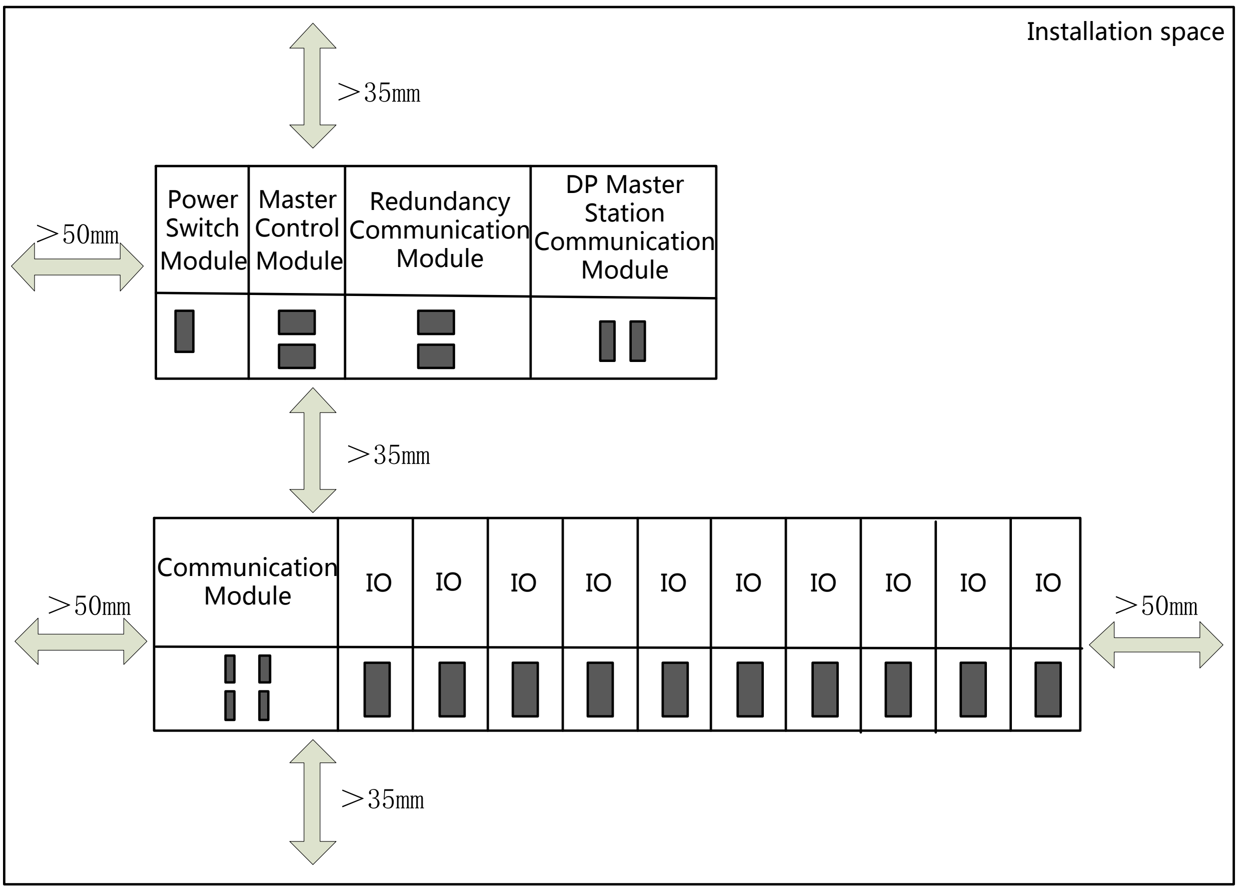
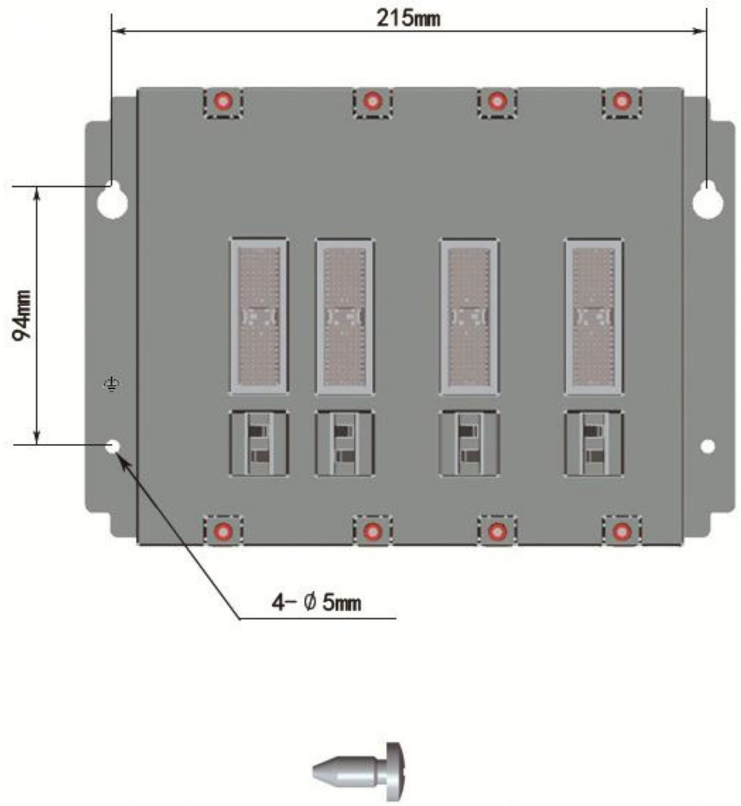


Figure 3-1　Spatial Layout Requirements Relating to LK Backboard Installation

3.1.2 Backboard Installation

3.1.2.1 Installation of Master Control Backboard

The LK130 backboard is surface mounted. A pair of mounting holes is provided at both ends, fastened to the mounting surface with M5 screws. The mounting surface shall be smooth, clean and even. Refer to Figure 3-2 for the hole size (Unit: mm).



GB/T6560 M5 x 10 cross recessed pan head thread forming screws

Figure 3-2 Hole Size on Master Control Backboard

The LK130 backboard is fixed by screws. Firstly drill 4 mounting holes on the mounting surface according to the hole size, with an aperture of 5 ± 0.5 mm. The specific installation steps as following:

Step 1. Select a M5 cross recessed head screw and screw it into the mounting hole for about 2/3 of the threads, keeping a clearance between the screw and the mounting surface.

Step 2. Put the master control backboard mounting hole in alignment with the screw, slightly push down to fix the screw into the mounting hole tightly, then fasten the screw.

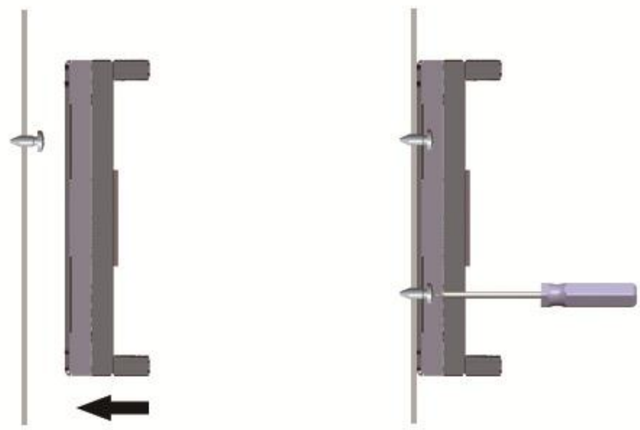


Figure 3-3　Installation Diagram of Master Control Backboard

Since the service life of all the electrical equipment continuously working with a higher ambient temperature is shortened, the ventilation of the electrical equipment must be considered carefully.

The LK series large-scale PLC system adopts radiation through natural convection. Therefore, some requirements are put forward for the installation mode and the placement space of backboards, thus ensuring that the PLC equipment is sound in ventilation and radiation.

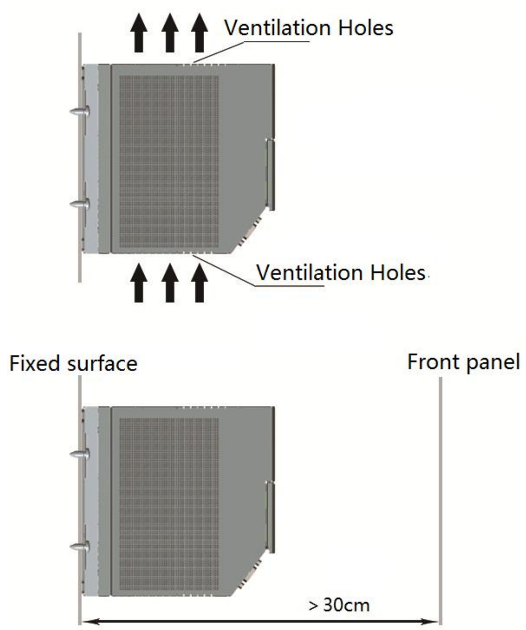


Figure 3-4　Correct Installation of The backboard

3.1.2.2　Installation of Extension Backboard

The LK extension backboard is surface mounted. A pair of mounting holes is provided at both ends, fastened to the mounting surface with M4 screws. The mounting surface shall be smooth, clean and even. Refer to Figure 3-5 for the hole size (Unit: mm).

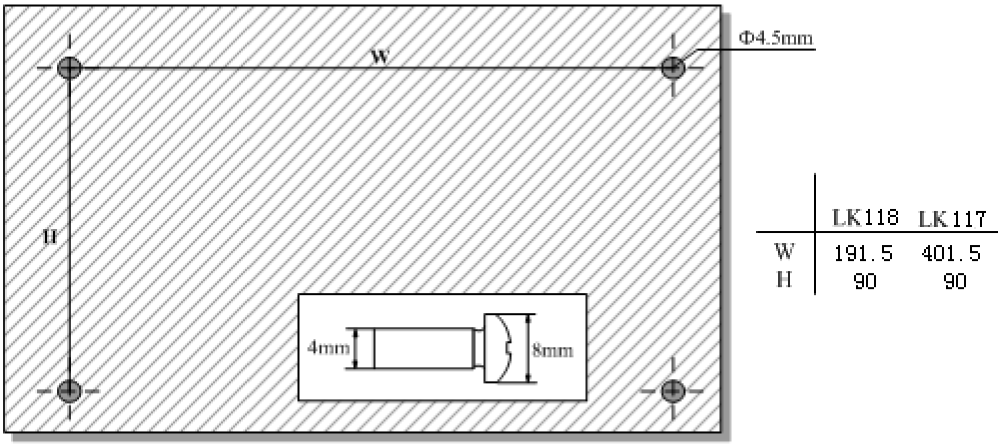


Figure 3-5 Hole Size on Extension Backboard

The extension backboard is fixed by screws. Firstly drill 4 mounting holes on the mounting surface according to the opening size, with an aperture of 4.5±0.5 mm. The specific installation steps as following:

Step 1. Select a M4 cross recessed head screw and screw it into the mounting hole for about 2/3 of the threads, keeping a clearance between the screw and the mounting surface.

Step 2. Put the extension backboard mounting hole in alignment with the screw, slightly push down to fix the screw into the mounting hole tightly, then fasten the screw.

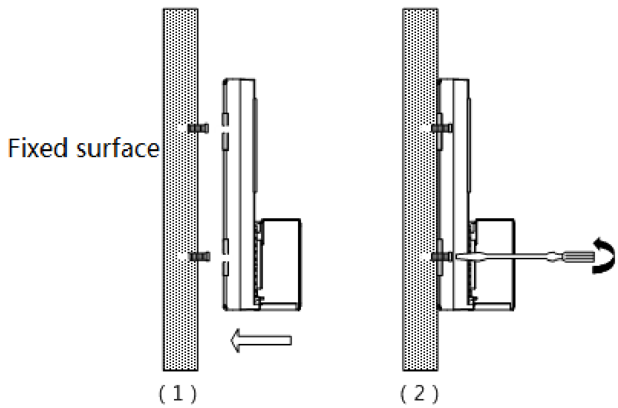


Figure 3-6 Installation Diagram of Extension Backboard

3.1.3 Protection Key

The I/O wiring is in the extension backboard, not in the module, so it must provide a coded protection key to prevent the module from being damaged when being plugged into an improper slot.

The protection key of the LK Series is located on the module and extension backboard. The code of a protection key for the LK Series includes two digits. One digit is letter from A to F, and other digit is number from 0 to 5, The combination of these two digits can provide 36 code positions (A0~F5).

Only IO module and communication module can set protection key code, specific modules and protection key code refer to Table 2-1.

The protection key on the module is of a female mold. Each type of electrically compatible module is allocated with a unique code, which is fixed and unable to modify upon delivery. The protection key on the extension backboard is of a male mold, able to rotate to fit into the plugged module.

Taking LK411 for example, the protection key code of the module is A1. When installing the module, rotate the protection key for the corresponding slot on the backboard to A1, which corresponds to the protection key position of the module, then plug in the LK411 module, as shown in Figure 3-7.

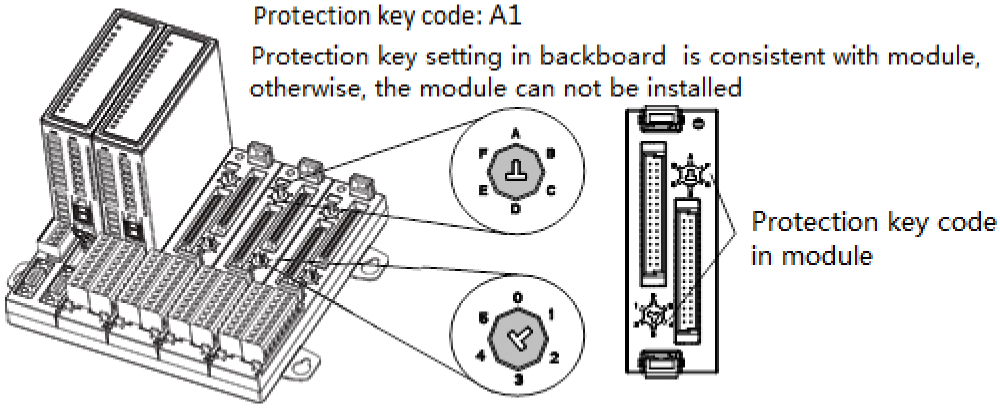


Figure 3-7 Set Protection Keys for LK Module

3.1.4 Module Installation and Disassembly

3.1.4.1 Installation and Disassembly of System Module

Installation steps as shown in Figure 3-8 about LK921 24V power switching module, LK220 master control module, LK249 DP master station communication module, LK240 redundancy communication module in LK130 backboard.

Step 1. After importing hole on the module and importing column on upper and lower ends of the slot are aligned, insert the module level, until completely into the bottom in slot.

Step 2. Using screwdriver to tighten screws at the upper & lower ends.

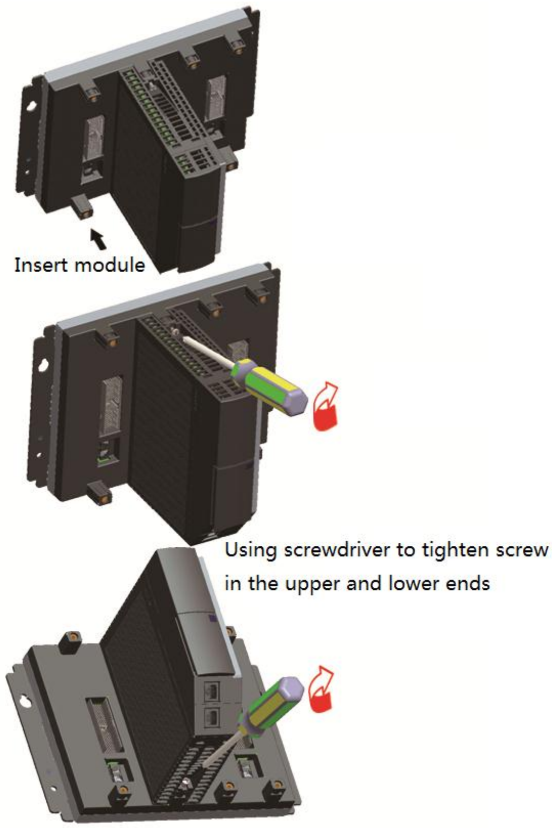


Figure 3-8　Install Module

- Points for attention
  - ☐ First, optical fiber is inserted to module, and then install the module into the backboard when LK240 module is installed.
  - ☐ Ensure that the position in backboard of A, B frame is consistent when you install the LK240 and LK249 module.

Disassembly, loosen the screw in top and bottom ends of the module, and then pull out the module level, as shown in Figure 3-9.

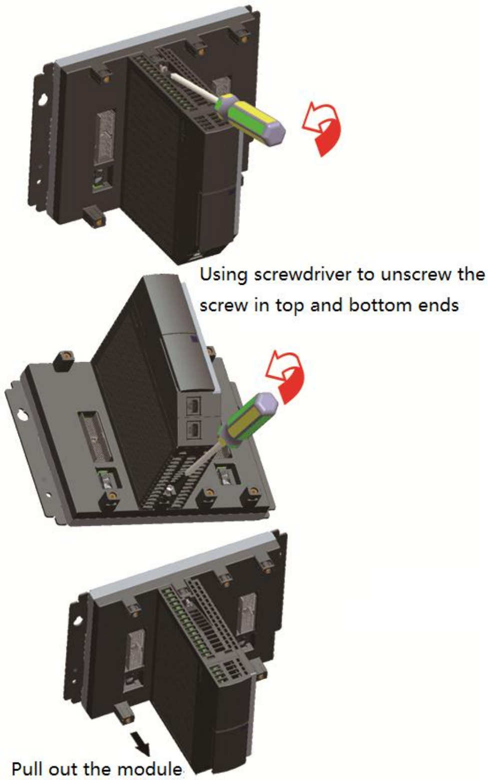


Figure 3-9 Dismantle Module

3.1.4.2 Installation and Disassembly of IO Module

IO modules are installed on extension backboard. After setting the protection key on the backboard properly, install the module by plugging in it according to Figure 3-10. After the module is installed and debugged, it can fix each module on the backboard with M3×20 screws prior to commercial operation. Each module requires one screw that is positioned on the top of the module. Note: to protect module from being damaged, movement shall not be too much when tightening the screw (3~4kgf-cm).

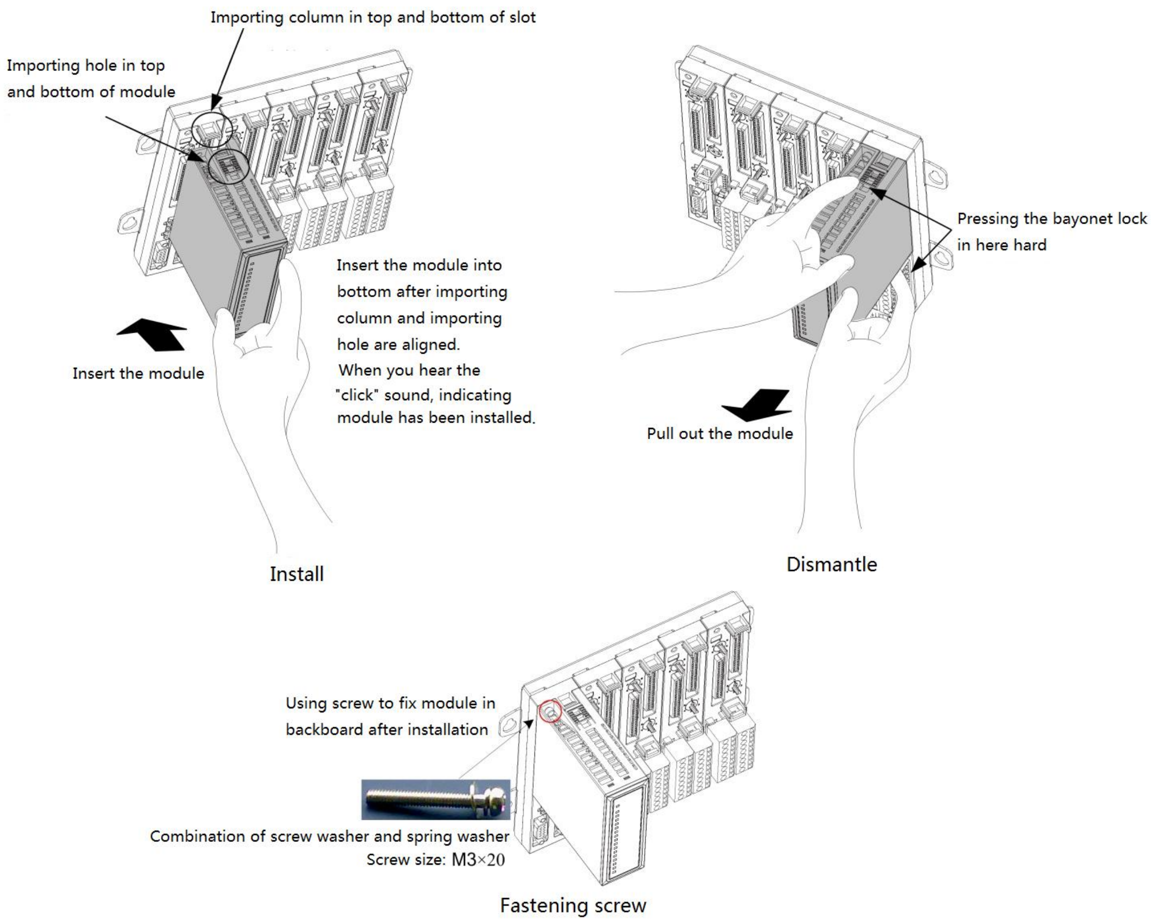


Figure 3-10 Installation and Disassembly of IO Modules

3.1.5 Installation of LK910

The LK910 adopt standard DIN rail mounting:

Step 1. Tilt the module, and make the module fastened the edge of the DIN rail.

Step 2. Push the module to make the slot in the lower edge fastened the edge of DIN rail, when you hear the "click" sound, indicating the module has been installed.

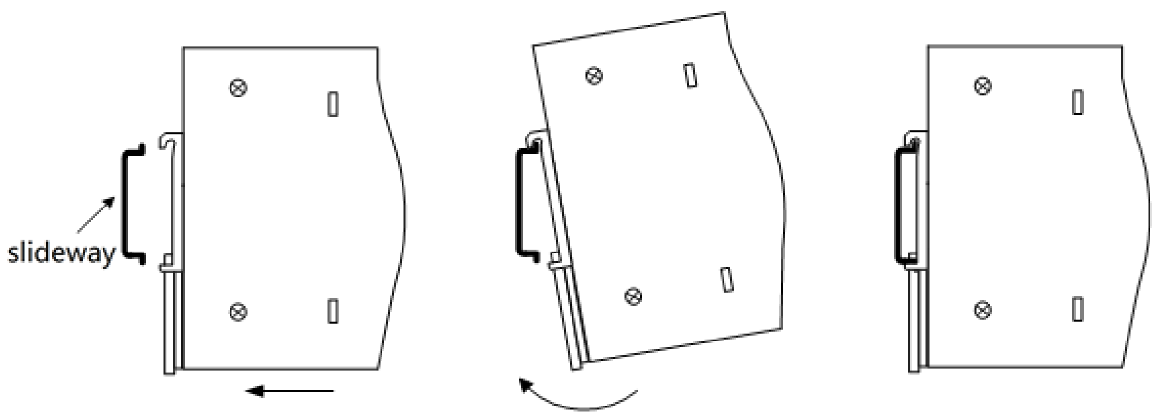


Figure 3-11 LK910 Installation

3.1.6 Installation of LKA104

LKA104 connector is used to connect DP signal between LK backplane.

You can insert the LKA104 connector into installation position. The installation steps are as follows:

Step 1. Insert the DB9 male connector into female socket in the backplane or in LK249 module.

Step 2. Tighten the fastening screws of the DB9 with a flat-head screwdriver.

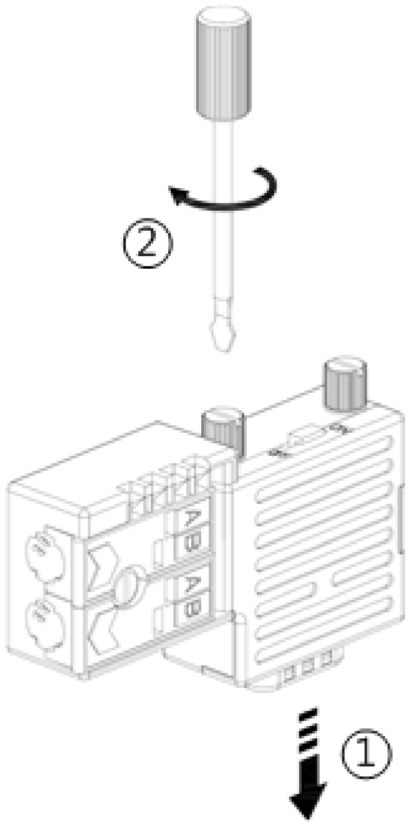


Figure 3-12 LKA104 Installation Schematic Diagram

3.1.7 Installation of Power Supply Box

Battery slot on the front panel of LK220 module that can be used to install LKA102 battery power supply box or LKA103 capacitor power supply box. The installation steps are as follows:

Step 1. The module is inserted into battery slot horizontally, with holding the top and bottom edges from the front of the module.

Step 2. Push the battery into the battery compartment bottom at an end, and complete installation after fastener is buckled.

Figure 3-13 Installation Schematic Diagram of Power Supply Box

3.2 System Wiring

3.2.1 Power Wiring

The LK921 power switching module has 2 sets input terminals. Three positions are provided in each terminal for 24V+, 24V- and system ground wire. System power wiring as shown in Figure 3-14.

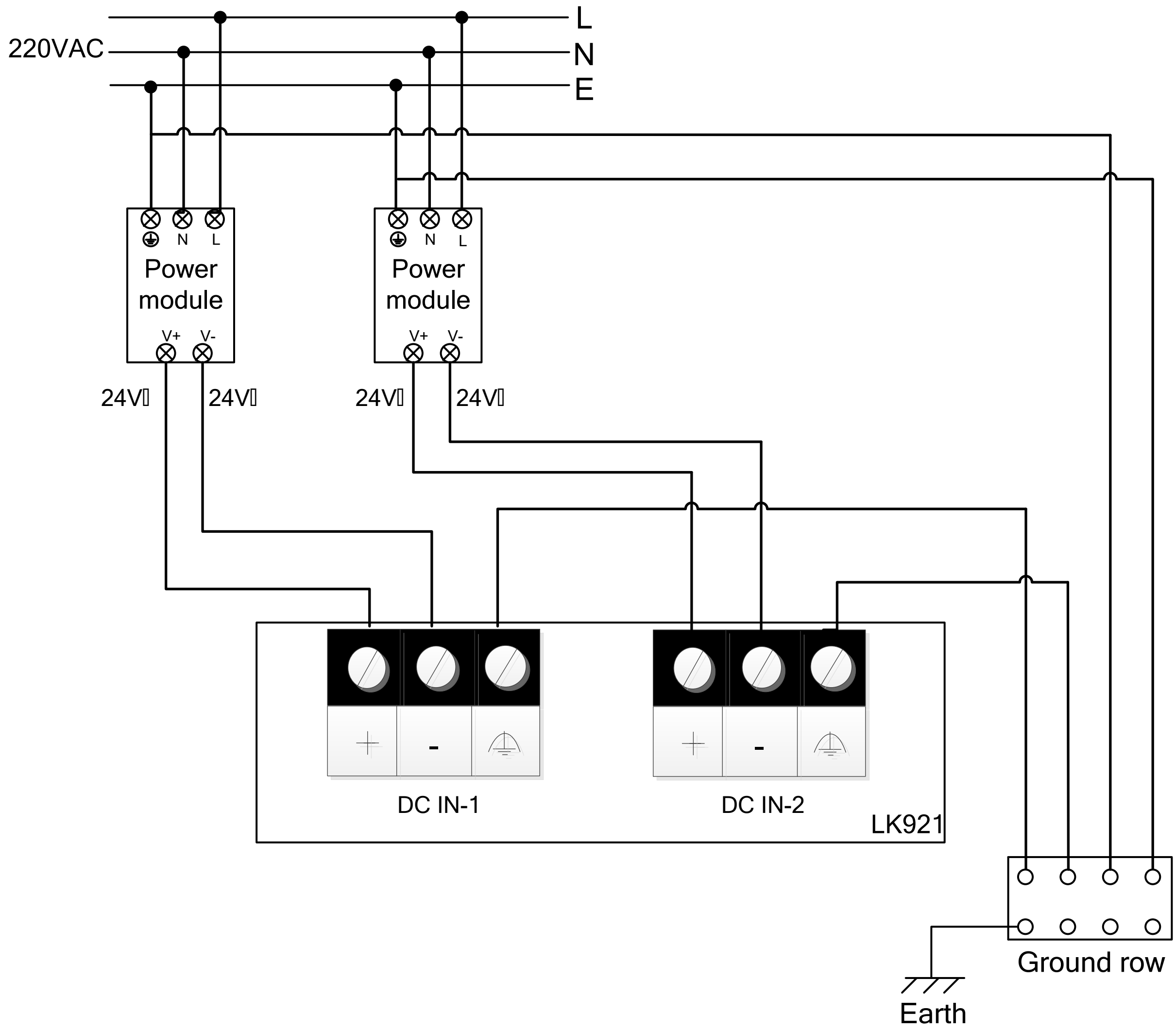


Figure 3-14 System Power Wiring

Note: Symbol ⏚ is functional ground of the system, to discharge electromagnetic interference.

3.2.2 Redundancy Communication Wiring

The LC plug of LKA105 optical fiber is inserted into FIBER X1 ports in the LK240 modules which located in master/slave frame, respectively. Another group optical fiber is inserted into FIBER X2 ports.

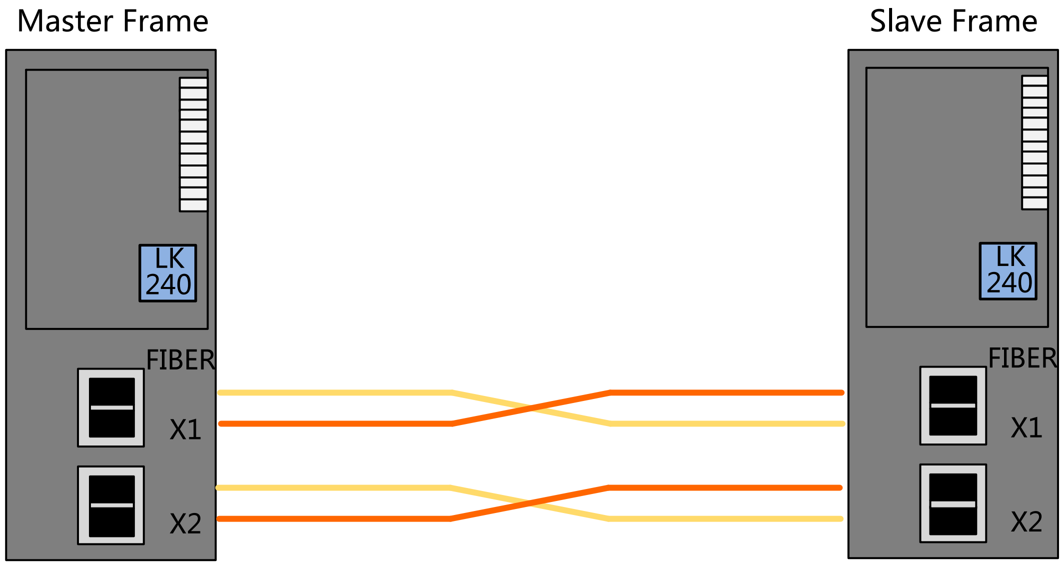


Figure 3-15 Redundancy Communication Module Wiring

3.2.3 PROFIBUS-DP Wiring

3.2.3.1 Cable Requirements

With a view to the network transmission technology of LK hardware, it shall adopt RS485 twisted-pair cable or optical fiber. Taking engineering applications (construction difficulty, maintainability and economy efficiency, etc.) and the actual circumstances in the product application fields into consideration, STP (Type A) is always used as transmission medium.

Such two conductors as Types A (STP) and B (UTP) can be selected as the transmission medium of RS485 twisted-pair cable. A refers to shielded twisted pair and B refers to unshielded twisted pair, as shown in Table 3-1. The characteristic impedance of bus cable ranges from 100 Ω to 165 Ω. The cable capacitance is less than 60 pF/m. The cross section area of conductor is more than or equal to 0.22 mm^2.

Table 3-1 Technical specifications for Cables

Cable Parameter	Type A	Type B
Impedance	135~165 Ω	100~130 Ω
Capacitance	＜30 pF/m	＜60 pF/m
Resistance	＜110 Ω/km	Not provided
Cross Section Area of Conductor	≥0.34 mm^2 (22AWG)	≥0.22 mm^2(24 AWG)

The following rules shall be followed when laying the cables:

- Do not twist the cables.
- Do not stretch the cables.
- Do not extrude the cables.
- Follow the basic restrictions (d= outer diameter of cable) listed in Table 3-2 when installing the house cable.

Table 3-2 Basic Restrictions for Cable Installation

Characteristics	Restrictions
Bending radius of a individual bending	≥80 mm (10×d)
Bending radius of repeated bending	≥160 mm (20×d)
Allowed installation temperature range	0℃~+50℃
Allowed operating temperature range	0℃~+60℃

3.2.3.2 Total Cable Length

The total cable length (Max. transmission distance) relies on transmission speed. The transmission distance of a signal is different for various media and baud rates. Refer to Table 3-3. For long-distance communication, it can extend the signal transmission distance via the LK232 PROFIBUS-DP bus repeater. For a linear bus topology, there are up to 3 repeaters between any two nodes, which divide the bus into four segments.

Apart from extending the network length, the bus repeater can also realize electrical isolation between various network segments, for example, isolation is required when connecting equipment with a different ground potential.

- The total cable length refers to the distance from the first node to the last node of the bus network segment.

Table 3-3 Max. Cable Length Based on Different Transmission Rates for Twisted-pair Cables (with no repeaters)

Content Item	Units	Value					
Data rate	kbps	9.6	19.2	93.75	187.5	500	1500
Cable Type A	m	1200	1200	1200	1000	400	200
Cable Type B	m	1200	1200	1200	600	200	70

3.2.3.3 LKA104 PROFIBUS-DP Bus Connector

LKA104 PROFIBUS-DP bus connector transfers DP signal form the upper backboard to lower backboard, and provides termination resistor matched.

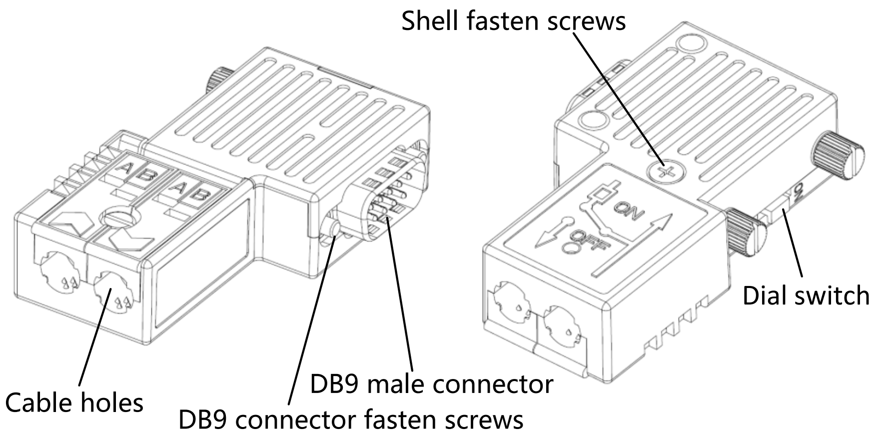


Figure 3-16 Appearance Schematic Diagram of LKA104 Connector

1. Termination resistor settings

Ends of the cable must have termination resistors. For LK system, termination resistors in ends of the DP bus are provided by LKA104, and the user can set termination resistors by dial switch.

As shown in Figure 3-17, termination resistor switch of LKA104 which located in the LK249 module is set to ON position, with only outlet wire. Termination resistor switch of LKA104 which located in middle extension backboard is set to OFF position, with both inlet wire and outlet wire. Termination resistor switch of LKA104 which located in end extension backboard is set to ON position, with only inlet wire.

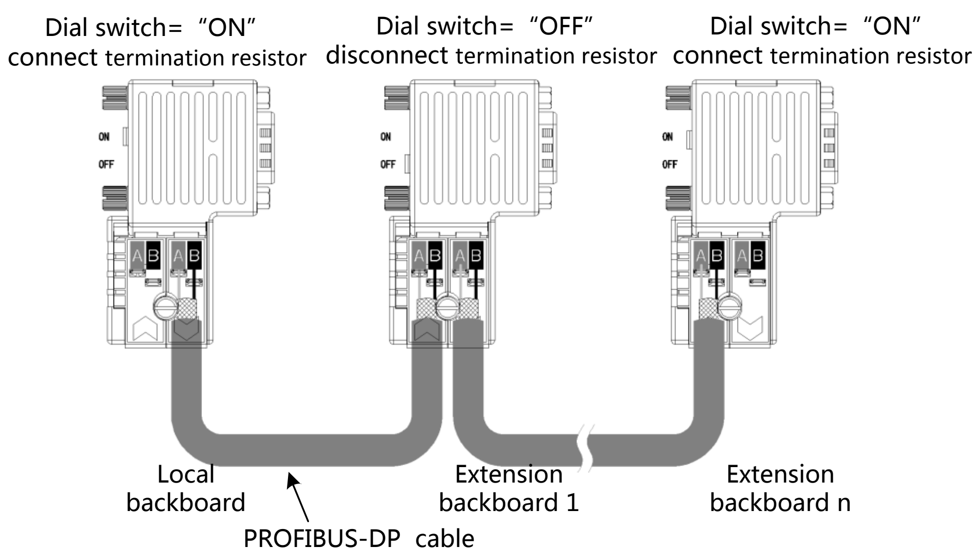


Figure 3-17 Termination Resistors Setting of Connector

2. LKA104 wiring

The cable processing requirements of the bus connector are shown in Figure 3-18. The outer diameter of cable is no more than 8 mm. Otherwise it cannot be put into the cable interface of the connector.

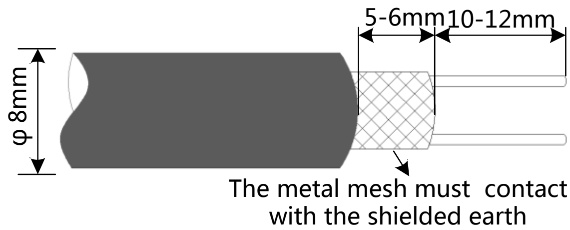


Figure 3-18 Requirements of DP Cables

Wiring of the bus cable:

(1) Unscrew the fastening screw of the wiring bracket and lift the wiring bracket up.

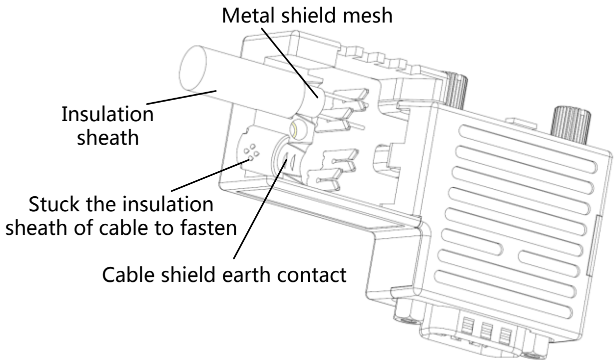
(2) Allow the appropriate length of shielding and core for wiring according to the standard of cable processing.

(3) Insert the red wire into the B hole of the wiring bracket and insert the green wire into the A hole.

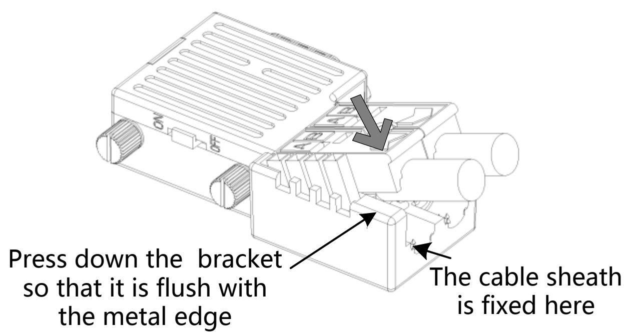
(4) The shield layer and the grounding contact are reliably connected, and the cable sheath is fastened.

(5) Press the wiring bracket downwards, so that the bracket is flush with the metal edge of the lower cover. Note: when pressing, press the wiring bracket on the inlet side first, then press the wiring bracket on the outlet side, otherwise it will damage the screw installation hole.

(6) Tighten the fasten screws.



(1)



(2)

Figure 3-19 LKA104 Wiring Schematic Diagram

DP network connect master control backboard and extension backboard via DP bus connector. Dial switch settings and wiring diagram as shown in Figure 3-20.

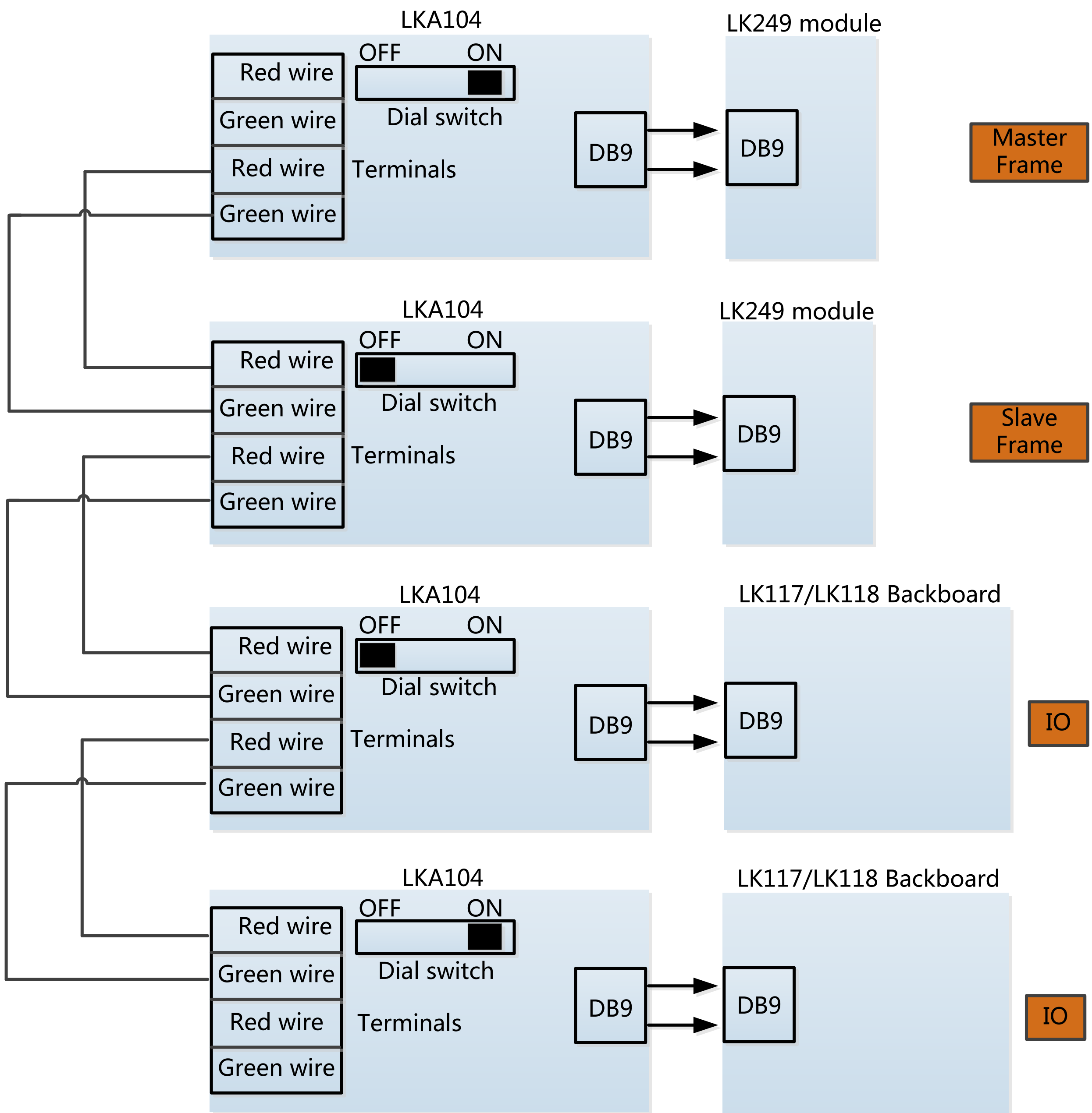


Figure 3-20 DP Network Connection

3.2.4 I/O Cable

The field I/O signals are generally divided into analog signals and digital signals.

- The analog signals include AI and AO signals. Such a type of signals is connected with STP.

- The digital signals include DI and DO signals. The low-level switching signal is connected with STP. The high-level (or heavy-current) digital input/output signal is connected with UTP, however, separated from the analog signal and the low-level switching signal in an individual cable tray.

When used for process control, the field I/O signal cable is laid in a special covered cable tray. The cable tray and the cover plate are well-grounded. It shall better apply a copper tape shield or aluminum foil shield to the cable shielding layer. The bonding principle is to ground on one side. It is recommended to ground the shielded cable on the CPU module side (system side) for LK series large-scale PLC system.

3.2.4.1 I/O Cable Processing

The aperture of backboard terminal is 5mm/0.197in. It adapts to a cable diameter of AWG28~AWG12/0.08~3.33 mm^2. The strip length is 8~9 mm/0.33in.

Firstly define the corresponding relationship between the field device signal and the terminal according to the wiring of I/O module. Then determine the cable type according to the signal type, determine the cable length according to the field device location. Finally prepare the signal cable according to the processing requirements, as shown in Figure 3-21.

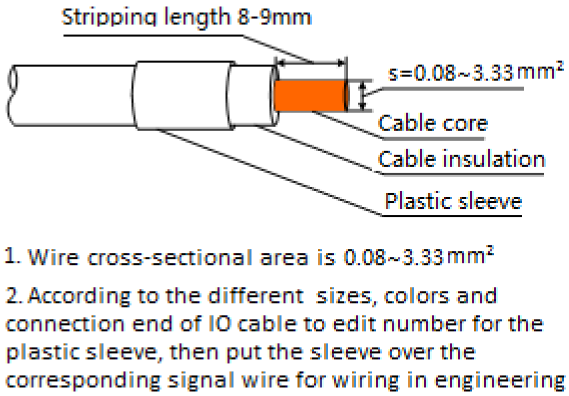


Figure 3-21 I/O Cable Processing Requirements

3.2.4.2 I/O Wiring

For LK117/LK118 backboard, the terminal is fixed on the backboard, located right beneath the module installation location, adopting new-type two-row 18-position pressure-clamped terminals. The pressure-clamped terminal (spring terminal) is more convenient for wiring as compared to a conventional screw terminal.

Wiring steps:

Step 1. Press a LK-dedicated screwdriver vertically into the square hole on the right of the terminal, opening the spring piece in the circular hole on the left of the terminal.

Step 2. Plug the processed signal line into the circular terminal. Plug out the screwdriver after being plugged in completely, with the spring piece clamped the cable.

Step 3. Check whether the cable is connected properly. Do not hold the naked line exposed in order to avoid a short-circuit hazard.

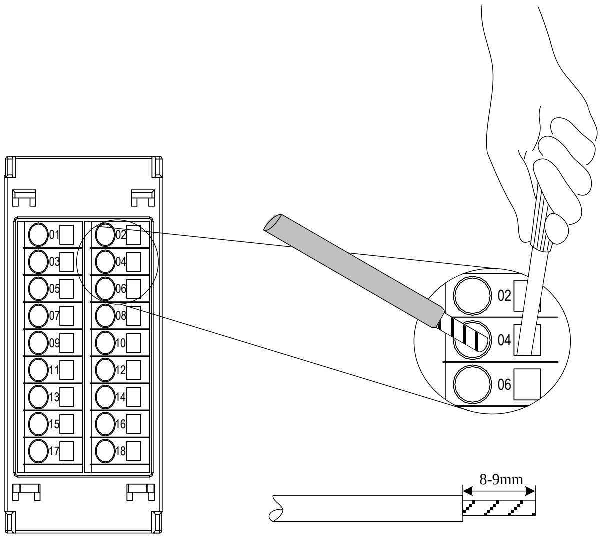


Figure 3-22 Wiring of I/O Terminals

3.3 Grounding

In common cases, the grounding system mainly includes protective grounding and shield grounding:

- Protective grounding: Protective grounding is a protection measure taken to prevent device enclosure from electrostatic charge accumulation and avoid personal injuries.
- Shield grounding: it means to screen out the interference during signal transmission in order to improve the signal quality. The shielded cable shall be grounded on the PLC system side for an analog signal. The backboard enclosure shall be grounded. The DP cable shielding layer shall be grounded.

The PLC must be grounded separately. Never to ground the PLC ground wire indirectly via other devices. The ground wire size shall be maximized, at least no less than 2.5 mm^2 (10 AWG). The ground resistance is generally less than 4Ω.

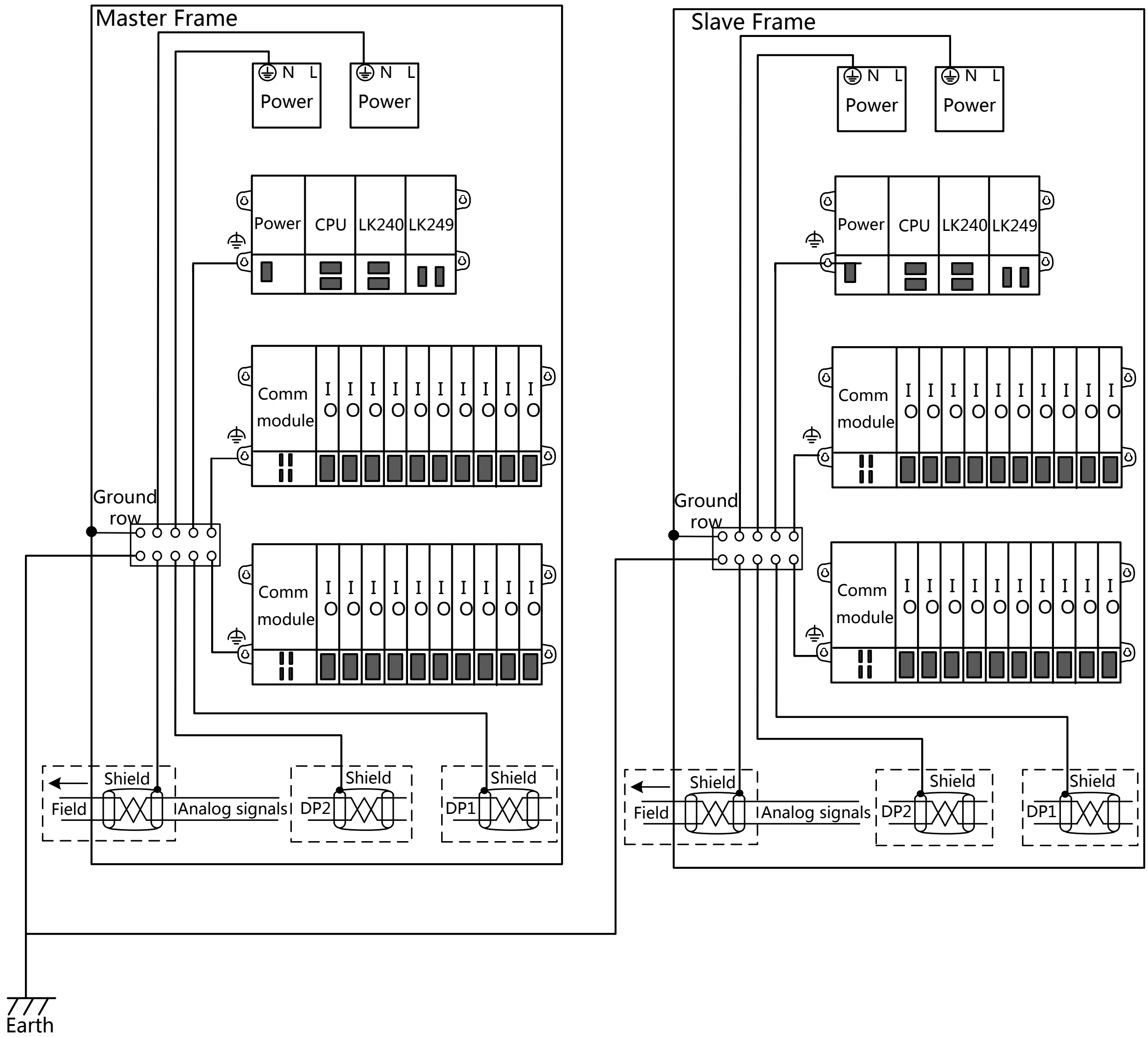


Figure 3-23　Grounding of LK Series Large-scale PLC System

Chapter 4 System Configuration

The LK220 module exchanges data with the controlled object or device via the input and output modules. The input module collects data from the controlled object and the output module controls the device for the controlled object. After installing and wiring the hardware, to realize the input, output and control of CPU module, it shall configure the LK series large-scale PLC system hardware accordingly via the programming software according to the hardware architecture of the actual project, including configuring the I/O module on the PROFIBUS-DP bus, parameter settings, MODBUS master/slave station and communication settings.

Start the AutoTink programming software and create a new project to configure the basic items of the project. These items include task configuration, creating program, hardware configuration, etc. Refer to the manual *AutoThink V3.1 User Manual_Project Configuration* for specific configuration. Only hardware-related configuration items are discussed here.

4.1 Hardware Configuration

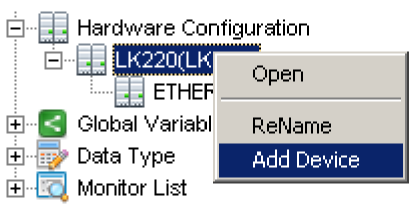
When a new LK project is created, A LK220 module is added by default with redundancy configuration. The entire hardware configuration will be completed in LK220 node.

4.1.1 Configure DP Slave Devices

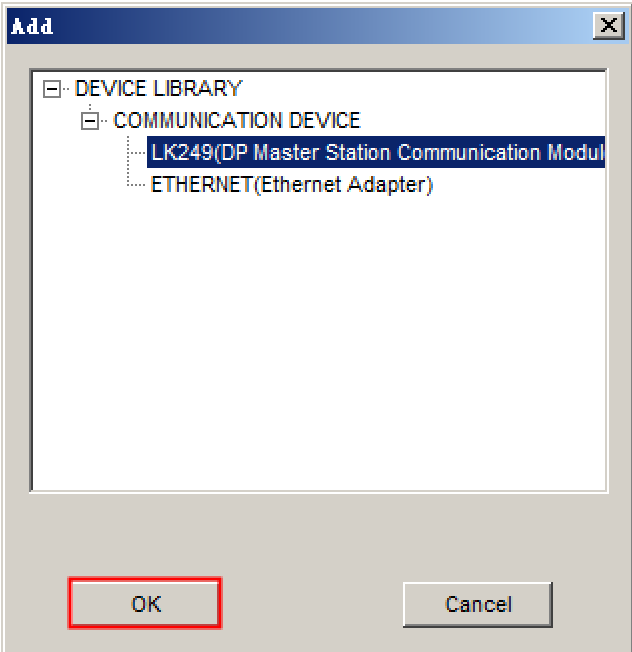
IO slave station configuration method is as shown in follows, when IO modules are connected by DP bus.

4.1.1.1 Add the DP Device

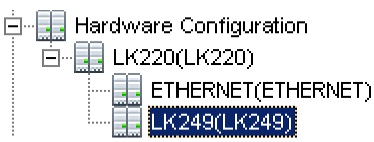
Ethernet Adapter is added under the controller by default. DP Master Station Communication Module is added through the [Add Device] command. As shown in Figure 4-1.



(a)



(b)



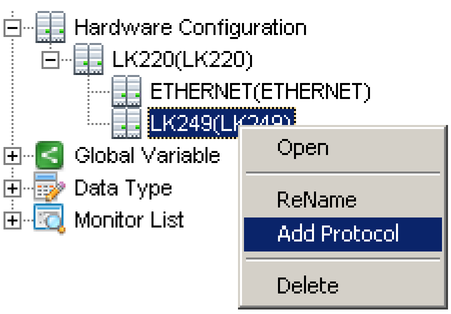
(c)

Figure 4-1 Add DP Communication Devices

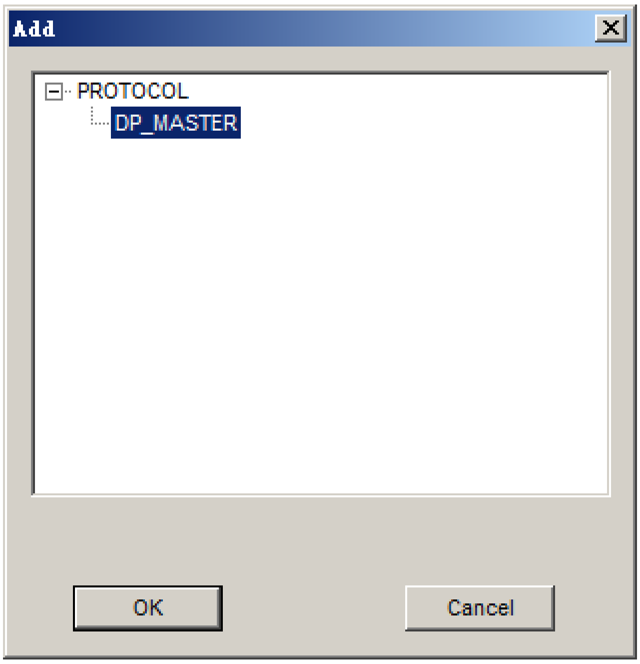
IO devices are configured through the LK249 module, and MODBUS communication is configured through the Ethernet Adapter.

4.1.1.2 Add the PROFIBUS-DP Protocol

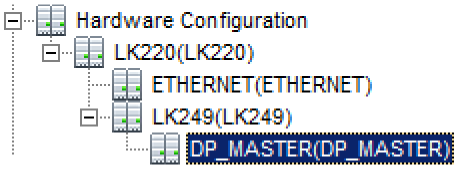
The LK220 module supports PROFIBUS—DP and MODBUS TCP, user can add protocol in corresponding communication device. As shown in Figure 4-2, select [Add Protocol] command in right click menu of LK249 module to add DP protocol.



(a)



(b)

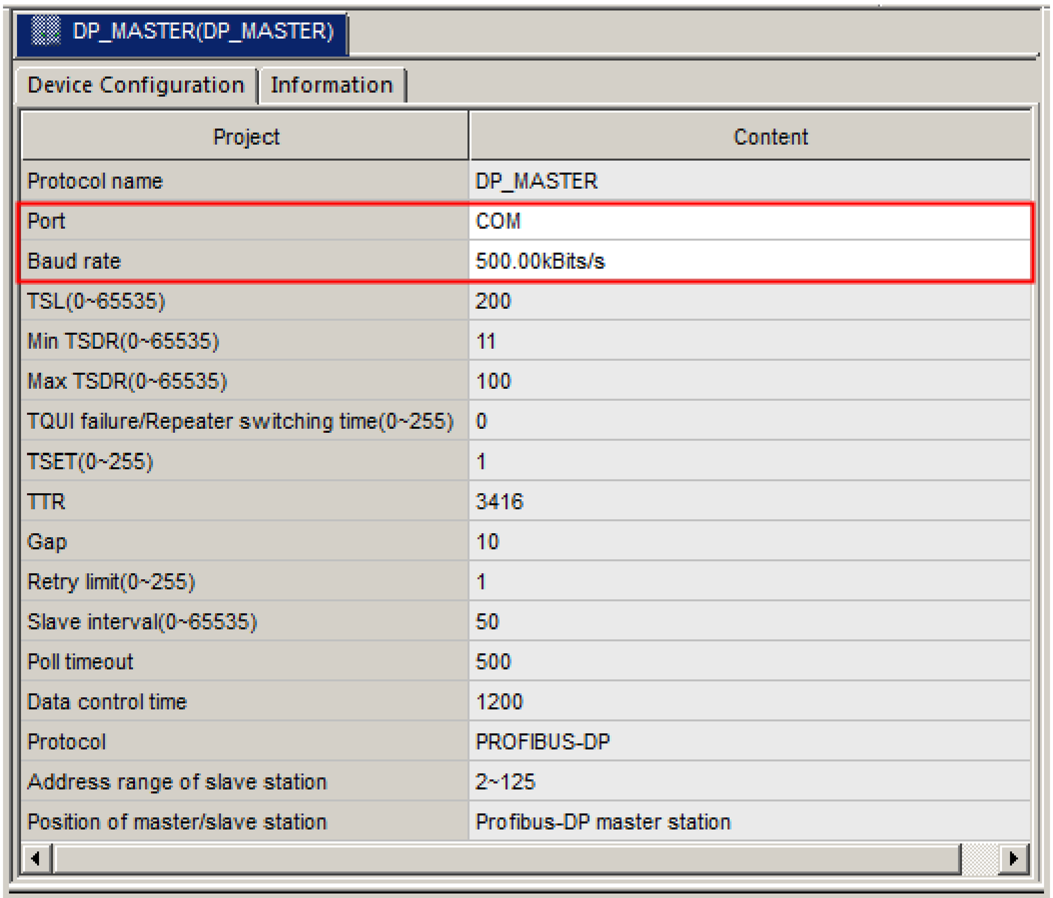


(c)

Figure 4-2　Add the PROFIBUS-DP Protocol

- Set the Port and Baud Rate

  Select [Open] command, or double-click the DP MASTER node to open the device information window in the right area, as shown in Figure 4-3.



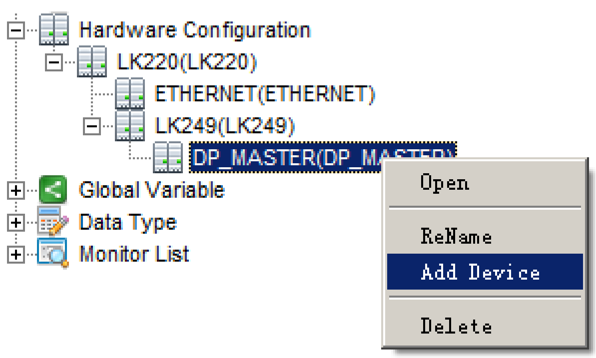
Project	Content
Protocol name	DP_MASTER
Port	COM
Baud rate	500.00kBits/s
TSL(0~65535)	200
Min TSDR(0~65535)	11
Max TSDR(0~65535)	100
TQUI failure/Repeater switching time(0~255)	0
TSET(0~255)	1
TTR	3416
Gap	10
Retry limit(0~255)	1
Slave interval(0~65535)	50
Poll timeout	500
Data control time	1200
Protocol	PROFIBUS-DP
Address range of slave station	2~125
Position of master/slave station	Profibus-DP master station

Figure 4-3　Set the Port and Baud Rate

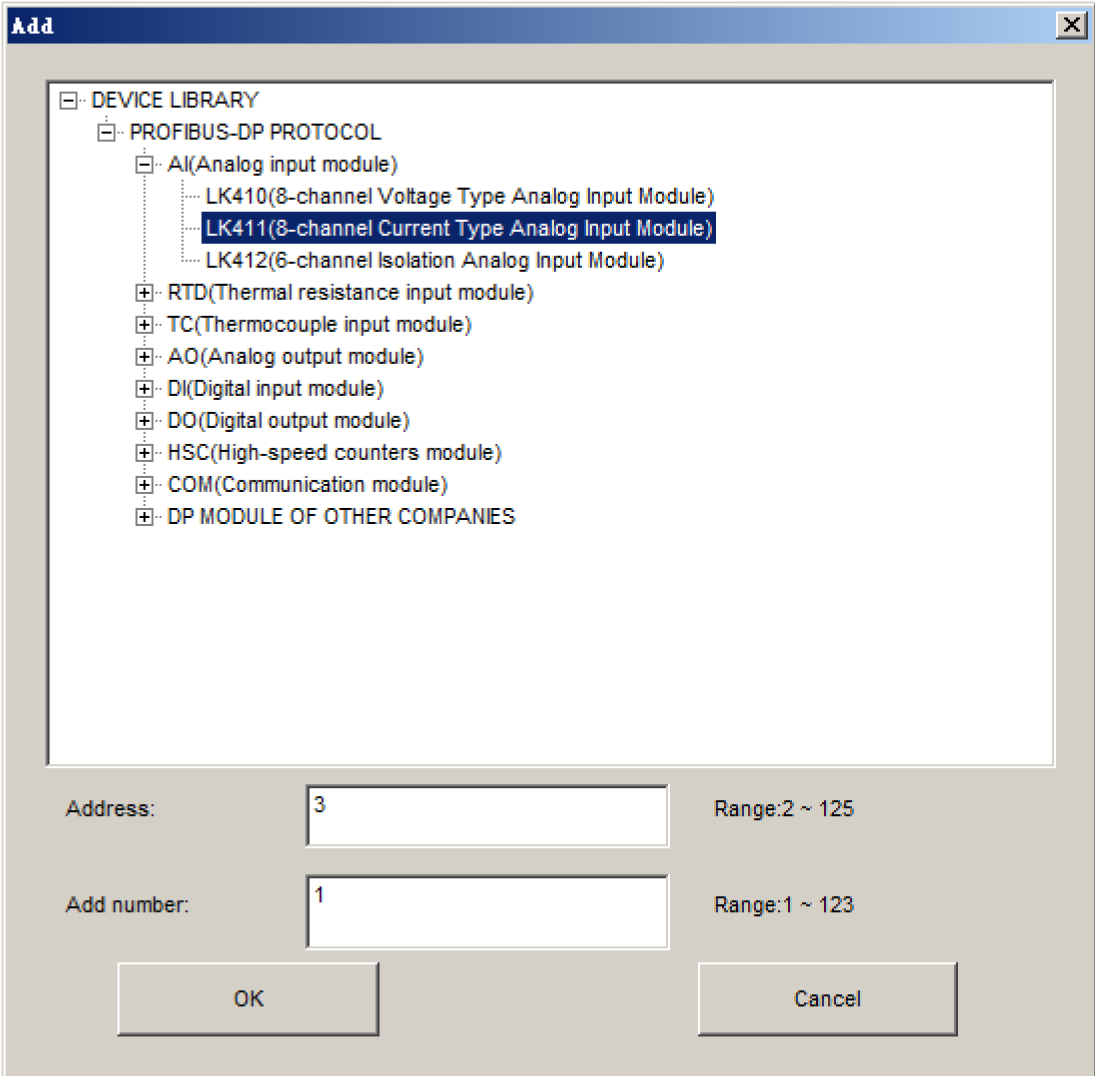
Port is set as **COM1**. Selecting different baud rate with other bus parameters switch to best value automatically when the baud rate is set.

4.1.1.3　Add DP Slave Module

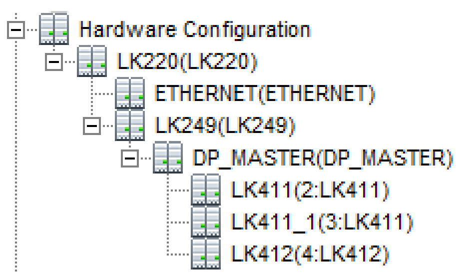
Select [Add Device] command to add the slave station, operate as shown in Figure 4-4.



(a)



(b)



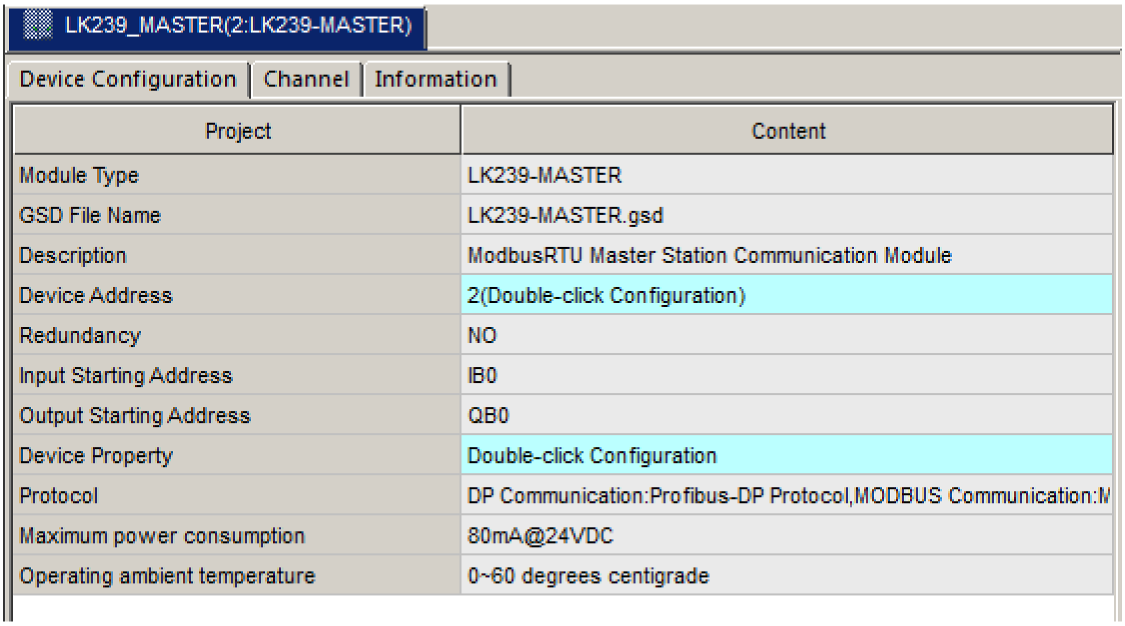
(c)

Figure 4-4 Add Slave Device

Select the slave module, enter the address and add number of slave station, click **OK**, then newly added module is generated in the DP_MASTER node.

4.1.1.4 IO Module Parameter

Select [Open] command, or double-click on the slave module to open the device information window of the module, as shown in Figure 4-5.



Project	Content
Module Type	LK239-MASTER
GSD File Name	LK239-MASTER.gsd
Description	ModbusRTU Master Station Communication Module
Device Address	2(Double-click Configuration)
Redundancy	NO
Input Starting Address	IB0
Output Starting Address	QB0
Device Property	Double-click Configuration
Protocol	DP Communication:Profibus-DP Protocol,MODBUS Communication:M
Maximum power consumption	80mA@24VDC
Operating ambient temperature	0~60 degrees centigrade

Figure 4-5 Module Device Information Window

Double-click blue area in **Device Address** to modify address, refer to *Hardware Configuration* in fifth chapter in the manual *AutoThink V3.1 User Manual_Project Configuration* for details.

Double-click the blue area in the **Device property** to set IO parameter. The **Device property** dialog is as shown in Figure 4-6.

The dialog contains [Input / output selection] tab and [User parameter] tab.

1. Input/output selection

Select the module in [Optional module] list box, click the button >>, and the selected module shall be added to the node of [Added module].Only communication modules and third-party devices can implement the operation that add and delete the sub-module in [Input / output selection] tab. The produced module can only view.

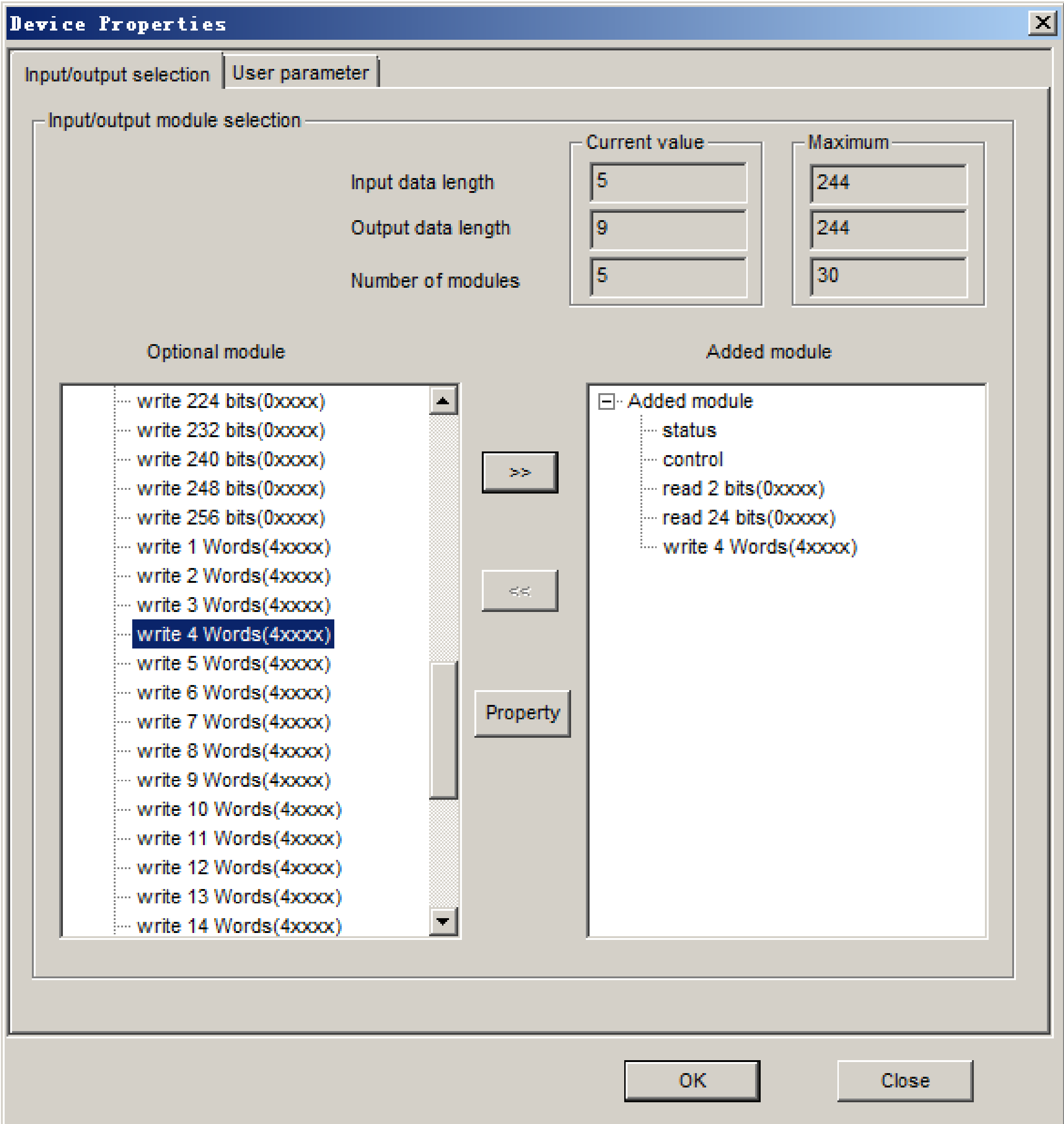


Figure 4-6　Add the Sub-module

2. Set Sub-module Parameter

Select the module in the node of [Added module], click the button of **Property**, pop up **Module Parameter** dialog, as shown in Figure 4-7. The parameter value can be modified.

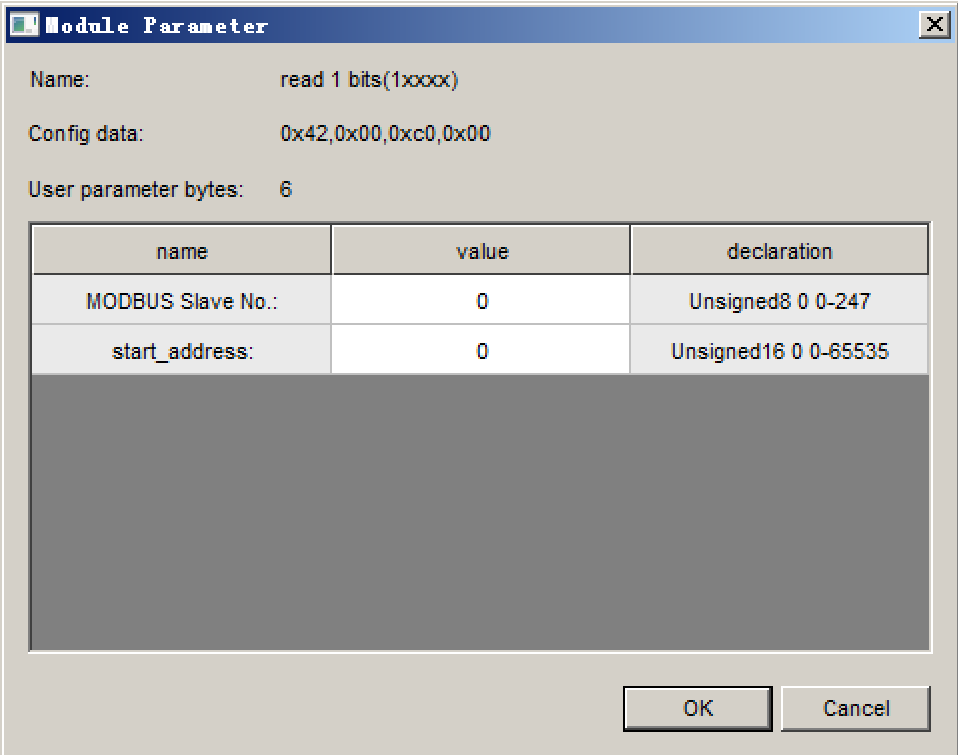


Figure 4-7 Sub-module Property Dialog

3. User Parameter

The user parameter be used to set working mode of module, with writing into CPU module when the user program is downloaded.

Each parameter has the default value and value range, and you can modify value according to the engineering requirements. The engineering need to be full downloaded after modifying the parameter value.

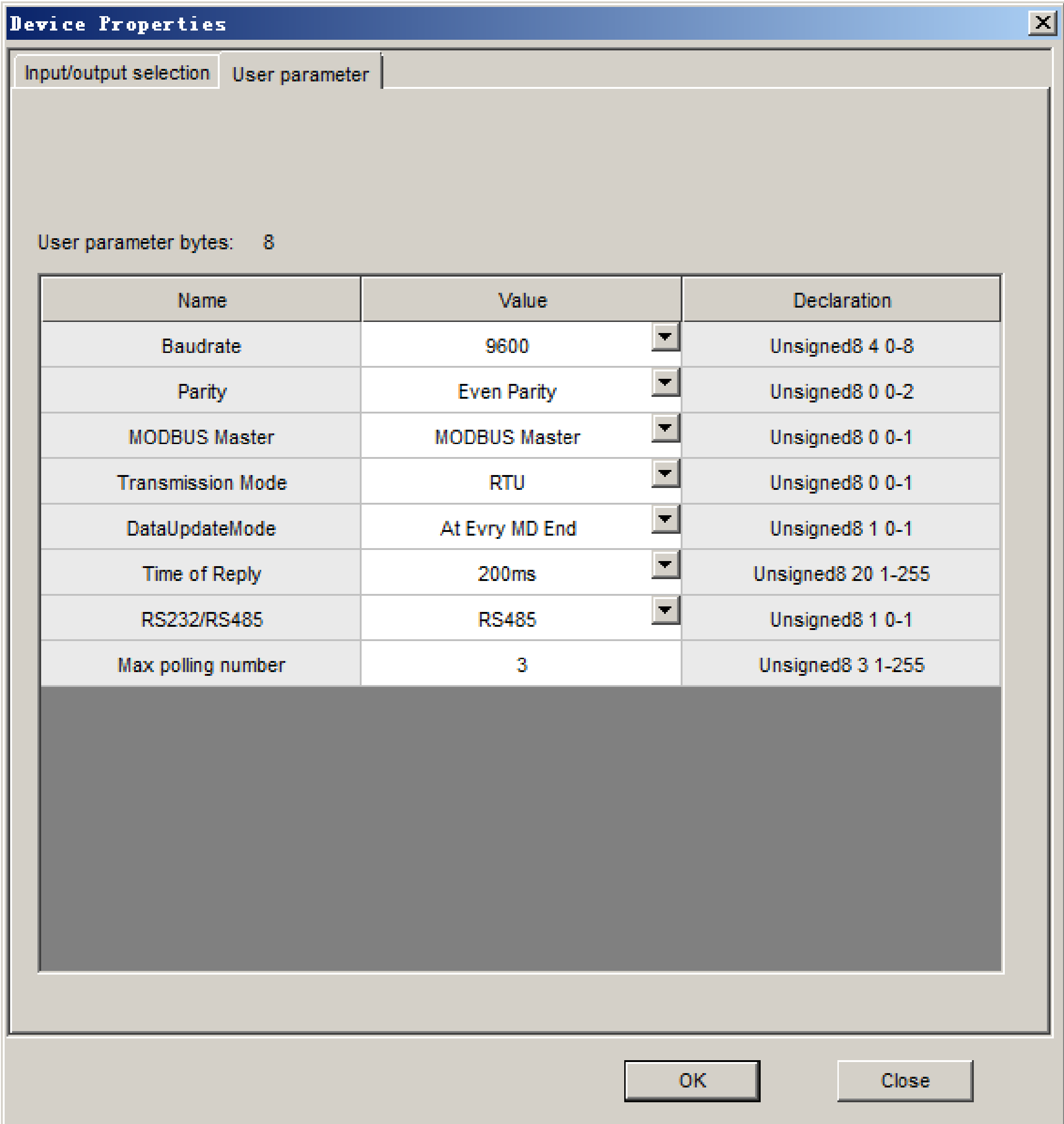


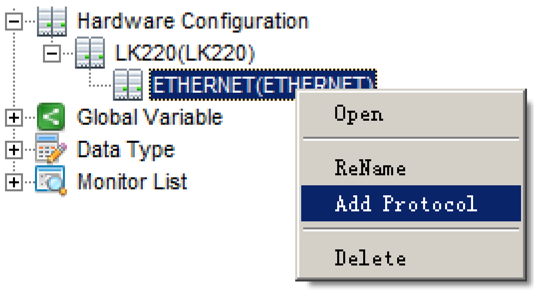
Figure 4-8 Set User Parameters

4.1.2 Configure HOLLITCP Slave Devices

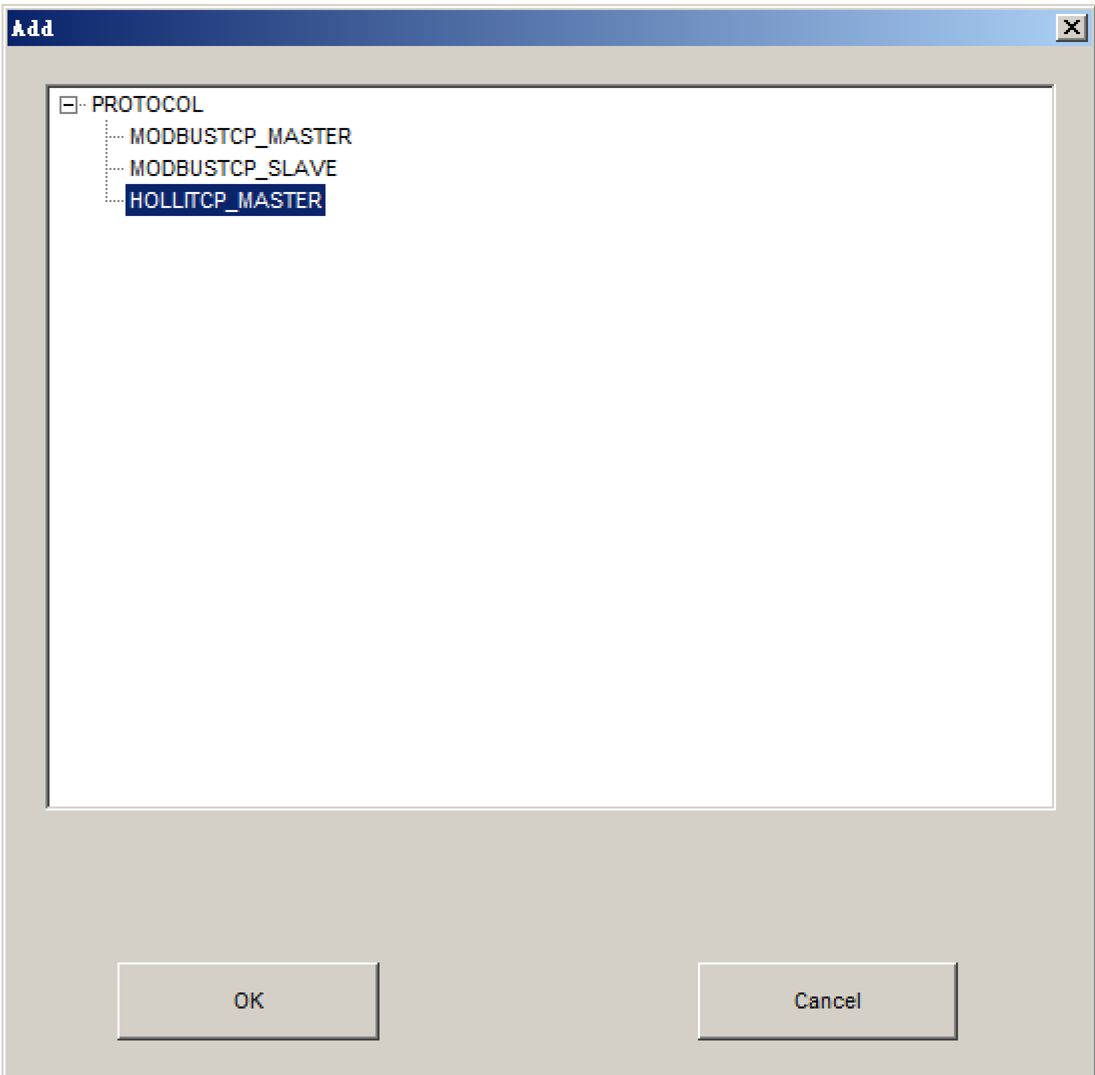
IO slave station configuration method is as shown in follows, when IO modules are connected by Ethernet.

4.1.2.1 Add the HOLLITCP MASTER Protocol

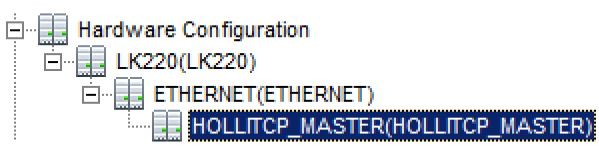
Select [Add Protocol] command in right click menu of the [ETHERNET] node, with an Add dialog box pop up, as shown in Figure 4-9.


Hardware Configuration
LK220(LK220)
ETHERNET(ETHERNET)
Global Variable
Data Type
Monitor List
Open
ReName
Add Protocol
Delete

(a)


Add
PROTOCOL
MODBUSTCP_MASTER
MODBUSTCP_SLAVE
HOLLITCP_MASTER
OK
Cancel

(b)


Hardware Configuration
LK220(LK220)
ETHERNET(ETHERNET)
HOLLITCP_MASTER(HOLLITCP_MASTER)

(c)

Figure 4-9　Add HOLLITCP MASTER Protocol

4.1.2.2　Configure Master Station of HOLLITCP MASTER Protocol

Double click the **HOLLITCP_MASTER** node, open the parameter configuration window of master station, as shown in Figure 4-10.

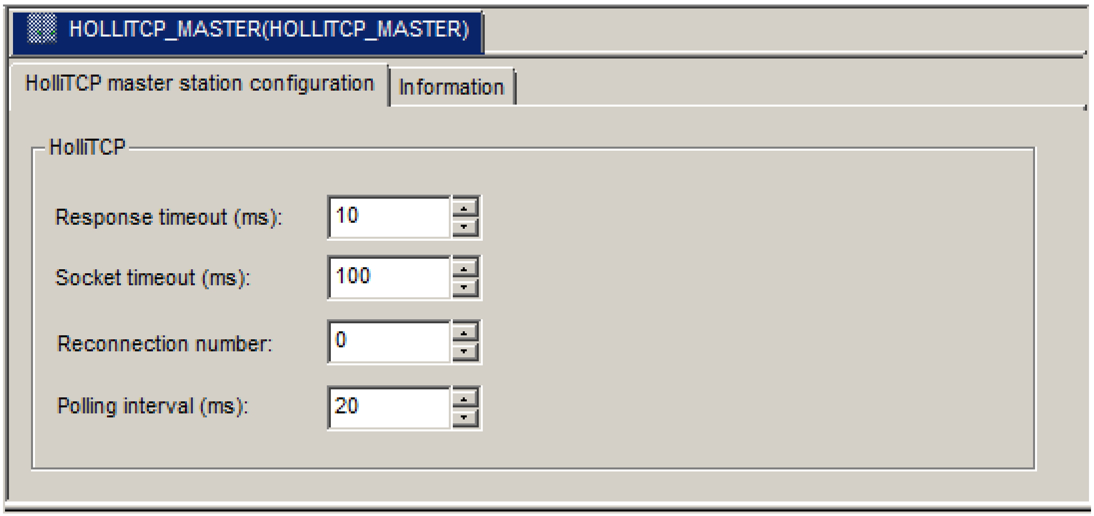


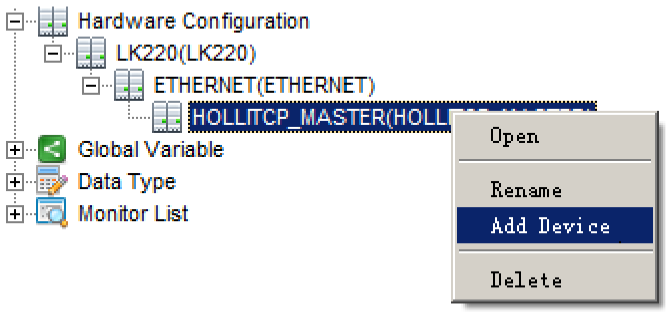
Figure 4-10　HOLLITCP MASTER Parameter Configuration Window

The HOLLITCP master station protocol parameters are displayed in the [HolliTCP master station configuration] tab.

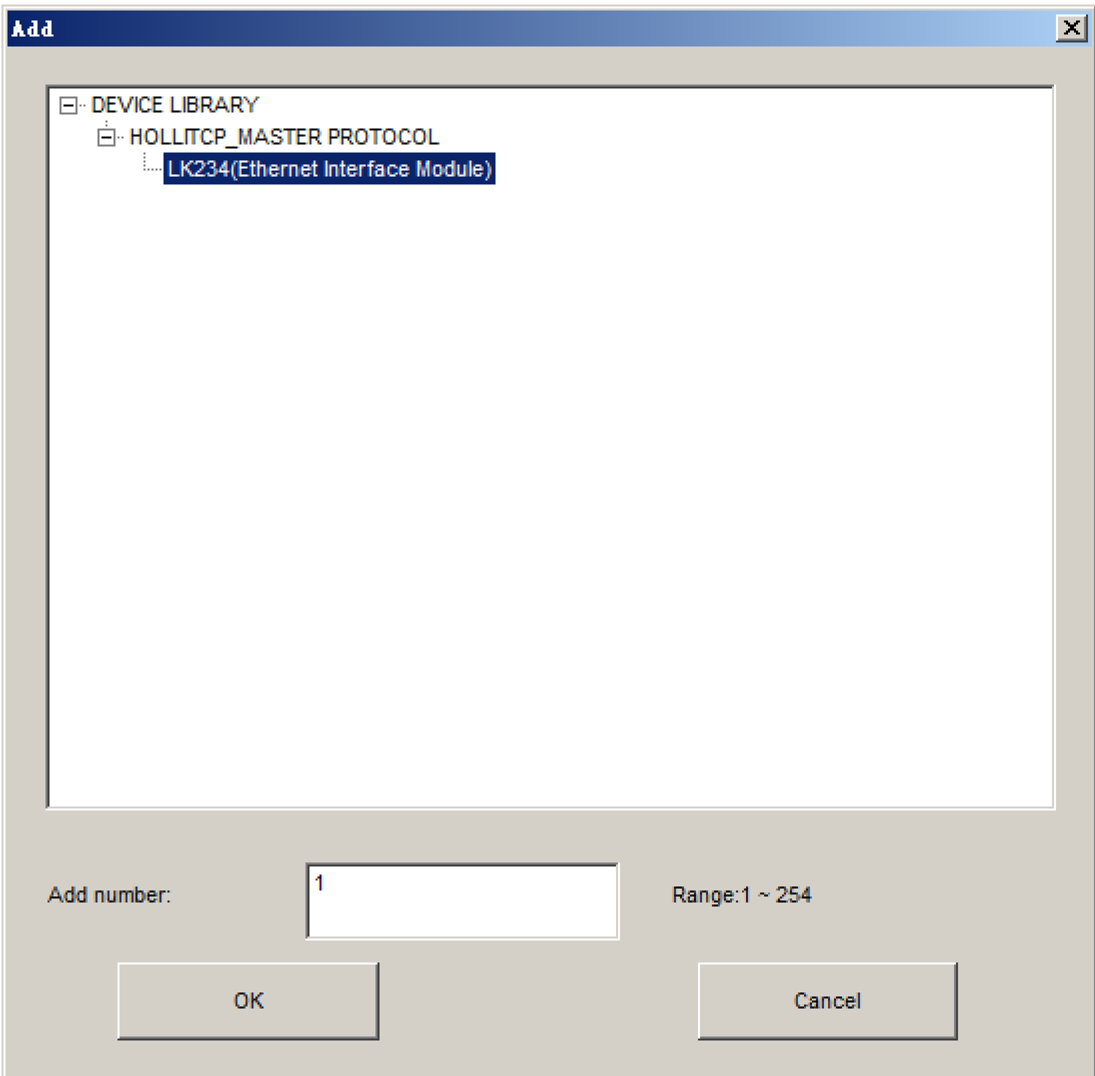
- Response timeout: the allowed delay response time after the HOLLITCP master station sends a request frame. The default value is 10 ms, and the recommended setting value is 20ms. **Response timeout** and **Reconnection number** to determine the dual-network switching time, the set parameter value to ensure that the redundancy switching time does not exceed 50ms.
- Socket timeout: The connection timeout time between HOLLITCP and Socket, the default value is 100 ms.
- Reconnection number: number of times that the master station re-sends the request after an abnormal response made by the slave station. The default value is 0.
- Polling interval: the time interval from the moment when the HOLLITCP master station receives the response frame from the slave station to the moment when it sends the next request frame. If the response made by the slave station is timed out for the last frame, then the master station can ignore the time interval and send the request frame directly. It is recommended that the value is set less than half the IEC time.

4.1.2.3　Configure LK234 module

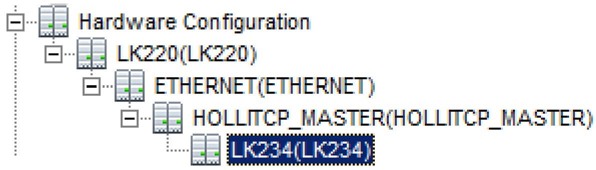
Add the LK234 module in HOLLITCP_MASTER protocol, as shown in Figure 4-11. 64 modules can be added at most.


Hardware Configuration
LK220(LK220)
ETHERNET(ETHERNET)
HOLLITCP_MASTER(HOLL
Global Variable
Data Type
Monitor List
Open
Rename
Add Device
Delete

(a)


Add
DEVICE LIBRARY
HOLLITCP_MASTER PROTOCOL
LK234(Ethernet Interface Module)
Add number:
1
Range:1 ~ 254
OK
Cancel

(b)



(c)

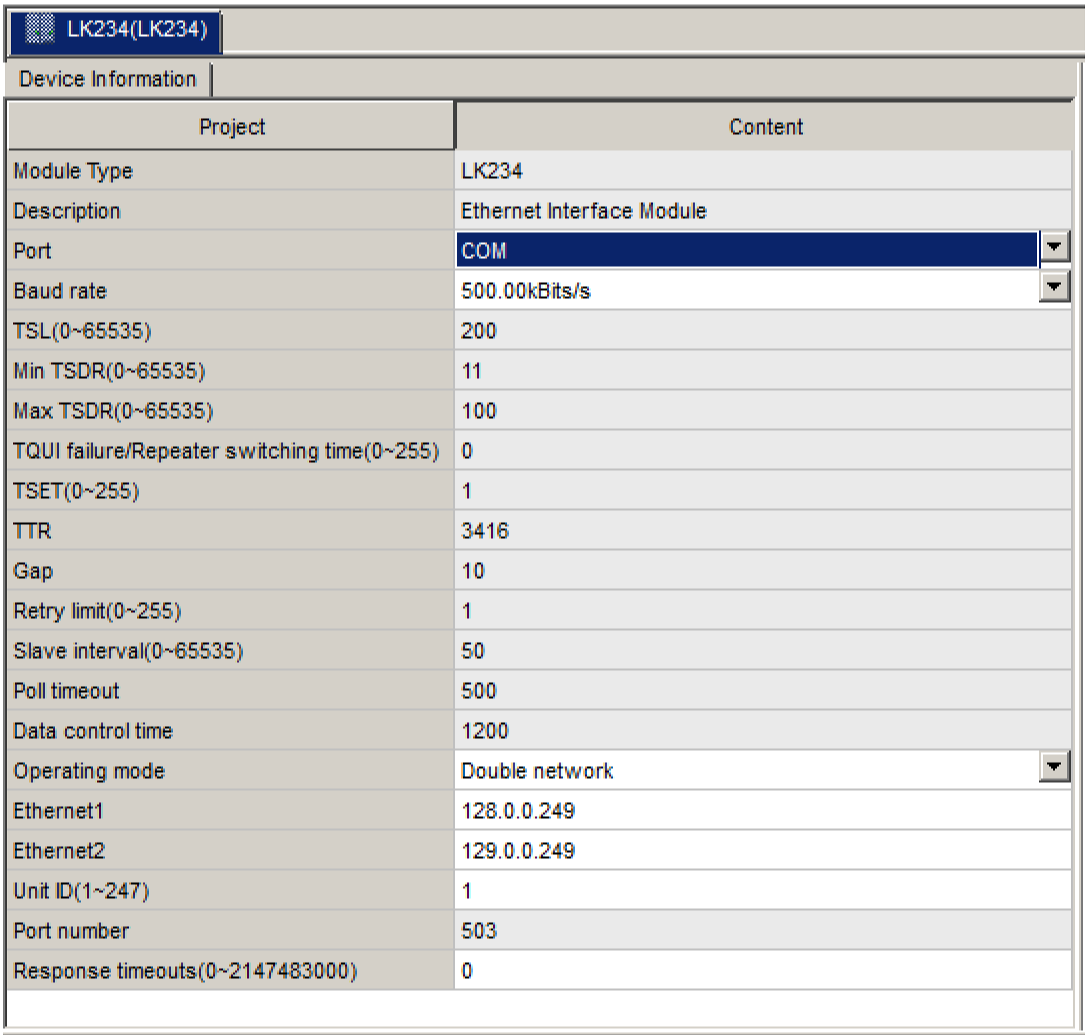
Figure 4-11 Add the LK234 Module

The **Range** in Figure 4-11 (b) is the maximum number that can be added at present. The added range is automatically adjusted according to the number of modules added. If the number entered exceeds the range or the LK234 module is not selected, the **OK** button is unavailable.

The composition of the added LK234: Device name (device model). If the name is duplicated, the default device name is **LK234_Number**.

- Parameter settings

  Double click LK234 node to open the **Device Information** window, as shown in Figure 4-17.



Project	Content
Module Type	LK234
Description	Ethernet Interface Module
Port	COM
Baud rate	500.00kBits/s
TSL(0~65535)	200
Min TSDR(0~65535)	11
Max TSDR(0~65535)	100
TQUI failure/Repeater switching time(0~255)	0
TSET(0~255)	1
TTR	3416
Gap	10
Retry limit(0~255)	1
Slave interval(0~65535)	50
Poll timeout	500
Data control time	1200
Operating mode	Double network
Ethernet1	128.0.0.249
Ethernet2	129.0.0.249
Unit ID(1~247)	1
Port number	503
Response timeouts(0~2147483000)	0

Figure 4-12 LK234 Device Information Window

- Port: Configured as **COM** port.

- Baud rate: Support 500kbps, 187.5kbps, 1.5Mbps.
- Operating mode: Double network.
- EtherNet1: Configure the IP address of the first Ethernet port of LK234 to be consistent with the actual IP address.
- EtherNet2: Configure the IP address of the second Ethernet port of LK234 to be consistent with the actual IP address.
- Unit ID: HOLLITCP_MASTER Protocol Unit ID. The default is 1, which can be set from 1 to 247.
- Port number: HOLLITCP_MASTER Protocol port number. The default is 503.
- Response timeouts: HOLLITCP_MASTER Slave delay response time allowed by the master after sending the request frame. The default value is 0, which can be set from 0 to 2,147,483,000.

4.1.2.4 Configure DP Slave

Right-click the LK234 module and select **Add Device** to add the IO module. As shown in Figure 4-13.

The method of adding a IO slave under LK234 is the same as adding of a IO slave in the LK249 module, refer to 4.1.1.3 Add DP Slave Module for details.

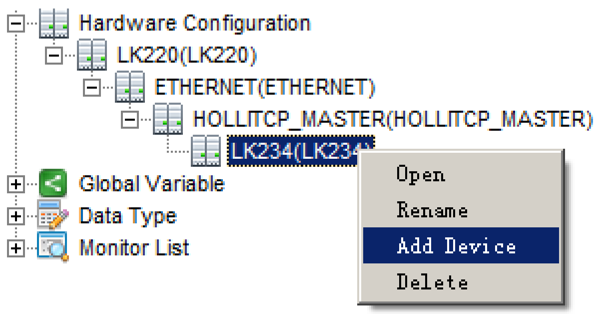
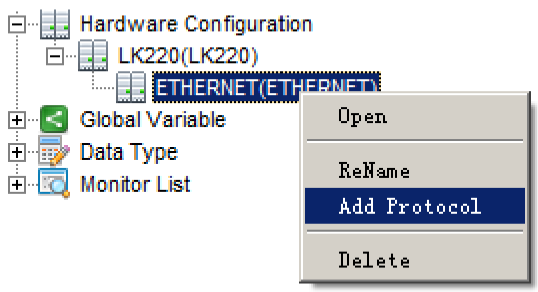


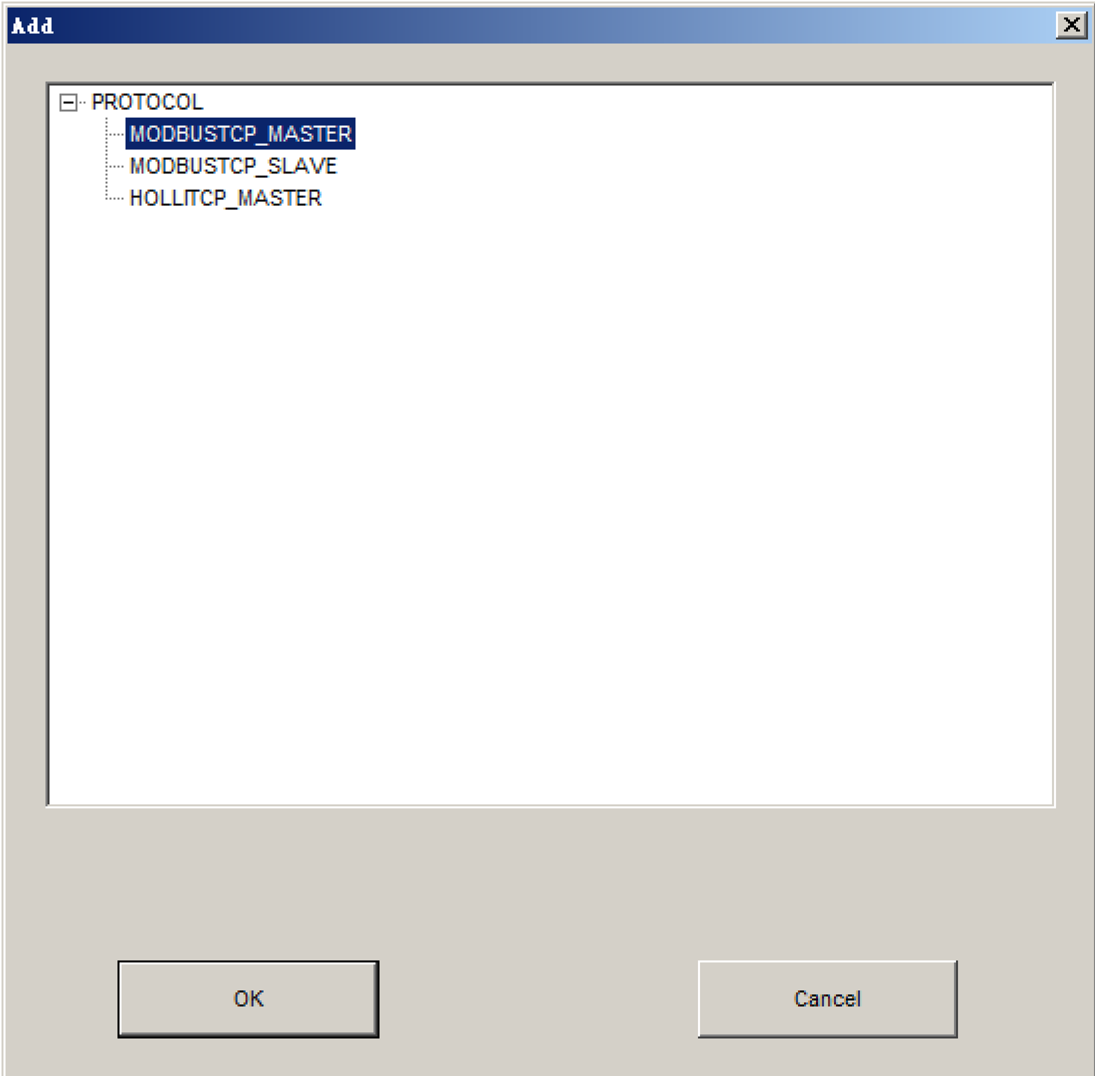
Figure 4-13 Add IO Module

4.1.3 Configure MODBUS TCP Protocol

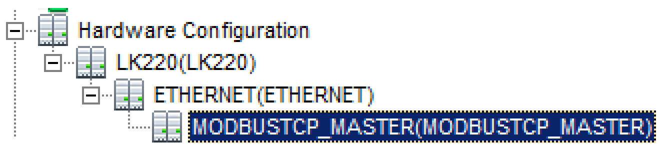
Select [Add Protocol] command in right click menu of the [ETHERNET] node, then pop up the **Add** dialog, as shown in Figure 4-14 (b). Two protocol types separately for the MODBUS TCP master station and the MODBUS TCP slave station are available. When the current CPU module is the master station, select the MODBUSTCP_MASTER master station protocol. When the current CPU module is the slave station, select the MODBUSTCP_SLAVE slave station protocol. Click **OK** after selecting the protocol type. The protocol is added, as shown in Figure 4-14 (c).



(a)



(b)



(c)

Figure 4-14 Add MODBUS TCP Protocol

4.1.3.1 Configure MODBUS TCP Master Station Protocol

Enter the master station configuration window by double clicking the MODBUSTCP MASTER node or selecting [Open] command in the right click menu, as shown in Figure 4-15. Configurable MODBUS TCP master protocol parameters are displayed, and the user can modify the parameter values.

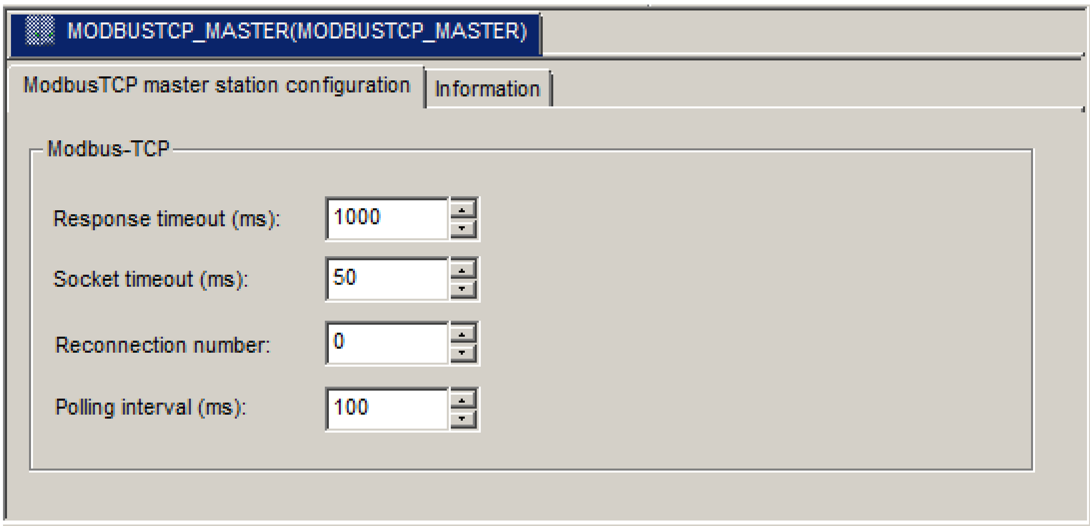
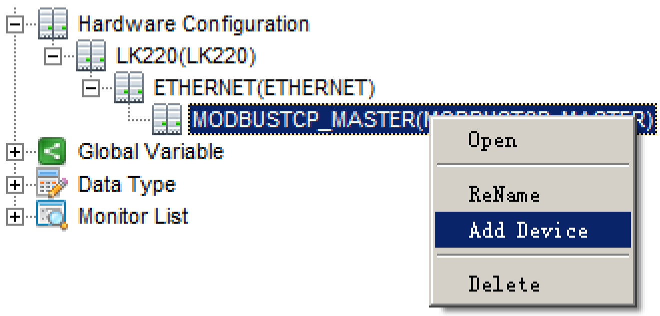


Figure 4-15　Master Station Configuration Window of MODBUS TCP

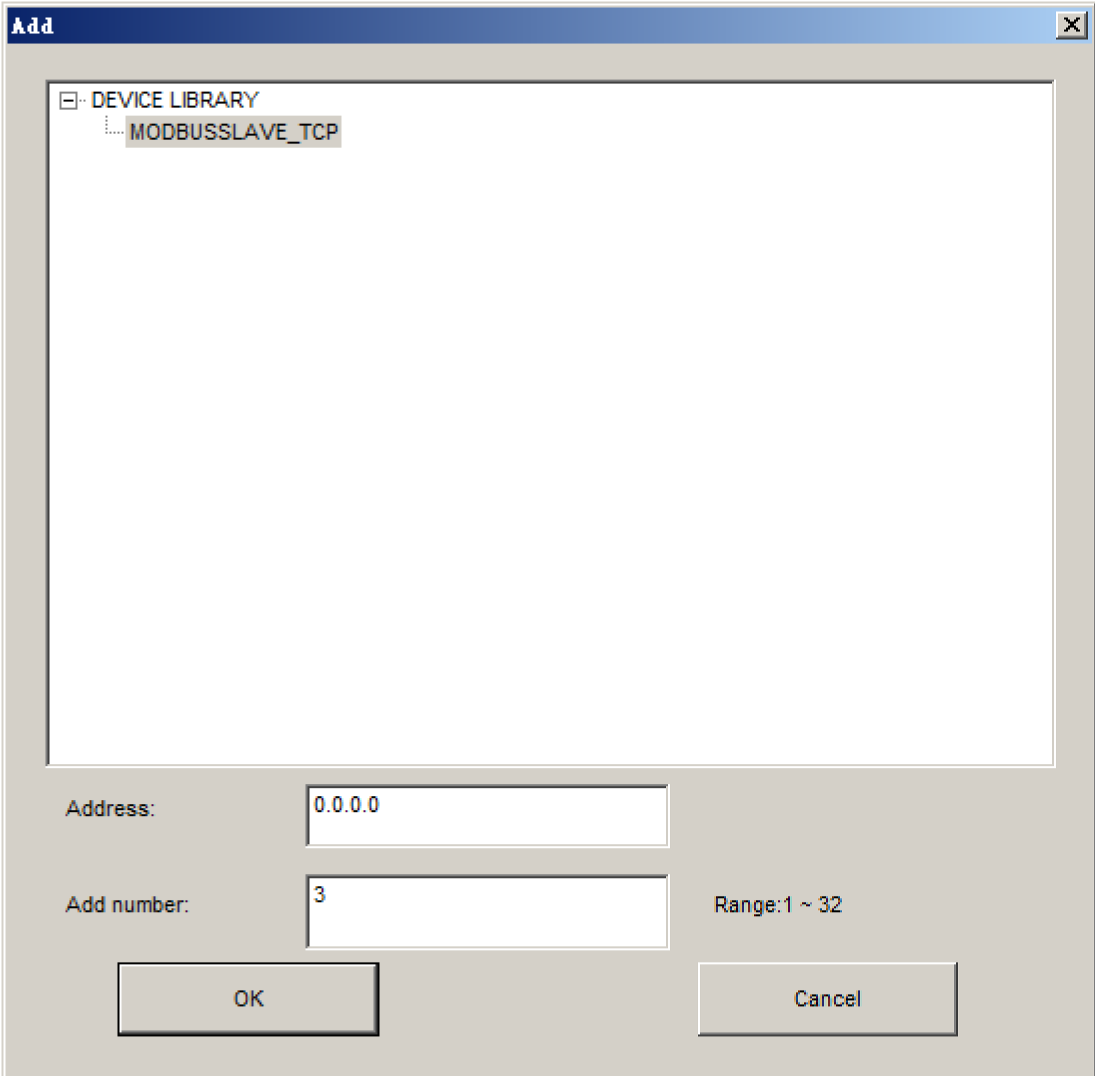
Parameter settings refer to 5.3.10 MODBUS Communication Settings for details.

4.1.3.2　Configured Slave Station of MODBUS Master Station Protocol

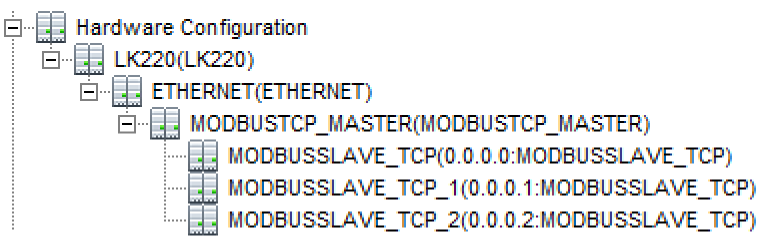
When the current CPU Act as a master station, it can configure one or more slave stations for data communication. Select [Add Device] in the right click menu in the MODBUSTCP_MASTER node to add slave station, as shown in Figure 4-16.



(a)



(b)



(c)

Figure 4-16 MODBUSTCP Master Configure Slave Station

- Configure instruction for MODBUS Slave Station

  Open the MODBUSSLAVE_TCP configuration window by double clicking the MODBUSSLAVE_TCP node or selecting [Open] command in the right click menu, as shown in Figure 4-17.

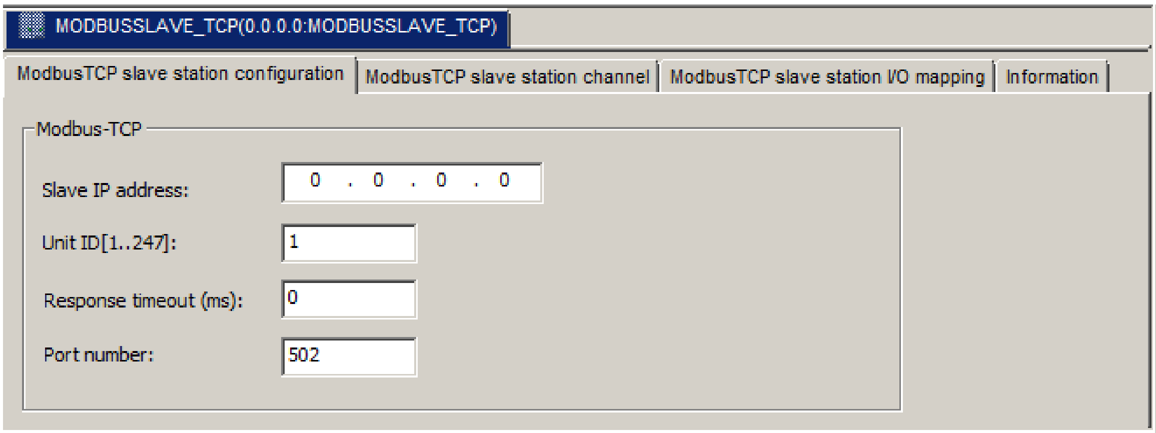
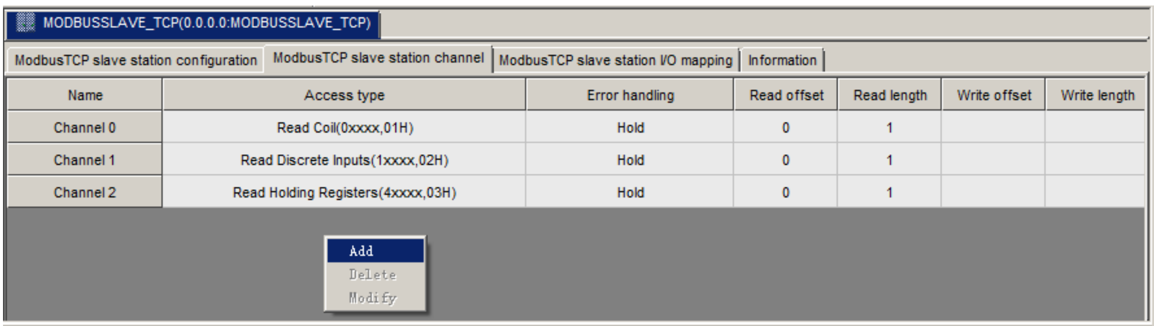


Figure 4-17 Configuration Window of MODBUS TCP Slave Station

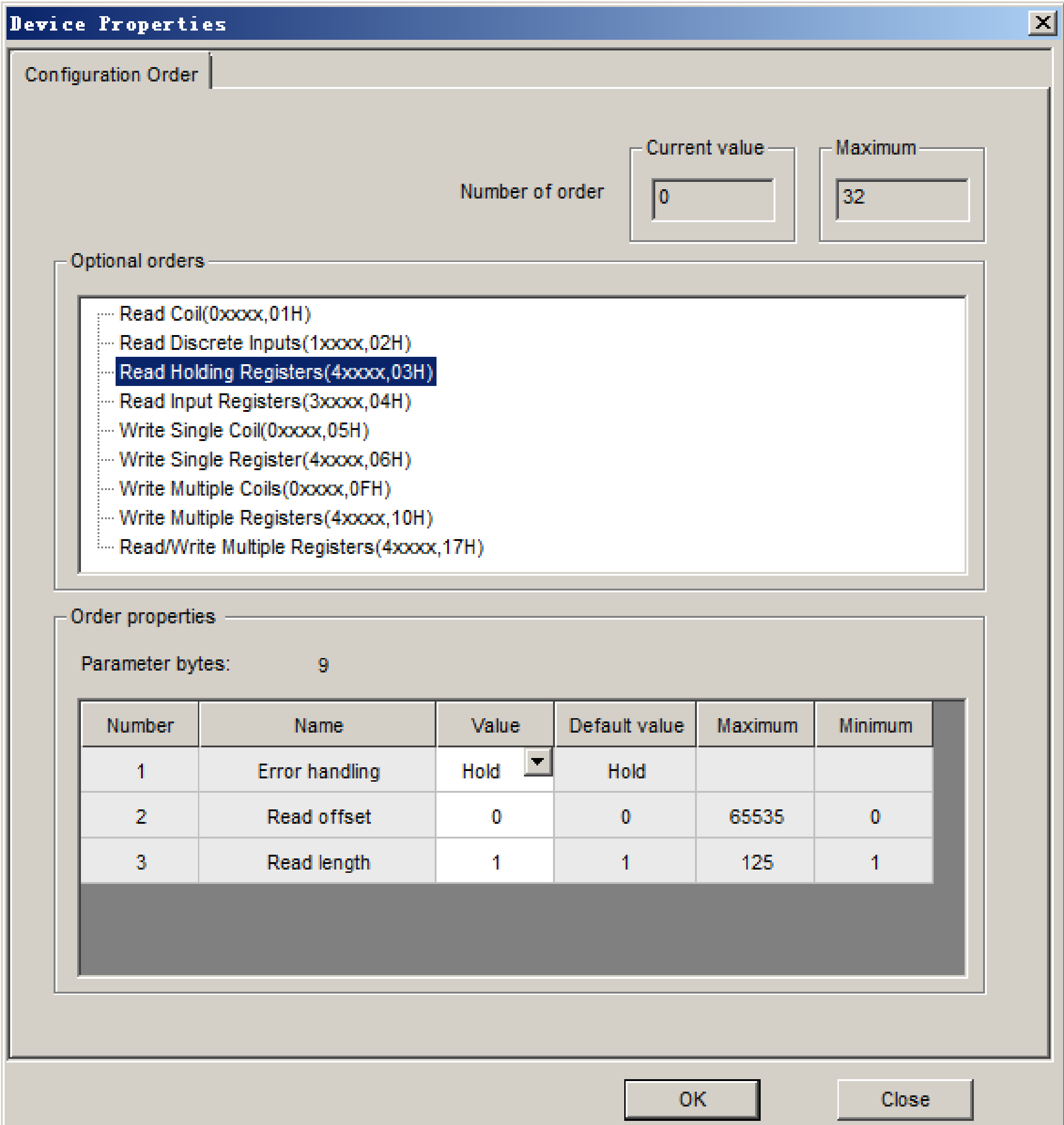
Parameter settings refer to 5.3.10 MODBUS Communication Settings for details.

- Configure slave station orders

  In the [ModbusTCP slave station channel] tab, you can add orders to the slave station through the [Add] command in the right-click menu, as shown in Figure 4-18.



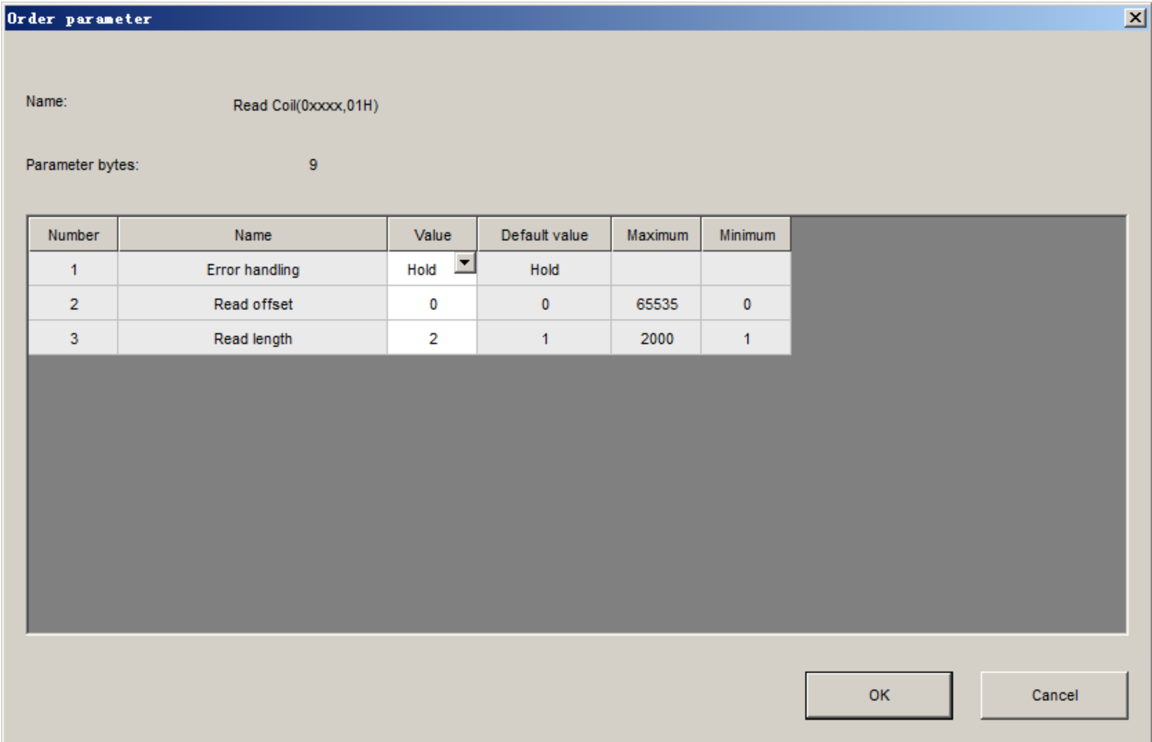
(a)



(b)

Figure 4-18　Add Slave Station Orders

Choose the instructions in **Optional Orders** list with parameters displayed in **Order properties** list. set parameters and click **OK** to complete adding. You can add up to 32 instructions.

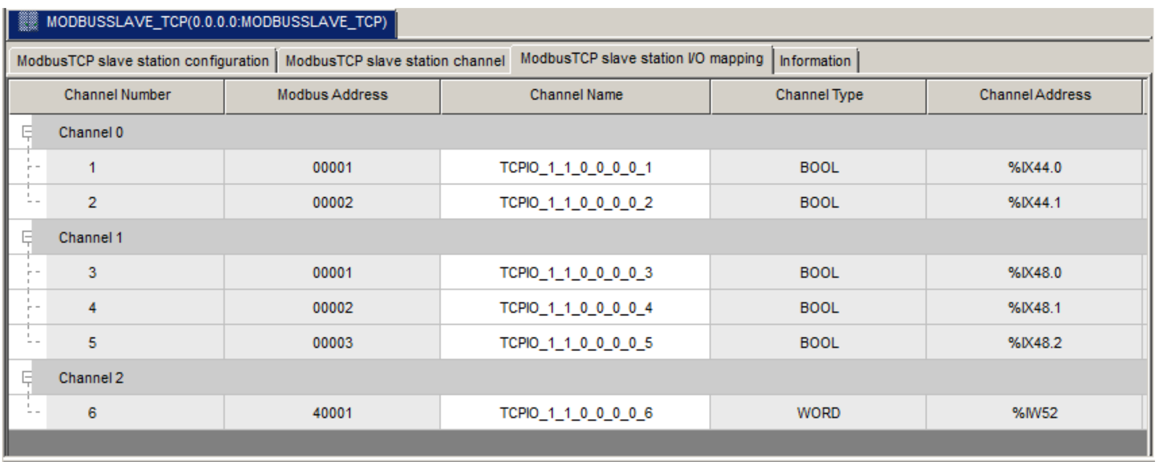


Number	Name	Value	Default value	Maximum	Minimum
1	Error handling	Hold	Hold		
2	Read offset	0	0	65535	0
3	Read length	2	1	2000	1

Figure 4-19 Instruction Parameter Settings of MODBUS TCP Slave Station

- Slave station I/O mapping

  After configuring the orders, the corresponding I/O channels are mapped in the [ModbusTCP slave station I/O mapping] tab.



Channel Number	Modbus Address	Channel Name	Channel Type	Channel Address
Channel 0				
1	00001	TCPIO_1_1_0_0_0_0_1	BOOL	%IX44.0
2	00002	TCPIO_1_1_0_0_0_0_2	BOOL	%IX44.1
Channel 1				
3	00001	TCPIO_1_1_0_0_0_0_3	BOOL	%IX48.0
4	00002	TCPIO_1_1_0_0_0_0_4	BOOL	%IX48.1
5	00003	TCPIO_1_1_0_0_0_0_5	BOOL	%IX48.2
Channel 2				
6	40001	TCPIO_1_1_0_0_0_0_6	WORD	%IW52

Figure 4-20 I/O Channels of Slave Station

4.1.3.3 Configure MODBUS Slave Station Protocol

LK220 as a salve station, you need to add MODBUSTCP_SLAVE protocol, reference to chapter 4.1.3.1 Configure MODBUS TCP Master Station Protocol.

Double-click MODBUSTCP_SLAVE node to open the slave station configuration window of MODBUS TCP, as shown in Figure 4-21.

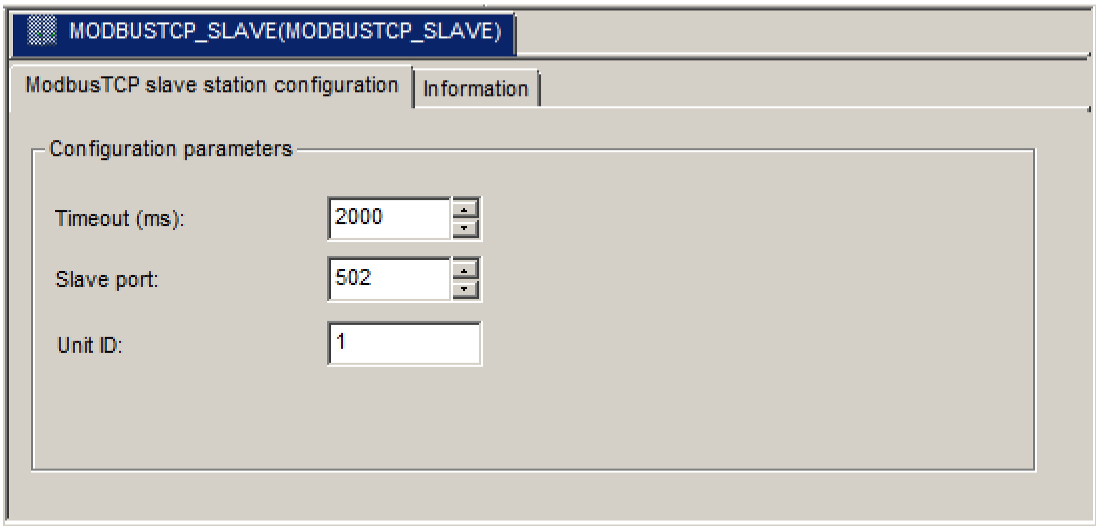


Figure 4-21 MODBUSTCP_SLAVE Configuration Window

Configurable MODBUS TCP slave protocol parameters are displayed in MODBUSTCP_SLAVE window, and the user can modify the parameter values.

Parameter settings refer to 5.3.10 MODBUS Communication Settings for details.

4.2 System Running

4.2.1 Required Devices

A set of basic hardware for LK series large-scale PLC system: master control backboard, extension backboard LK117/LK118, power supply module, 24V power switching module LK921, master control module, communication module, I/O module, connecting cable.

A PC installed with the professional programming software AutoThink and provided with the RJ45 network port.

4.2.2 Device Wiring

- Signal wiring of the I/O module.
- Wiring of the 24VDC system power supply: positive terminal connected to DC IN—1/2+, negative terminal connected to DC IN—1/2－ in LK921 module.
- Network wiring: two RJ45 network cable, with one end connected to the network interface of the PC and the other end connected to the ETHERNET1 or ETHERNET2 port in LK220 module.
- PROFIBUS-DP wiring: via the LKA104 to connect the LK249 module in master chassis and slave chassis, then expand to the backboard LK117/LK118. Also DP can be expanded by LK233.
- Redundancy communication wiring: two fiber cable LKA105 are separately connected to the FIBER X1, FIBER X2 in LK240 module in master-slave frame.

Configure redundancy system, the suggested steps as following:

(1) Network cable, DP cable, fiber cable are connected well (to ensure correct wiring method).

(2) Power -on for a single frame and you need to wait for some time until it becomes the master frame.

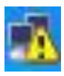
(3) Power -on for other frame and you need to wait for some time until it becomes the slave frame.

- It is not suggested that the fiber cable is inserted into module to compose the redundancy system when both frames are master with running normally.

4.2.3 Network Connection

After completing various configuration items, use any of the four programming languages provided by the software to write and compile the program, finally download the compiled user program to the CPU module and run it. Only by doing so can achieve the control goal.

The CPU module and the programming device (PC) are connected via the industrial Ethernet, with the connection steps given below:

Step 1. Double click the icon  of **Local Area Connection** in the taskbar to pop up the **Local Area Connection Status** window, as shown in Figure 4-22.

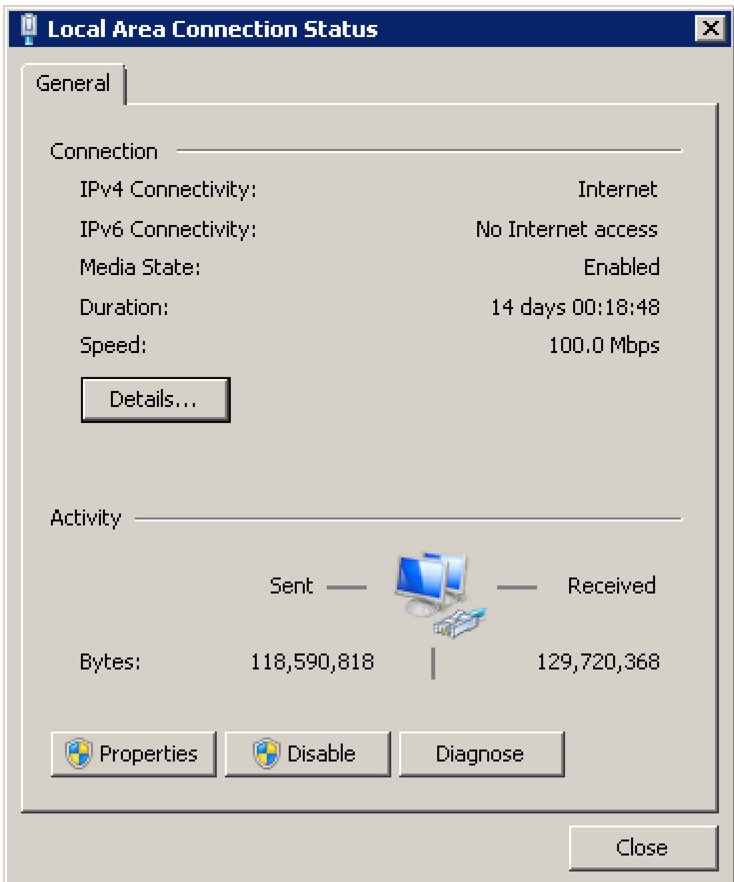


Figure 4-22 Local Connection Status

Step 2. Click the **Properties** button to pop up the **Local Area Connection properties** window, as shown in Figure 4-23.

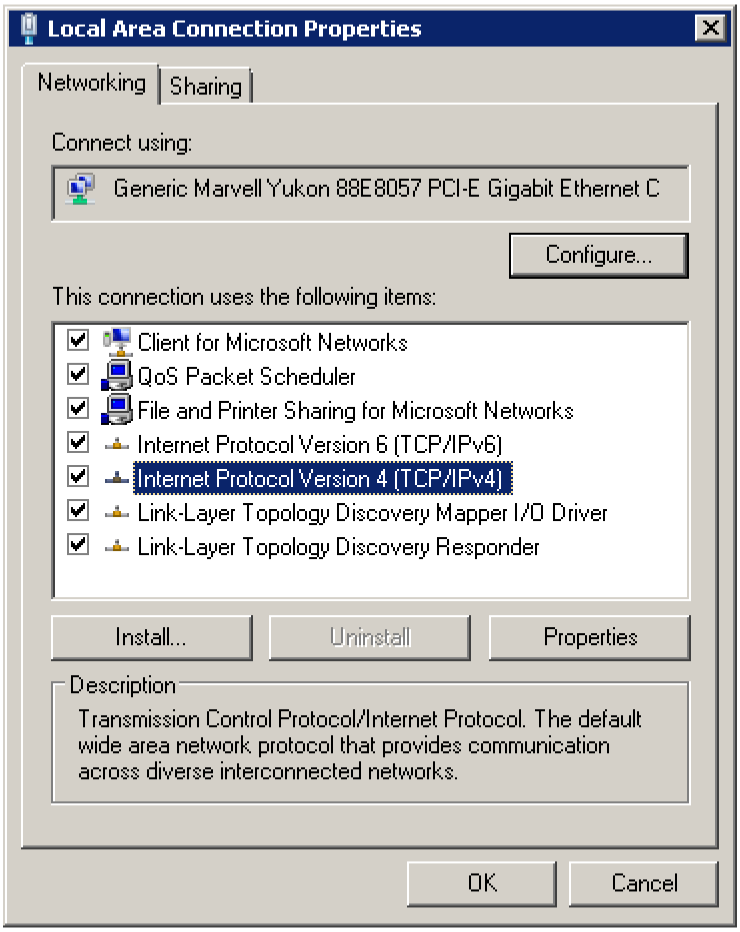


Figure 4-23 Local Area Connection Properties

Step 3. Select the **Internet Protocol Version 4 (TCP/IPv4)**, click the **Properties** to pop up the Internet Protocol Version 4 (TCP/IPv4) Properties window.

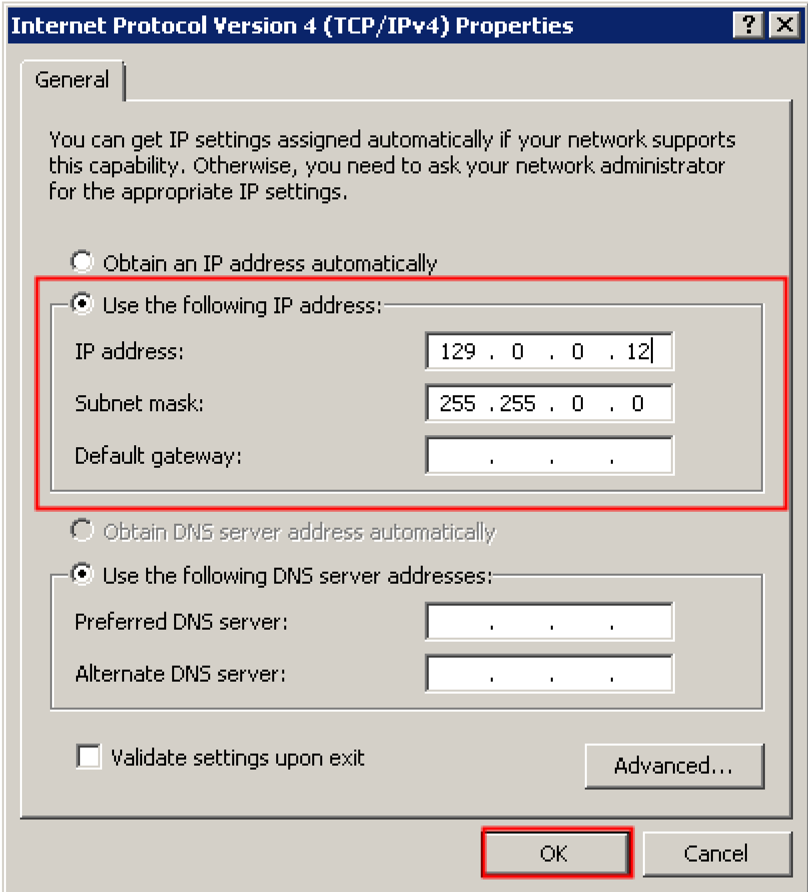


Figure 4-24 Dialog Box of Internet Protocol (TCP/IP) Properties

Select **Use the following IP address** and fill in IP address of PC in the **IP address** field. Notably, the first three digits shall conform to those for the IP address of the CPU module (default 128.0.0 and 129.0.0). The final digit shall be any number, only of there is no address conflicts with the CPU module or other devices, such as 129.0.0.12. Click the **Subnet mask** bar to automatically pop up 255.255.0.0, as shown in Figure 4-24. Click **OK** to Close the dialog box, the **Local Area Connection** network icon in the task bar shall change into , which indicates successful network connection.

4.2.4 Example Program

Configure the pump P101's logic of starting, keeping and stopping. Pump P101 starts when start button K101 is pressed, while stops when stop button K102 is pressed.

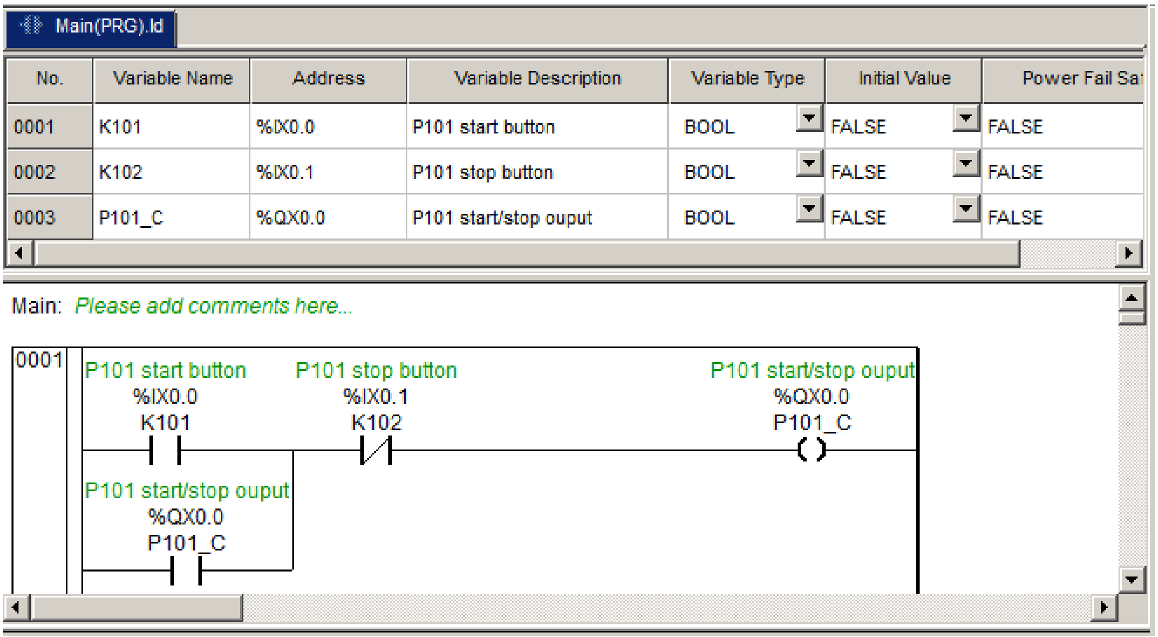


Figure 4-25 Example for Program Configuration

4.2.5 Download Program

After establishing the network connection, it can download the user program from the programming device to the CPU module. See the following for the main operation steps:

Step 1. Select [Online]-[Set Communication] in the menu bar of AutoThink software, as shown in Figure 4-26.

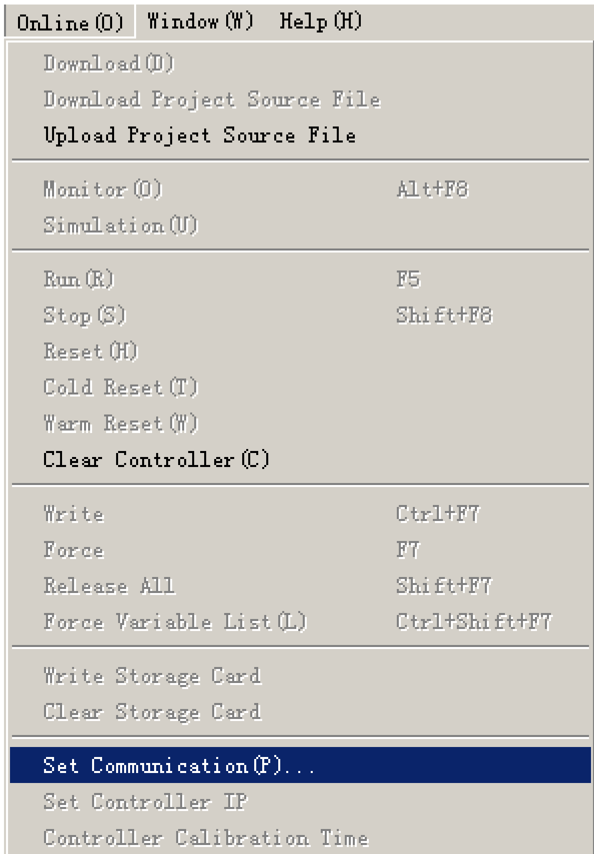


Figure 4-26 Online Menu

Step 2. Enter the IP address of the CPU module in the **Communication Settings** window, such as 128.0.0.250, as shown in Figure 4-27.

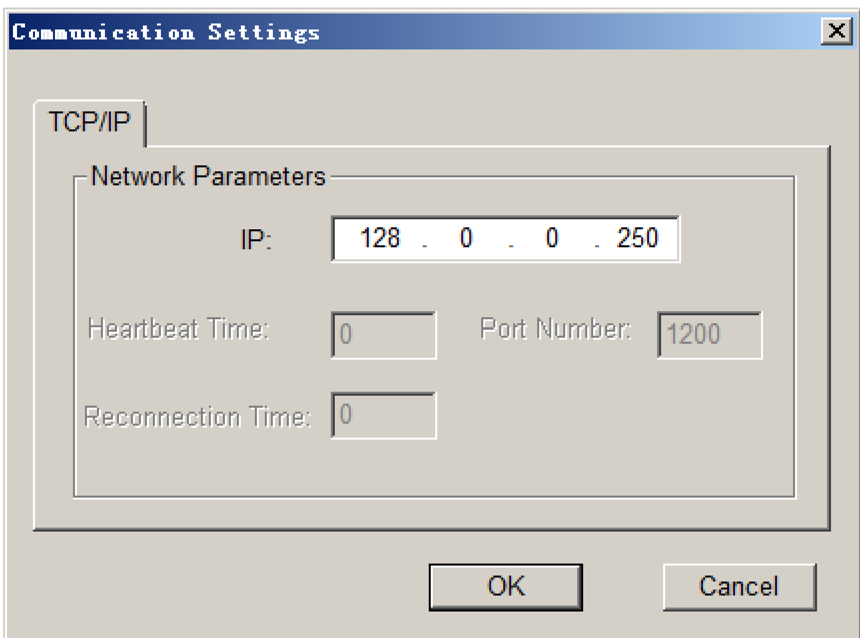


Figure 4-27 Communication Parameters Settings

Step 3. Set the key switch in the CPU panel as **PRG** or **REM**, and Select [Online]-[Download] in the menu bar, as shown in Figure 4-28.

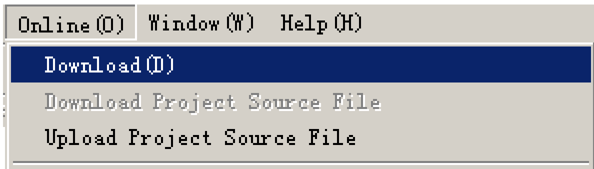


Figure 4-28 Select the Download Command

Step 4. Pop up an information window prompting full download as shown in Figure 4-29, click **OK** to download the user program. In this case, ensure good communication connection between the programming device and the CPU module. Otherwise, an error message shall be prompted.

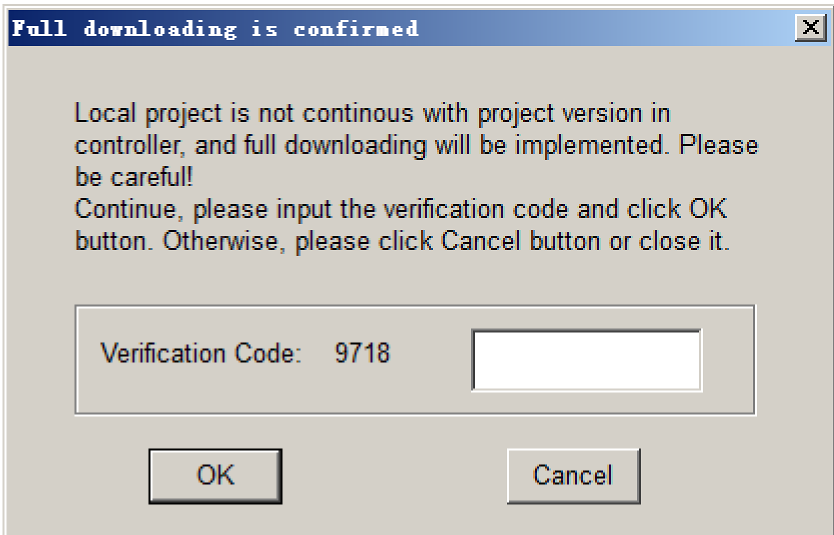


Figure 4-29 Message Prompting Full Download

4.2.5.2 Program Run

After downloading, the user program is in a stopped status.

Start the user program, with the methods making it run as following:

Method 1: The controller can be run or stopped via AutoThink when the key switch is in REM position. Turn the key switch on the CPU module panel to **REM**, select [Online]-[Monitor] to run the user program, as shown in Figure 4-30. For **Start Type** is manual, you need to click [Online]-[Run] to make task run. The user program run based on the **REM** mode is not completely out of the control of the programming software. It is allowed that forcing variable, increment download, full download, running, stopping. Select [Online]-[Stop] to stop the running program, And then you can modify the user program and download again.

Prior to officially run, this method can be used to debug the user program online. After the project run normally, to ensure that the program is not modified accidentally, it shall turn the key switch to **RUN** and pull it out, with any operation forbidden.

Method 2: Control user program via key switch, that is in RUN position for running and in PRG position for stopping. Turn the key switch on the CPU module panel to **RUN**, with the CPU module starting to run the user program. In this case, it can neither stop the user program via the programming software, nor modify the user program.

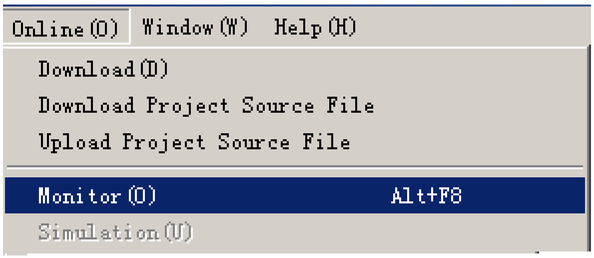


Figure 4-30　Online Operation

Chapter 5 Master Control Unit

5.1 LK130 4-slot Backboard Module

LK130 is a 4-slot backboard module for large-scale PLC of the new-generation LK Series. It works with controllers and I/O modules of the new-generation LK Series. The module has 4 slots in total, which can be connected to power modules, CPU modules and communication extension modules.

Supporting modules:

- Power modules: LK921
- Controller: LK220
- Communication extension modules: LK240, LK249

5.1.1 Module Composition

See Figure 5-1 for the external structure of the LK130 module.

Figure 5-1 LK130 Backboard Schematic Diagram

The backboard slots from left to right are as follows:

1. Power Module Slot
2. CPU Module Slot

3. Extension Module Slot 1
4. Extension Module Slot 2

Only the corresponding modules can be inserted into the power module slot and the CPU module slot. Both extension slots 1 and 2 supportLK240 and LK249.

The LK130 backboard supports the PCIE bus and the RS485 bus, exchanging the data between each module via the PCIE bus. The RS485 bus exchanges the status diagnosis information on each module. See Figure 5-2 for the internal structure schematic diagram of the LK130 module.

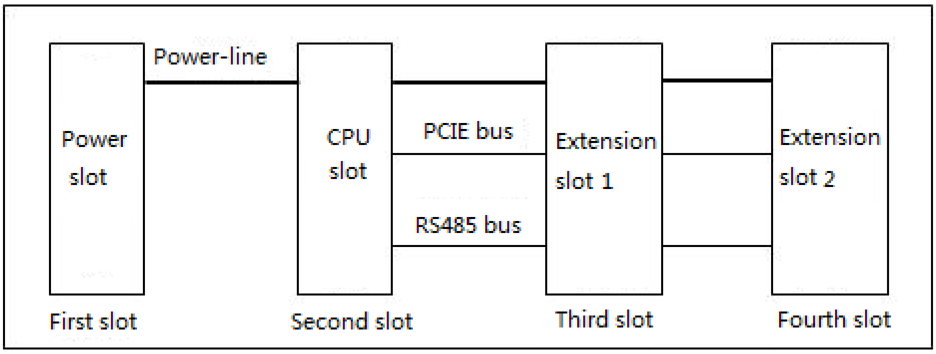


Figure 5-2 Internal Structure Schematic Diagram of LK130 Module

5.1.2 Installation Dimension

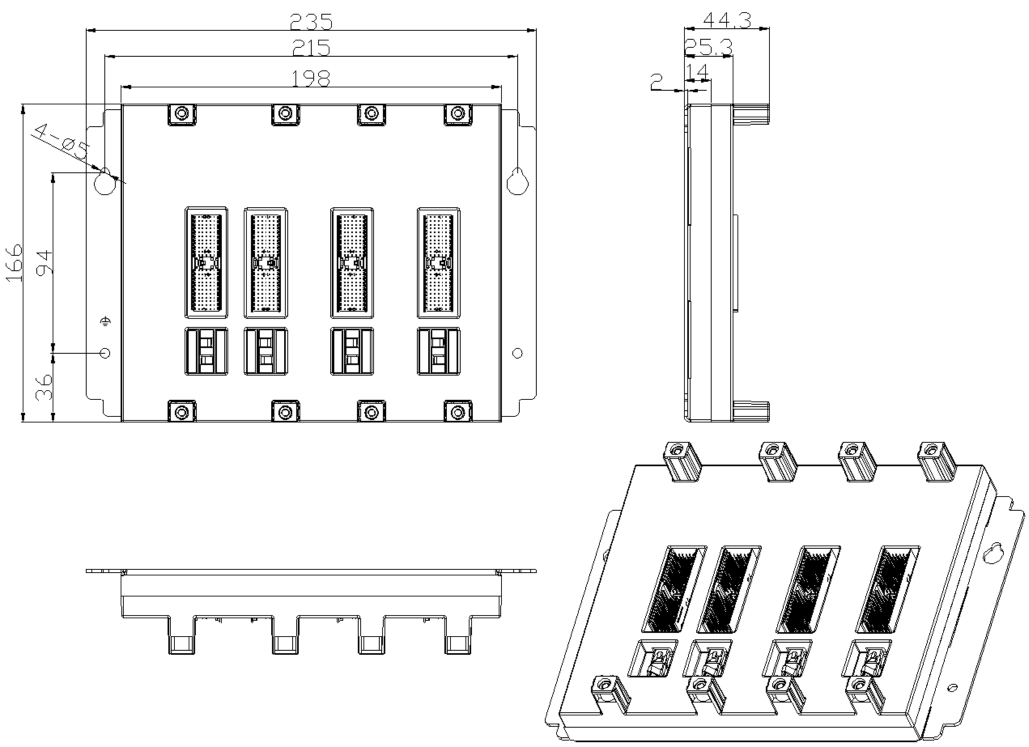


Figure 5-3 LK130 Backboard Size

5.1.3 Technical specifications

LK130 4-slot Backboard Module	
Interface	
Number of Slots	4
Physical Property	
Installation Pattern	Install via a screw hole
Module Dimension (W*H*D)	235 mm *166 mm*44.3 mm

5.2 LK921 24V Power Switching Module

The LK921 module is a redundancy power module for the large-scale LK PLC. It can convert two 24VDC inputs into a 24VDC output, which is powering the master control module, redundancy communication module and DP master station communication module via the LK130 backboard.

- Feature
  - Input voltage: 24VDC (-15%,+20%)
  - Input short circuit protection
  - Hot swapping
  - Support anti-reverse insert

Figure 5-4   LK921 Module Schematic Diagram

5.2.1   Operating Principle

The two 24VDC power supplies input by LK921 forms a protective circuit via the slow-break fuse and the varistor to provide short circuit protection and overvoltage protection. It outputs a 24VDC power supply after eliminating the interfering signal via the filter circuit. After an input circuit fails, it switches to the other one without affecting the output voltage. Thus it can realize a safe and reliable redundancy power supply mode.

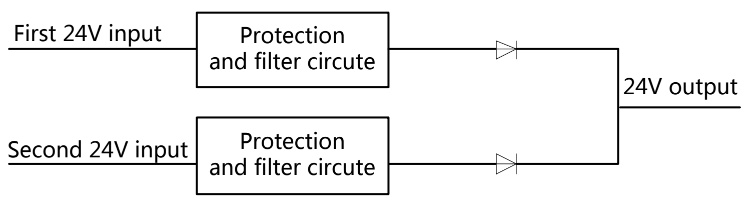


Figure 5-5   Power Supply Switching Module Block Diagram

5.2.2   Wiring

See chapter 3.2.1 Power Wiring.

- Please note that operating temperature of the wire should higher than 70℃.

5.2.3 Status Indication

Table 5-1 Instructions to LK921 Status Indicator

Name	Function	Colour	Status	Description
DCIN-1	Indication of Input Power Supply 1	Yellow	On	Input Power Supply 1 works regularly
			Off	Input Power Supply 1 fails
DCIN-2	Indication of Input Power Supply 2	Yellow	On	Input Power Supply 2 works regularly
			Off	Input Power Supply 2 fails
DCOUT	Indication of output supply power	Green	On	The output supply power works regularly
			Off	The output supply power fails

5.2.4 Installation Dimension

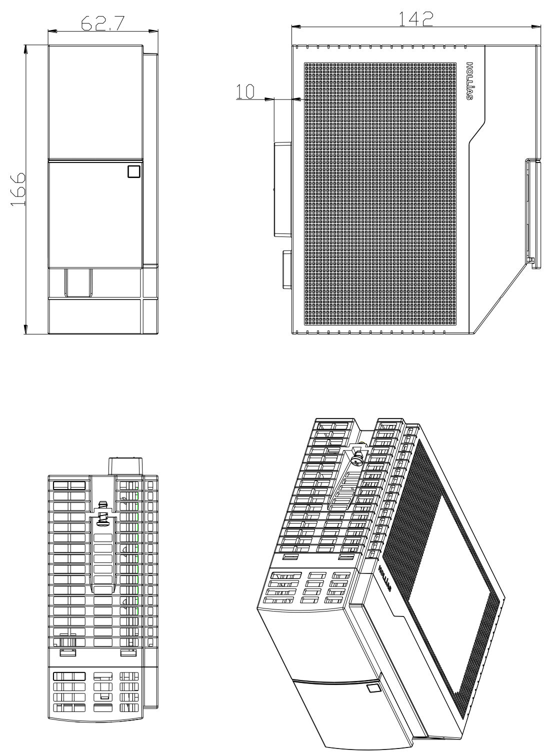


Figure 5-6 LK921 Dimension Figure

5.2.5 Technical Specifications

24V Power Switching Module	
Power Input	
Quantity	2

24V Power Switching Module	
Input Voltage	24VDC(-15%,+20%)
Input Current	2A max.
Power Output	
Quantity	1
Input/Output Voltage Drop	1V±0.2V (based on a single -channel current of 2A)
Physical Property	
Installation Pattern	Backboard slot
Protection Key Position	None
Module Dimension (W*H*D)	62.7 mm*166 mm*152 mm±0.5 mm

5.3 LK220 Master Control Module

LK220 is the master control module of PLC. It is the core for PLC operation and control, capable of raw data input, data operation and new data output. The master controller realizes man-machine interaction with the master control room via Ethernet. The master controller realizes interaction with the redundancy, communication and I/O module data via the internal bus.

When LK249 is used to connect IO slave station, up to 124 IO slave stations are available, with the address range of 2~125. When LK234 is used to connect IO slave station, up to 640 IO slave stations are available. The supported I/O points no less than 10,000.

5.3.1 Features

- Support storage via Flash and SD card
- Support dual Ethernet ports
- Support TCP/IP and MODBUS-TCP Protocols
- To support the backboard bus
- Hot swapping
- Support SD card update
- Support power fail safeguard

5.3.2 Appearance

Figure 5-7 Appearance of LK220 Module

As shown in Figure 5-7, the CPU module panel is provided with:

- 10 LED Status Indicator, indicating the running status of the CPU module in real time.
- 1 key switch, switching the working pattern of the CPU module (RUN, PRG, REM).
- Mounting groove for SD cards.
- Power fail safeguard battery/capacitance box.
- Two Ethernet ports.

5.3.2.1 Dimension

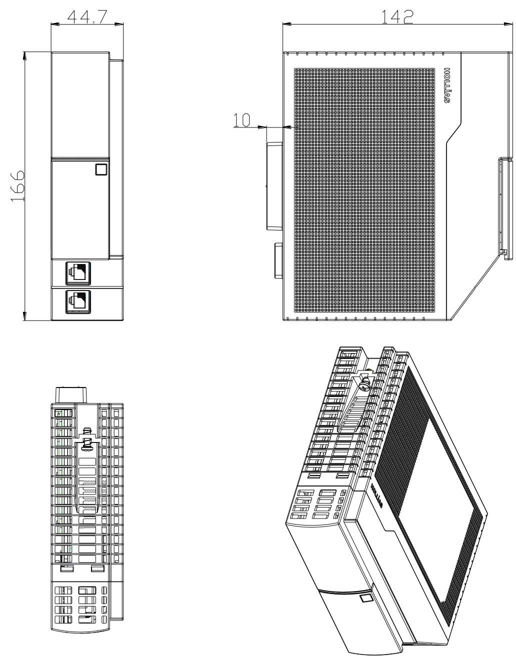


Figure 5-8 LK220 Module Dimension

5.3.3 Operating Principle

The LK220 module transmits data via the Ethernet interface and the programming device. The LK220 module isolates the Ethernet signal and the internal CPU signal via the isolator. It switches the Ethernet signal and the internal CPU signal via the PHY transceiver. See Figure 5-9 for the internal schematic diagram.

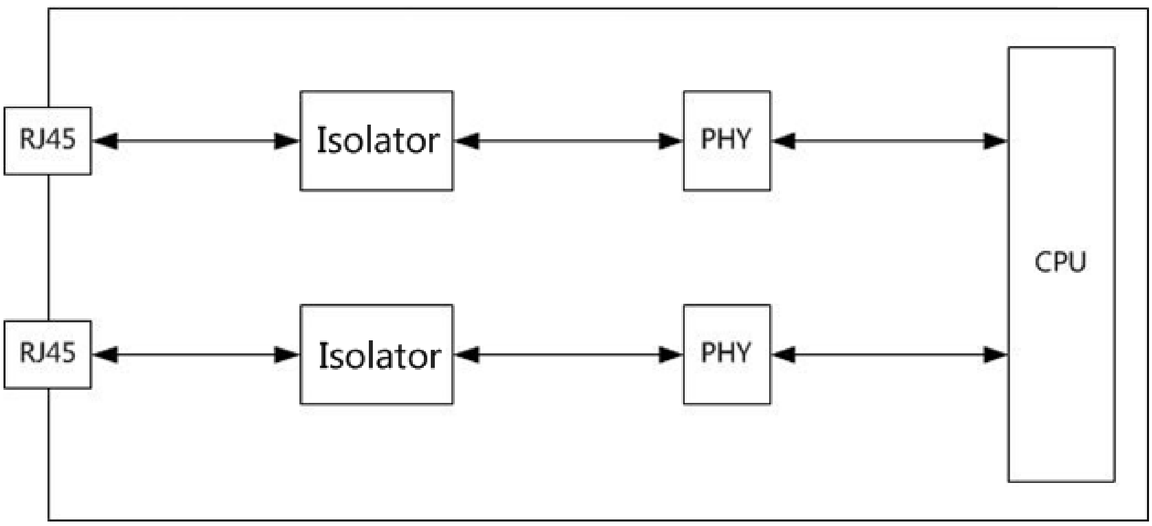


Figure 5-9 LK220 Rationale Diagram

- Communication of LK220 will be interrupted when the network storm occurs, the communication will resume after the network storm disappears. Pay attention to system construction and maintenance, the events or operations that caused the network storm must be eliminated.

5.3.4 Status Indication

Table 5-2 Instructions to Status Indicator

Name	Function	Colour	Status	Description	Combined Indication of Status Indicator
PWR	Indication of power supply	Yellow	On	The power supply is normal	
			Off	The power supply fails or no power.	
RUN	Indication of operating pattern	Green	On	There is a project but not run.	
			Slow flashing	There is a project and running.	
			Off	There is no projects.	
ERR	Indication of module failure	Red	On	The module fails.	
			Slow flashing	The module is powered up or restarted, in initialization.	
			Off	There is no failures	
FRC	Forced indication	Green	On	With force data	All Status Indicator flash slowly: updating the firmware All Status Indicator flash quickly: restoring factory settings
			Off	With no force data	
BAT	Indication of battery status	Yellow	On	The battery capacity is full, in normal operation	
			Off	The battery is not installed or the battery capacity is lower than 90% of the ratings, thus requiring replacement	
SDIN	Indication of SD cards	Green	On	The SD card has been inserted	
			Slow flashing	Reading/writing the data on SD cards	
			Off	No SD cards has been inserted	
LNK1	Indication of connecting Ethernet Interface 1	Green	On	Ethernet Interface 1 has been connected successfully	
			Off	Ethernet Interface 1 has not been connected yet	
ACT1	Indication of receiving and sending data via Ethernet Interface 1	Yellow	Slow flashing	Ethernet Interface 1 is receiving and sending data	
			Off	Ethernet Interface 1 is not receiving and sending data	
LNK2	Indication of connecting Ethernet Interface 2	Green	On	Ethernet Interface 2 has been connected successfully	
			Off	Ethernet Interface 2 has not been connected yet	

Name	Function	Colour	Status	Description	Combined Indication of Status Indicator
ACT2	Indication of receiving and sending data via Ethernet Interface 2	Yellow	Slow flashing	Ethernet Interface 2 is receiving and sending data	
			Off	Ethernet Interface 2 is not receiving and sending data	

5.3.5 Interface Specification

5.3.5.1 Ethernet Interface

The LK220 master controller has two Ethernet interfaces. The Ethernet interface adopts a standard RJ45 receptacle, with a communication rate of 10/100 Mbps, taking five-type STP as the transmission medium. The LK220 master controller is connected to the programming computer via Ethernet to download or update the user program.

5.3.5.2 SD Card Interface

User can update the controller via the SD card or AutoThink software.

- Update the controller firmware via the SD card:

Step 1. Copy the firmware file that suffix name is .bin to SD card from the released CD.

Step 2. Insert the SD card into the SD slot in controller.

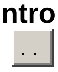
Step 3. Restarting power or resetting controller to update firmware automatically.

Step 4. At this time, the ERR light flash slowly, ERR light is off, then the firmware upgrade is complete.

- Update the controller firmware via the AutoThink software

  The user can also update the firmware via the AutoThink software, in the case of SD card is not inserted.

Step 1. Click menu [Tool]-[Assistant tool]-[Controller operation] in AutoThink.

Step 2. Open the dialog **Controller operation**, as shown in Figure 5-10. In the [Firmware Upgrading] tab, click  in the Path field to select the .bin file of controller firmware, click **Upgrade** to pop up a prompt box of confirming Update, click **YES**, with the firmware file uploaded to the controller.

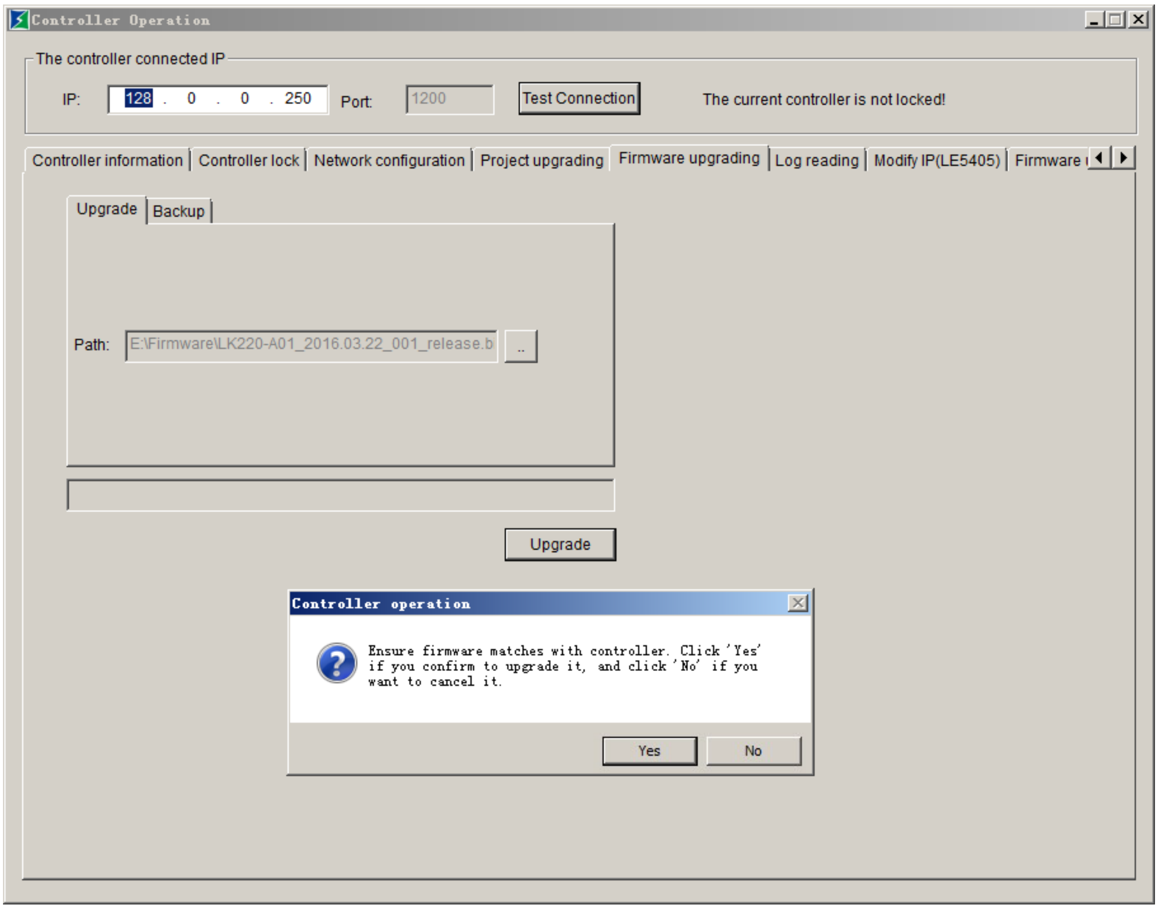


Figure 5-10 Firmware Upgrading Tools for AutoThink

Step 3. A prompt box as shown in Figure 5-11 popped up. Click **OK** to start upgrade.

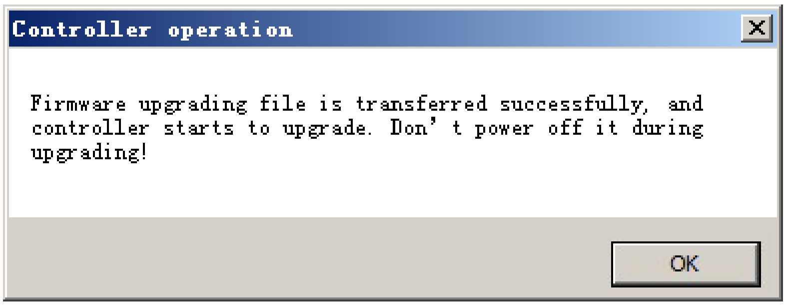


Figure 5-11 The Prompt box for Transmission of Firmware File

Step 4. Fourth step: FRC light and BAT light flash slowly together. The ERR light flash slowly after the FRC and BAT lights are off. Completing controller upgrade when the ERR light is off.

The controller automatically runs after the upgrade.

- Caution of updating firmware

  Updating firmware can only be done in a single-machine mode.

  The key switch is set to PRG or REM mode, and IEC is stopping when you upgrade firmware.

  Disconnect the DP when updating the firmware via the SD card.

5.3.6 Key Switch

It can set the current CPU operation pattern via the key switch. The LK220 CPU module has three working patterns: RUN, PRG and REM patterns. It can select the REM pattern as the default by make a selection via the key switch. The key switch can be pulled out in RUN, REM, PRG patterns.

Table 5-3 Definition of Key Switch

Key Position	Mode Type	Definition
RUN	Running Mode	CPU can execute the user program, but cannot modify it nor operate it via AutoThink.
REM (remote)	Remote control pattern	A user can control the program to run and stop, modify the user program and conduct operations including Force, Reset and Write-in, etc.
PRG (program)	Program Mode	CPU can stop executing the user program and cannot run the program via the software. It can modify the user program and conduct operations including Force, Reset and Write-in, etc.

The three working modes are specified in details below:

RUN: to run the user program, unable to stop the user program via the programming software, nor to modify the user program.

- Enable output.
- The CPU module executes I/O scanning and operation.
- Cannot be forced.
- The human-machine interface software (that is, HMI) can write variables. The programming software (AutoThink) cannot write variables.
- Cannot reset and clear.
- Cannot change the operating mode of the CPU module remotely via the programming software.

PRG (Program): the user program is stopped and cannot be enabled via the programming software. It is capable of full download and increment download.

- The CPU module does not execute the (scanning) task.
- Create, modify and delete the task, program and routine.
- Download the user program.
- Reset and clear.
- Cannot change the operating mode of the CPU module remotely via the programming software.

REM: (Remote) to control the user program to run and stop via the programming software. However, the agreed initial status is that: switch from RUN to REM, with the user program keeping its running. Switch from RPG to REM, with the user program keeping its original stopped status. If the key is in REM position before enabling the CPU module, after starting the system program, the running status stays the same to that before power off or resetting. In REM mode, it can download the user program, including full download (full download can be conducted only after stopping the running of the user program) and increment download (can be conducted when the user program is running or stopped).

- Force variables.
- Write variables.

- Reset and clear.
- Program download.
- Change the operating mode of the CPU module remotely via the programming software.

The master controller changes the CPU IEC running status by toggling the key switch, with the IEC running status of the slave controller keeping pace with that of the master controller. For example, when toggling the key switch of the master controller to the PRG position and IEC operation stops, IEC operation of the slave controller also stops even if the key switch of the controller is not at the PRG position.

- The key switch is not allowed during the download.

5.3.7 Reset

Reset: operate the key switch in the sequence of REM→RUN→REM→RUN→REM (that is, start from the REM position, switch twice toward the RUN position and then go back to the REM position). If the operation is completed in 1.5s, the CPU module can reset the hardware.

It can reset the user program via the programming software, including the following reset methods.

- Reset: except the power fail safeguard data (that is, to hold the retain variable), all the data shall be recovered to their starting values.
- Cold reset: all the data including the power fail safeguard data shall be recovered to their starting values.
- Warm reset: all the data stays in the status before resetting.
- Clear controller: it shall delete all the user programs and recover all the variables to their starting values.

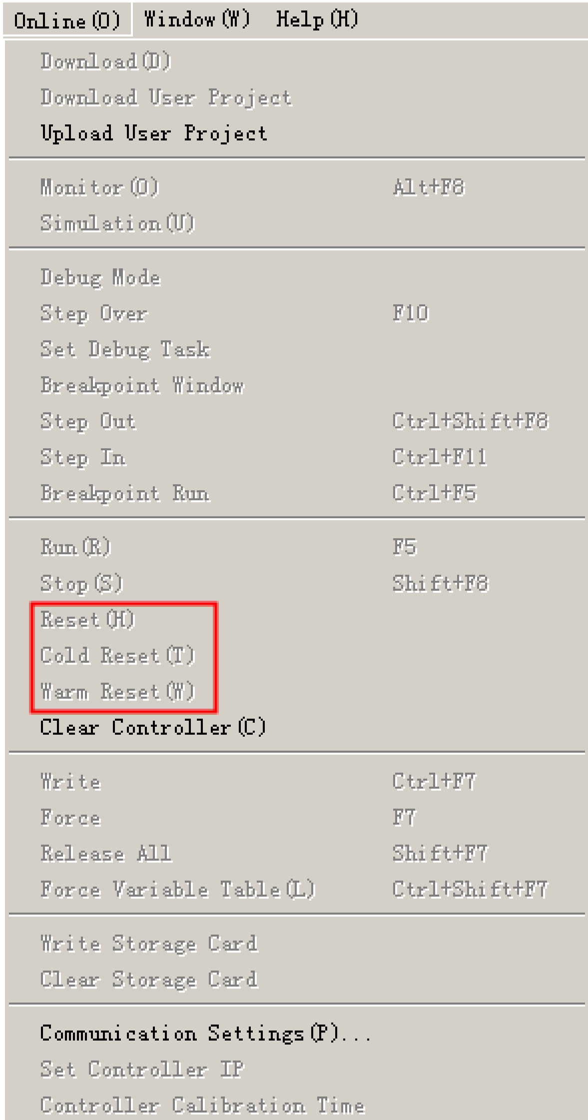


Figure 5-12　Reset Command of Online Menu

- System running, prohibit resetting master controller !
- In redundancy mode, reset is only effective for current frame. If master controller is reset, it will cause master-slave switching.

Restore factory defaults: operate the key switch in the sequence of REM→PRG→REM→PRG→REM. If the operation is done in 1.5s, CPU can be recovered to factory defaults. In this process, the FRC lamp and the BAT lamp flash alternately. After the factory defaults are recovered, the FRC lamp and the BAT lamp stop flashing. It shall initialize the user data, clear the user files, user logic source projects, static routing lists and control locks, etc.

By restoring the factory defaults to resolve this issue when you forget the IP address of the controller.

■ Cautions

External connection must be disconnected when you restore factory defaults.

- Restoring factory defaults must ensure that the controller had no effect to the field.

5.3.8 Power Fail Safeguard

The MRAM memory of the LK220 module provides power fail safeguard. When CPU module is running, the MRAM memory will backup and save the data from the SRAM memory periodically. It can still keep the data after the CPU module is power off.

In case the user sets **Power Fail Safeguard** when defining the variables in the AutoThink configuration software, the LK220 module can provide power fail safeguard for the real-time numerical of the retain-type variables in the user program. After restarting the power-failed CPU module, the retain-type variables can be recovered to the values before power loss, with other variables recovered to their initial values.

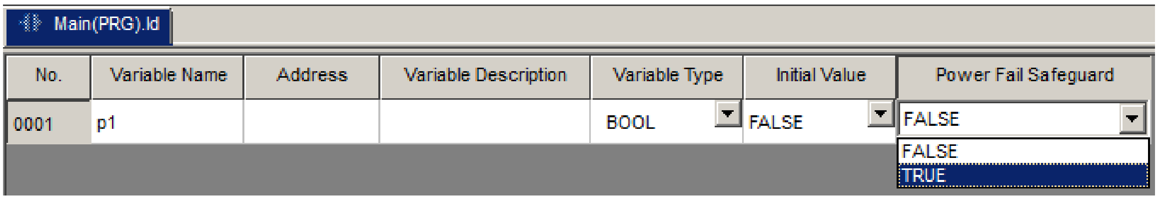


Figure 5-13 Setting Power Failure Retention

Data area supporting power fail safeguard:

- Area R: with a size of 64k Bytes.
- Area M: the first 4,000 bytes in Area M, that is, %MB0~%MB3999, provides power fail safeguard. The addresses after the 4,000 bytes in Area M does not provide power fail safeguard.

5.3.9 Backup Battery

The front panel of the LK220 module is provided with a backup battery slot. The user can choose to insert the LKA102 battery power box or the LKA103 capacitance power box. The backup battery can provide power fail safeguard for the real-time clock data. Upon the power loss of the CPU module, the real-time clock data can still be kept. The max. power fail safeguard period for battery power supply is 1 year. The max. power fail safeguard period for capacitance power supply is 7 days.

In case of low battery, BAT indicator lamp shall give an alarm. Check the battery regularly and replace it timely, ensuring that power fail safeguard can work well. See the chapter 8.2.4 Battery Replacement for battery replacement.

LKA102 is not necessary for customers who do not need keep real-time clock data when the system is power-off. LKA102 is a standard product of hollysys, you can only buy it from hollysys.

5.3.10 MODBUS Communication Settings

5.3.10.1 MODBUS TCP MASTER

When the current CPU is the master station, it can set parameters for the slave station modules and MODBUS TCP master station communication. In the AutoThink configuration software, double click the created [MODBUSTCP_MASTER] master station node under the controller tree node, open the master station configuration window, as shown in Figure 5-14.

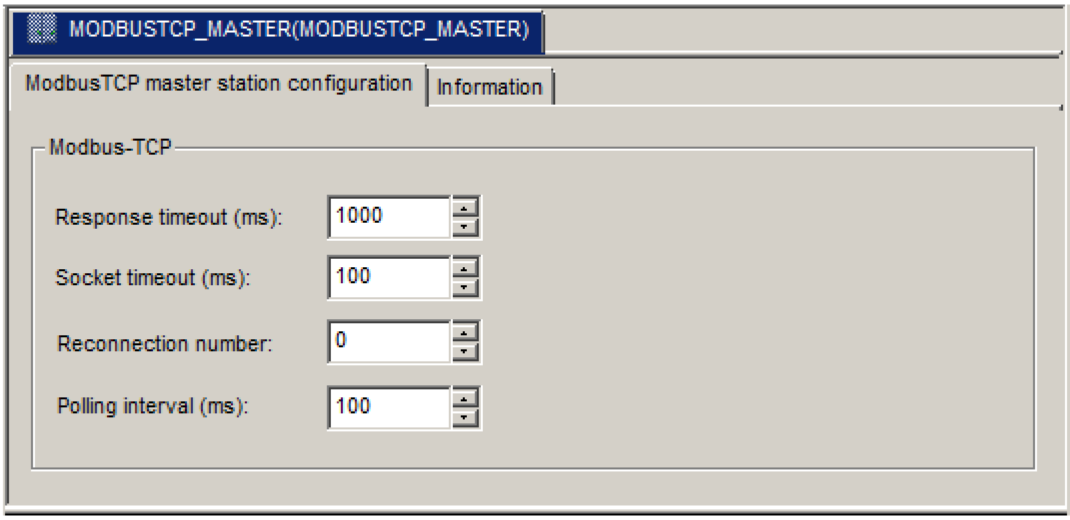


Figure 5-14 Master Station Communication Parameter Settings

- Response timeout (ms): the allowed delay response time after the MODBUSTCP master station sends a request frame. The default value is 1000, with a range of 10~2,147,483,000.
- Socket timeout (ms): TCP/IP connection Socket timeout. Default value is 100, with a range of 10~2,147,483,000.
- Reconnection number count: number of times that the master station re-sends the request upon an abnormal response made by the slave station. The default value is 0, with a range of 0~ 10.
- Polling interval: the time interval from the moment when the MODBUSTCP master station receives the response frame from the slave station to the moment when it sends the next request frame. If the response made by the slave station is timed out for the last frame, then the master station can ignore the time interval and send the request frame directly. The default value is 100, with a range of 100~2,147,483,000.

To ensure the validity of the polling interval, you should note the following points in configuration:

- It is suggested that you need to use less instructions to read data from slave station, in other words, each read instruction to read more data.
- If slave station has been configured, please ensure that communication link is normal between the master and slave, and slave stations run fine. If the slave station does not exist, to delete the configuration of slave station.
- Theoretical calculation formula of polling interval in worst case: 80ms * the number of instruction configured in slave station (Note: if all slaves run fine, the worst value is not reached).

5.3.10.2 MODBUS TCP Slave Station Configuration

Right click the slave station that is added under the [MODBUSTCP_MASTER] node, open the MODBUSSLAVE_TCP window, as shown in Figure 5-15.

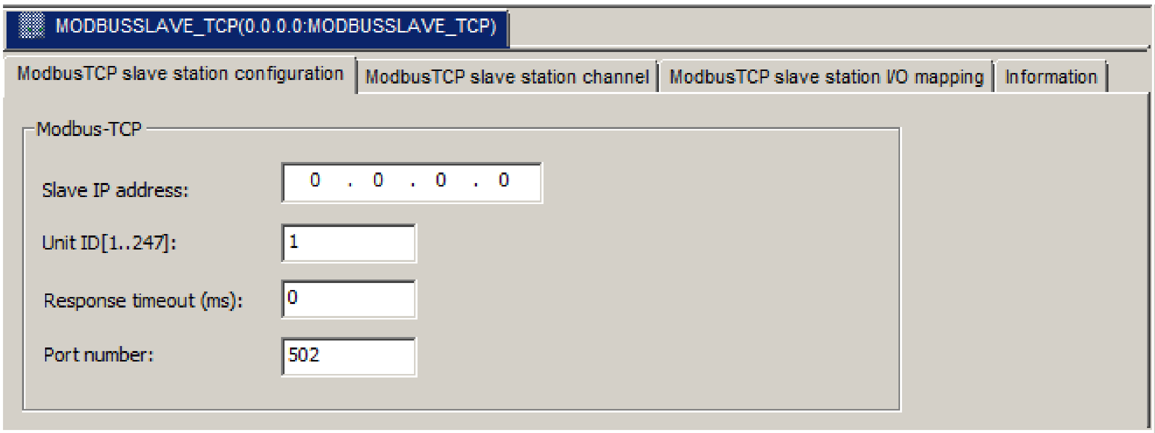


Figure 5-15 MODBUSSLAVE_TCP Slave Station Configuration Window

- Slave IP address: IP address of the slave station requested by master station, which is set according to the actual IP address of slave station.
- Unit ID: MODBUS TCP Protocol Unit ID. The default value is 1, with a range of 1~247.
- Response timeout (ms): the allowed delay response time after the MODBUSTCP master station sends a request frame. The default value is 0, with a range of 0~2,147,483,000.
- Port number: MODBUS TCP protocol port number. The default value is 502, with a range of 1~65,535.

5.3.10.3 MODBUS TCP SLAVE

When the current CPU act as a slave station, the MODBUS TCP communication parameters shall be set. In the AutoThink configuration software, double click the created ［MODBUSTCP_SLAVE］ slave station node under the controller tree node, open the MODBUSTCP_SLAVE slave station configuration window, as shown in Figure 5-16.

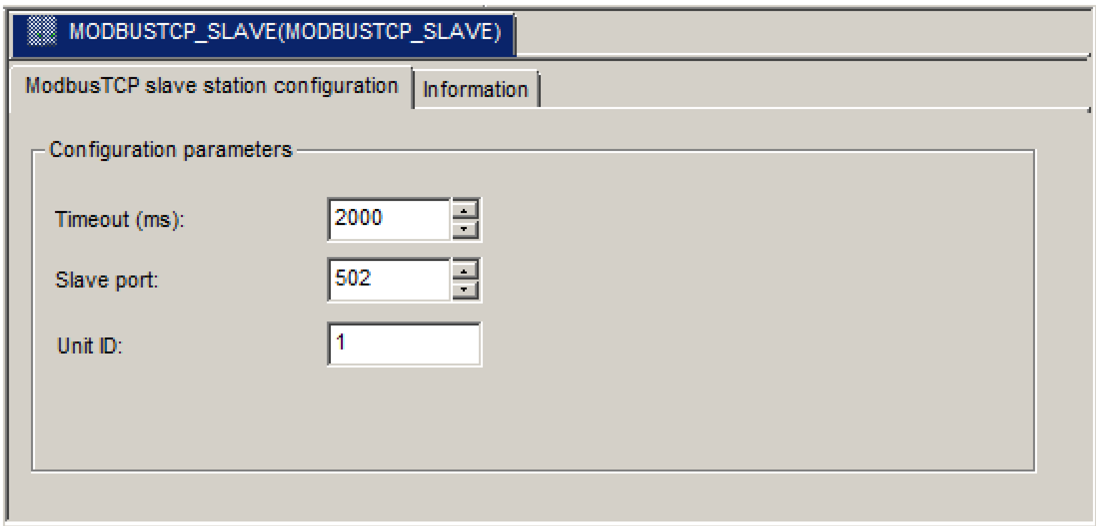


Figure 5-16 Open Configuration Window for MODBUSTCP_SLAVE Slave Station

- Timeout (ms): the time interval in which the slave station has not received the data sent by the master station. If the set time is exceeded, the slave station disconnects the communication link to the master station. The default value is 2000s, with a range of 500~2,147,483,000.

- Slave port: MODBUS TCP protocol port number. The default value is 502, with a range of 1~65，535.
- Unit ID: MODBUS TCP Protocol Unit ID. The default value is 1, with a range of 1~247.

Data areas which is accessed by MODBUS TCP slave protocol include that input area (I area), output area (Q area), middle area（M area).

The three data areas are accessed by BOOL data or WORD data. Mapping relations between the data areas and MODBUS TCP slave protocol is as shown in Table 5-4.

Table 5-4　Mapping Relations between the Data Areas and MODBUS Address

Data area		Type	Address range	MODBUS address	Mapping Relation	X（register type）selection
I area	%IX	BOOL	%IX0.0,… %IX0.7 %IX1.0,… %IX1.7 …%IX374.7	X0000,…X0007 X0008,…X0015 …X2999	IXm.n: m*8+n	Read-only, X selects 1
	%IW	WORD	%IW0, %IW2,…%IW5998	X0000, X0001,…X2999	IWm: m/2	Read-only, X selects 3
Q area	%QX	BOOL	%QX0.0,…%QX0.7 %QX1.0,…%QX1.7 …%QX374.7	X0000,…X0007 X0008,…X0015 …X2999	QXm.n: m*8+n	Read-only, X selects 1 Read and Write, X selects 0
	%QW	WORD	%QW0, %QW2,…%QW5998	X0000, X0001,…X2999	QWm: m/2	Read-only, X selects 3 Read and Write, X selects 4
M area	%MX	BOOL	%MX0.0,…%MX0.7 %MX1.0,…%MX1.7 …%MX7816.7	X3000,…X3007 X3008,…X3015 …X65，535	MXm.n: m*8+n+3000	Read-only, X selects 1 Read and Write, X selects 0
	%MW	WORD	%MW0, %MW2,…%MW125070	X3000,X3001,…X65，535	MWm: m/2+3000	Read-only, X selectes 3 Read and Write, X selects 4

The following four cases describe the mapping relationship through examples:

- Read switch data in I area (or write Q area): such as reading a piece of data beginning from % IX2.6 (or writing % QX2.6), you need to reference mapping formula for BOOL type data in I area (or Q area), reading (or writing) slave start address in the master station to fill should be: 2 * 8 + 6= 22.
- Read analog data in I area (or write Q area): such as reading a piece of data beginning from % IW8 (or writing % QW8), you need to reference mapping formula for WORD type data in I area (or Q area), reading (or writing) slave start address in the master station to fill should be: 8 / 2 = 4.

- Read and write switch data in M area: such as reading and writing a piece of data beginning from % MX2.6, you need to reference mapping formula for BOOL type data in M area, reading and writing slave start address in the master station to fill should be: 2 * 8 + 6 + 3000 = 3022.
- Read and write analog data in M area: such as reading and writing a piece of data beginning from % MW1000, you need to reference mapping formula for WORD type data in M area, reading and writing slave start address in the master station to fill should be 1000/2 + 3000 = 3500.

> - The read and write start address add the data length no greater than 3000 when I area or Q area is accessed in slave station.
> - When data in input area of the IO slave station is used, the slave is online as the prerequisite (the information is obtained from the S area) and the diagnosis information of the slave station is viewed (online state and diagnosis information of the IO slave stations under the LK249 are obtained via the function block), to ensure that the read data is normal.

5.3.10.4 Command Parameter

In the MODBUS master station communication mode, a master station can be configured with up to 32 slave stations. Each slave stations can be configured with up to 32 orders. See Figure 5-17 for the optional orders.

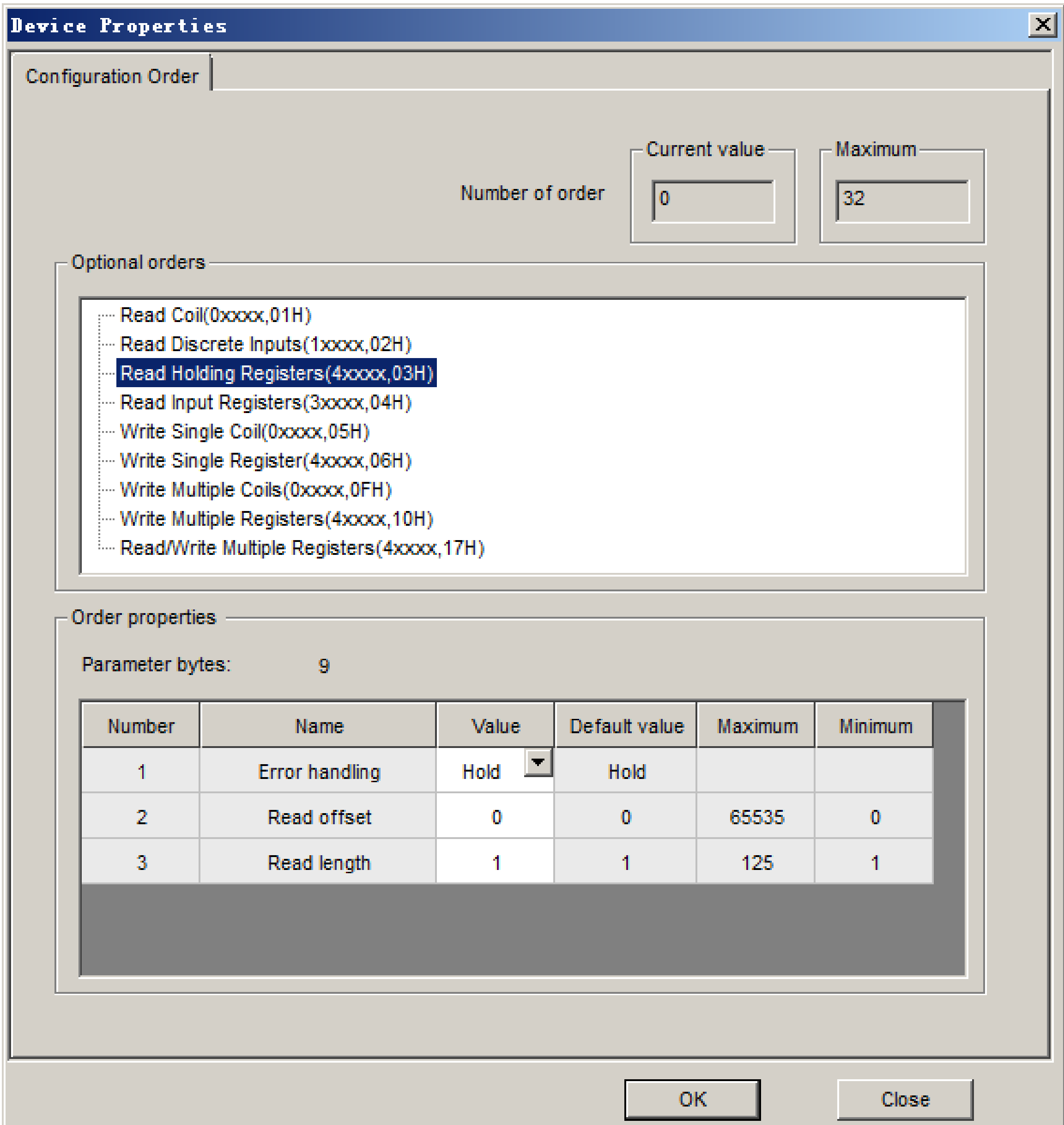


Figure 5-17　Optional Command List of Slave Station

Choose the instructions in **Optional Orders** list, and set parameters, click **OK** to complete adding.

Table 5-5　Listing of Supporting Functional Code

Function Code	Data Area	Function
Read Coil (0xxxx, 01H)	0xxxx	Read the status (ON/OFF) of 1~2000 (0x07D0) continuous logic coils from a remote device
Read Discrete Inputs (1xxxx, 02H)	1xxxx	Read the status (ON/OFF) of 1~2000 (0x07D0) continuous discrete inputs from a remote device
Read Holding Registers (4xxxx, 03H)	4xxxx	Read the binary values for 1~125 (0x007D) continuous holding registers from a remote device

Function Code	Data Area	Function
Read Input Registers (3xxxx, 04H)	3xxxx	Read the binary values for 1~125 (0x007D) continuous input registers from a remote device
Write Single Coil (0xxxx, 05H)	0xxxx	Force to set a single coil output as ON or OFF in a remote device
Write Single Register (4xxxx, 06H)	4xxxx	Force to write a binary value into a single holding register in a remote device
Write Multiple Coils (0xxxx, 0FH)	0xxxx	Force to set each single coil in a group of coils (1~1968 pcs) as ON or OFF in a remote device
Write Multiple Registers (4xxxx, 10H)	4xxxx	Force to write a binary value into a continuous register (1~123 pcs) in a remote device
Read/Write Multiple Registers (4xxxx, 17H)	4xxxx	Read or Write a binary value from a continuous register (1~118 pcs) in a remote device

- The channel value for a coil and discrete command is digital. The channel value for a register is analog.

Table 5-6 Listing of Instruction Parameters

parameter Name	Parameter Value	Default	Description	Name of Commands Having This Parameter
Error handing	Hold, Clear	Hold	Hold: keep the current data upon an abnormal response Clear: clear the current data upon an abnormal response	
Read and write start address	0~65,535	0	The MODBUS Initial Address corresponding to the slave station	
Read and write switch length	1~2000	1	Number of channels corresponding to the slave stations relating to the length value	Read Coil Read Discrete Input Write Multiple Coils
Read and write analog length	1~125	1	Number of channels corresponding to the slave stations relating to the length value	Read Holding Register Read Input Register Write Multiple Register
Read start address	0~65,535	0	The MODBUS Initial Address of Read Memory Area Corresponding to the slave station	Read/Write Multiple Register
Write start address	0~65,535	0	The MODBUS Initial Address of Write Memory Area Corresponding to the slave station	
Read analog length	1~118	1	Number of Channels Reading Analog Data	
Write analog length	1~118	1	Number of Channels Writing Analog Data	

- Read: Master station data memory area I and M.
- Write: Master station data memory area Q and M.

MODBUS start address=first address in command data area +Read and write start address, MODBUS end address=zero address in command data area +Read and write start address + Read and write length.

Taking the Read Discrete inputs (1xxxx,02H) command for instance, Read and write start address is set as 10, Read and write switch length is set as 20, then MODBUS start address is 10001+10, that is, 10,011. MODBUS end address is 10000+10+20, with the address range of 10,011~10,030.

5.3.11 Redundancy Data Area

The task cycle is set to 50 ms, the maximum matching redundancy data is 512KB. The redundancy data increases each 100KB with the task cycle increasing10 ms. That is, task cycle corresponding to the 612KB redundancy data is 60ms. Redundancy data includes all data which in N area, G area, R area, I area, Q area, between %MB0 and maximum variable address defined in M area. Among them, the direct address used directly in M area and address accessed by MODBUS TCP does not belong to redundant data when using the M area address, the maximum variable address represents the size of the entire M area. If only the address% MB999 is used between address% MB0 ~% MB1000, the all address between % MB0 ~%999 are redundant. You should pay attention to avoid that overmuch data area is wasted and effect redundancy rate when you define a variable in M area.

Variables which have been deleted in G and R area are not released, and you can execute full compilation to reduce the memory occupied by variables.

Stop data redundancy between master and slave frame when IEC running cycle not matches with the size of the engineering data area configured. The function block sysGetRedState report the error code 130.

5.3.12 Technical Specifications

LK220　Master Control Module	
Operating Speed	
CPU	667MHz
Execution Speed of Commands	Typical value 2.5DMIPS/MHz
Memory	
Program memory	32MB (16MB for the system, 16MB for users)
Data memory	512MB, 800Mbps, bit width 32
Power-loss retentive memory	512KB
Extend memory	SD card , max. 32GB
Ethernet	
10/100M	2-channel Dual network interfaces in redundancy, supporting the TCP/IP protocol
Real-time clock	
Data Format	YY:MM:DD:HH:MM:SS, BCD code
Clock precision	No more than 1 minute/month @25℃
PCIE Bus	
Communication Speed	Meet PCIE(1.0) interface 2.5Gb/S
with a load capacity	4-channel×1
Debugging interface	
RS232	2-channel

LK220 Master Control Module	
Rate	115200bps
Protection Rating	
Protection Rating	IP20
Hot-swappable	
Hot Plug	Support hot-plug of the module and the SD card
Scale of Single System	
IO Capacity	IO supported by system is not less than 10,000 points
Configuration Capacity	
Input Variable Area (Area I)	The max. space is 128KB
Output Variable Area (Area Q)	The max. space is 128KB
Global Variable Area (Area G)	The max. space is 5MB
Free Variable Areas (Zone M)	The max. space is 5MB
Retain Area (Area R)	The max. space is 64kB
Specified Register Area (Area S)	The space is fixed to be 2KB
Power Supply	
Input Voltage	Related to the output of LK921
Module Dissipation (max.)	7.2W
Backup Battery	Based on battery/capacitance power supply
Dual-machine Redundancy	
Dual-machine Redundancy	Support dual-machine redundancy
Starting Time	
Time from the moment when the module is powered on to the moment when the user's project begins	≤40 s
Physical Property	
Installation Pattern	Backboard slot
Module Dimension (W*H*D)	44.7 mm*166 mm*152 mm ±0.5mm
Weight	382 g

5.4 LK249 DP Master Station Communication Module

LK249 is a DP master station communication module for large-scale PLC of the new-generation LK Series. The module has 2 DB9 communication interfaces, supporting Hollysys PROFIBUS-DP master station communication protocol. It can be connected to up to 124 slave stations.

5.4.1 Features

- Support the PROFIBUS-DP master station communication protocol

- Hot swapping
- Two DB9 interfaces

5.4.2 Appearance and Size

5.4.2.1 Appearance

Figure 5-18 LK249 Module Schematic Diagram

As shown in Figure 5-18, the LK249 module panel is provided with:

- 5 LED indicators, indicating the running status of the LK249 module in real time.
- Two DB9 interfaces.

5.4.2.2 Module Size

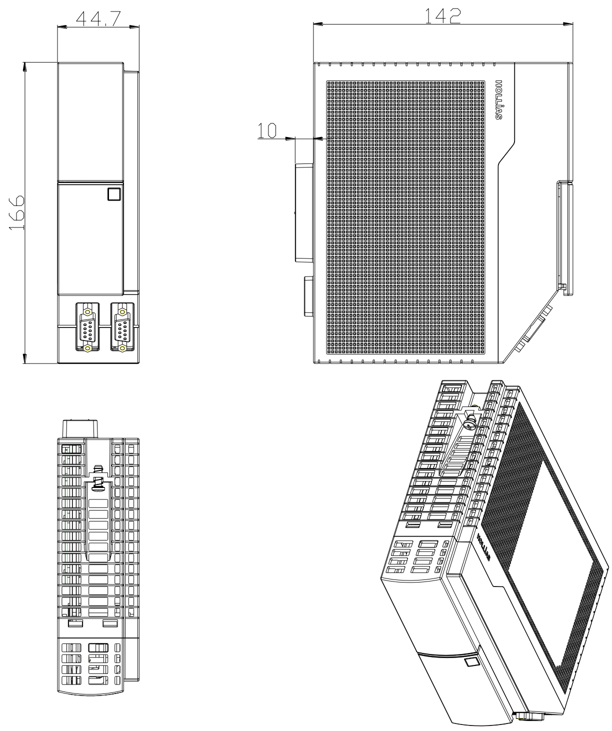


Figure 5-19 LK249 Module Size

5.4.3 Status Indication

Table 5-7 Instructions to Status Indicator

Name	Function	Colour	Status	Description
PWR	Indication of power supply	Yellow	On	The power supply works regularly.
			Off	The power fails/not powered on
RUN	Indication of operating pattern	Green	Slow flashing	The module is working properly.
			On/Off	The module fails.
ERR	Indication of module failure	Red	On	The module appearance fails.
			Off	The module is free of failures.
DP1	Indication of data sending/receiving via DP Communication Interface 1	Green	Slow flashing	DP Communication Interface 1 is sending/receiving data
			On/Off	DP Communication Interface 1 does not send/receive data
DP2	Indication of data sending/receiving via DP Communication Interface 2	Green	Slow flashing	DP Communication Interface 2 is sending/receiving data
			On/Off	DP Communication Interface 2 does not send/receive data

- Slow flashing: with a frequency of 1Hz

- Quick flashing: with a frequency of 4Hz

5.4.4 Operating Principle

The DB9 interface of the LK249 module receives the data sent from the I/O device. Upon conversion via RS485, the signal is converted into a signal supported by the bottom protocol, with the interfering signal coming from the field eliminated via an isolator. The signal is transmitted to MUC for processing.

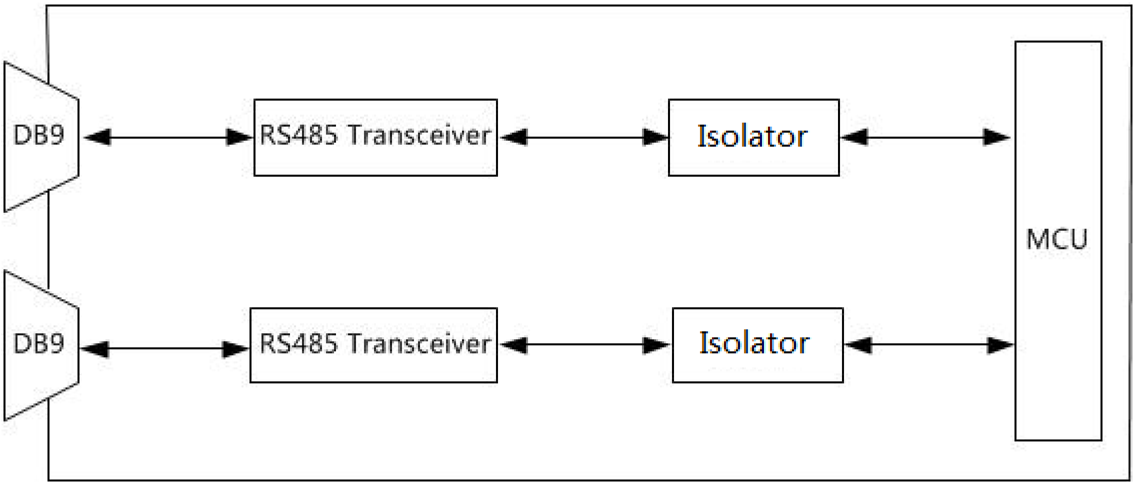


Figure 5-20 LK249 Internal Schematic Diagram

The DP master station in the master frame is in operation. The DP master station in the slave frame is in the listening mode. The data is synchronized periodically between the DP master stations. When the controller switches between the master and slave machines, the DP master station also switches accordingly.

5.4.5 Terminal Definition

The LK249 module has two DB9 interfaces with each redundancy, which used to connect the IO devices and DP master station communication module in the redundancy cabinet.

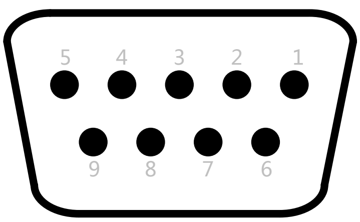


Figure 5-21 DB9 Interface Schematic Diagram

Table 5-8 DB9 Pin Signal Definition

Pin	Signal Definition	Description
1/4/9	NC	Not used
2、3	DP+	DP signal positive
5	DP1_GND	Signal grounding
6	DP1_5V	5VDC power supply

Pin	Signal Definition	Description
7, 8	DP1-	DP signal negative

See Section 3.2.3.3 LKA104 PROFIBUS-DP Bus Connector for the connection between LK249 and the LKA104 bus connector.

5.4.6 Diagnosis

- LK249 can diagnose the following functions: module status diagnosis (module failure).
- Internal module failure (FPGA failure, PCIe link failure).
- Dual DP link break failure.

5.4.7 Set Baud Rate

In the AutoThink software, double click the configured DP_MASTER node under the [Hardware Configuration] node, to open the **Device Information** window, as shown in Figure 5-22 to set the Baud rate.

The Baud rate is the communication rate between the controller and the IO device. It can be set as 500, 187.5 and 1500 (unit: kbps).

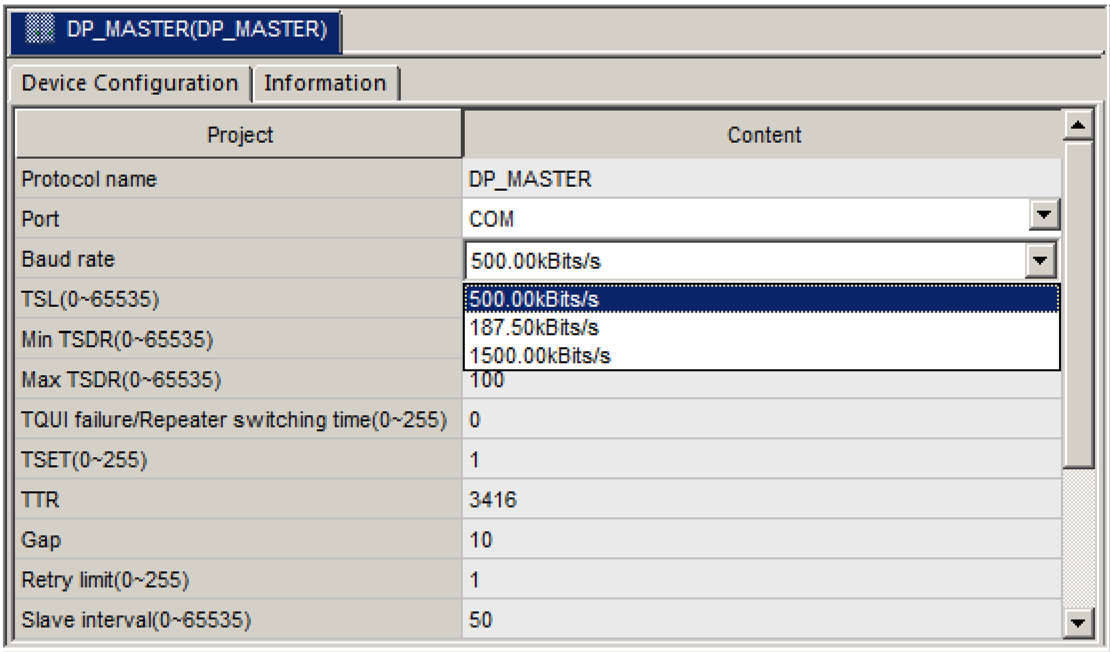


Figure 5-22 DP_MASTER Device Information Window

5.4.8 Technical Specifications

LK249 DP Master Station Communication Module	
Processor	
CPU platform	ARM
Memory	
SRAM	Off-chip memory, 512KB, bit width 16

LK249 DP Master Station Communication Module	
DP bus	
Number of Channels	2
Physical Interface	1 double-layer DB9 receptacle
Communication Rate	187.5kbps, 500 kbps, 1.5M bps
PCIE Bus	
Communication Speed	Meet PCIE(1.0) interface
with a load capacity	1-channel X1
Transmission Speed	2.5GB/sec
Protection Rating	
Protection Rating	IP20
Hot-swappable	
Hot Plug	Supported
Power supply	
Input voltage	Related to the output of LK921
Module Dissipation (max.)	6W
Dual-network Redundancy	
Dual-network Redundancy	The DP bus supports redundancy
Starting Time	
Time from the moment when the module is powered on to the moment when initialization is done	≤10 s
Physical Property	
Installation Pattern	Backboard slot
Module Dimension (W*H*D)	44.7mm*166mm*152mm±0.5 mm
Weight	365 g

5.5 LK240 Redundancy Communication Module

LK240 is the redundancy communication module in the large-scale PLC redundancy system. It is the dedicated module for data synchronization between the master frame and the slave frame in the redundancy system. Redundancy communication between the master frame and the slave frame can be realized via respective redundancy communication modules by taking optical fiber as the medium. It is connected to the LK130 backboard module via the bus connector.

- Features
  - Determine the master/slave mechanism
  - Support gigabit optical fiber communication
  - Support 2-channel fiber interfaces

- ☐ Hot swapping
- ☐ Support anti-reverse insert

5.5.1 Appearance and Size

5.5.1.1 Appearance

Figure 5-23 LK240 Module Schematic Diagram

As shown in Figure 5-23, the LK240 module panel is provided with:

- 10 LED indicators, indicating the running status of the LK240 module in real time.
- 1 DIP switch, setting Series A/B of the current CPU.
- Two fiber interfaces

5.5.1.2 Module dimension

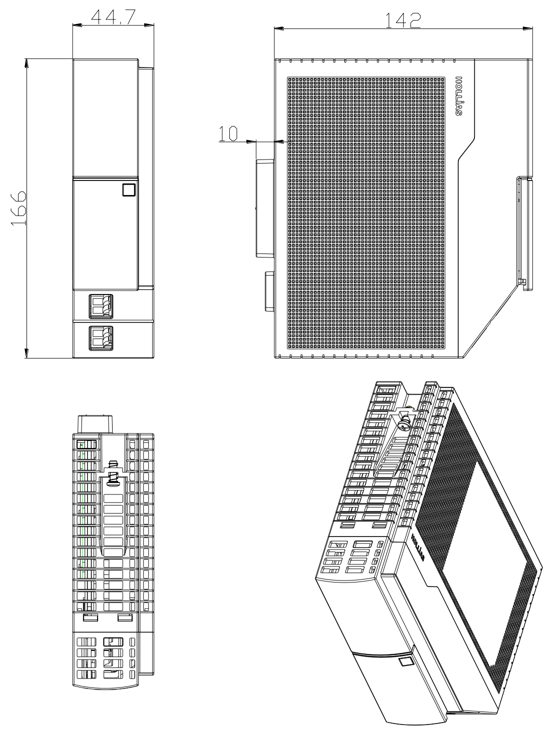


Figure 5-24 LK240 Module Dimension

5.5.2 Status Indication

Table 5-9 Instructions to Indicator Lamps

Name	Function	Colour	Status	Description
PWR	Indication of power supply	Yellow	On	The power supply is normal
			Off	The power supply fails.
RUN	Indication of operating pattern	Green	On/Off	The firmware does not work regularly.
			Slow flashing	The firmware works regularly.
ERR	Indication of module failure	Red	On	The module fails.
			Off	The module is free of failures.
RDNT	Indication of redundancy communication	Green	On/Off	Redundancy communication fails.
			Slow flashing	Redundancy communication work regularly.
STDB	Indication of master-slave status of CPUs	Green	On	The current CPU is in standby mode
			Off	The current CPU is in running mode
			Slow flashing	The master-slave status is not determined.
A/B	Indication of Machine A/B	Green	On	The current CPU is Machine A

Name	Function	Colour	Status	Description
			Off	The current CPU is Machine B
TX1	Indication of data sent via Fiber Interface 1	Green	Slow flashing	Fiber Interface 1 is sending data
RX1	Indication of data received via Fiber Interface 1	Green	Slow flashing	Fiber Interface 1 is receiving data
TX2	Indication of data sent via Fiber Interface 2	Green	Slow flashing	Fiber Interface 2 is sending data
RX2	Indication of data received via Fiber Interface 2	Green	Slow flashing	Fiber Interface 2 is receiving data

- Slow flashing: with a frequency of 1Hz
- Quick flashing: with a frequency of 4Hz

5.5.3 Operating Principle

Upon signal conversion via the Ethernet transceiver, the data from the fiber interface is transmitted to FPGA for logical processing, which is then transmitted to the CPU module via the PCIE backboard bus.

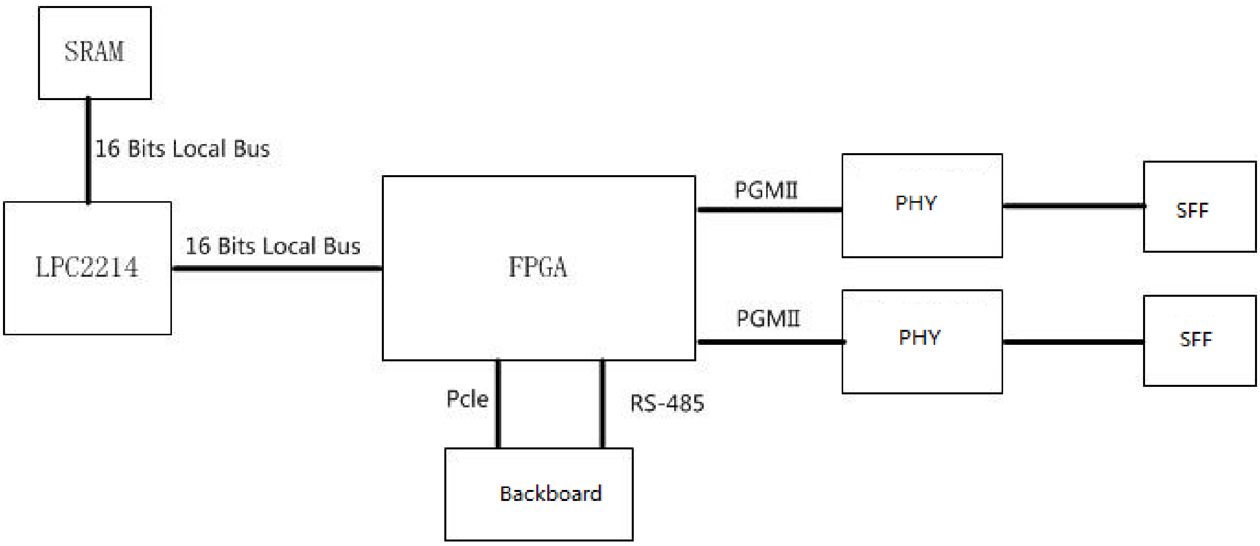


Figure 5-25 LK240 Module Block Diagram

Optical fiber interface in two redundant communication modules is connected by special optical cable to data communication. The two links work redundantly. When a link failure and another link without fault, it can switch to normal link automatically with the switching time no more than 10ms, thus improving the reliability of continuous system operation.

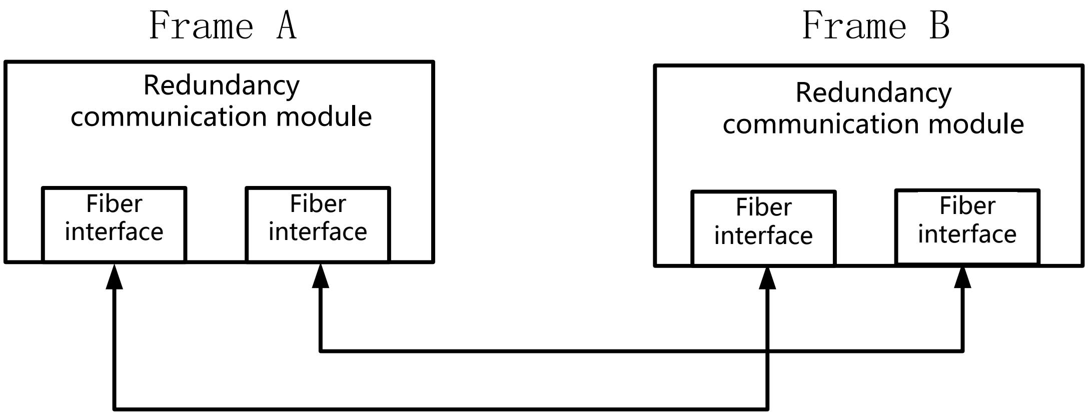


Figure 5-26 Redundancy Communication Schematic Diagram

5.5.4 Wiring

The LK240 redundancy communication module has two optical fiber communication interfaces, both of which are standard LC fiber interfaces, based on a communication rate of 1Gbps and above. Each fiber interface includes one TX and one RX, which are cross connected to the redundancy communication module of another frame, with one as the sender and the other as the receiver. Take a fiber interface for instance, as shown in Figure 5-27.

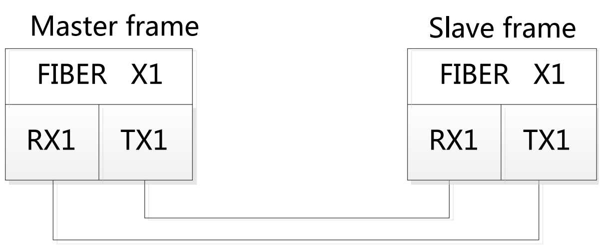


Figure 5-27 LK240 Optical Fiber Connection

Table 5-10 Definitions of LK240 Cable Ports

Port Identifier	Meaning
TX1	Transmitting end, Channel 1
RX1	Receiving end, Channel 1
TX2	Transmitting end, Channel 2
RX2	Receiving end, Channel 2

5.5.5 Set A/B Frame

It can set the current CPU as Machines A or B via the two-bit DIP switch on the front panel.

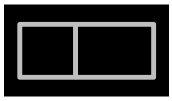


Figure 5-28 Series A/B DIP Switch Schematic Diagram

- Switch to the SYS-A position, set the current CPU as Machine A.
- Switch to the SYS-B position, set the current CPU as Machine B.

You need to restart the controller in current frame to make settings effective after the A/B DIP switch was modified.

5.5.6 Master-slave Determination

When the redundancy module is powered on with no fault in current, it can determine whether the module that is newly powered on is the master or the slave machine according to the following principle. The master-slave determination principle (with a descending priority) is:

- The last running status of the controller. When the last redundancy is regular, then the master-slave status is kept unchanged.
- The module involved in a project is the master one.
- When a dual-machine project and the last running status are same, then Machine A is the master one.

> • It is recommended that, in case of dual frame operation, it shall firstly power up the master frame, then power up the slave frame after the master frame works regularly.

5.5.7 Conditions of Master-slave Switchover

In the following cases, the master switches to slave when the slave station works normally. The switching process is non disturbance which will not affect the output of the control process.

- Conditions of triggering master-slave switchover
  - Power failure (One CPU module is power off)
  - Major failure in the controller (PCIE link failure, FPGA failure)
  - Plug and pull the module on the backboard
  - Any module failure on the backboard
  - Communication link failure in the DP master station module (dual-DP link break failure, PCIE link break failure in the DP module, FPGA failure)
  - Dual Ethernet connection is broken
  - Call the sysMasterSwitchToSlave (master-slave switchover) command in AutoThink to make a switchover

After switching redundant controller, RTC restores default value. The controller timing needs to be operated as following:

- Each controller timing is operated alone after power on.
- Configure SET_RTC function blocks for redundancy controller timing at the same time. Refer to *HollySys Programmable Logic Controller PLC Instruction Manual* for SET_RTC function block.

5.5.8 Technical Specifications

LK240 Redundancy Communication Module	
Processor	
CPU platform	ARM
Memory	
SRAM	Off-chip memory, 512KB, bit width 16
Fiber Interface	
Number of Channels	2
Interface Type	LC type
Media Redundancy	Supported
PCIe Bus	
Communication Speed	Meet PCIE(1.0) interface, 2.5Gb/S
with a load capacity	1-channel X1
Protection Rating	IP20
Hot Plug	Supported
Power supply	
Input voltage	Related to the output of LK921
Module Dissipation (max.)	6W
System Performance	
Redundancy Performance	The redundant switching time is no more than 130 ms
Starting Time	
Time from the moment when the module is powered on to the moment when initialization is done	≤10 s
Physical Property	
Installation Pattern	Backboard slot
Module Dimension (W*H*D)	44.7 mm*166 mm*152 mm±0.5 mm
Weight	365 g

5.6 LK141-A Empty Module

LK141 is an empty module of LK series controller, which only has a structure part, without circuit board, and be used to cover unused empty slots on the backboard.

Figure 5-29 LK141-A Module Schematic Diagram

Chapter 6 IO Unit

6.1 Power Module

6.1.1 LK910 24VDC Power Module

6.1.1.1 Basic Features

- Input voltage: 100VAC ~ 120VAC / 200 ~ 240VAC, switch selection
- Output voltage: 24VDC
- Input-output isolation
- Rated power: 120W
- 1 + 1 redundancy
- Output short circuit protection
- Output over-temperature protection
- Output overload / overvoltage protection
- Output status inquiry

LK910 achieve AC 110VAC / 220VAC to 24VDC DC conversion, input and output isolation, output rated power 120W. LK910 has output short circuit protection & automatic recovery after the power fault is eliminated. An output status inquiry function, state switch is turned on when the power output is normal, Otherwise off. Provide the interface for remote diagnosis power state.

LK910 has modular design with overall structure of aluminum material, strong anti-seismic & anti – interference ability.

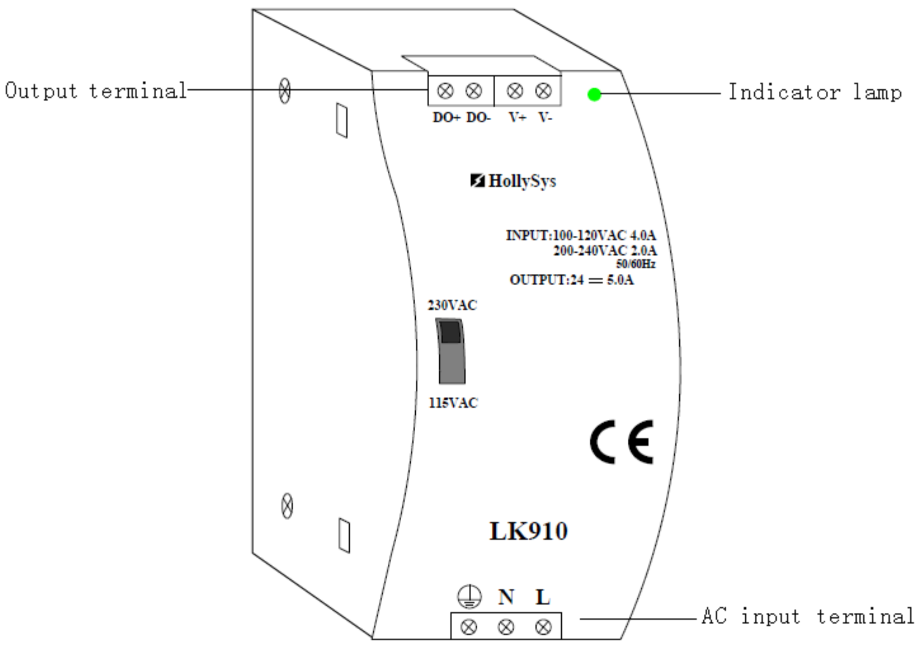


Figure 6-1 LK910 Wiring Terminals and Indicator Lamp

6.1.1.2 Operating Principle

LK910 power input 110VAC or 220VAC, and output 24VDC after EMI suppression and rectifier circuit.

AC input part in LK910 includes the input protection, input rectifier, noise filtering circuit to complete AC power rectification and filtering, while suppressing electromagnetic interference coming from the electrical network to ensure that the AC input is not be interfered by electromagnetic. Then, control circuitry outputs 24VDC after overvoltage protection, current-limiting protection. And display the working status of the power module by the alarm output terminal "DO +", "DO-". Alarm output circuit is achieved by the optical coupling devices, the optocoupler is turn on when the power supply is normal, while output indicator lamps is on. The optocoupler is turn off when the output is owed-voltage, while the output lights is off.

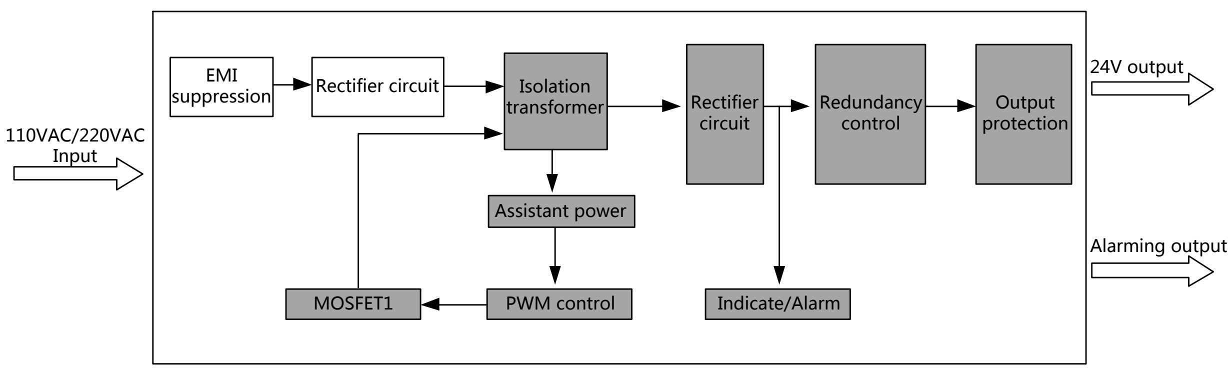


Figure 6-2 LK910 Schematic Diagram

6.1.1.3 Instructions for using

1. Indicator Lamp and Terminal

After the module power up, the green LED indicator lamp on the front panel displays the current working state. The indicator light is on when power supply is normal.

Terminals are located in upper and lower ends on the module. The 24VDC output terminals and the alarm output terminals in the upper end, the AC input terminals in the lower end. The specifically definition as shown in Figure 6-3.

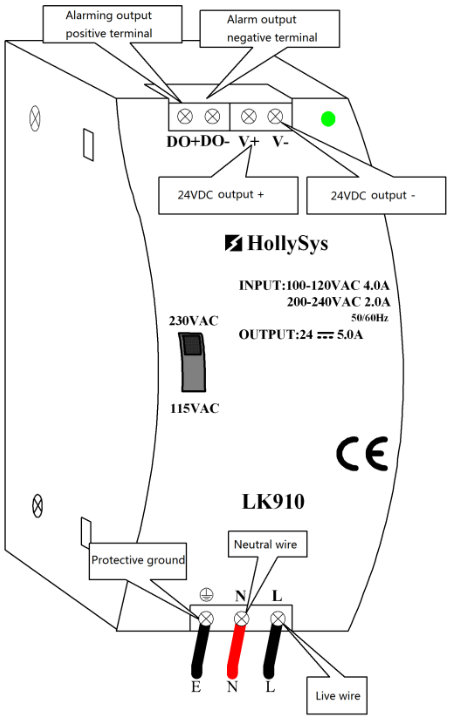


Figure 6-3 LK910 Wiring Terminals Instruction

2. Parallel redundancy

For improving the reliability of the system, LK910 power supply can be configured as two or more parallel operation to reduce the fault caused by the power supply. Dual redundancy power is achieved by using rectifier diodes. The undisturbed switching and replacing of the power is achieved in the 1 + 1 mode, redundancy power supply configuration as shown in Figure 6-4.

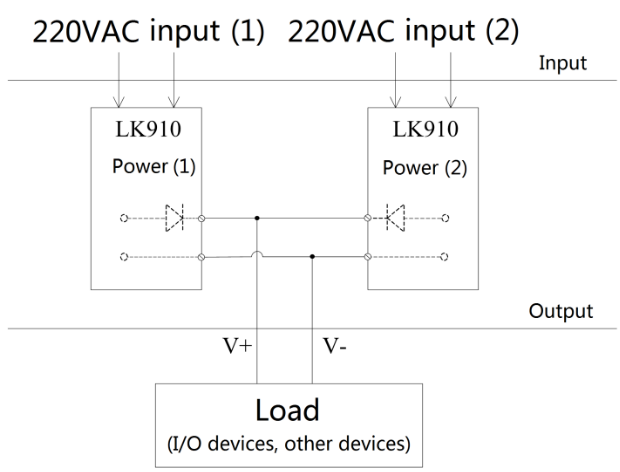


Figure 6-4 LK910 Power Redundancy Configuration

6.1.1.4 Installation Dimension

The LK910 power module adopt standard rail mounting, with mounting slot on the back, installation dimensions as shown in Figure 6-5.

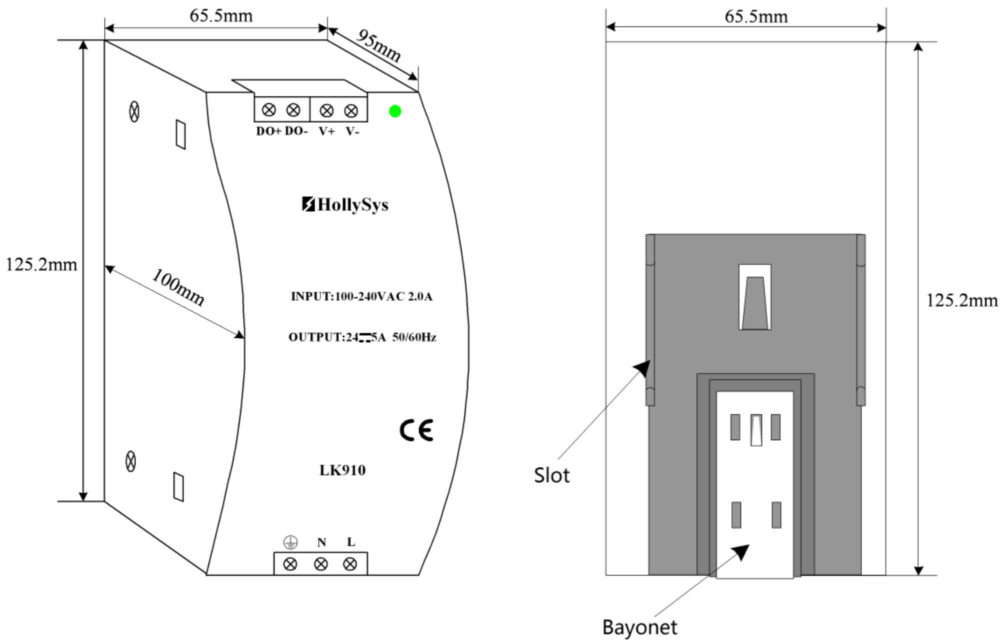


Figure 6-5 LK910 Appearance Dimension Diagram

6.1.1.5 Technical Specifications

LK910 24VDC Power Module	
Input	
Input voltage range	100 VAC~240 VAC
Input frequency range	47 Hz~63 Hz
Output	
Rated output	24 VDC±5%
Rated output current	5 A
rated power	120 W
Ripple (Including noise)	<240 mV
Load adjusting rate	<±5%
Voltage adjusting rate	<±2%
Step load characteristics	<±5%@ the load sudden change from 20% to 70%, stable time<50 ms
Conversion efficiency	>80%
Maintaining time	220VAC input, 70% load, the output not less than 95% rated voltage with maintaining 30 ms ater the power off
Cooling method	Natural cooling
1+1 parallel redundancy	Supported
Output overload protection	105%~150%, automatically recovery after eliminating the overload

LK910 24VDC Power Module	
Output overvoltage protection	120%~140% rated voltage
Output short circuit protection	Output short circuit fault protection, power automatically recovery after fault is eliminated
Power fault state output	The state switch is turned on when power is normal, otherwise off. state switch is isolated with power
Ouput state indicate	Indicator lamps is on when ouput is normal
insulation	
Insulation resistance	Input and shell: 500 VDC, >100 MΩ Input and output: 500 VDC, >100 MΩ Output and shell: 500 VDC, >100 MΩ
Dielectric Voltage withstan	Input and shell:1500 Vrms, 1 min., leakage current<10 mA Input and output: 3000 Vrms, 1 min., leakage current <10 mA Output and shell: 500 Vrms, 1 min., leakage current <20 mA
Environmental Condition	
Ambient Temperature for Operation	-10℃~+50℃, and full-load output in 50℃
Storage Temperature	-20℃~+80℃
RH	5%~95%, with no condensation
Physical Property	
Module Dimension (W*H*D)	65.5 mm×125.2 mm×100 mm
Installation Pattern	Standard rail mounting
Standards and Certification	
Safety certification	UL508,TUVEN60950, CE
EMC	EN55022/EN55011classB
	EN61000-4-2/3/4/5/6/8/11
	EN61000-3-2/3
	EN61000-6-2
	ENV50204

6.2 Extension Backboard

The extension backboard can only install IO module. E.g. LK117 for example, as shown in Figure 6-6, Slot 1 is the communication module slot, installed with a LK-dedicated communication module. Slots 2~11 are I/O module slot, installed with an I/O module of the DP bus interface. Each terminal block corresponds to an I/O module, directly connecting to the field signal via an I/O cable.

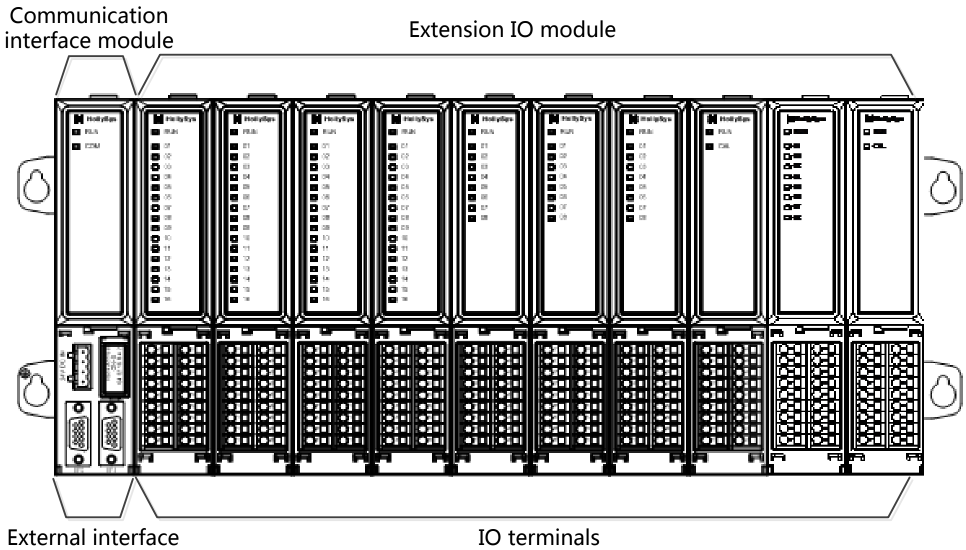


Figure 6-6 Structure of LK117 Backboard

As shown in Figure 6-7, the extension backboard supports the redundant DP bus. It provides the DP bus input and output interfaces and connects to the local backboard for extending the I/O points. In case of multiple extension backboard cascade connection, it shall better adopt serial connection, not allowed to connect multiple extension backboards to a local backboard.

The extension backboard does not provide the terminal matching resistance for the DP bus, with the matching resistance provided by the communication module.

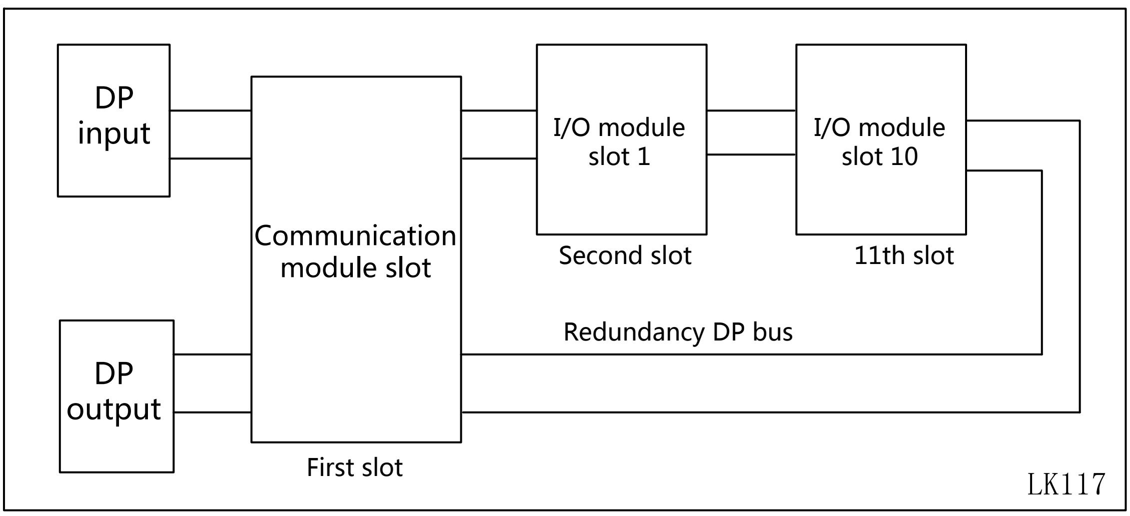


Figure 6-7 Internal Structure of Extension Backboard

6.2.1 Interface Specification

The extension backboard interfaces can be divided into power supply interface and communication interface.

6.2.1.1 24 VDC Power Supply Interface

The 24VDC working power supply for the hardware module on the backboard is led in from the power supply interface of the backboard.

Table 6-1 Signal Definition of Power Connector on Extension Backboard

Pin No.	Terminal Identifier	Meaning
1	L+	24V+
2	L+	24V+
3	M	GND
4	M	GND

6.2.1.2 Communication Interface

The I/O module on the extension backboard communicates and exchanges data with the CPU module on the local backboard via the PROFIBUS-DP bus interface. The DP bus interface is a DB9 hole receptacle.

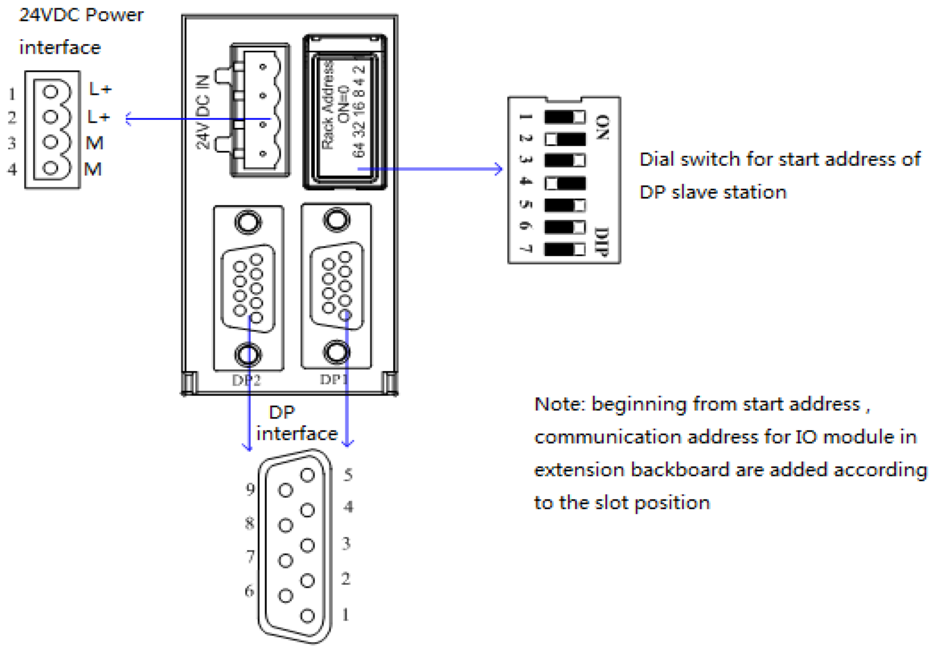


Figure 6-8 Power and Communication Interfaces of LK117 and LK118 Backboards

6.2.1.3 PROFIBUS-DP Bus Interface

The DP bus interface realizes the communication between the I/O module on the backboard and the controller on the local board, adopting two DB9 hole receptacle connectors.

- During wiring, it can work with the LKA104 PROFIBUS-DP bus connector, leading in and out the DP cable via LKA104.

Refer to chapter 3.2.3.3 LKA104 PROFIBUS-DP Bus Connector for the detailed information on wiring.

Table 6-2 Signal Definition of DP Connectors on LK117 Backboard

Pin No.	Signal Name	Meaning
1	Null	Null

Pin No.	Signal Name	Meaning
2	DPIN+	DP incoming line, signal positive
3	DPOUT+	DP outgoing line, signal positive
4	Null	Null
5	GND	GND
6	+5V	5VDC, provided by the communication module
7	DPIN-	DP incoming line, signal negative
8	DPOUT-	DP outgoing line, signal negative
9	Null	Null

6.2.2 Communication Address

The communication address of the I/O module consists of the backboard base address and the backboard offset address.

Taking LK117 for example, the base address is the communication address of the first I/O module from the left, which is set via the 7-bit dial code DIP switch on the backboard. The backboard offset addresses of the 2nd~11th I/O slave station modules are 1~10, as shown in Figure 6-9.

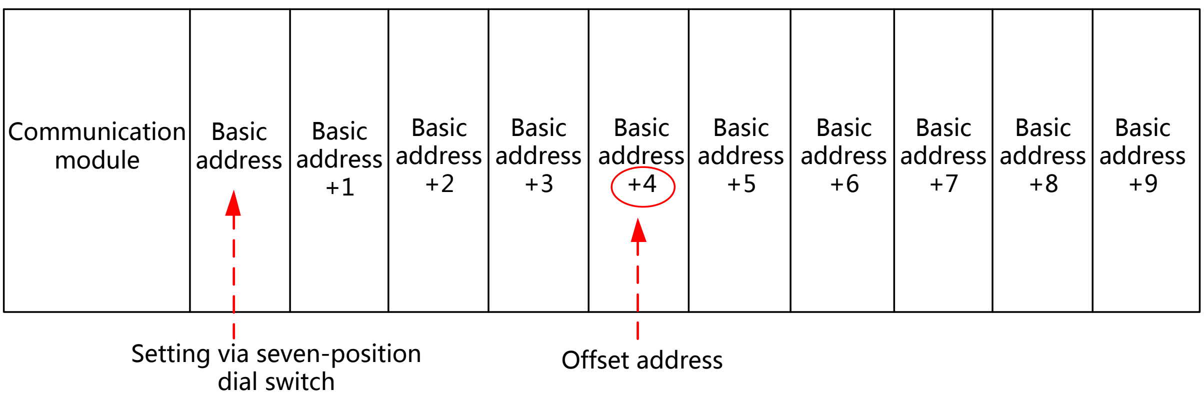


Figure 6-9 Communication Address Allocation of I/O Module on LK117 Backboard

When certain bit of the dial code on the DIP switch is turned to the **ON** side, the bit is 0. When turned to the numeric side, the bit is 1. The 7-bit dial codes are combined into a binary number from high to low. It's corresponding decimal number is the base address of the backboard.

See the following for the conversion:

Base Address=64×K7+32×K6+16×K5+8×K4+4×K3+2×K2+1×K1

Notably, Ki (i=1~7) indicates the status of the 1th dial code

For example, the DIP switch is set successively from high to low as 0001010, the corresponding decimal number 10 is the base address of the extension backboard, and then the communication addresses of the I/O modules on the LK117 backboard are successively: 10, 11, 12, 13... 19.

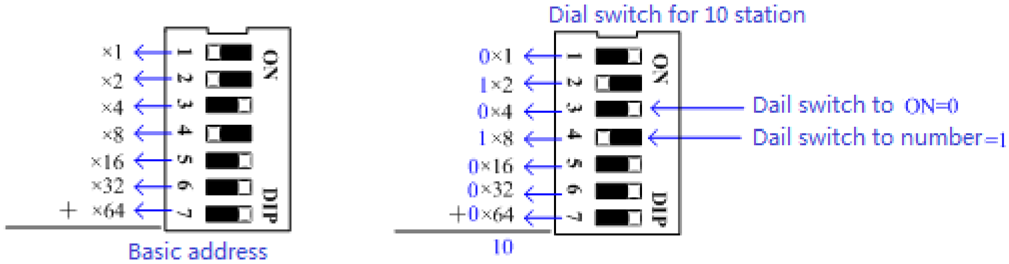


Figure 6-10　Setup of Backboard Base Address

- In case of multiple backboard cascade connection, it cannot set the communication addresses repeatedly.

6.2.3　LK117　11-slot Extension Backboard

6.2.3.1　Composition

- 1 communication slot, 10 I/O slots
- Dial code of the base address of the slave station
- Redundant PROFIBUS-DP bus interface, DB9 hole receptacle
- To support the cascade connection of the extension backboard
- 24 VDC system power supply interface, 4-pin receptacle
- Shrapnel terminals, pluggable

6.2.3.2　Installation Dimension

Apart from power supply, all other LK hardware modules are installed on the backboard. The LK backboard is surface mounted, fastened to the mounting surface with M4 screws.

All the module widths on the extension backboard are 35 mm. Therefore, for a LK117 backboard, the horizontal spacing between the crew hole centers on both sides is (35×11+16.5) mm＝401.5 mm, with the vertical spacing between the screw hole centers on the same side of 90 mm, as shown in Figure 6-11.

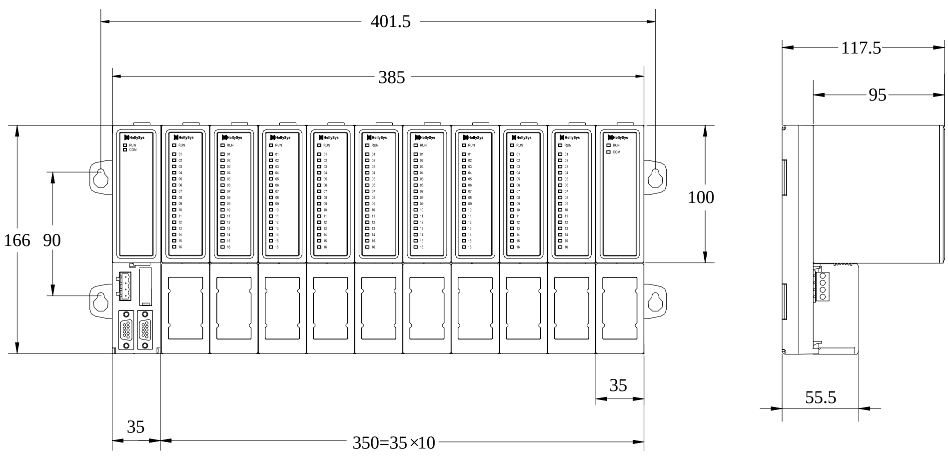


Figure 6-11　Installation Dimension of LK117 Backboard

6.2.3.3 Technical Specifications

LK117 11-slot Extension Backboard	
Slot and Interface	
Number of Slots	11 slots (1 communication slot, 10 I/O slots)
PROFIBUS-DP Interface	DB9, hole receptacle, receptacle duplex
System Power Supply Interface	4-pin receptacle, connected to 24 VDC system power supply
Isolated and voltage withstand	
Channel-to-channel	≥ 1000 VAC@1 min, leakage current: 5 mA
Channel-to-system	≥ 1000VAC@ 1min, leakage current: 5 mA
Electrical Specification	
Input voltage	24 VDC (-15%~20%)
Terminal Matching Resistance	None, can be provided by the communication module
Physical Property	
Installation Mode	Plane installation
Module Dimension (W*H*D)	385 mm×166 mm×55.5 mm
Enclosure Protection Rating	IEC60529 IP20
Weight	1740 g

6.2.4 LK118 5-slot Extension Backboard

6.2.4.1 Composition

- 1 communication slot, 4 I/O slots
- Dial code of the base address of the slave station
- Redundant PROFIBUS-DP bus interface, 9-pin Type-D receptacle
- 24VDC system power supply interface, 4-pin receptacle
- To support the cascade connection of the extension backboard
- Pluggable & Shrapnel I/O terminals

LK118 is a 5-slot extension backboard, as shown in Figure 6-12, from the left, Slot 1 is a communication module slot, installed with a communication module. Slots 2~5 are I/O module slots, installed with 4 I/O modules of the DP bus interface. The corresponding terminal beneath the I/O module slot is used to connect the field I/O module.

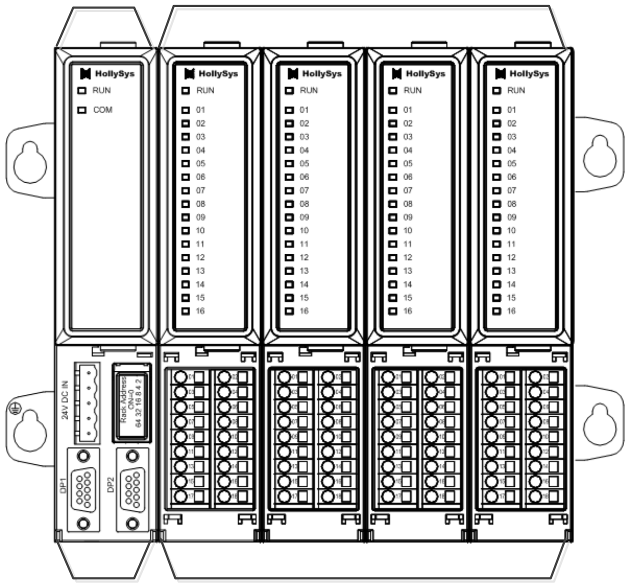


Figure 6-12　Structure of LK118 Backboard

Refer to Figure 6-13 for the internal structure of the LK118 extension backboard.

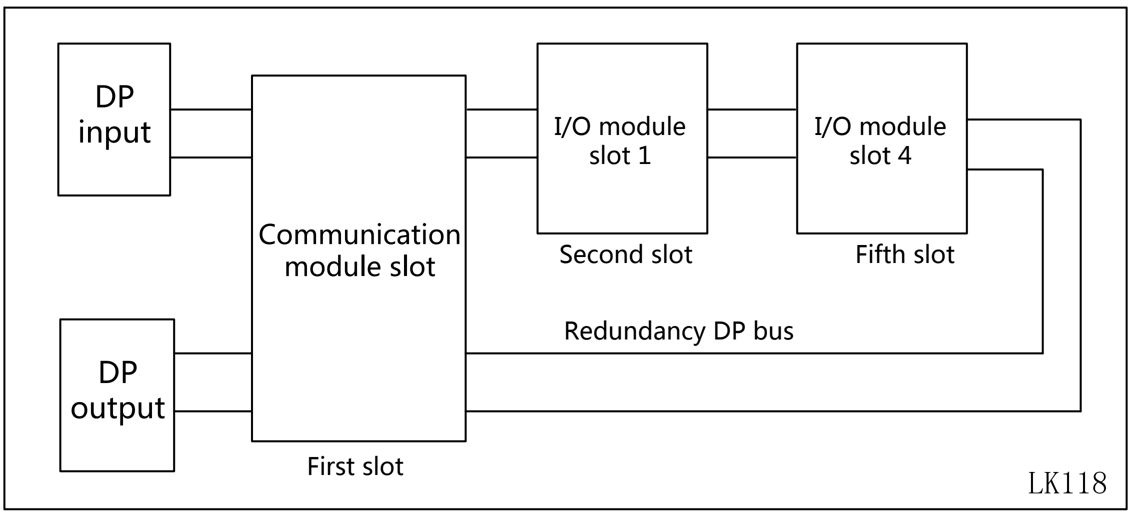


Figure 6-13　Internal Structure of Extension Backboard

6.2.4.2　Installation Dimension

Apart from power supply, all other LK hardware modules are installed on the backboard. The LK backboard is surface mounted, fastened to the mounting surface with M4 screws.

All the module widths on the extension backboard are 35 mm. Therefore, for a LK118 backboard, the horizontal spacing between the crew hole centers on both sides is (35×5+16.5) mm= 191.5 mm, with the vertical spacing between the screw hole centers on the same side of 90 mm, as shown in Figure 6-14.

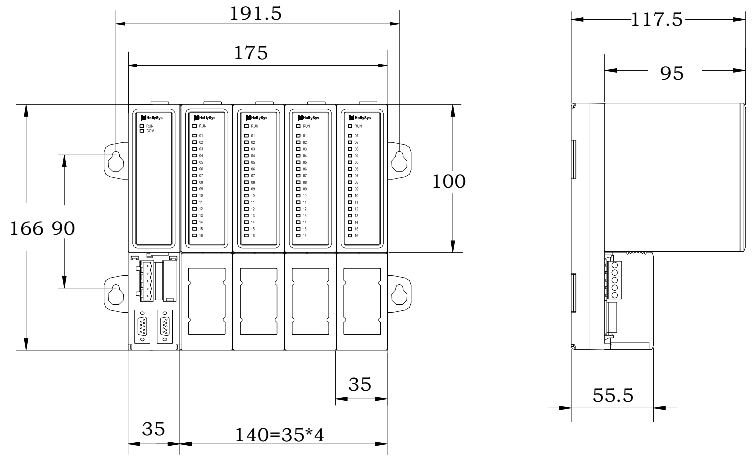


Figure 6-14 Installation Dimension of LK118 Backboard

6.2.4.3 Technical Specifications

LK118 5-slot Extension Backboard	
Number of Slots	
Number of Slots	5 slots (1 communication slot, 4 I/O slots)
PROFIBUS-DP Interface	DB9, hole receptacle, receptacle duplex
System Power Supply Interface	4-pin receptacle, connected to 24 VDC system power supply
Isolated and voltage withstand	
Channel-to-channel	≥500 VAC@1 min@5 mA
Channel-to-system	≥500 VAC@1 min@5 mA
Electrical Specification	
Input voltage	24 VDC (-15%~20%)
Terminal Matching Resistance	None, can be provided by the communication module
Physical Property	
Installation Mode	Plane installation
Module Dimension (W*H*D)	210 mm×166 mm×55.5 mm
Enclosure Protection Rating	IEC60529 IP20
Weight	880 g

6.3 Communication Module

6.3.1 LK232 PROFIBUS-DP Bus Repeater Module

6.3.1.1 Basic Features

- To extend the physical length of the PROFIBUS-DP bus
- To isolate the two PROFIBUS-DP buses
- Installed on the extension backboard
- To provide the terminal matching resistance for the PROFIBUS-DP bus
- Hot swapping

6.3.1.2 Operating Principle

LK232 is the repeater module of the PROFIBUS-DP bus, installed on the first slot on the left of the extension backboard.

If the transmission distance is too long or load is too high, it can result in weak of transmitted signal on twisted pair. LK232 outputs two DP signals after selecting a normally working one for shaping and amplification from two redundant DP signals, as shown in Figure 6-15.

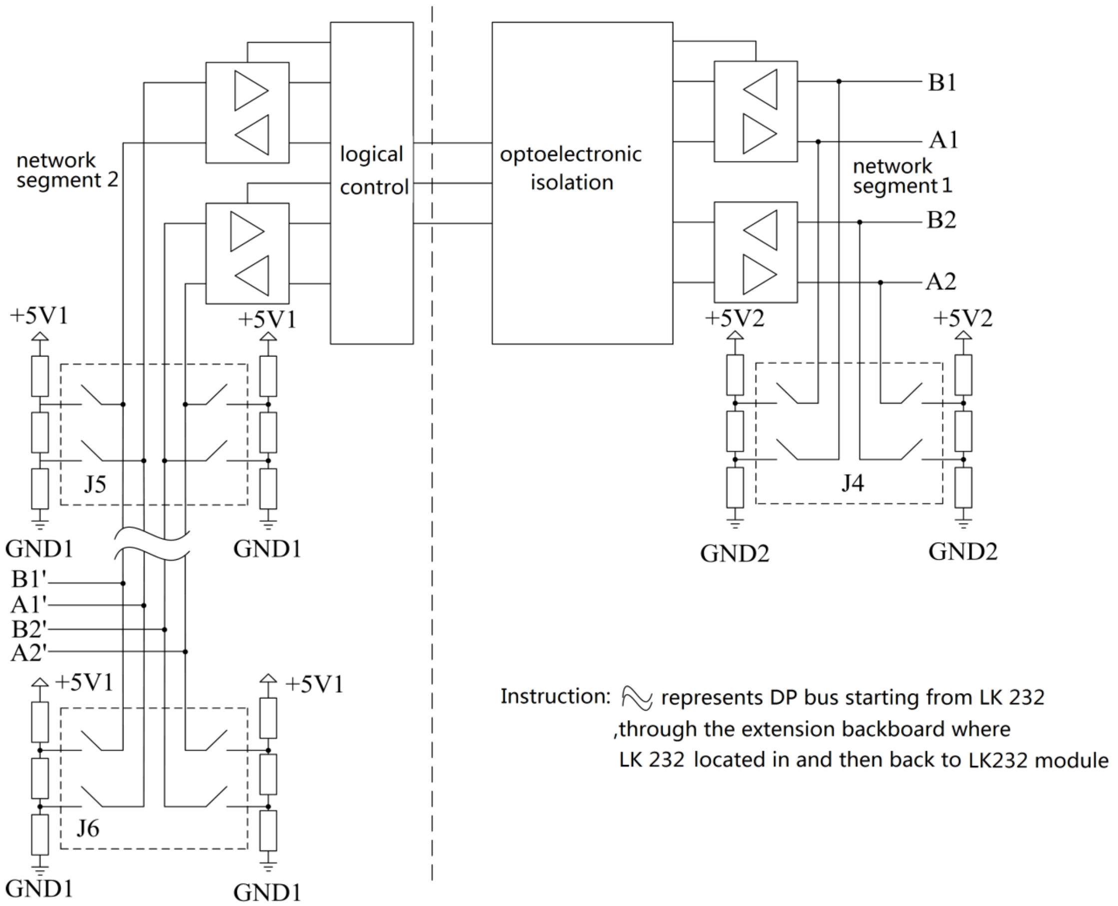


Figure 6-15 Bus Transition Diagram of LK232

To avoid the interference on the bus from spreading along the whole bus, it can isolate the two segments of the DP bus via the DP bus repeater.

The LK232 module has a DIP switch. It can set whether to connect the DP bus with an active matching resistance network. The factory settings are defaulted to disconnect the terminal matching resistance.

The LK232 module is installed in the far left communication slot of the extension backboard. The protection key is coded as A5.

DP bus is extended by LK232 with using LKA104 connector together.

6.3.1.3 Terminal Matching

For the built-in terminal matching DIP switch (J4, J5, J6) of LK232, as shown in Figure 6-17, it can select whether to connect the PROFIBUS-DP bus with an active matching resistance network.

You need to set dial switch in LK232 which located in each extension board when LK232 is used with LKA104, You can set J5,J6 as ON, and J4 as OFF to configure the terminal resistance in the backboard side. Matching resistance in initial terminal and in end terminal of DP bus are provided by LKA104, As shown in Figure 6-16.

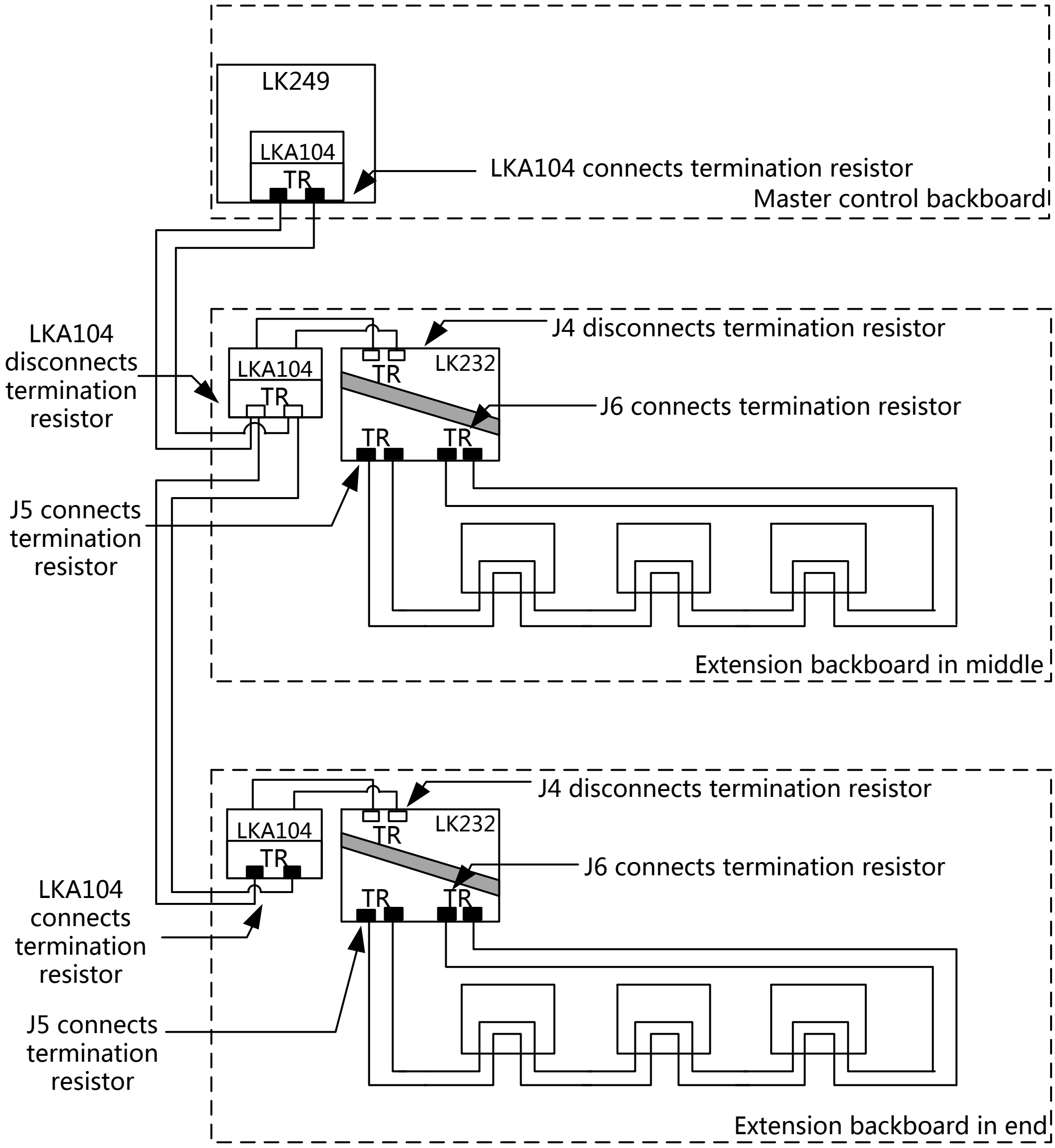


Figure 6-16 Terminal Matching Resistance Settings

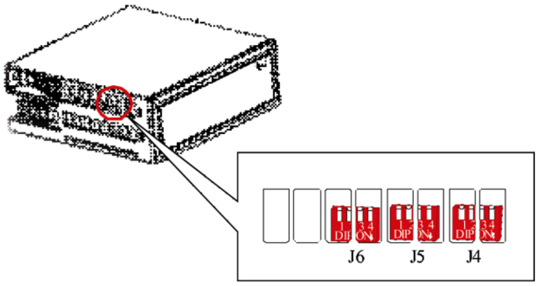


Figure 6-17 Position of LK232 Terminal Matching DIP switch

The DIP switch of LK232 is in the module, defaulted as not been connected with the terminal matching resistance. It is not required to disassemble the enclosure when changing the position of the switch. Via the heat emission hole of the enclosure, it can conveniently set the position by using a small **flathead** screwdriver, as shown in Figure 6-18.

The four keys of each DIP switch are turned consistently when setting. When the four keys are dialed downward at the same time, which is in **ON** status, the terminal matching resistance is connected. When the four keys are dialed upward at the same time, which is in **OFF** status, the terminal matching resistance is disconnected.

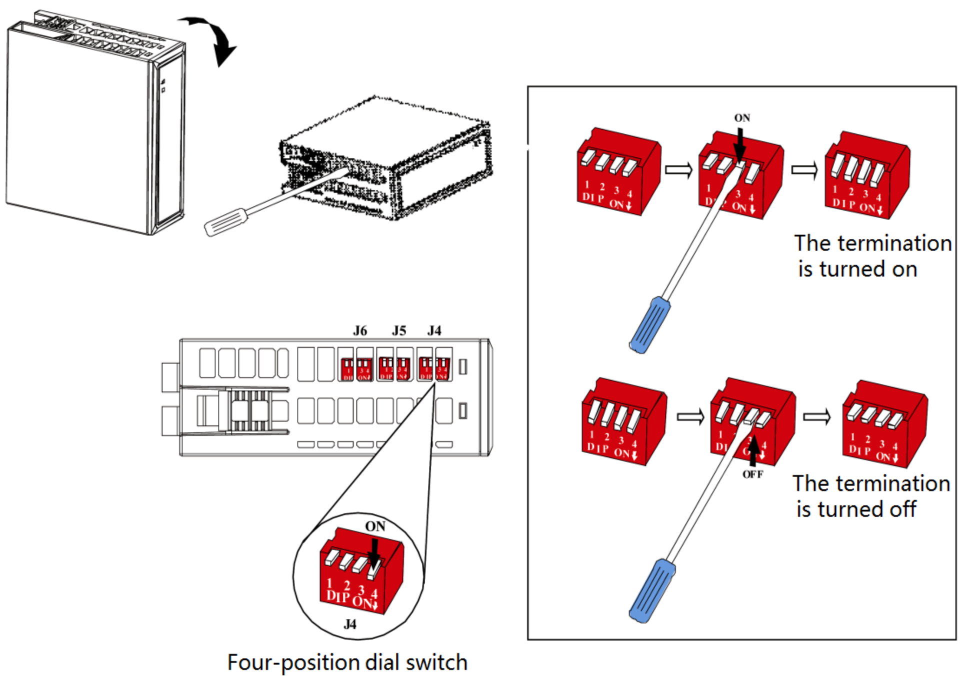


Figure 6-18 Setting LK232 Terminal Matching DIP Switch

6.3.1.4 Indicator Lamps

The definitions for the Indicator lamps of the LK232 module are as shown Table 6-3, the **RUN** indicates the communication link between LK232 and the CPU module. The **COM** lamp indicates the communication link between LK232 and the extension I/O module.

Table 6-3 Definitions of LK232 Indicator Lamps

Name	Status	Description
RUN (green)	Flash	No data transmission between LK232 and controller.
	On	Data is being transferredby PROFIBUS-DP bus between LK232 and controller.
	Off	The module is no power or damaged.
COM (yellow)	Flash	Data is being transferred by PROFIBUS-DP bus between LK232 and IO modules . The greater the data volume , the higher the flashing frequency.
	Off	No data transmission between LK232 and IO modules.

- Flashing frequency of the RUN lamp: on for 125ms and off for 125 ms.
- Flashing frequency of the COM lamp: flash once when transmitting 30 data packages each time

6.3.1.5 Technical Specifications

LK232 PROFIBUS-DP Bus Repeater Module	
Backboard Power Supply	
Operating Voltage	24VDC（-15%~20%）
Power consumption	60 mA max.@24 VDC
Isolation Voltage	
Network Segments 1 and 2	To test for 1 minute based on 500 VAC, with a leaking current 5 mA
Communication	
Protocol	PROFIBUS-DP
Dual-network Redundancy	Supported
Communication rate	9.6 kbps, 19.2 kbps, 31.25 kbps, 45.45 kbps, 93.75 kbps, 187.5 kbps, 500 kbps, 1.5 Mbps self-adapting
Physical Property	
Installation Mode	Slot Installation
Installation Position	Communication slots of extension backboard
Protection Key	A5
Module Dimension (W*H*D)	35 mm×100 mm×100 mm
Hot Plugging	Supported

6.3.2 LK233 PROFIBUS-DP Bus Optoelectronic Transceiver

6.3.2.1 Basic Features

- To extend the transmission distance of the PROFIBUS-DP bus
- Dual redundant transmission
- To support multi-mode glass fiber (6.25/150 um or 50/150 um), ST interface
- To provide the terminal matching resistance
- Installed in the I/O slot of extension backboard
- Hot swapping

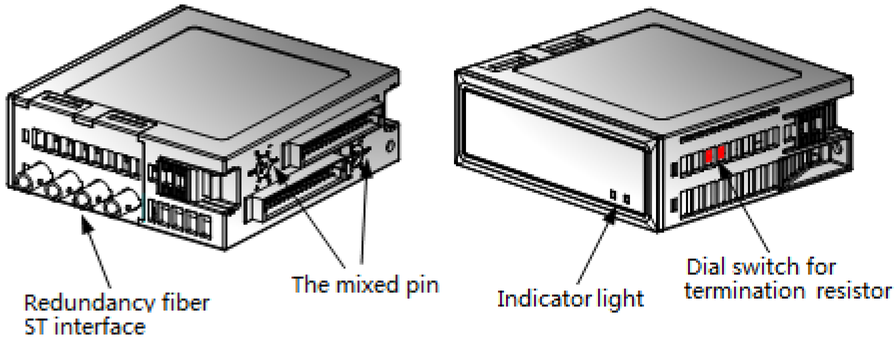


Figure 6-19 External View of LK233 Module

LK233 is the optoelectronic transceiver module of the PROFIBUS-DP bus. It is applied to special engineering fields requiring protection against electromagnetic interference, lightning, chemical corrosion and long-distance transmission, etc. LK233 interconverts the opto-electronic transmission media of the DP bus network in the physical layer, extends the physical length of the DP bus, thus ensuring the security and validity of data transmission.

LK233 provides two optical fiber channels, which can realize the redundant transmission of DP optical fibers.

LK233 is installed in the I/O slot of the extension backboard, with the protection key coded as A5. The LK232 repeater module is installed in the communication slot of the backboard, used jointly with LK233.

The LK233 modules are used in pairs, realizing data exchange and communication between the CPU module and the remote I/O module. The near-end LK233 module converts the electrical signal of the CPU module into an optical signal, and then sends it to the far-end LK233 module via optical fiber. The far-end LK233 module restores the received optical signal into an electrical signal, and then sends it to the I/O module. Inversely, the far-end LK233 module converts the electrical signal of the I/O module into an optical signal, and then sends it to the near-end LK233 module via optical fiber. The near-end LK233 module converts it into an electrical signal and then uploads it to the CPU module.

In the network system, upon each access of a LK233 module pair, a new network segment or link is created. LK233 can divide the PROFIBUS-DP bus into multiple network segments. Refer to Figure 6-20 for the basic network topology structure. Both ends of the electrical signal network segment transmitted by each RS-485 are connected to a terminal resistance. The terminal resistance at one end is connected (defaulted to be disconnected) via the DIP switch inside LK233. The terminal resistance at the other end is provided by the communication module (defaulted to be disconnected).

A LK233 module can drive multi-mode glass fiber for up to 5km. It can support up to a 4-segment cascade connection, with 4-pair (8) LK233 modules connected to 5 backboards, based on the max. extension communication distance 4×5 km＝20 km.

The optoelectronic transceiver module of the LK233 module requires no configuration. It can be used directly and occupies one I/O slot. It occupies one node in terms of electrical specification, without occupying a logic node. However, since the slave station addresses of the backboard are allocated in sequence, the LK233 module still occupies a slave station address.

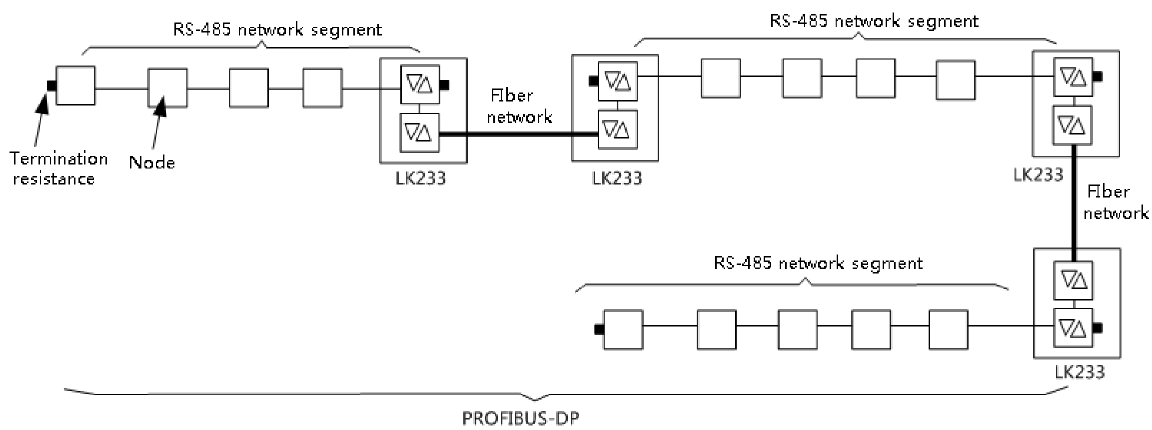


Figure 6-20 Network Topology Structure Connected with Optical Fiber

6.3.2.2 Operating Principle

As shown in Figure 6-21, LK233 outputs two DP optical signals after selecting a normally working one for photoelectric conversion from two redundant DP electrical signals.

When sending data, the DP electrical signal is transmitted from the DP bus on the backboard. It is converted into an optical signal and transmitted via optical fiber. When receiving data, the DP optical signal is transmitted from the optical fiber receiver. It is converted into an electrical signal and then transmitted to other I/O modules via the DP bus on the backboard.

DIP Switch J5 is used to connect the terminal matching resistance, defaulted to be disconnected.

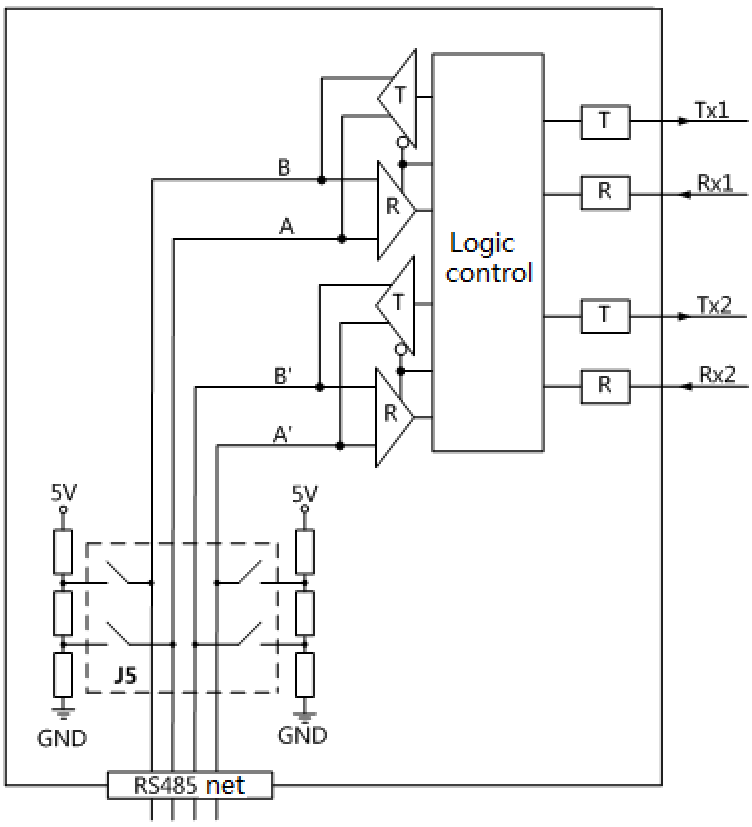


Figure 6-21 Internal Structure Diagram of LK233

6.3.2.3 Terminal Matching

For the built-in terminal matching DIP switch (J5) of LK233, it can select whether to connect the PROFIBUS-DP bus with an active matching resistance network or not.

The DIP switch is located in the module, defaulted as not to be connected with the terminal matching resistance. It is unnecessary to disassemble the enclosure when changing the position of the switch. Via the heat emission hole at the top enclosure of the module, it can conveniently set the position by using a small flathead screwdriver, as shown in Figure 6-22.

The four keys of the DIP switch are turned consistently when setting. When the 4 keys are dialed downward at the same time, which is in **ON** status, the terminal matching resistance is connected. When the 4 keys are dialed upward at the same time, which is in **OFF** status (default), the terminal matching resistance is disconnected.

DIP Switch J6 on the right of DIP Switch J5 is a reserved switch and requires no settings. It can just hold the default status.

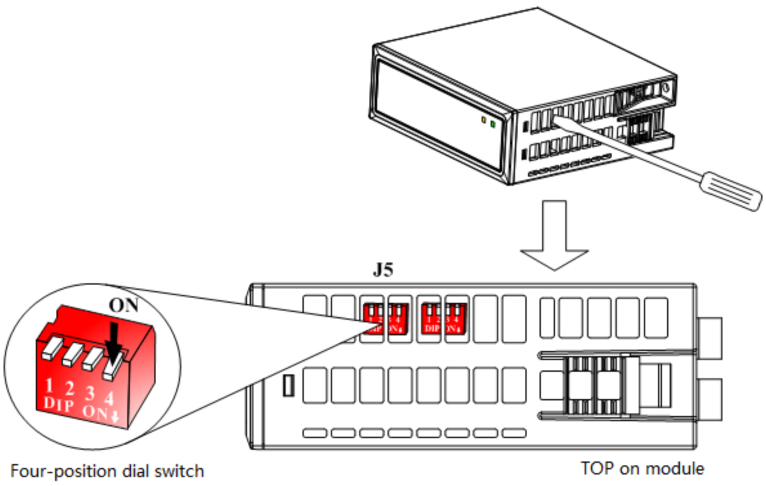


Figure 6-22　Position of LK233 DIP Switch

The whole DP bus is divided into multiple network segments by optical fiber. Both ends of each network segment are connected to the terminal matching resistance. Terminal matching resistance in master control backboard is provided by LKA104 or LKA101 and network segment on the extension backboard refer to the following principles for a specific settings:

When the LK232 module is installed in the communication slot, the matching resistances of the initial and end terminals are provided by the LK232 module. The LK233 module can be installed in any I/O slot, with the DIP switch turned to **OFF**. DIP Switch J5, J6 of the LK232 module are turned to **ON**. Terminal resistance connection is shown in Figure 6-23.

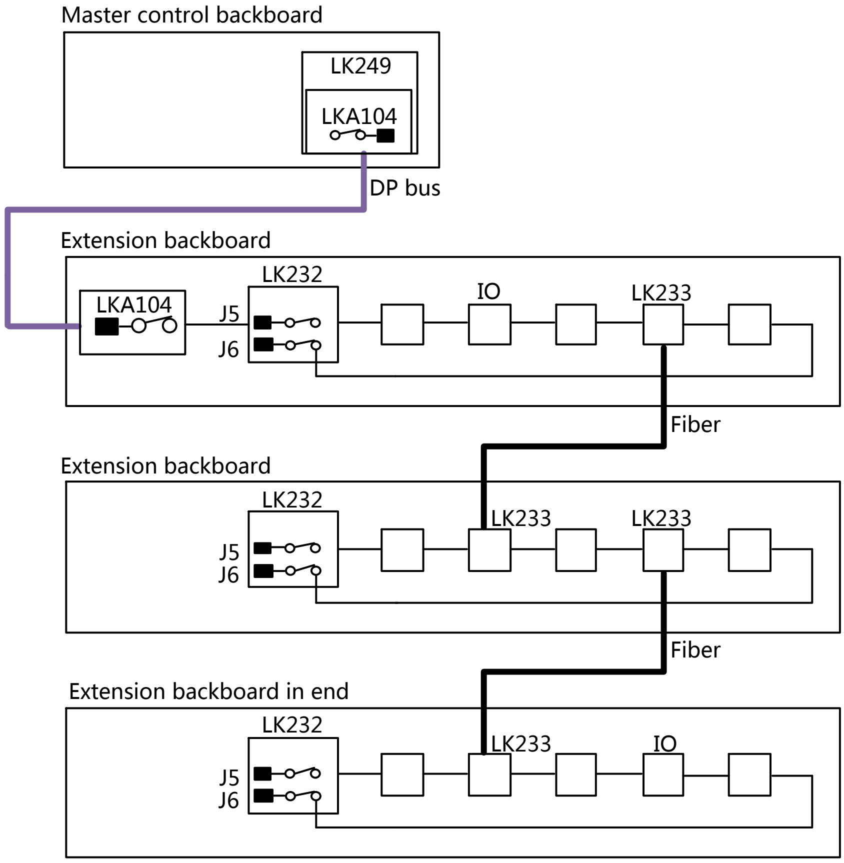


Figure 6-23 Terminal Resistance Connection Working with LK233 and LK232

LK233 must be placed in system end when backboard is expanded by LKA104 and LKA233 module.

6.3.2.4 Indicator Lamps

Refer to Table 6-4 for the definitions of the indicator lamps of the LK233 modules. The **RUN** lamp indicates the communication link between LK233 and the CPU module. The **COM** lamp indicates the communication link between LK233 and the extension I/O module.

Table 6-4 Definition of Indicator Lamps of LK233

Lamp Name	Status	Meaning
RUN (green)	Flash	No data transmission is available for the PROFIBUS-DP bus between LK233 and the CPU module
	On	Data transmission is available for the PROFIBUS-DP bus between LK233 and the CPU module
	Off	The module is not powered up or damaged.
COM (yellow)	Flash	Data transmission is available to the PROFIBUS-DP bus of between LK233 and the I/O module. The greater the data volume is, the higher the flashing frequency is.
	Off	No data transmission is available for the PROFIBUS-DP bus between LK233 and the I/O module

- Flashing frequency of the RUN lamp: on for 125ms and off for 125 ms.
- Flashing frequency of the COM lamp: flash once when transmitting 30 data packages each time.

6.3.2.5 Wirings

- The optical fiber port of LK233 is located at the bottom of the module. Wiring cannot be applied to the I/O terminal block under the module slot.

The LK233 module can be used with 62.5/125 or 50/125 um multi-mode glass fiber, as well as plastic or ceramic ST type connectors, with a wave length of 1300 nm. The max. length of an optical cable section is 5 km, supporting multi-section cascade connection.

The optical fiber type is selected by the user according to the network environment. It can determine the optimal optical fiber type for specifically applied environmental conditions by consulting professional installation personnel.

The optical fiber cables are cross-connected between the two modules, with one end used for transmitting and the other end used for receiving. The transmitting end (TX) is connected to the receiving end of another LK233 module (RX). And vice versa, as shown in Figure 6-24.

See the following for the steps to connect optical fiber:

(1) Dismantle the protective cap of the module port and keep the protective cap properly for future application.

(2) Plug the optical cable connector into the port by aligning the knob of the optical cable connector with the groove of the module port.

(3) Tighten the optical cable connector till the bayonet socket lug is locked into place.

(4) Keep the protective cap of a port that is not used on the port to avoid dust.

Table 6-5 Definitions of LK233 Cable Ports

Port Identifier	Meaning
TX1	Transmitting end, Channel 1
RX1	Receiving end, Channel 1
TX2	Transmitting end, Channel 2
RX2	Receiving end, Channel 2

The PROFIBUS-DP communication link between two LK backboards cannot be connected to optical fiber and STP at the same time. When the communication link is changed from STP to optical fiber, the switchover sequence when powered up is: firstly to plug out the STP, disconnect the DP communication, then install the LK233 module to switch to the optical fiber mode successfully.

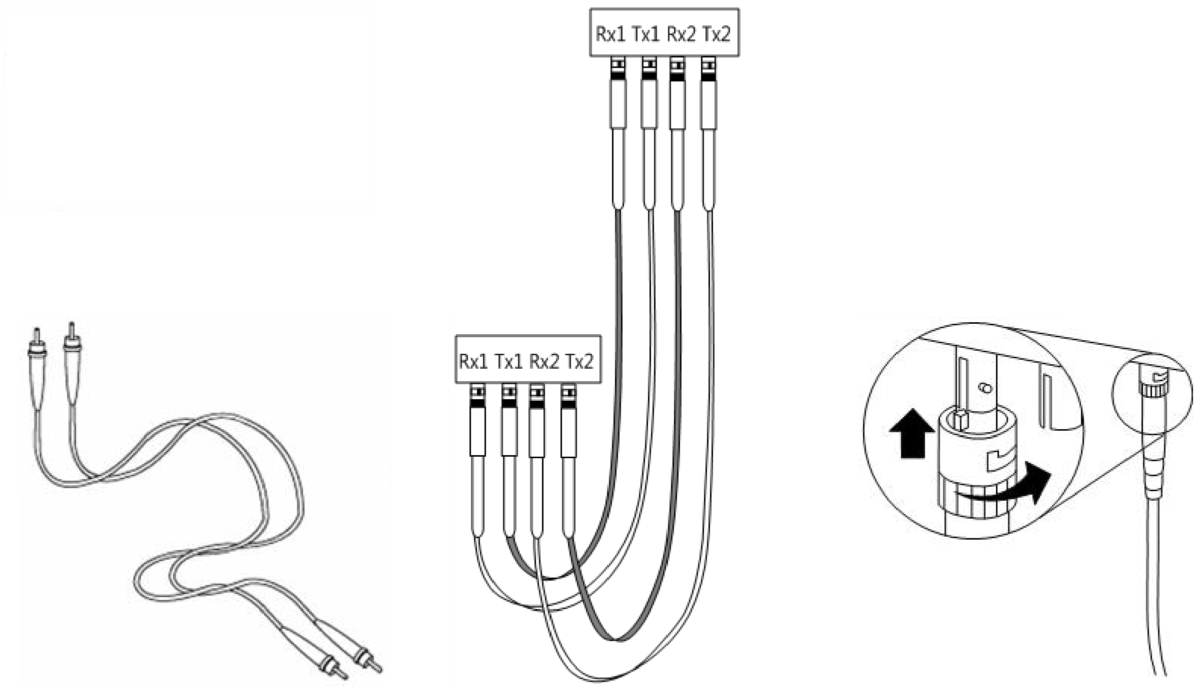


Figure 6-24　Optical Fiber Connection of LK233

6.3.2.6　Technical Specifications

LK233　PROFIBUS-DP Bus Optoelectronic Transceiver	
System Power	
Operating Voltage	24VDC（-15%~20%）
Backboard Current	80 mA max.@24 VDC
Port Characteristics	
Connector Type	ST (ceramic or plastic)
Optical Fiber Type	62.5/125 um or 50/125 um multi-mode glass fiber
Operating Wavelength	1300 nm
Transmission Distance	0~5 km
Drive Capability	
Load Capacity of Optic Terminals	To drive multi-mode glass fiber for up to 5km
Load Capacity of Electric Terminals	To drive up to 256 LK I/O modules
Number of Cascade Connections	4-segment cascade connection (8 LK 233 modules in total, with a data delay of 1.2 us for every 2 LK233 modules)
Communication	
Protocol	PROFIBUS-DP
Dual-network Redundancy	Supported
Communication rate	9.6 kbps, 19.2 kbps, 31.25 kbps, 45.45 kbps, 93.75 kbps, 187. 5 kbps, 500 kbps, 1.5 Mbps self-adapting

LK233 PROFIBUS-DP Bus Optoelectronic Transceiver	
Physical Property	
Fiber Interface	4 ST connectors
Installation Mode	Slot Installation
Installation Position	I/O slots on the extension backboard
Protection Key	A5
Module Dimension (W*H*D)	35 mm×100 mm×100 mm
Hot Plugging	Supported

6.3.3 LK234 Ethernet Interface Module

6.3.3.1 Basic Features

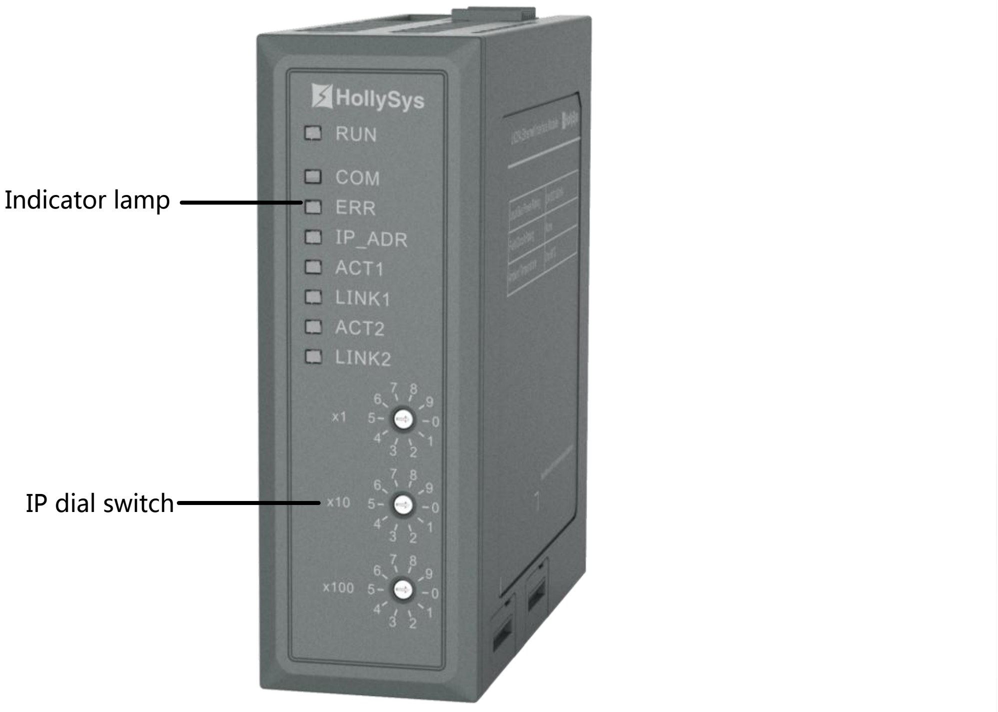
- 2-way redundant RS485 backboard communication (Profibus-DP)
- 2-way redundant Ethernet interface (10 / 100bps self-adaptation HOLLITCP protocol)
- 16MB Serial Flash memory space
- 8KB ferroelectric memory space
- Hot swapping

6.3.3.2 Function

LK234 is a communication module which converts HOLLITCP to DP, and it is used to connect expansion IO modules of LK series for LK controller.

LK234 module communicates with the controller through two-way redundant HOLLITCP, and communicates with DP slave through two-way redundant Profibus-DP. LK234 module as a slave station in the HOLLITCP protocol side and as the master in the Profibus-DP protocol side.

6.3.3.3 Interface



(a)

(b)

Figure 6-25 LK234 Module Schematic Diagram

6.3.3.4 Indicator Lamps

LK234 has 8 indicator lamps, the specific meaning as shown in Table 6-6.

Table 6-6 Definition of Indicator Lamps

Indicator Type	Color	State	Meaning
RUN (Running indicator)	Green	On	The LK234 module has loaded the configuration file and is running normally
		Fast flashing	The LK234 module has loaded the configuration file but is not running (communication with the controller is not successful)
		Slow flashing	The LK234 module does not load the configuration file
		Off	No power or the module is damaged
COM (Communication indicator)	Yellow	On	Establish communication with at least one DP slave
		Off	No communication is established with any DP slaves
ERR (Abnormal indicator)	Red	On	Module failure (eg configuration file loading error; DP master works abnormally)
		Slow flashing	The module is starting up
		Off	The module is no fault
IP_ADR (IP address indicator)	Green	On	The IP address of the software configuration takes effect
		Slow flashing	The default IP address takes effect
		Off	No power or the module is damaged
ACT1 (Ethernet 1 Data interaction indicator)	Yellow	Flashing	The Ethernet 1 interface is sending and receiving data
		Off	No data is received or sent in Ethernet 1
LINK1 (Ethernet 1 link indicator)	Green	On	Ethernet 1 interface has been connected successfully
		Off	The Ethernet 1 interface is not connected
ACT2 (Ethernet 2 Data interaction indicator)	Yellow	Flashing	The Ethernet 2 interface is sending and receiving data
		Off	No data is received or sent in Ethernet 2
LINK2 (Ethernet 2 link indicator)	Green	On	Ethernet 2 interface has been connected successfully
		Off	The Ethernet 2 interface is not connected

- Fast flashing: 4 Hz, 125 ms is on, 125 ms is off.
- Slow flashing: 1 Hz, 500 ms is on, 500 ms is off.
- When the firmware is upgraded, the RUN lamp will be off and the COM, ERR and IP_ADR lamps will flash slowly.

- Flashing frequency of the ACT indicator lamp is related to the amount of communication data on the current network, ACT indicator lamp is On when the amount of data on the network is high.

6.3.3.5 IP Address Settings

The fourth field of the LK234 IP address can be set via the three 10-position IP dial switches on the front panel. Fourth field IP address = 100 × dial switch setting value + 10 × dial switch setting value + dial switch setting value.

If the IP address of the LK234 is set to X.X.X.51, turn the hundred-digit dial switch to 0, the ten-digit dial switch to 5, and the single-digit dial switch to 1.

Refer to Table 6-7 for the meaning of the IP setting value when the IP address in fourth field is set by DIP switch.

Table 6-7 Description of IP Address Settings in Fourth Field

IP Address	Dial Switch Setting Value	Meaning	Function Description	Note
x.x.x.0	0	IP reset	When dial switch is set as 0, IP address of LK234 is reset to default value 128.0.0.249, 129.0.0.249	
x.x.x.1	1	Gateway address		Setting is not recommended
x.x.x.255	255	Broadcast address		Setting is not recommended
x.x.x.249	256~999	IP address in fourth field is as a default value	When dial switch is set as 256~999, IP address in fourth field is 249	The dial switch is in 999, the LK234 configuration file will be deleted automatically when power on

The IP address in the first three fields of the LK234 is set by the [Network Configuration] tool in the AutoThink configuration software, as shown in Figure 6-26.

After connecting to the LK234 successfully, the IP address can be read from the LK234 by **IP Reading**. Address set by the dial switch is shown in the fourth field and can not be modified. Enter IP address of the first three fields to be modified in the **IP Address** box, click **IP Modification**, IP address is set to complete.

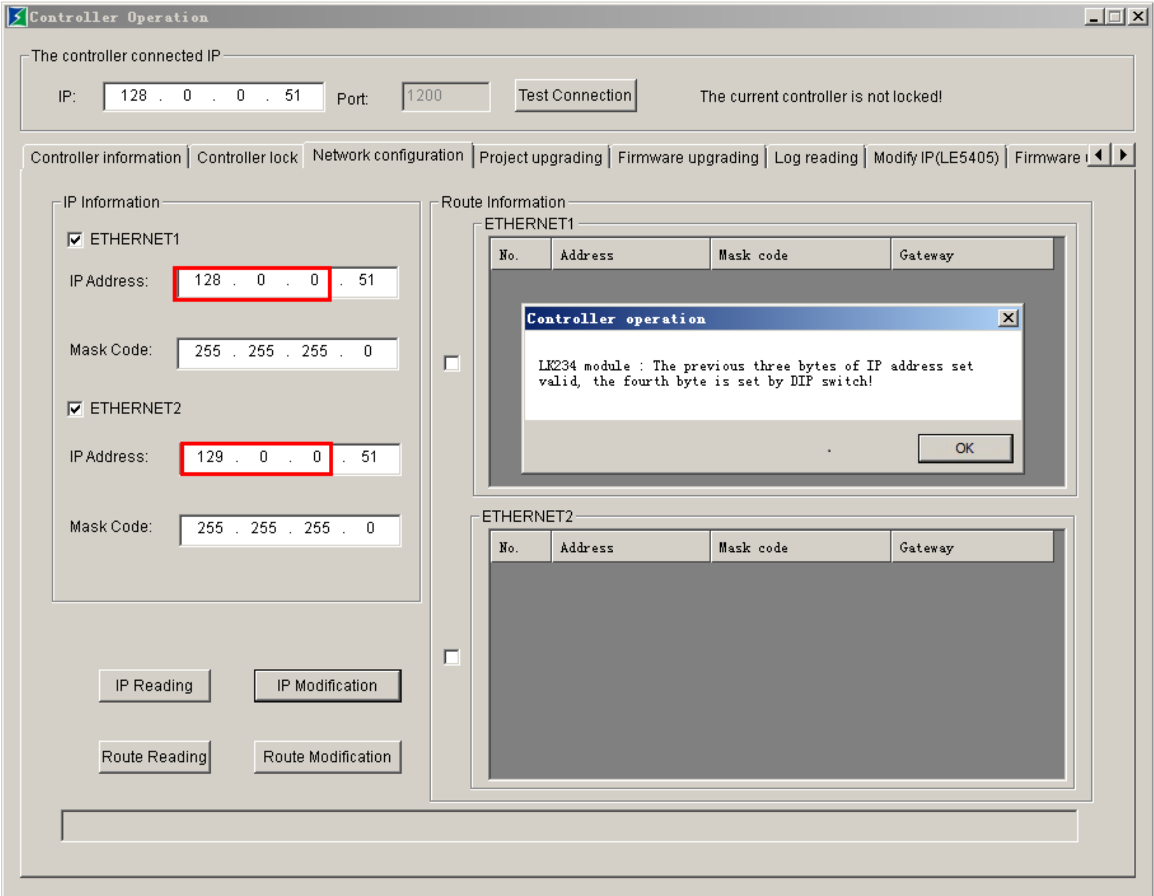


Figure 6-26　The First Three Fields Settings of LK234 IP Address

LK234 configuration refers to LK Hardware Configuration in Chapter 5 in *AutoThink V3.1 User Manual_Project Configuration.*

6.3.3.6　Wirings

The LK234 module is installed in the first slot on the left side of the expansion backboard and The protection key is coded as A5.

LK234 module is connected with the LK controller through the switch, and connected with the LK expansion IO modules through the backboard bus.

Currently, on an extended backboard, the LK234 module supports up to 10 IO modules.

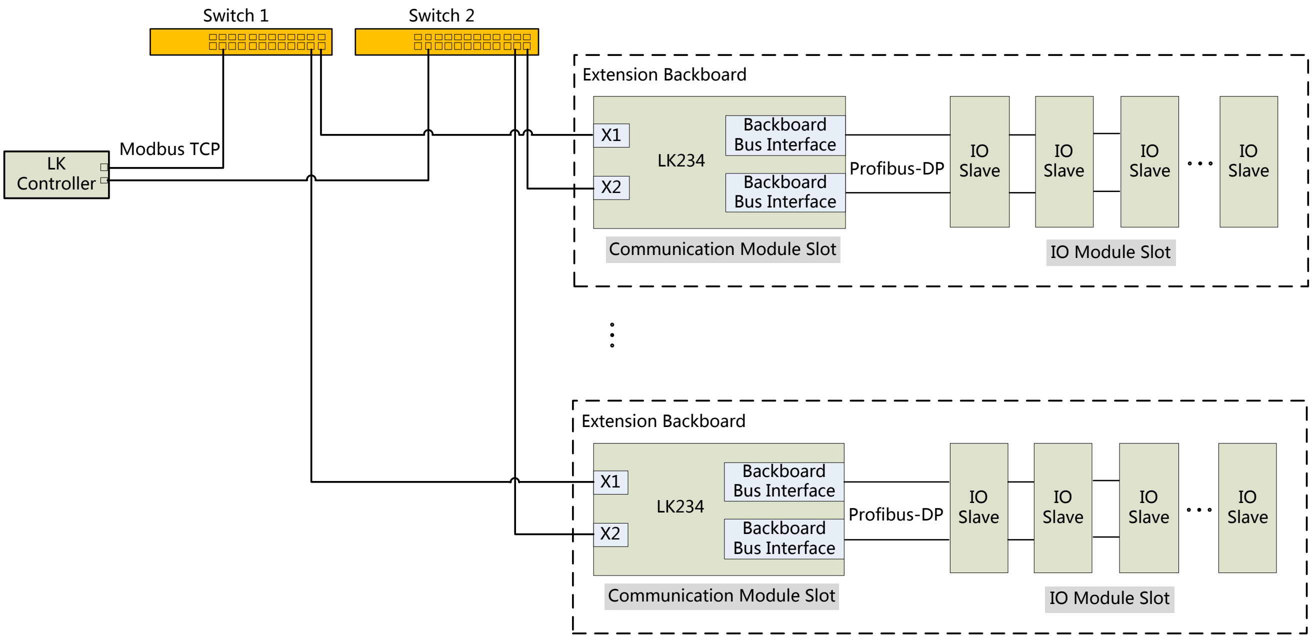


Figure 6-27 LK234 Connection Schematic Diagram

- It is recommended that you do not use the routing function when using the LK234.
- Users should ensure that the LK234 communication network is normal and avoid that the high network load caused by the external modules, the long network transmission time caused by the network configuration, a lot of useless packets (such as network storm) in the network.

6.3.3.7 Diagnosis

Diagnosis information of LK234 module and its attached DP slave modules is viewed by global variable group LK234DiagGroup in AutoThink configuration software.

When the LK234 module is configured in the LK project, the diagnosis variables are generated in the variable group after compilation, as shown in Figure 6-28. The number of variables in the variable group depends on the number of LK234 currently added. The name of the variable is the same as the name of the LK234 node under the [Hardware Configuration] node.

LK234DiagGroup

No.	Variable Name	Address	Variable Description	Variable Type	Initial Value	Power Fail Safeguard
0001	LK234	%SB2000	No. 1 LK234 diagnostic information	ARRAY[0..16] OF BYTE		FALSE
0002	LK234_1	%SB2020	No. 2 LK234 diagnostic information	ARRAY[0..16] OF BYTE		FALSE

Figure 6-28 LK234 Diagnosis Variable

Diagnosis variables are ARRAY of BYTE type. The first five bytes are the diagnosis information of the LK234 module, the diagnosis information of the DP slave module starts from sixth byte, arranging from the first DP slave to the Nth.

The diagnosis information of each DP slave module consists of three parts: the first three bytes are the module status diagnosis information, the fourth byte is the device diagnosis information, and the following bytes are the channel Diagnosis information, as shown in Figure 6-29.

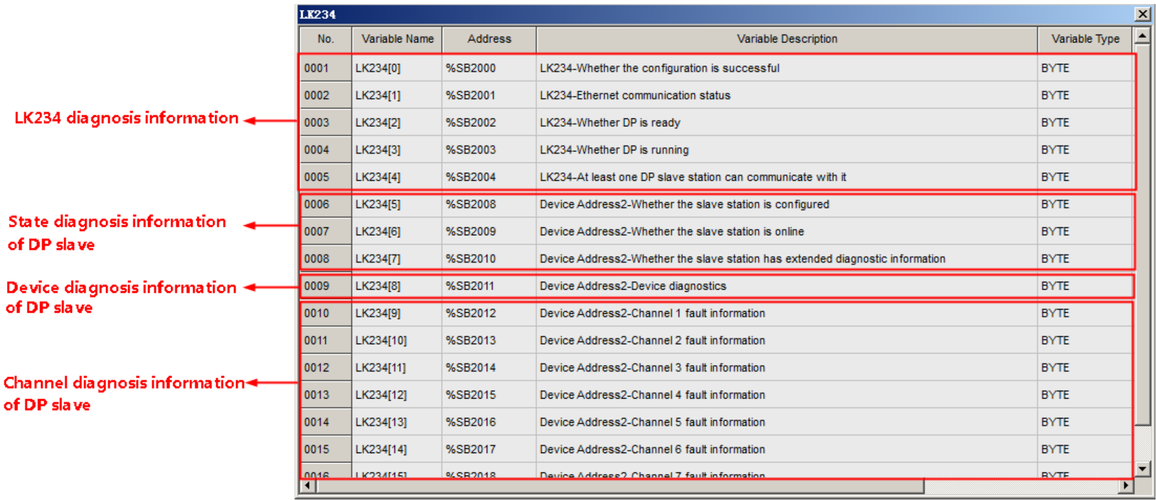


Figure 6-29 Diagnosis Information

Table 6-8 Diagnostic Byte Description

Diagnosis Information	Diagnostic Description	Diagnostic Value Description	Note
LK234 diagnosis information	Whether LK234 is configured successfully	0: Unsuccessful 1: Successful	
	LK234 Ethernet communication status	0: Not connected Non-zero: Normal running	
	Whether LK234 DP is ready	0: Not ready 1: Ready	
	Whether the LK234 DP is running	0: Not running 1: Running	
	The LK234 establishes communication with at least one DP slave	0: No 1: Yes	
State diagnosis information of DP slave	Whether DP slave is configured	0: Not configured 1: Configured	
	Whether DP slave is online	0: Offline 1: Online	
	Whether the DP slave has extended diagnosis information	0: none 1: Yes	
Device diagnosis information of DP slave	Device address number - Device diagnostics	The device diagnosis of each module is different. Refer to the description of devices diagnosis information of the following module	No device diagnostic information for LK239
Channel diagnosis information of DP slave	Device address number - channel number fault information	The device diagnosis of each module is different. Refer to the description of devices diagnosis information of the following module	LK610, LK710, LK239 without channel diagnostic information

Device diagnosis and channel diagnosis information of each DP slave module:

- LK610、LK710

Table 6-9 Description of Device Diagnostic Information

Value	Meaning
0x00	The failure is recovered or there is no diagnosis data
0x04	Field power loss

- LK411

Table 6-10 Description of Device Diagnostic Information

Value	Meaning
0x00	The current device without any fault
0x01	The current device has channel fault

Table 6-11 Description of Channel Diagnostic Information

<table>
<tr><th colspan="2">Bit</th><th>Bit7</th><th>Bit6</th><th>Bit5</th><th>Bit4~ Bit0</th></tr>
<tr><td>Byte1</td><td>Channel 1 fault information</td><td colspan="3" rowspan="8">000</td><td rowspan="8">0: Channel fault recovery
2: Under range
3: Over range
6: Line broken
7: Upper limit exceeded
8: Lower limit exceeded</td></tr>
<tr><td>Byte2</td><td>Channel 2 fault information</td></tr>
<tr><td>Byte3</td><td>Channel 3 fault information</td></tr>
<tr><td>Byte4</td><td>Channel 4 fault information</td></tr>
<tr><td>Byte5</td><td>Channel 5 fault information</td></tr>
<tr><td>Byte6</td><td>Channel 6 fault information</td></tr>
<tr><td>Byte7</td><td>Channel 7 fault information</td></tr>
<tr><td>Byte8</td><td>Channel 8 fault information</td></tr>
</table>

- LK412

Table 6-12 Description of Device Diagnostic Information

Value	Meaning
0x00	The current device without any fault
0x01	The current device has channel fault
0x02	The current device has checking data fault
0x03	The current device have both channel fault and checking data fault

Table 6-13 Description of Channel Diagnostic Information

<table>
<tr><th colspan="2">Bit</th><th>Bit7</th><th>Bit6</th><th>Bit5</th><th>Bit4~ Bit0</th></tr>
<tr><td>Byte1</td><td>Channel 1 fault information</td><td colspan="3" rowspan="2">000</td><td rowspan="2">0: Channel fault recovery
2: Under range</td></tr>
<tr><td>Byte2</td><td>Channel 2 fault information</td></tr>
</table>

Bit		Bit7	Bit6	Bit5	Bit4~ Bit0
Byte3	Channel 3 fault information				3: Over range 6: Line broken 7: Upper limit exceeded 8: Lower limit exceeded
Byte4	Channel 4 fault information				
Byte5	Channel 5 fault information				
Byte6	Channel 6 fault information				

- LK430

Table 6-14 Description of Device Diagnostic Information

Value	Meaning
0x00	The current device without any fault
0x01	The current device has channel fault
0x02	The current parameter read error
0x03	The current device have both channel fault and reading parameter error

Table 6-15 Description of Channel Diagnostic Information

Bit		Bit7	Bit6	Bit5	Bit4~ Bit0
Byte1	Channel 1 fault information	000			0: Channel fault recovery 6: Line broken 7: Upper limit exceeded 8: Lower limit exceeded
Byte2	Channel 2 fault information				
Byte3	Channel 3 fault information				
Byte4	Channel 4 fault information				
Byte5	Channel 5 fault information				
Byte6	Channel 6 fault information				

- LK441

Table 6-16 Description of Device Diagnostic Information

Value	Meaning
0x00	The current device without any fault
0x01	The current device has channel fault
0x02	The current device has checksum fault
0x03	The current device have both channel fault and checksum fault

Table 6-17 Description of Channel Diagnostic Information

Bit		Bit7	Bit6	Bit5	Bit4~ Bit0
Byte1	Channel 1 fault information	000			0: Channel fault recovery 2: Under range 3: Over range
Byte2	Channel 2 fault information				
Byte3	Channel 3 fault information				

Bit		Bit7	Bit6	Bit5	Bit4~ Bit0
Byte4	Channel 4 fault information				6: Line broken 7: Upper limit exceeded 8: Lower limit exceeded
Byte5	Channel 5 fault information				
Byte6	Channel 6 fault information				
Byte7	Channel 7 fault information				
Byte8	Channel 8 fault information				
Byte9	Channel 9 fault information (cold junction compensation terminal)				

- LK511

Table 6-18 Description of Device Diagnostic Information

Value	Meaning
0x00	The current device without any fault
0x01	The current device has channel fault
0x02	The current device calibration data error
0x03	The current device have both channel fault and calibration data error

Table 6-19 Description of Channel Diagnostic Information

Bit		Bit7	Bit6	Bit5	Bit4~ Bit0
Byte1	Channel 1 fault information	000			0: Channel fault recovery 6: Line broken 18:Channel output fault
Byte2	Channel 2 fault information				
Byte3	Channel 3 fault information				
Byte4	Channel 4 fault information				

- When data in input area of the IO slave station is used, the slave is online as the prerequisite (the information is obtained from the S area) and the diagnosis information of the slave station is viewed, to ensure that the read data is normal.
- All the diagnosis information will be cleared after 20s when LK234 was in offline.

6.3.3.8 Technical Specifications

LK234 Ethernet Interface Module		
CPU	667MHz	
Memory	FLASH	16MB (used in the system)
	DDR	256MB，800Mbps, bit width 32
	FRAM	8KB
DP Bus		

LK234 Ethernet Interface Module	
Number of Communication Ports	2-way
Redundancy Function	Support redundancy
Level Standard	EIA/TIA-485
Communication Port Type	Backboard communication
Communication Speed (bps)	187.5kbps, 500kbps, 1.5Mbps
Protocol	Hollisys DP master station
Electrical Isolation	No isolation between channel and system Two-way RS485 are not isolated
Ethernet Bus	
Number of Communication Ports	2-way
Redundancy Function	Support redundancy, switching time is not more than 50ms
Level Standard	IEEE 802.3
Communication Port Type	Standard RJ45
Communication Speed (bps)	10/100Mbps, self-adaption
Communication Protocol	HolliTCP protocol
Protection Rating	
Protection Rating of Module	IP20
Hot Plug	
Module Hot Plugging	Supported
Power Supply	
Input Voltage	24VDC（-15%~+20%）
Module Power Consumption (max.)	180mA@24VDC
Rated Voltage	24.0VDC
Dual-network Redundancy	
DP Dual-network Redundancy	DP bus support redundancy
HolliTCP Dual-network Redundancy	HolliTCP supports redundancy
Start Time	
The time from power-up to initialization of the module	≤40 s
Physical Property	
Installation Way	Slot installation

LK234 Ethernet Interface Module	
Installation Position	Communication slot on backboard
Protection Key	A5
Module Dimension (W*H*D)	35 mm*100 mm*100 mm ±0.5 mm
Weight	300g

6.3.4 LK239 MODBUS Master/Slave Communication Extension Module

6.3.4.1 Basic Features

- Support the PROFIBUS-DP slave protocol
- To support the MODBUS master /slave protocol
- To connect the LK CPU module and the external MODBUS master /slave station
- Installed in the I/O slot
- Hot swapping

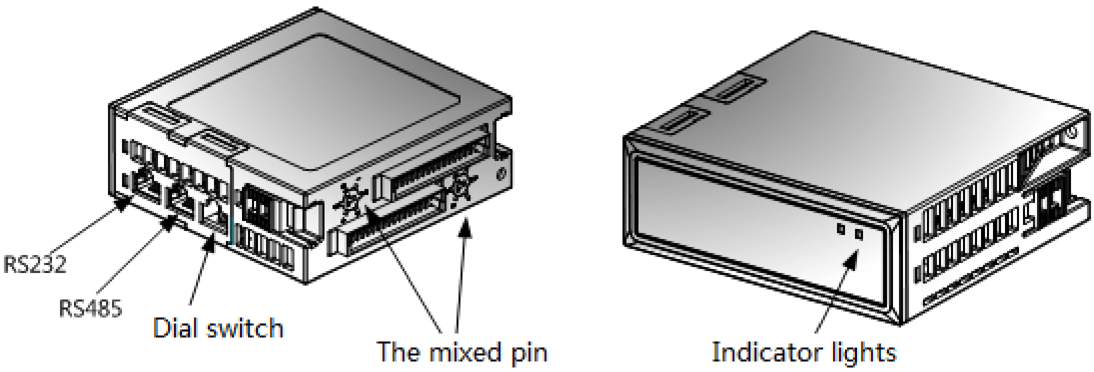


Figure 6-30 External View of LK239 Module

The LK239 module is the MODBUS master/slave communication extension module, supporting the PROFIBUS-DP bus protocol and the MODBUS protocol, realizing the data communication from the external MODBUS station to the LK CPU module.

The LK239 module on the PROFIBUS-DP side can only be used as the DP slave station and exchanges the parameters and data with the LK CPU module, thus realizing the functions of the DP slave station.

The LK239 module on the MODBUS side can be used as the MODBUS master station, or as the MODBUS slave station, to obtain or send the MODBUS data, with function codes 01, 02, 03, 04, 05, 06, 15, 16 supported.

The max. input and output data lengths for the MODBUS data area of the LK239 module are up to 244 bytes separately. As the MODBUS master station, the max. number of the supported slave stations must meet two restrictions of up to 244 bytes in total input (output) data length and up to 28 slave stations at the same time.

- Whether the slave station or the master station, the LK239 module cannot transmit the REAL data directly by configuring the input/output data. It shall do this with the help of Zone M, with the high-low byte sequence exchanged.

The LK239 module is installed in the I/O slot of the LK backboard. The module itself provides the MODBUS communication interface and the MODBUS terminal matching DIP switch, as shown in Figure 6-30.

The MODBUS communication adopts a response mode: the master station sends command to one slave station, and wait for the response from slave station. After receiving the instruction from the master station, the slave station executes the instruction and feedback the execution results to the master station, then wait for the next instruction. The time interval from the moment that the master station gives an instruction to the moment that the slave station responds data is received is the time-out value, which can be set via the user parameter **Time of Replay**.

For the RS485 or RS232 (select one from the two) interfaces for the MODBUS physical layer, the transmission speed can be 115.2 kbps in the RTU transmission mode.

6.3.4.2 Operating Principle

The LK239 module creates the PROFIBUS-DP data area and the MODBUS data area in the data memory, exchanges the data between the two data storage areas periodically, thus realizing the data communication from MODBUS to PROFIBUS-DP.

The communication data of the PROFIBUS-DP master station (the CPU module) and LK239 is saved in the PROFIBUS-DP data area. The communication data of the external MODBUS master station slave station and LK239 is saved into the MODBUS data area. Upon the completion of the PROFIBUS-DP data communication each time, it shall exchange the data of the two data storage areas once according to the corresponding relationship between the PROFIBUS-DP address and the MODBUS address.

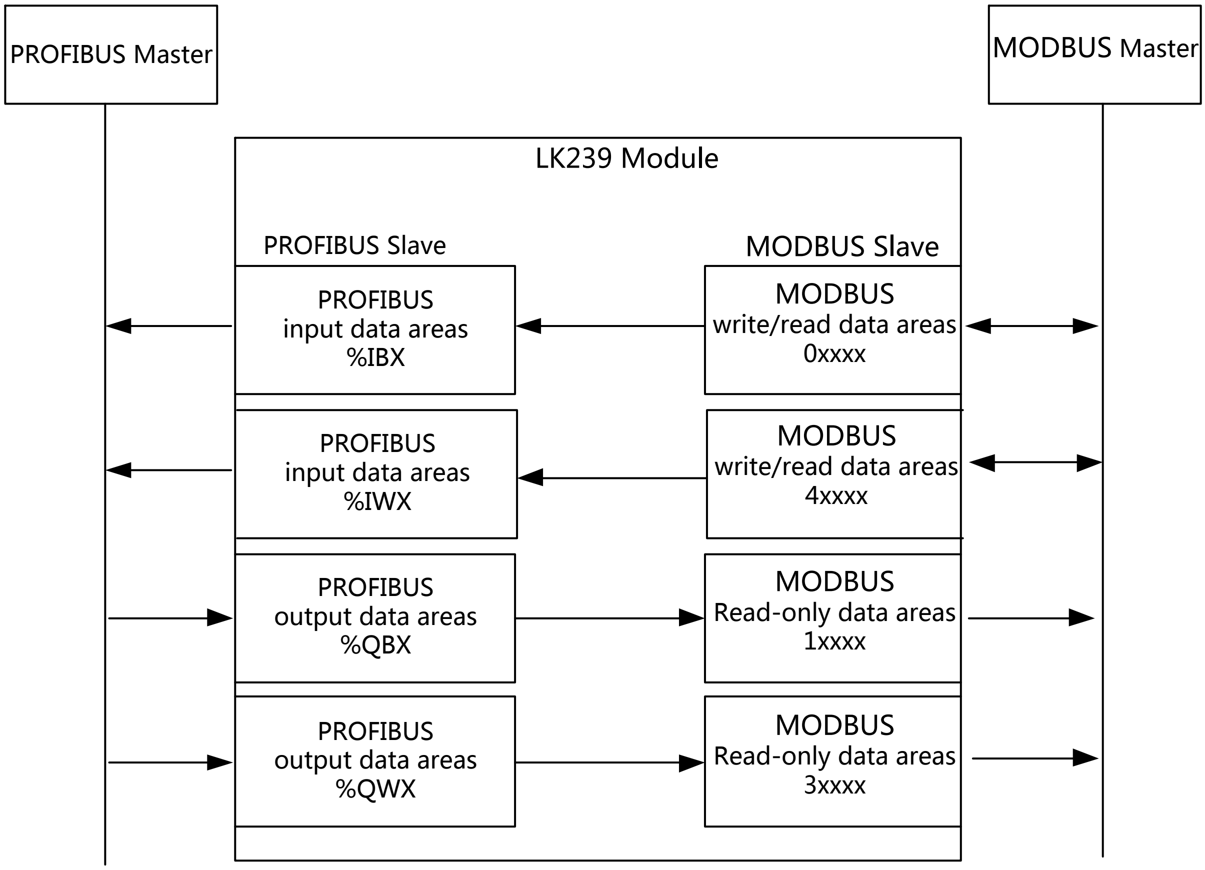


Figure 6-31　Schematic Diagram of Data Exchange Realization of LK239 Module as Slave

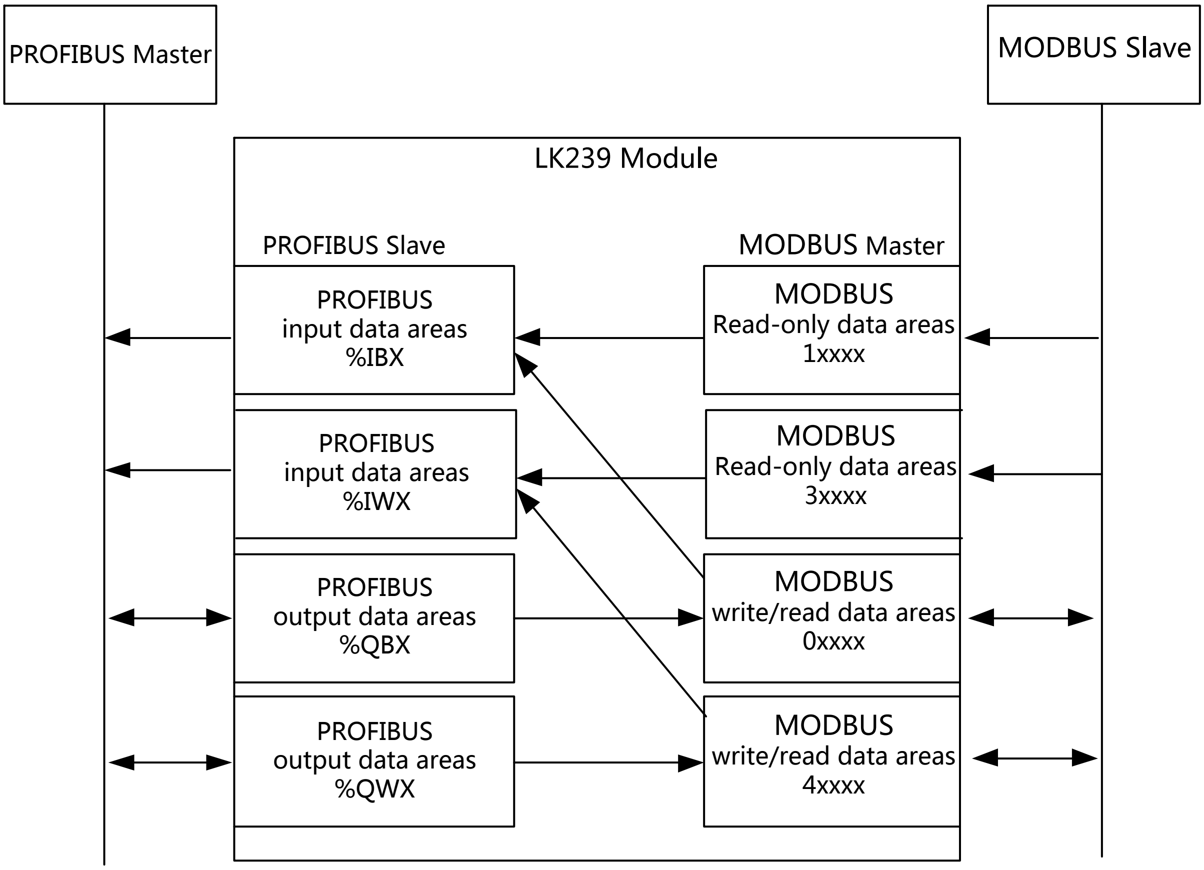


Figure 6-32 Schematic Diagram of Data Exchange Realization of LK239 Module as Master

6.3.4.3 Indicator Lamps

Refer to Table 6-20 for the definitions of the indicator lamps of the LK239 module, the **RUN** lamp indicates the communication link with the LK CPU module. The **COM** lamp indicates the MODBUS communication link.

Table 6-20 Definition of LK239 Indicator Lamps

Name	Status	Description
RUN (green)	On	The communication between LK239 and the LK CPU module is normal
	Flash	It is just powered up and establishing the communication, or a communication error occurs between LK239 and the LK CPU module, or the module is disabled
	Off	The module is not powered up or damaged.
COM (yellow)	On	The MODBUS communication is normal
	Flash	It is just powered up and establishing the communication, or a MODBUS communication error occurs, or no MODBUS slave station is available to LK239
	Off	The module is not powered up or damaged.

- Flashing frequency: 4 Hz.

6.3.4.4 Wirings

The MODBUS communication interface is located at the bottom of the module, supporting the RS232 and RS485 modes, adopting two RJ45 outlets. It can use a customized cable to convert the RJ45 interface into the Type-D 9-pin plug. Refer to Table 6-21 for the cable information.

Table 6-21 MODBUS Connecting Cable

Cable Name	Cable Specification	Definition of RJ45 Signal	Definition of DB9 Signal
RS485 wiring mode, MODBUS communication cable	Shielded cable with a magnet ring. 3m, with one end of a RJ45 interface and the other end of a DB9 plug (RS485)	4—RS485+ 5—RS485- 8—GND	5—RS485+ 9—RS485- 1—GND
RS232 wiring mode, MODBUS communication cable	Shielded cable with a magnet ring. 3m, with one end of a RJ45 interface and the other end of a DB9 plug (RS232)	1—TXD (LK239 send) 2—RXD (LK239 receive) 8—GND	2—TXD (LK239 send) 3—RXD (LK239 receive) 5—GND

- Wiring cannot be applied to the I/O terminal block under the LK239 module slot.

6.3.4.5 Terminal Matching

On the MODBUS bus, when selecting a RS485 interface, if the LK239 module is located at the initial terminal or end terminal of the bus, it is connected to a matching resistance.

The terminal matching DIP switch is located in the module, defaulted as disconnected. As shown in Figure 6-33, it is unnecessary to disassemble the enclosure when changing the position of the switch. Via the heat emission hole at the top enclosure of the module, it can conveniently set the position by using a small flathead screwdriver.

The four keys of the DIP switch are turned consistently when setting. When the 4 keys are dialed downward at the same time, which is in **ON** status, the terminal matching resistance is connected. When the 4 keys are dialed upward at the same time, which is in **OFF** status (default), the terminal matching resistance is disconnected.

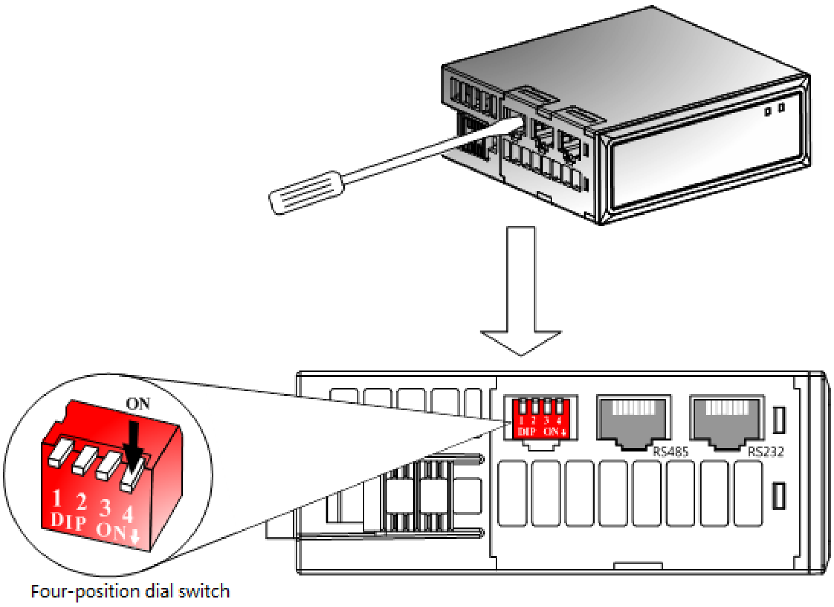


Figure 6-33 Setup of LK239 DIP Switch

6.3.4.6 MODBUS Communication Messages

The MODBUS communication protocol is the master/slave communication protocol. The master station sends the message. Only a slave station with an address same to the calling address in the message sent from the master station can send a response message.

The slave station address range of the LK239 module is 1~247. The 0 address in the protocol refers to the messaging mode of the broadcasting message. The LK239 module does not support the 0 address.

1. MODBUS Storage Area

The device storage area relating to MODBUS is identified with 0xxxx, 1xxxx, 3xxxx and 4xxxx, as shown in Table 6-22.

Table 6-22 Specifications for MODBUS Storage Area

MODBUS Storage Area	Type	Write/Read	Name	Storage Unit Address
0xxxx	Bit	Write and read	Coil	00001~0xxxx
1xxxx	Bit	Read only	Input of discrete magnitude	10001~1xxxx
3xxxx	Word	Read only	Input register	30001~3xxxx
4xxxx	Word	Write and read	Holding register	40001~4xxxx

MODBUS address form is used in this system. If register address form is used, corresponding address subtracts 1.

2. Definition of Function Code

The function code is used by the MODBUS master station to notify the MODBUS slave station of the operation to be executed. As a response, the slave station sends the same function code to the master station, indicating that it has responded to the master station by executing the operation.

Table 6-23 lists the MODBUS function codes supported when taking LK239 as the MODBUS master station. For a function code excluded in the list, LK239 gives no responses.

If the most significant bit of the function code sent from the slave station is 1 (with the function code more than 127), it indicates that the slave station does not make any response or a sending error occurs.

Table 6-23 Definition of Supported Function Code

Function Code	Data Type	Meaning	Role
01	BIT	To read the DO status (DO readback)	To read back the current status of a group of digital outputs (not supporting the broadcast mode)
02	BIT	To read the DI status (DI)	To obtain the current status of a group of digital inputs (not supporting the broadcast mode)
03	WORD	To read the AO status (AO readback)	To read back the current status of a group of analog output (not supporting the broadcast mode)
04	WORD	To read the AI status (AI)	To obtain the current status of a group of analog inputs (not supporting the broadcast mode)
05	BIT	To force single-channel digital outputs (single-channel DO)	To force to set a certain digital output value (not supporting the broadcast mode)
06	WORD	Force single-channel analog outputs (single-channel AO)	To force to set a certain analog output value (not supporting the broadcast mode)
15	BIT	Force multiple-channel digital outputs (multiple-channel DO)	To force to set several continuous digital output values of the slave station (not supporting the broadcast mode)
16	WORD	Force multi-channel analog outputs (multi-channel AO)	To force to set several continuous analog output values of the slave station (not supporting the broadcast mode)

3. Diagnosis Message Code

When a request message error in the master station is detected, the slave station sets the most significant bit (bit 7) of the function code as 1 in the response message, with a one-byte error code sent at the same time. Error codes 1~7 separately represents various error types, as shown in Table 6-24.

Upon receiving an error code, it can take responsive measures according to the error type and re-send a request.

Table 6-24 Supported Diagnosis Message Code

Error Code	Meaning	Cause
1	An illegal function code	The slave station does not support such a function code
2	An illegal data address	The initial data address is set improperly
3	Data area overflow	The data length is set improperly
4	An error in the interconnecting device	The slave device fails
5	Confirming the receipt of the request	It takes a rather long time for the slave device to process, therefore, it can confirm the receipt first
6	Busy now, with the request refused	The slave device is busy

Error Code	Meaning	Cause
7	Request received without no confirmation	The request is not executed

6.3.4.7 GSD File

On the MODBUS side, LK239 can not only be used as the master station, but also a slave station, with different GSD files selected during configuration, as shown in Figure 6-34.

When LK239 is used as a master station, add a LK239-MASTER module.

When LK239 is used as a slave station, add a LK239-SLAVE module.

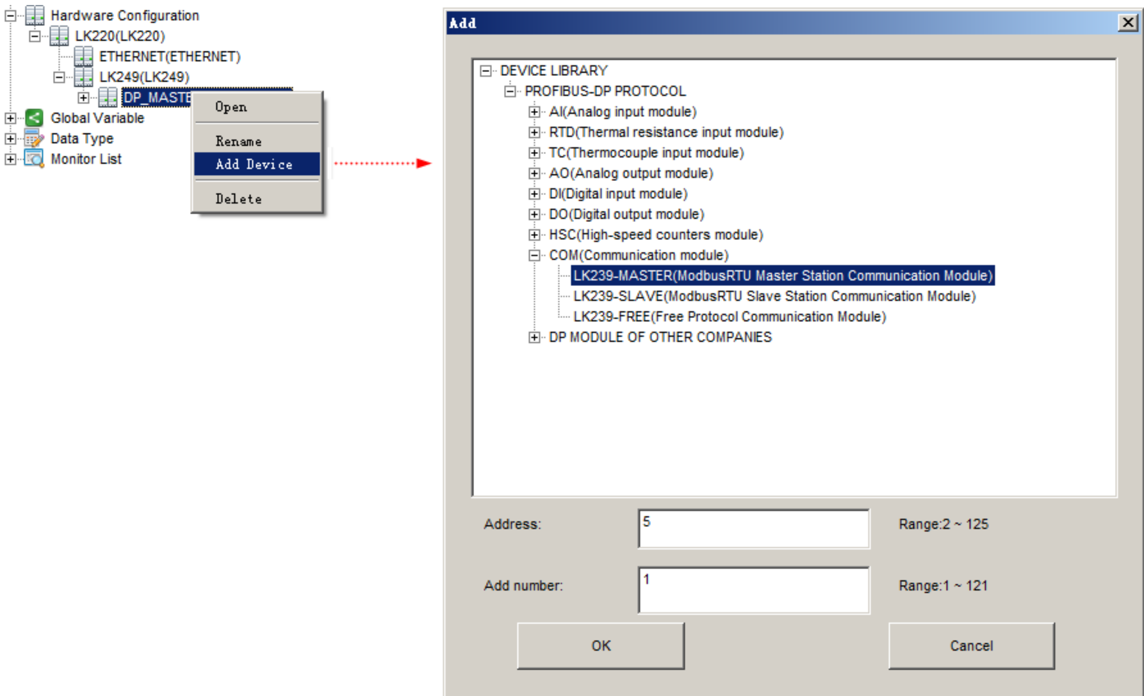


Figure 6-34 Adding a LK239 Module

6.3.4.8 Configuration for LK239 as MODBUS Master

1. Set Station Address

In PROFIBUS-DP side, LK239 supports PROFIBUS-DP slave protocol, and address uniquely identified by a backboard number and a slot number. During configuration, double-click the **Device Address** item, as shown in Figure 6-35. Enter a physical communication address in **New** address, and click **OK**.

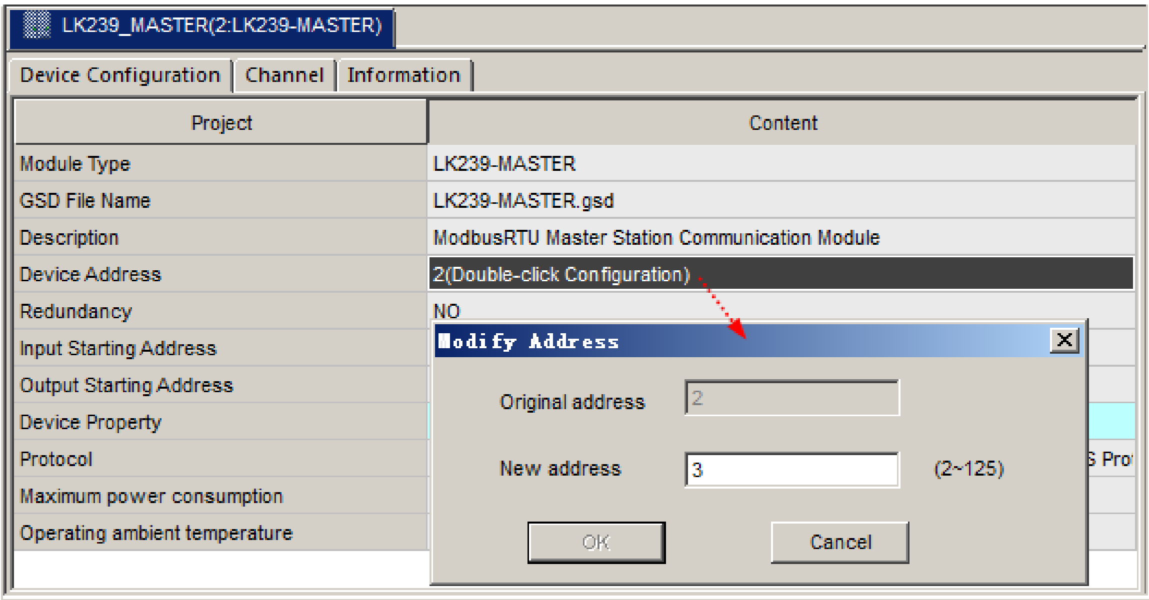


Figure 6-35 Set Station Address

2. Input/output Selection

The [Input/output selection] are used to configure the data space on the MODBUS side of the LK239 module, realizing the data transmission between LK239 and the external MODBUS station.

The data length in the module is limited. The max. length of input data is 244 bytes. The max. output data length is 244 bytes. When the length of the added data goes beyond the limit, an error prompt is popped up.

As shown in Figure 6-36, all the input /output data selected is displayed in **Optional module** list box, you can select data to be added, and click button >> to add data to **Added module** list box. You can view the parameters of current slave station after selecting the data added to click **Property**.

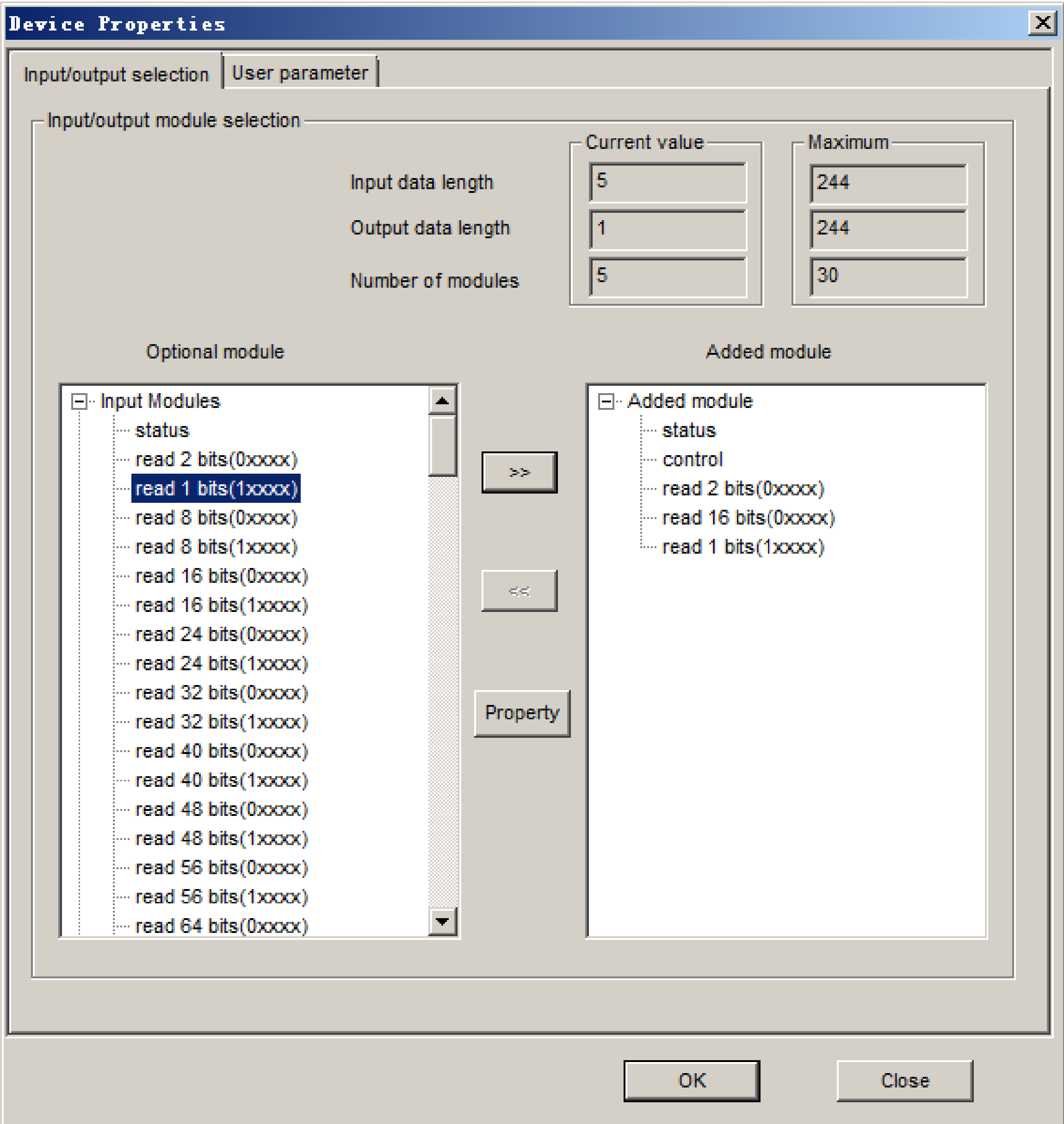


Figure 6-36 Input/output Module of MODBUS Master Station

When taking LK239 as the master station, the MODBUS data area includes Input Modules and Output Modules, as shown in Figure 6-37. Each module indicates a function code that is supported by MODBUS. It can select the module according to the MODBUS slave station device property. Notably, Status and Control are required. Refer to current chapter Status and Control Byte for the specific meanings.

- When taking LK239 as the MODBUS master station, it shall add strictly in the following sequence. Otherwise, the module cannot work normally: first **Status**, then **Control** and finally Data.

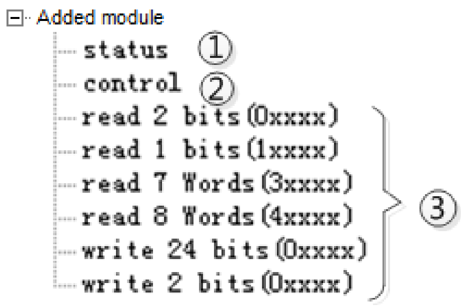
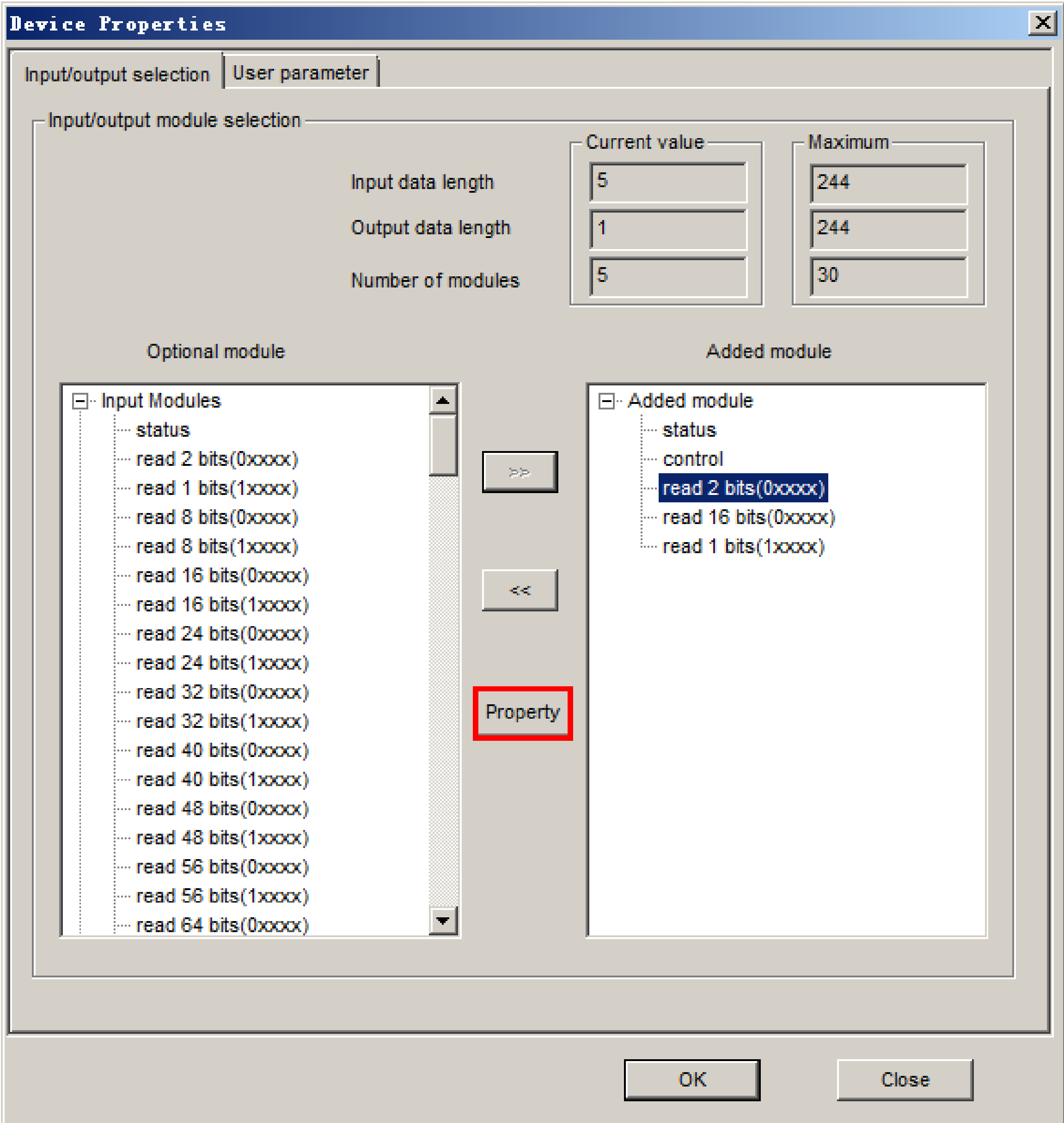
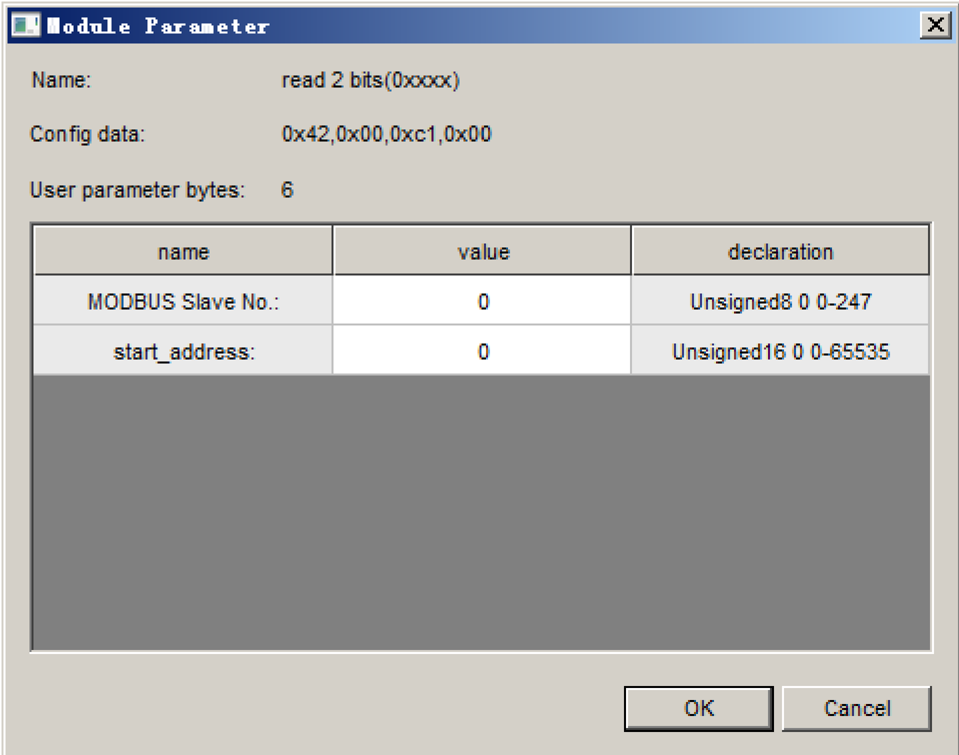


Figure 6-37 Sequence of Adding MODBUS Master Station Data

When LK239 is used as the MODBUS master station, apart from selecting a correct input/output module, for each MODBUS slave station, it is also required to specify the slave station address and the start address to realize the reading and writing of the slave station data. Refer to Figure 6-38 for the specific flow, the **Module Parameter** dialog is opened via selecting the module added to click **Property**, and you can set parameters.


Device Properties
Input/output selection
User parameter
Input/output module selection
Current value
Maximum
Input data length
Output data length
Number of modules
5
1
5
244
244
30
Optional module
Added module
Input Modules
status
read 2 bits(0xxxx)
read 1 bits(1xxxx)
read 8 bits(0xxxx)
read 8 bits(1xxxx)
read 16 bits(0xxxx)
read 16 bits(1xxxx)
read 24 bits(0xxxx)
read 24 bits(1xxxx)
read 32 bits(0xxxx)
read 32 bits(1xxxx)
read 40 bits(0xxxx)
read 40 bits(1xxxx)
read 48 bits(0xxxx)
read 48 bits(1xxxx)
read 56 bits(0xxxx)
read 56 bits(1xxxx)
read 64 bits(0xxxx)
>>
<<
Property
Added module
status
control
read 2 bits(0xxxx)
read 16 bits(0xxxx)
read 1 bits(1xxxx)
OK
Close

(a)



(b)

Figure 6-38 Slave Station Parameter Setup

Table 6-25 Specification for MODBUS Slave Station Parameters

Parameter Name	**Parameters**	**Value**
MODBUS Slave No.	Slave station address	0~247
Start_address	Initial data address	0~65,535

3. User Parameter

When LK239 is used as the MODBUS master station, the user parameter length is 8 bytes. Refer to Table 6-26 for the meaning.

Table 6-26 User Parameter List of MODBUS Master Station

Parameter Name	**Meaning**	**Value**
Baud rate	To select the baud rate for MODBUS communication	1200 bps, 2400 bps, 4800 bps, 9600 bps (default), 19.2 kbps, 38.4 kbps, 57.6 kbps, 115.2 kbps
Parity	To select the verification mode	=Even Parity, even-parity check (default) = Odd Parity, odd-parity check =No Parity, no check
MODBUS Master	To select the MODBUS master and slave stations	=MODBUS Master, master station
Transmission Mode	MODBUS data transmission mode	= RTU, RTU transmission mode

Parameter Name	Meaning	Value
Data Update Mode	MODBUS data update mode	=At MD_scan End, to updated upon the completion of all the MODBUS instructions =At Evry MD End (default), to update upon the completion of the MODBUS instruction each time
Time of Reply	Time-out setup	The value is selected by drop-down menu, and 200 ms (default)
RS232/RS485	To select RS232 /RS485 communication interface	= RS232 = RS485 (default)
Max. polling number	The response that is made from the slave station is timed out, the max. re-sending times for the master station	1~255, defaulted to 3 times

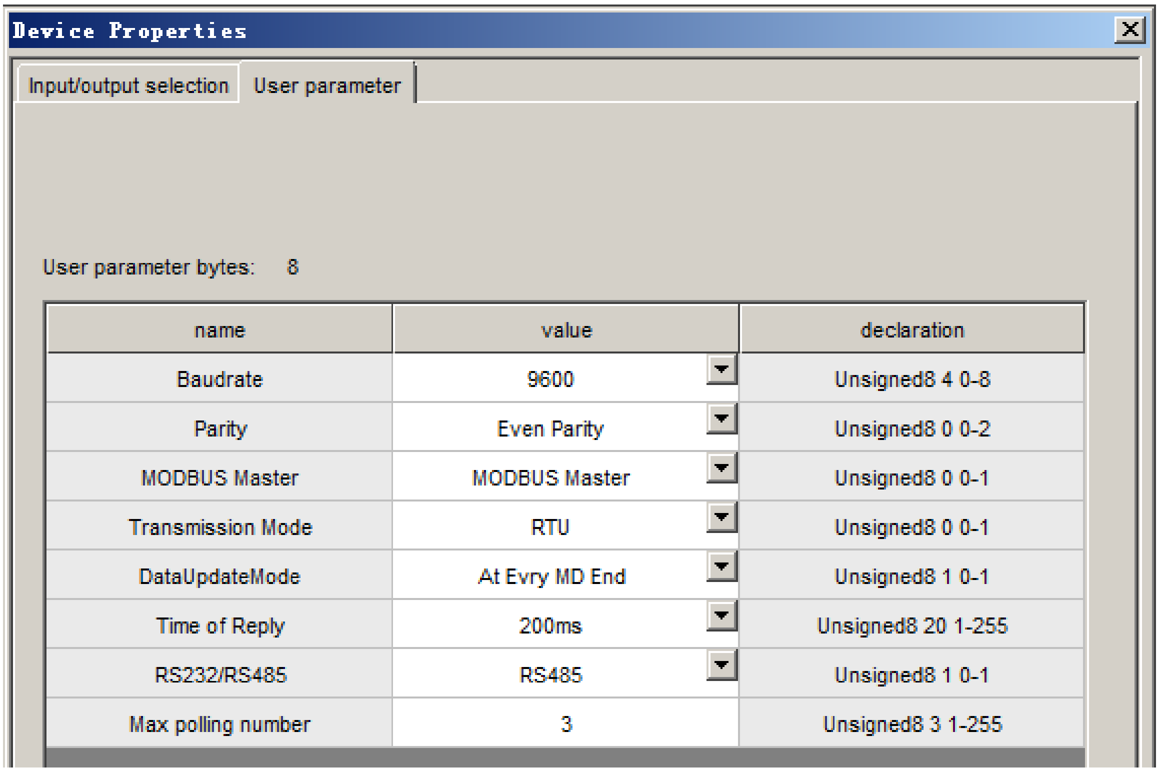


Figure 6-39 User Parameters for MODBUS Master Station

4. Status and Control Byte

Definitions of the Status (device status) byte and the Control (device control) byte when LK239 is used as the MODBUS master station.

- Definition of the Status (device status) byte
  - □ Bit0: indicates whether the MODBUS slave station is offline or not. Bit0=0 indicates no slave stations are offline. When the response that is made from the slave station is timed out and the max. re-sending times are met, Bit0=1 indicates that a slave station is offline.
  - □ Bit4~Bit1: indicates a diagnosis message code. When multiple MODBUS slave station are abnormal, the code is displayed in a scrolling manner.
  - □ Bit5: indicates the running status of the master station, with 1 set in normal services.

- ☐ Bit6: with 1 set to indicate an error in data verification.

- ■ Definition of the Control (device control) byte
  - ☐ Bit0: with 1 set to indicate the startup of the MODBUS device. In case of zero clearing, it indicates to forbid the MODBUS device.
  - ☐ Bit7~Bit1: hold.

Special attention: in order to maintain the effectiveness and continuity of data , first, DP communication connection between controller and LK239 should be established, and then start MODBUS device (Control byte is set to 1). When communication connection is disconnected, prohibit MODBUS device (Control byte is cleared), when communication is restored, restart MODBUS device.

5. Data Communication

After adding the data in [Input/output selection] tab for LK239, corresponding input/output data is displayed in the data list, including input data of up to 244 bytes and output data of up to 244 bytes, notably, **Status** and **Control** are required.

> • The LK239 module cannot transmit the REAL data directly by configuring the input/output data. It shall do this with the help of Zone M, with the high-low byte sequence exchanged.

When LK239 is used as the master station, each module in the MODBUS data area indicates one function code supported by MODBUS. Refer to Figure 6-40 for the function codes and data lengths represented by each module.

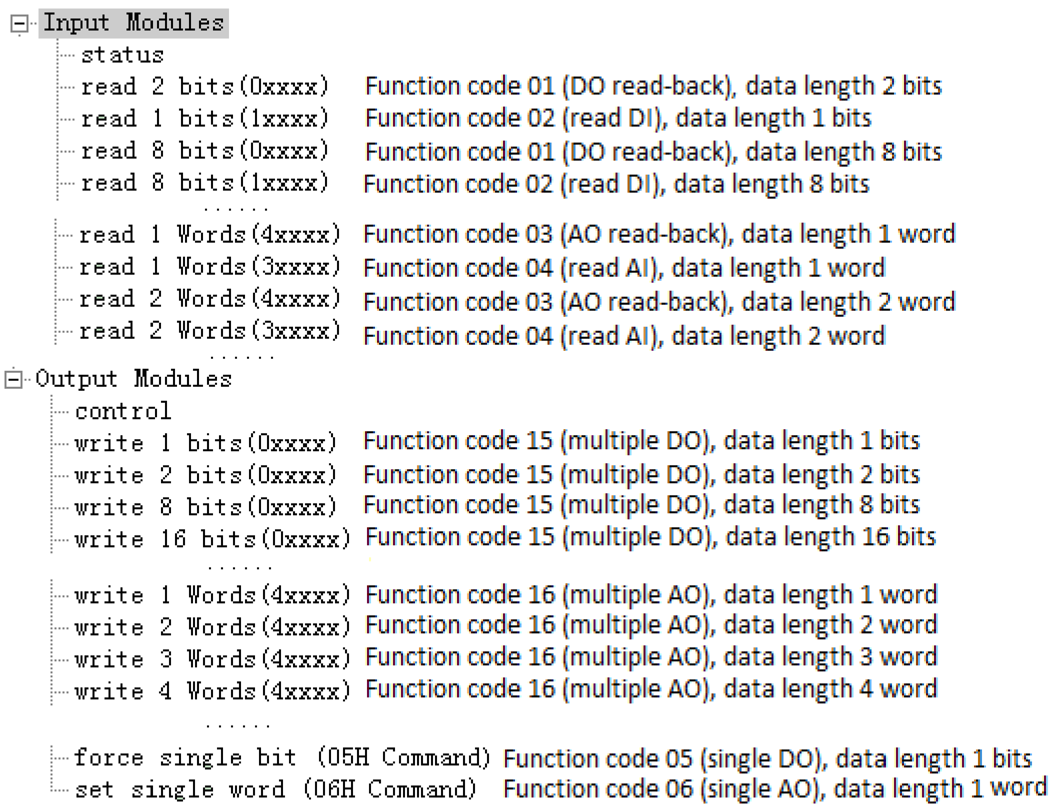


Figure 6-40 Specification for MODBUS Master Station Data Area

6.3.4.9 Configuration for LK239 as MODBUS Slave

1. Set Station Address

In PROFIBUS-DP side, LK239 supports PROFIBUS-DP slave protocol, and address uniquely identified by a backboard number and a slot number. During configuration, double-click the **Device Address** item, as shown in Figure 6-41. Enter a physical communication address in **New** address, and click **OK**.

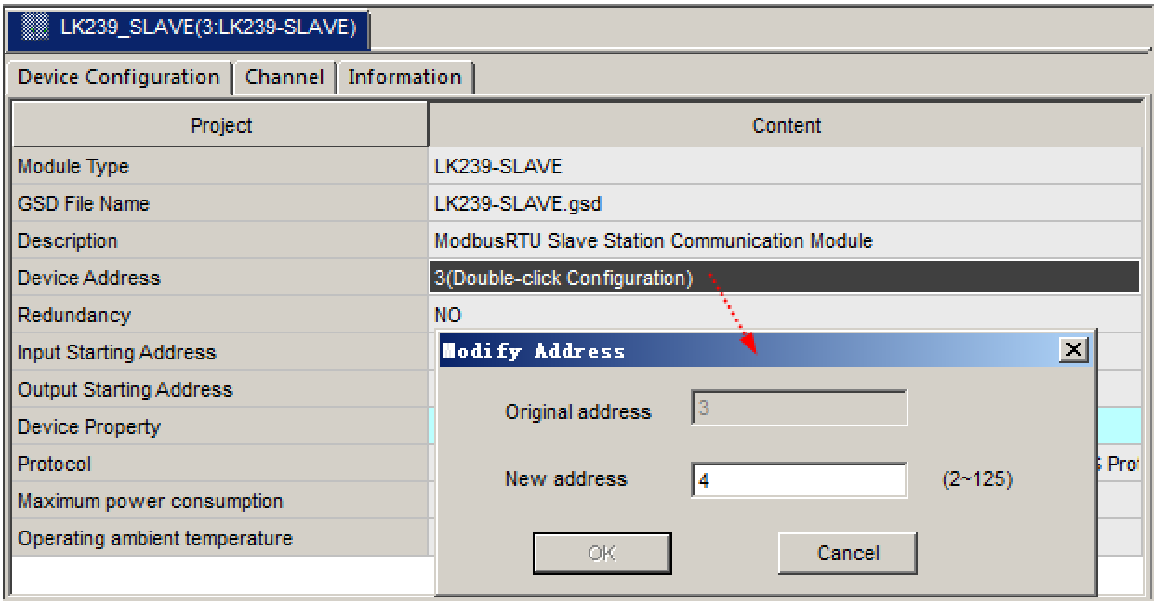


Figure 6-41 Set Station Address

2. Input/output Parameters

When LK239 is used as the slave station, as shown in Figure 6-42, the MODBUS data area includes Input Modules and Output Modules. The data length of each module is different. Notably, **Status** and **Control** are required.

All the input /output data selected is displayed in **Optional module** list box. you can select data to be added, and click button >> to add data to **Added module** list box.

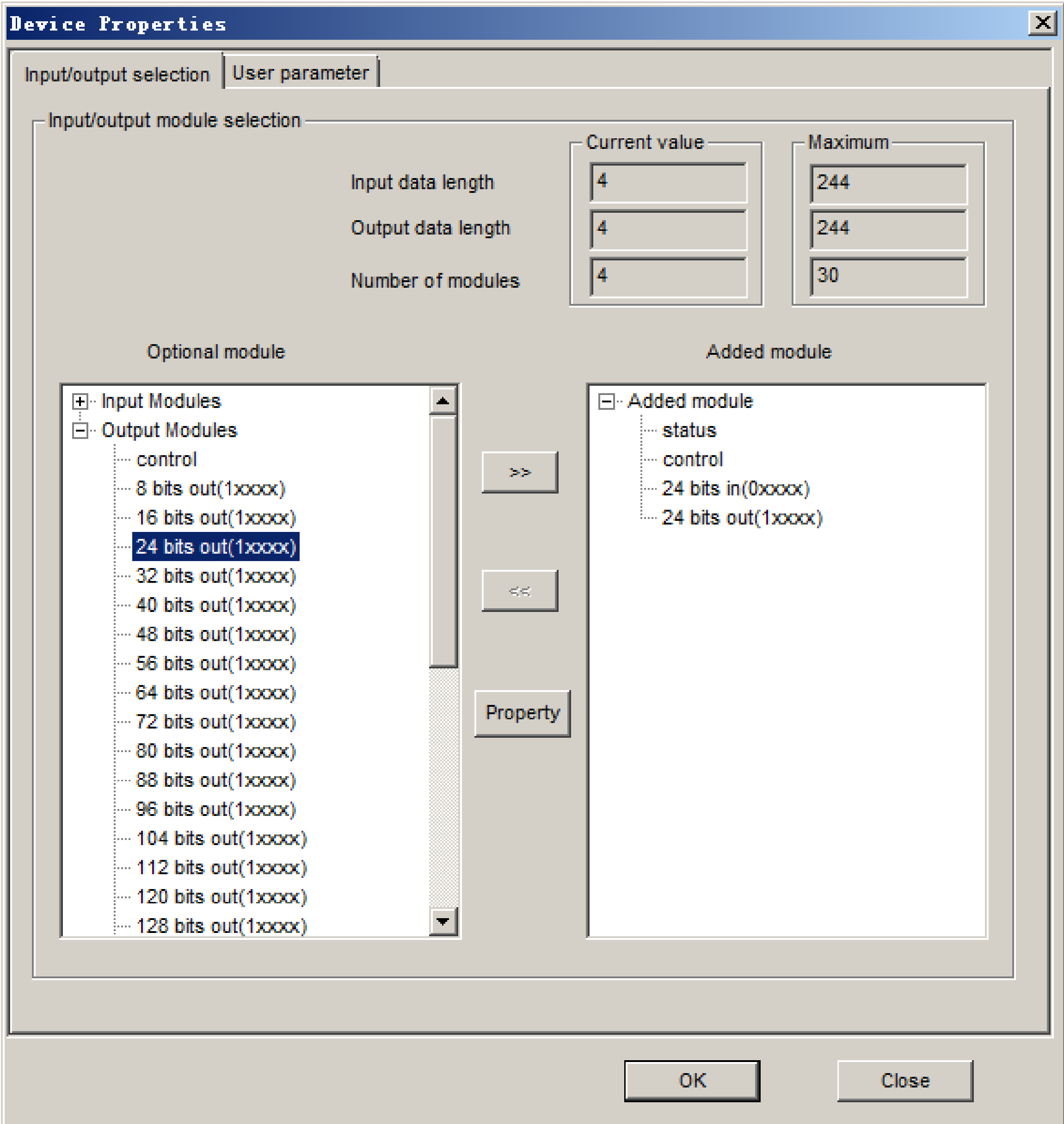


Figure 6-42 Input/output Module of MODBUS Slave Station

- When taking LK239 as the MODBUS slave master station, it shall add strictly in the following sequence. Otherwise, the module cannot work normally: first **Status**, then **Control** and finally Data.

Step 1. Status first, then Control and finally Data.

Step 2. Add **bits** into the data first, then add **Words**.

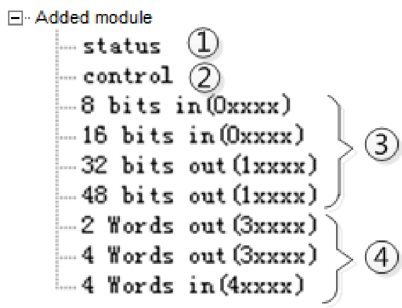


Figure 6-43 Sequence of Adding MODBUS Slave Station Data

3. User Parameter

When LK239 is used as the MODBUS slave station, the user parameter length is 6 bytes. Refer to Table 6-27 for the meaning.

Table 6-27 User Parameter List of MODBUS Slave Station

Parameter Name	Meaning	Value
Baud rate	To select the baud rate for MODBUS communication	1200 bps, 2400 bps, 4800 bps, 9600 bps (default), 19.2 kbps, 38.4 kbps
Parity	To select the verification mode	=Even Parity, even-parity check (default) = Odd Parity, odd-parity check =No Parity, no check
MODBUS Master	To select the MODBUS master and slave stations	=MODBUS Slave, slave station
Transmission Mode	MODBUS data transmission mode	= RTU, RTU transmission mode
RS232/RS485	To select RS232 /RS485 communication interface	=RS232 = RS485 (default)
MODBUS Slave No.	Slave station address	1 (fault) ~ 247

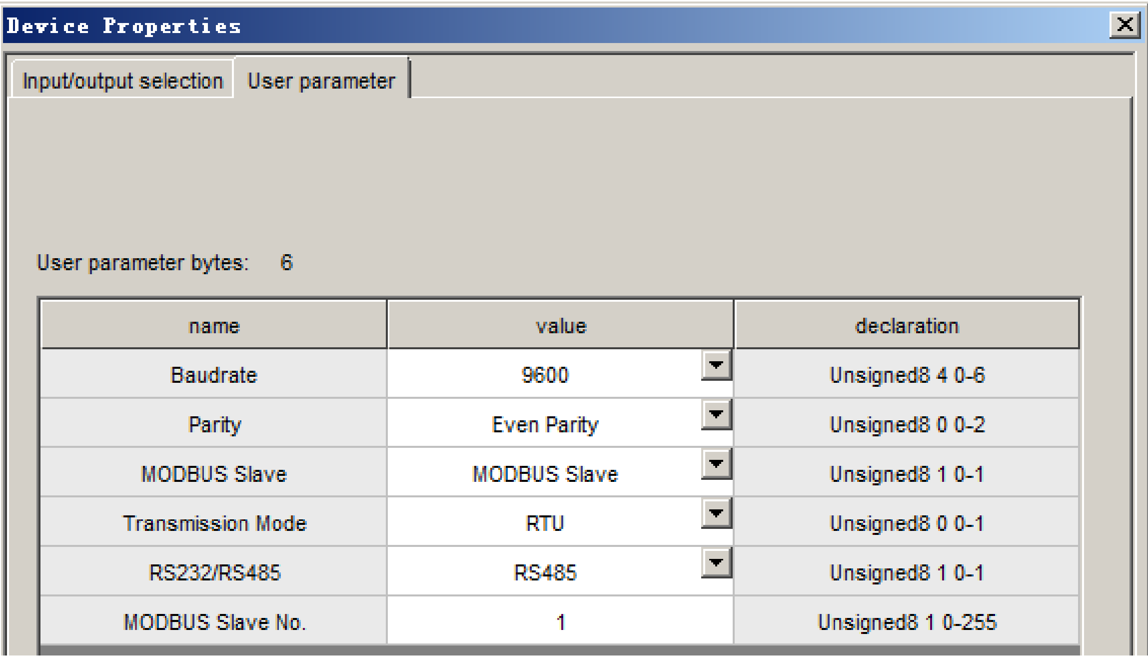


Figure 6-44　User Parameters for MODBUS Slave Station

4. Status and Control Byte

Definitions of the Status (device status) byte and the Control (device control) byte when LK239 is used as the MODBUS slave station.

- Definition of the Status (device status) byte
  - Bit0: hold.
  - Bit4~Bit1: diagnosis message code.
  - Bit5: indicates the running status of the slave station, with 1 set in normal services.
  - Bit6: with 1 set to indicate CRC or LRC verification error.
  - Bit7: with 1 set to indicate an error in parity check error.
- Definition of the Control (device control) byte
  - Bit0: with 1 set to indicate the startup of the MODBUS device. In case of zero clearing, it indicates to forbid the MODBUS device.
  - Bit7~ Bit0: hold.

5. Data Communication

After adding the data in [Input/output selection] tab for LK239, corresponding input/output data is displayed in the data list, including input data of up to 244 bytes and output data of up to 244 bytes, notably, **Status** and **Control** are required.

- The LK239 module cannot transmit the REAL data directly by configuring the input/output data. It shall do this with the help of Zone M, with the high-low byte sequence exchanged.

When LK239 is used as the slave station, each module in the MODBUS data area indicates the MODBUS slave station data, with the module name intuitively indicating the data length and type of each module, as shown in Figure 6-45.

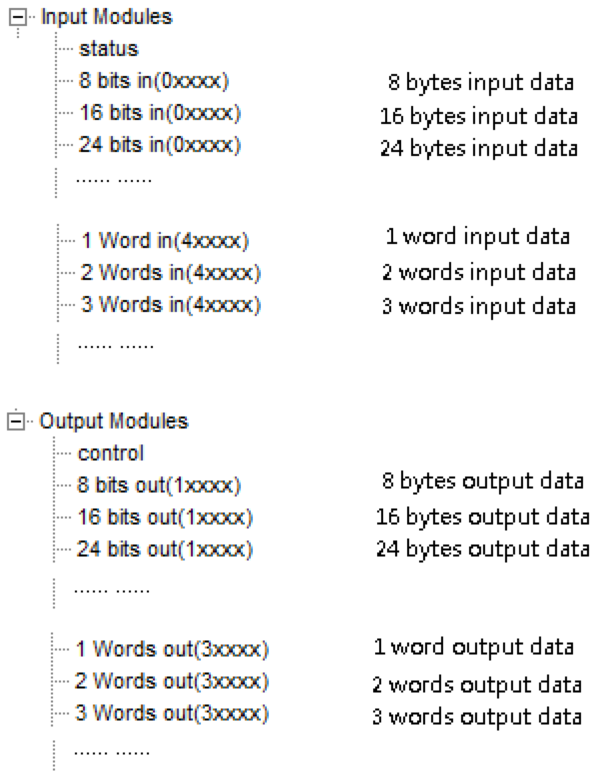


Figure 6-45　Specification for MODUBS Slave Station Data Area

6.3.4.10 Configuration for LK239 as Free Protocol

1. Set Station Address

In PROFIBUS-DP side, LK239 supports PROFIBUS-DP slave protocol, and address uniquely identified by a backboard number and a slot number. During configuration, double-click the **Device Address** item, as shown in Figure 6-46. Enter a physical communication address in **New** address, and click **OK**.

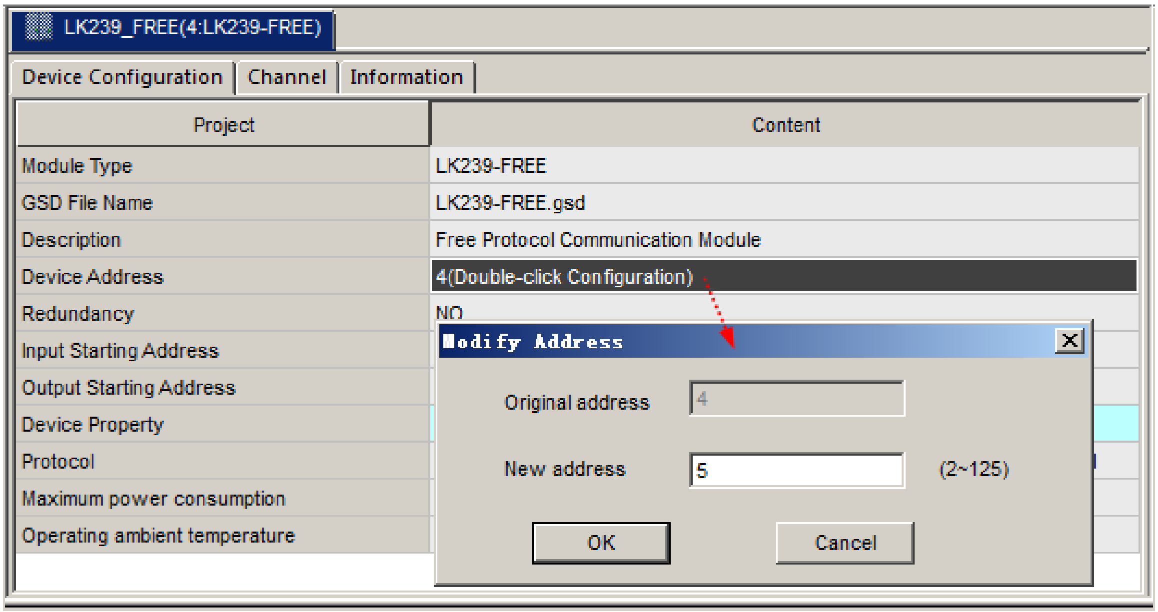


Figure 6-46 Set Station Address

2. Input/output Parameters

When LK239 is used as the free protocol station, as shown in Figure 6-47, the data area includes **Input Modules** and **Output Modules**. The data length of each module is different, and the maximum data length is 244 bytes (including the Control and Status).

Input modules can be added when **Free** parameter is configured as **Only Receive**, and input, output modules can be added when **Free** parameter is configured as **Send and Receive**. **Status** and **Control** are required in two modes.

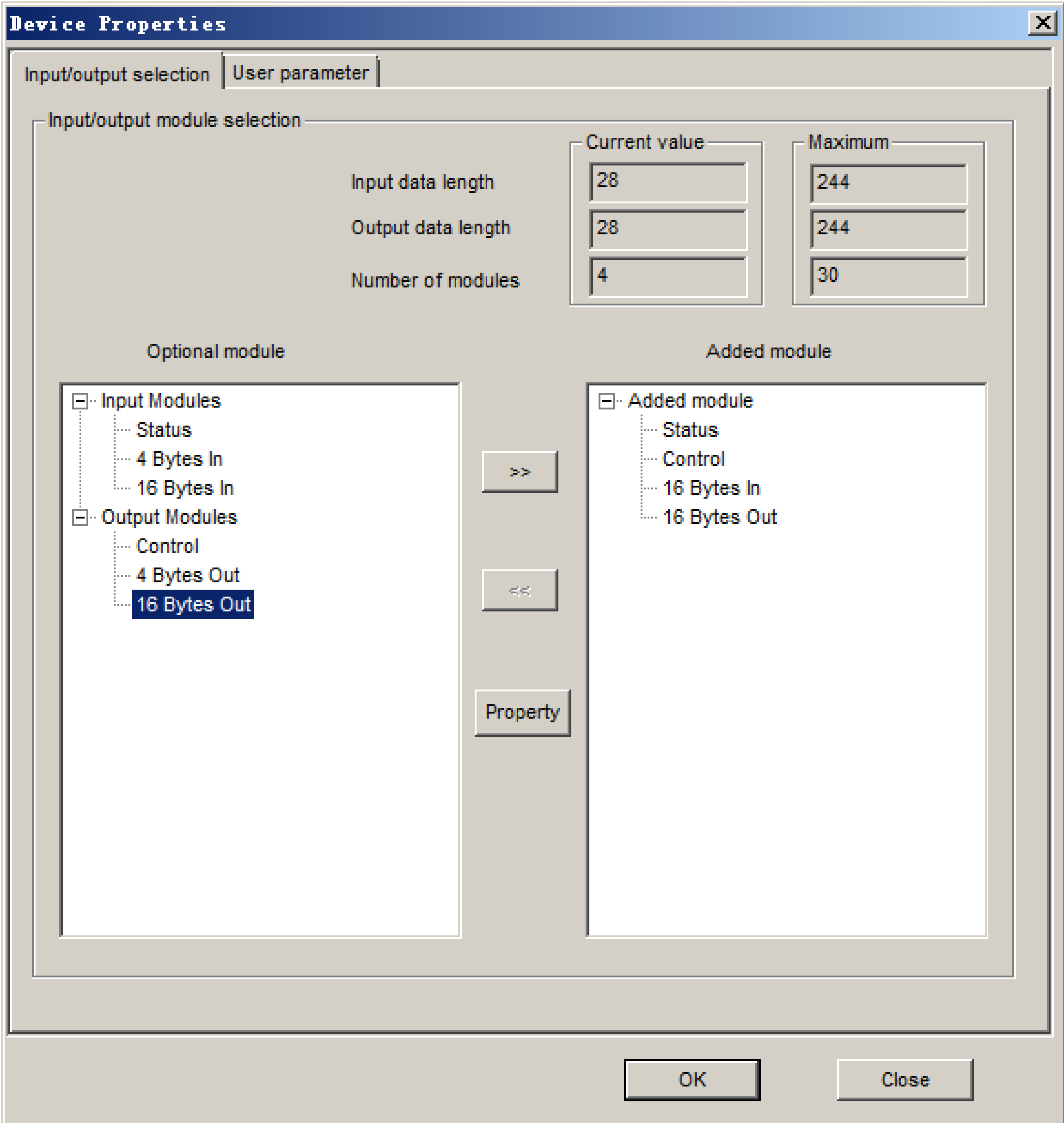


Figure 6-47 Input/output Module of Free Protocol

- Use free protocol with the following addition sequence. Otherwise, the module cannot work normally: first **Status**, then **Control** and finally Data.

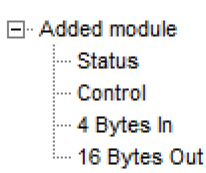


Figure 6-48 Sequence of Adding Free Protocol Data

3. User Parameter

When LK239 is used as Free protocol, the user parameter length is 6 bytes. Refer to Table 6-28 for the specific meaning.

Table 6-28 User Parameter List of Free Protocol

Parameter Name	Meaning	Value
Baud rate	To select the baud rate for Free protocol	1200, 2400, 4800, 9600 (default), 19.2 K, 38.4 K 57.6 K, 115.2 K, unit: bps
Parity	To select the verification mode	=Even Parity, even-parity check (default) = Odd Parity, odd-parity check =No Parity, no check
Free	To select the Only Receive mode and Send and Receive mode	=Only Receive, only receive data =Send and Receive, send and receive data (default)
Reserved	Ignore	Ignore
Reserved	Ignore	Ignore
RS232/RS485	To select RS232 /RS485 communication interface	=RS232 = RS485 (default)

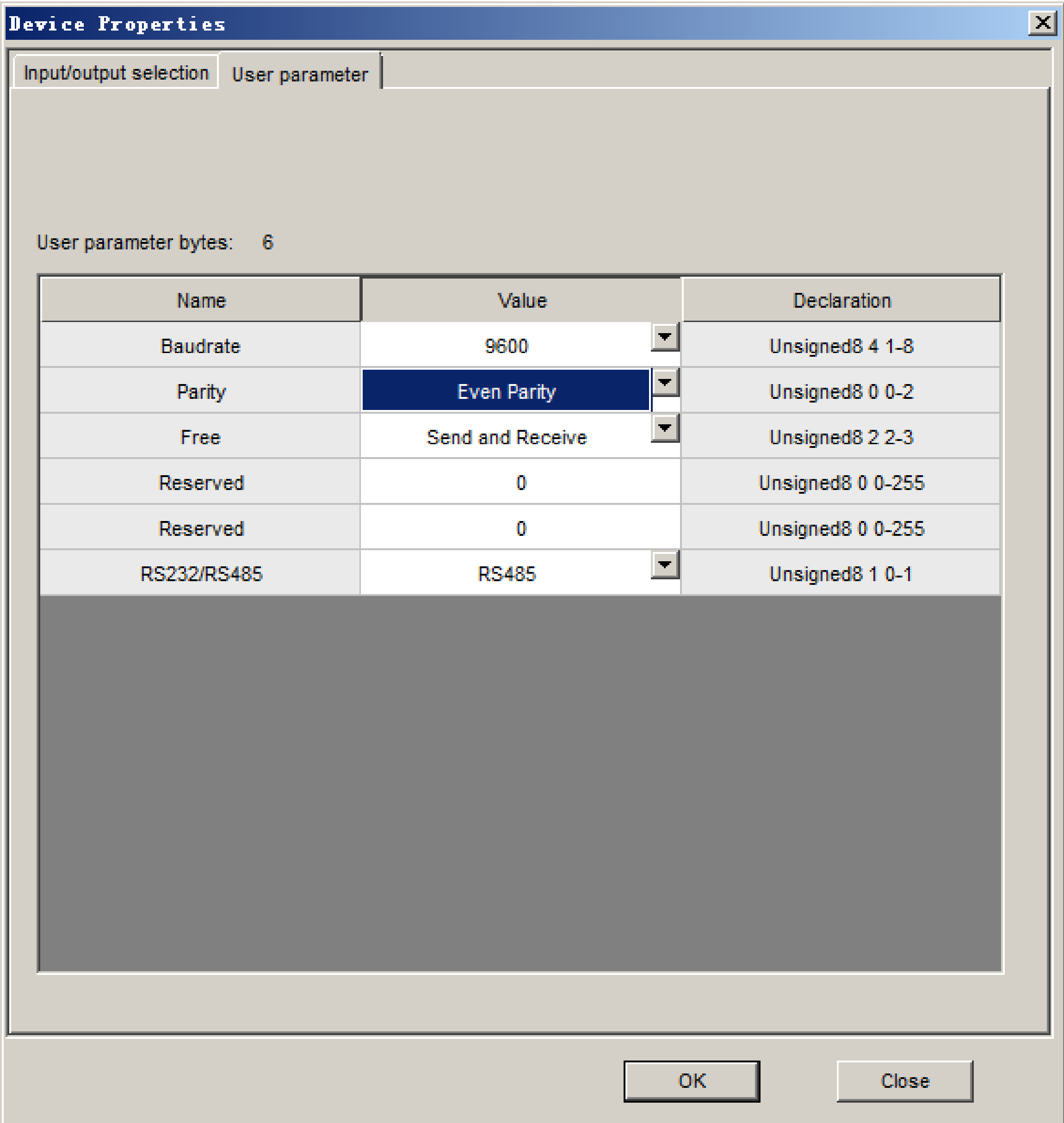


Figure 6-49　User Parameters for Free Protocol

4. Status and Control Byte

(1) Free protocol Only Receive mode

Only Receive in **Free** parameter be selected when free protocol as only receive mode.

In only receive mode, definitions of the Control (device control) byte as shown in Table 6-29.

Table 6-29　Control Byte of Free Protocol in Only Receive Mode

Control	Name	Meaning
Byte0	—	—
Byte1	—	—
Byte2	—	—

Control	Name	Meaning
Byte3	—	—
Byte4	RecvEn	Receive data is enabled, high level for receiving data, low level disabled
Byte5	RecvLen	Data length received
Byte6	StartCahar	Set the starting character received
Byte7	EndChar	Set the ending character received
Byte8	RecvTimeout	Set receiving timeout (unit: 10ms)
Byte9	RecvMode	bit0: Timeout enabled bit1: Ignore bit2: Ending character enabled bit3: Starting character enabled bit4~7: Ignore
Byte10	—	—
Byte11	AckID	ID acknowledged by master station

The Status byte (device control) is defined as shown in Table 6-30 when LK239 adopts the **Only Receive** mode of free protocol.

Table 6-30 Status Byte of Free Protocol in Only Receive Mode

Status	Name	meaning
Byte0	—	—
Byte1	—	—
Byte2	—	—
Byte3	—	—
Byte4	RecvQ	1: receiving end 0: receiving
Byte5	RecvCount	Data length received
Byte6	RecvErr	Receiving error: =0: Correct =1: Data length error =2: Data storage address out of bound =3: Enable starting character, but no setting =4: Enable ending character, but no setting =5: Timeout is set too low =6: Failed to obtain user space pointers =7: Receive timeout =8: No selecting the free protocol =9: Calling multiple function blocks =21: In this case, en neither 0 nor 1 =22: Read starting character error (fpga receiving error) =24: Serial port to receive data error =26: Ending character not found =27: Length parameter error
Byte7	—	—
Byte8	—	—
Byte9	—	—

Status	Name	meaning
Byte10	—	—
Byte11	RecvSN	LK239 return the command number

(2) Free protocol Send and Receive mode

Send and Receive in **Free** parameter be selected when free protocol as send and receive mode. In send and receive mode, definitions of the Control (device control) byte as shown in Table 6-31.

Table 6-31 Control Byte of Free Protocol in Send and Receive Mode

Control	Name	Meaning
Byte0	SendEn	Sending data is enabled (Sending data with rising edge, high level for holding)
Byte1	SendLength	Set sending length
Byte2	Sendtimeout	Set sending timeout (unit: 10ms)
Byte3	SendSN	Command number
Byte4	RecvEn	Receiving data is enabled, receiving with rising edge, high level for holding
Byte5	RecvLen	Data length received
Byte6	StartCahar	Set the starting character received
Byte7	EndChar	Set the ending character received
Byte8	RecvTimeout	Set receiving timeout (unit: 10ms)
Byte9	RecvMode	bit0: Timeout enabled bit1: Ignore bit2: Ending character enabled bit3: Starting character enabled bit4-7: Ignore
Byte10	—	—
Byte11	AckID	ID acknowledged by master station

The Status byte (device control) is defined as shown in Table 6-32 when LK239 adopts the **Send and Receive** mode of free protocol.

Table 6-32 Status Byte of Free Protocol in Send and Receive Mode

Status	Name	meaning
Byte0	SendQ	1: Sending end 0: Sending
Byte1	SendErr	Sending error: =0: Correct =1: Data length error =2: Data storage address out of bound =3: Failed to obtain user space pointers =4: Send timeout =5: No selecting the free protocol =6: Calling multiple function blocks =20: System abnormal =21: In this case, en neither 0 nor 1 =27: Length parameter error

Status	Name	meaning
Byte2	—	—
Byte3	SendSN	The sending command number returned
Byte4	RecvQ	1: receiving end 0: receiving
Byte5	RecvCount	Data length received
Byte6	RecvErr	Receiving error: =0: Correct =1: Data length error =2: Data storage address out of bound =3: Enable starting character, but no setting =4: Enable ending character, but no setting =5: Timeout is set too low =6: Failed to obtain user space pointers =7: Receive timeout =8: No selecting the free protocol =9: Calling multiple function blocks =21: In this case, en neither 0 nor 1 =22: Read starting character error (fpga receiving error) =24: Serial port to receive data error =26: Ending character not found =27: Length parameter error
Byte7	—	—
Byte8	—	—
Byte9	—	—
Byte10	—	—
Byte11	RecvSN	LK239 return the command number

5. Data Communication

As shown in Figure 6-50, the name of each data visually marked out its length and data type in data area of free protocol, according to the need to add.

Input and output data accumulated no more than 244 bytes (including the Control and Status).

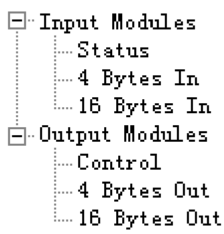
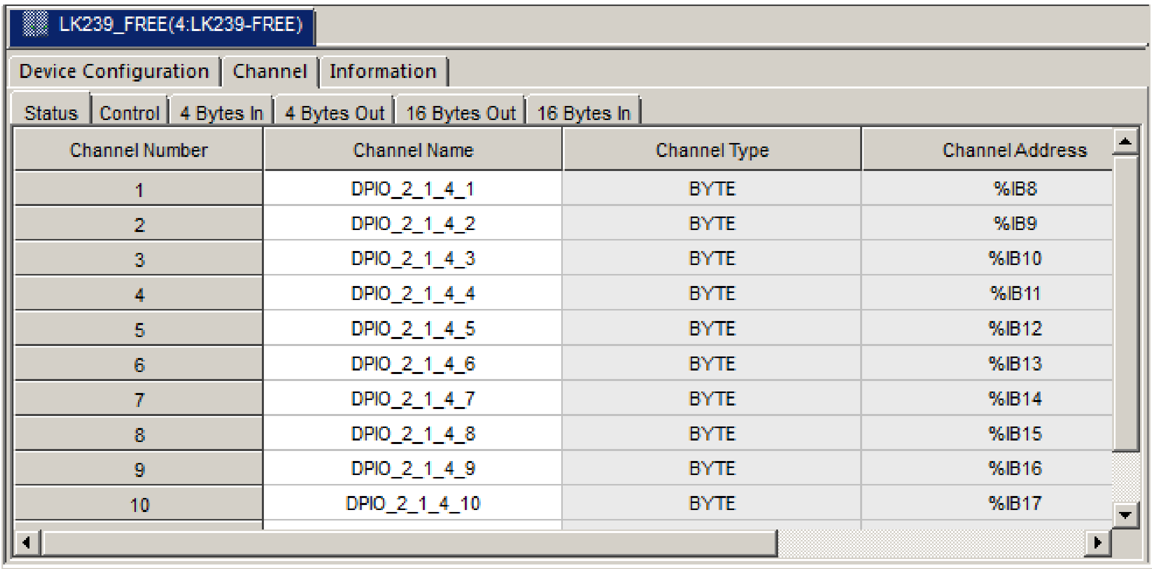


Figure 6-50 Optional Data Type of Free protocol

Corresponding input data or output data is displayed in [Channel] tab after data is added for LK239 in [Input/output selection] tab, with Status and Control data must be selected. As shown in Figure 6-51.



Channel Number	Channel Name	Channel Type	Channel Address
1	DPIO_2_1_4_1	BYTE	%IB8
2	DPIO_2_1_4_2	BYTE	%IB9
3	DPIO_2_1_4_3	BYTE	%IB10
4	DPIO_2_1_4_4	BYTE	%IB11
5	DPIO_2_1_4_5	BYTE	%IB12
6	DPIO_2_1_4_6	BYTE	%IB13
7	DPIO_2_1_4_7	BYTE	%IB14
8	DPIO_2_1_4_8	BYTE	%IB15
9	DPIO_2_1_4_9	BYTE	%IB16
10	DPIO_2_1_4_10	BYTE	%IB17

Figure 6-51 the Data Added

(1) Free protocol Only Receive mode

Only Receive mode is selected if the user just use LK239 receiving external serial data and no sending. In **Only Receive** mode, enable RecvEn (rising edge enable, continue to receive data in high levels), K239 will automatically enter the receiving data state. When enable the starting character, which as a starting point to begin receiving data. The data will be discarded If the starting character not be received. If the starting characters are forbidden, you must enable the length and ending characters, otherwise it will be error. If the receiving length is set as 0, the starting and ending characters must be enabled.

When data is received, if enable the ending characters, which as ending to end the current packet and continue receiving the next packet, then receiving until the specified data length is met. If disenable the ending character, enable the starting character and length, stop receiving when the specified data length which to begin for starting character is met. LK239 free protocol Only Receive mode with cache which is used to store data from external device (25 * 64 Byte cache for a total of 64 data packets, each packet 25 Byte, less than 25 Byte part as a packet, the data more than 64 packets, which not be promptly removed, it will be overwritten by the new data), and then sequentially send to LK master control module after adding the ID.

In summary, the starting characters and / or ending character must be set correctly and be consistent in sending and receiving ends for receiving data correctly.

Free protocol in only receive mode for example as following:

As shown in Figure 6-51, after data is added, you can set **Only Receive** mode and configure the baud rate (The description use RS485 as an example, please select baud rate according to the actual project) as shown in Figure 6-52.

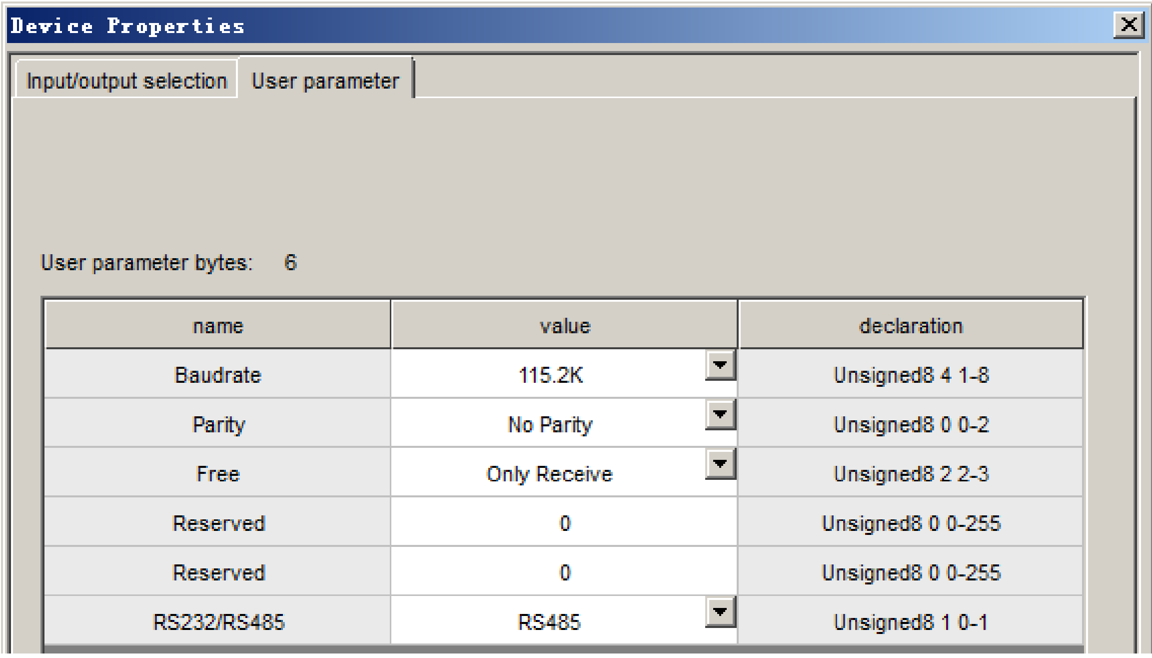


Figure 6-52 LK239 configured as Only Receive Mode

Engineering configuration is as shown in Figure 6-53.

PLC_PRG(PRG).st

No.	Variable Name	Address	Variable Description	Variable Type	Initial Value	Power Fail Safeguard
0001	RecvQ	%IB4		BYTE	0	FALSE
0002	RecvSize	%IB5		BYTE	0	FALSE
0003	RecvErr	%IB6		BYTE	0	FALSE
0004	PackID	%IB11		BYTE	0	FALSE
0005	RecvEn	%QB4		BYTE	0	FALSE
0006	RecvLen	%QB5		BYTE	0	FALSE
0007	StartChar	%QB6		BYTE	0	FALSE
0008	EndChar	%QB7		BYTE	0	FALSE
0009	RecvTimeout	%QB8		BYTE	0	FALSE
0010	RecvMode	%QB9		BYTE	0	FALSE
0011	RecvSN	%QB10		BYTE	0	FALSE
0012	AckID	%QB11		BYTE	0	FALSE
0013	Complete			BOOL	FALSE	FALSE

```
RecvLen:=40;
StartChar:=1;
EndChar:=255;
RecvTimeout:=200;
RecvMode:=13;
RecvEn := 1;
Complete := 1= RecvQ;
AckID := PackID;
```

Figure 6-53 Configuration for Only Receive Mode

Only confirming the data reported by LK239, then the next packet data will be reported. Error information can be obtained by% IB6 bytes. Test the starting characters and / or ending character, when LK239 is configured as only receive data, starting characters and / or ending characters need to be enabled in Control byte, starting characters and / or ending characters must be filled correctly and be consistent with settings in sending for receiving data correctly. When receiving data, the system will send packet received (including the starting characters and / or ending characters) to input data area.

(2) Free protocol Send and Receive mode

If LK239 both send data through the serial port and receive data from external device, you will select **Send and Receive** mode. In **Send and Receive** mode, enable the SendEn (rising edge enable and high level is effective, the data is sent once in each rising edge). K239 will send valid data in output area, if the device returns data to the LK239, the users should enable RecvEn with sending enabled (rising edge enable, high level for holding, the data is received once in each rising edge). receiving process is similar with the Only Receive mode (no cache for receiving in Send and Receive mode).

When data is received, if enable the ending characters, which as ending to end the current packet and continue receiving the next packet, then receiving until the specified data length is met. If disenable the ending character, enable the starting character and length, end receiving when the specified data length which to begin for starting character is met. If the receiving length is set as 0, the starting and ending characters must be enabled.

In summary, the starting characters and / or ending character must be set correctly and be consistent in sending and receiving ends for receiving data correctly.

Free protocol in **Send and Receive** mode for example as following:

As shown in Figure 6-51, after data is added, you can set **Send and Receive** mode and configure the baud rate (The description use RS485 as an example, please select baud rate according to the actual project) as shown in Figure 6-54.

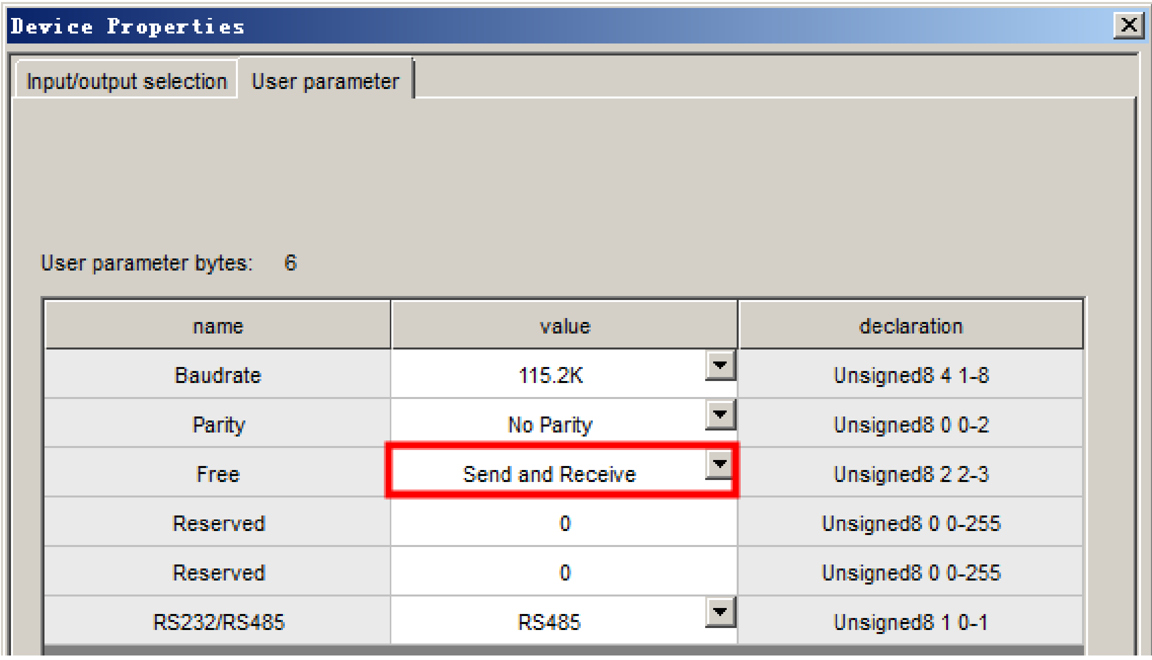


Figure 6-54 LK239 configured as Send and Receive Mode

Engineering configuration as shown in Figure 6-55.

PLC_PRG(PRG).st

No.	Variable Name	Address	Variable Description	Variable Type	Initial Value	Power Fail Safegua
0001	RecvQ	%IB4		BYTE	0	FALSE
0002	RecvSize	%IB5		BYTE	0	FALSE
0003	RecvErr	%IB6		BYTE	0	FALSE
0004	PackID	%IB11		BYTE	0	FALSE
0005	RecvEn	%QB4		BYTE	0	FALSE
0006	RecvLen	%QB5		BYTE	0	FALSE
0007	StartChar	%QB6		BYTE	0	FALSE
0008	EndChar	%QB7		BYTE	0	FALSE
0009	RecvTimeout	%QB8		BYTE	0	FALSE
0010	RecvMode	%QB9		BYTE	0	FALSE
0011	RecvSN	%QB10		BYTE	0	FALSE
0012	AckID	%QB11		BYTE	0	FALSE
0013	Complete			BYTE	0	FALSE
0014	SendQ	%IB0		BYTE	0	FALSE
0015	SendEn	%QB0		BYTE	0	FALSE
0016	SendLength	%QB1		BYTE	0	FALSE
0017	SendTimeout	%QB2		BYTE	0	FALSE
0018	SendSN	%QB3		BYTE	0	FALSE
0019	CompleteSend			BOOL	FALSE	FALSE

```
0001 RecvLen:=40;
0002 StartChar:=1;
0003 EndChar:=255;
0004 RecvTimeout:=200;
0005 RecvMode:=13;
0006 SendLength:=40;
0007 SendTimeout:=1;
0008 SendEn:=1;
0009 CompleteSend:= 1= SendQ;
```

Figure 6-55 Configuration for Send and Receive Mode

Here simply to show the data sending, and receiving process is similar with the Only Receive mode.

- The LK239 module cannot transmit the REAL data directly by configuring the input/output data. It shall do this with the help of Zone M, with the high-low byte sequence exchanged.

6.3.4.11 Technical Specifications

LK239 MODBUS Master/Slave Communication Extension Module

LK239 MODBUS Master/Slave Communication Extension Module		
System Power		
Operating Voltage		24VDC（-15%~20%）
Backboard Current		80 mA max.@24 VDC
DP Communication Bus		
Protocol		PROFIBUS-DP slave station protocol
Dual-network Redundancy		Supported
Communication rate		9.6 kbps, 19.2 kbps, 45.45 kbps, 93.75 kbps, 187. 5 kbps, 500 kbps, 1.5 Mbps self-adapting
Medium		Led out to the backboard via an European connector
MODBUS Communication		
Protocol		MODBUS protocol
Transmission Mode and Frame Format		RTU
Physical Layer Interface		RS485 interface (RJ-45), RS232 interface (RJ-45), configuration selection
Function code supported		01, 02, 03, 04, 05, 06, 15, 16 (decimal)
Max. Number of Supported Slave Stations		28
Input/Output Data Length		Up to 244 bytes
Communication Rate		1200 bps, 2400 bps, 4800 bps, 9600 bps, 19200 bps, 38400 bps, 57600 bps, 115200 bps (configuration selection)
Verification Mode		Odd parity check, even parity check, no check (configuration selection)
Master Slave Mode		To support the master and slave stations (configuration selection)
Isolation Voltage betwen System and Communication Interface		≥500 VAC@1 min, leakage current: 5 mA
Free Protocol		
Protocol		Free protocol, send and receive at the same time
Communication Rate		1200 bps, 2400 bps, 4800 bps, 9600 bps, 19200 bps, 38400 bps, 57600 bps, 115200 bps (configuration selection)
Physical interface		Choose one in RS485 or RS232
Verification Mode		Odd parity check, even parity check, no check (configuration selection)
Input/Output Data Length		The input / output data length is up to 244 bytes each
Start byte		One byte, data range: 0~255, Occupies starting address
End byte		One byte, data range: 0~255, Occupies end address
Isolation Voltage between System and Communication Interface		≥500 VAC@1 min, leakage current: 5 mA
Physical Property		
Indicator Lamp	RUN (green)	Indicator lamp for PROFIBUS-DP bus communication
	COM (yellow)	MODBUS communication/Free protocol indicator
Installation Mode		Slot Installation
Installation Position		I/O slot on the LK backboard

LK239 MODBUS Master/Slave Communication Extension Module	
Protection Key	F1
Module Dimension (W*H*D)	35 mm×100 mm×100 mm
Hot Plugging	Supported
Weight	180 g

Chapter 7 IO Module

7.1 LK610 16-channel Leaking Type Digital Input Module

7.1.1 Basic Features

- 16-contact leaking type input
- Field supply voltage: 10 VDC~31.2 VDC
- Field power loss detection
- Reverse supply protection
- Isolation between each field channel and the system
- Support the PROFIBUS-DP slave station protocol
- Hot swapping

7.1.2 Operating Principle

Threshold level of LK610:

Logic 1: voltage range: 10~31.2 VDC, current: 2 mA (10 VDC)~10 mA (31.2 VDC).

Logic 0: Max. Voltage: 5 VDC, Max. Current: 1.5 mA.

As shown in Figure 7-1, LK610 adopts the leaking type input, with the negative pole of the field power supply connected to the 16-channel common terminal. The one end of the switch is connected to the positive pole of the field power supply, with the other end connected to the input terminal of the DI channel. When the switch is turned off, the current flows into the optocoupler from the input terminal, and then flows out of the common terminal and back to the negative pole of the field power supply.

When the input voltage is 10~31.2 VDC, the LED side of the optocoupler is turned on, providing a high level output. When the input voltage is no more than 5VDC or the input voltage is more than 1.5 mA LED side of the optocoupler is cut off, providing a low level output.

The RC filter circuit filters the input voltage to remove dithering, with the LED playing a role in reserve protection.

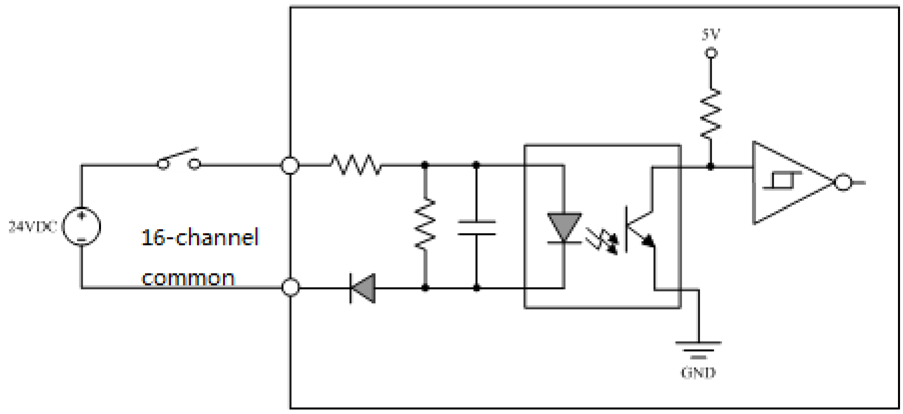


Figure 7-1　LK610 Channel Interface Circuit Diagram

7.1.3　Indicator Lamps

Table 7-1　Definition of LK610 Indicator Lamps

Name	Status	Description
RUN indicator lamp (green)	On	The communication is established, and the module works well
	Flash	The communication is not established or incorrect.
	Off	The module is not powered on or module is fault.
01~16-channel indicator lamp (yellow)	On	The channel is connected.
	Off	The channel is disconnected.

See the following for the specific description of the green RUN lamp:

- Immediately after being powered on, the green lamp flashes to wait for the initialized data, with a flashing frequency of 4 times/second.
- Upon the completion of initialization, the green lamp is turned normally on, which indicates that the module works well. In case of any error in the initialized data, communication cannot be established and the green lamp keeps flashing. Check whether the communication parameters (slave station address, etc.) are set correctly.
- When the communication is normal, the green lamp is normally on. When the communication is disconnected, the green lamp flashes. When the communication is established again, the green lamp is turned on again.

7.1.4　Wirings

LK610 receives the 16-channel wet contact signal. The 16-channel circuit supply is provided by the external 24 VDC power supply. To ensure the isolation between the field and the system, the field 24 VDC power supply shall be configured separately and cannot be commonly used as the power supply for the backboard.

LK610 be installed on the extension backboard. The LK backboard can provide both terminal connection and precast cable connection. Only the backboard terminal connection is discussed here.

The one ends of the 16-channel contacts are separately connected to the terminals of corresponding channels (01~16), with all the other ends shorted to the positive terminal of the field power supply, as shown in Figure 7-2.

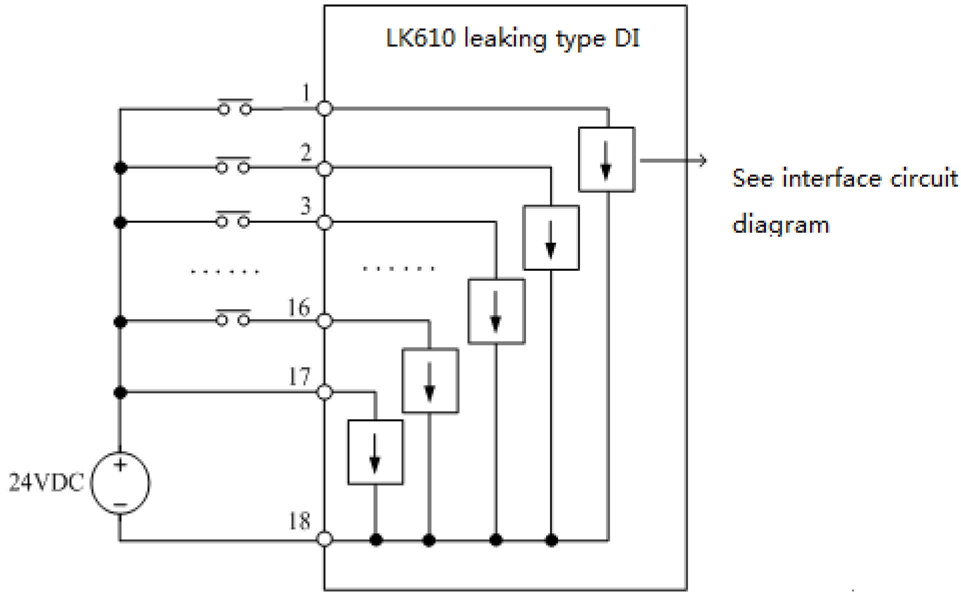


Figure 7-2 LK610 16-channel DI Interface Block Diagram

LK610 goes through the corresponding terminal connections under the mounting groove of the backboard, as shown in Figure 7-3. Following pints need attention during wiring:

- It is required to connect a separate 24 VDC field power supply externally for LK610 (that is: the field power supply cannot use the 24 VDC power supply on the backboard). Only in this way can ensure the electrical isolation between the field and the system.
- The 16 channels use the 24 VDC field power supply commonly.
- Terminals 1~16 are the dry contact digital input terminals for Channels 1~16.
- Terminal 17 is the diagnosis input of the field power supply, connected to the positive terminal of the field power supply and used for field power loss detection.
- Terminal 18 is the negative terminal of the field power input, and also the common terminal inside the module for Channels 1~16.
- Do not crimp multiple cables on the same terminal. It can realize multipoint connection via a bus-bar or a conversion terminal.

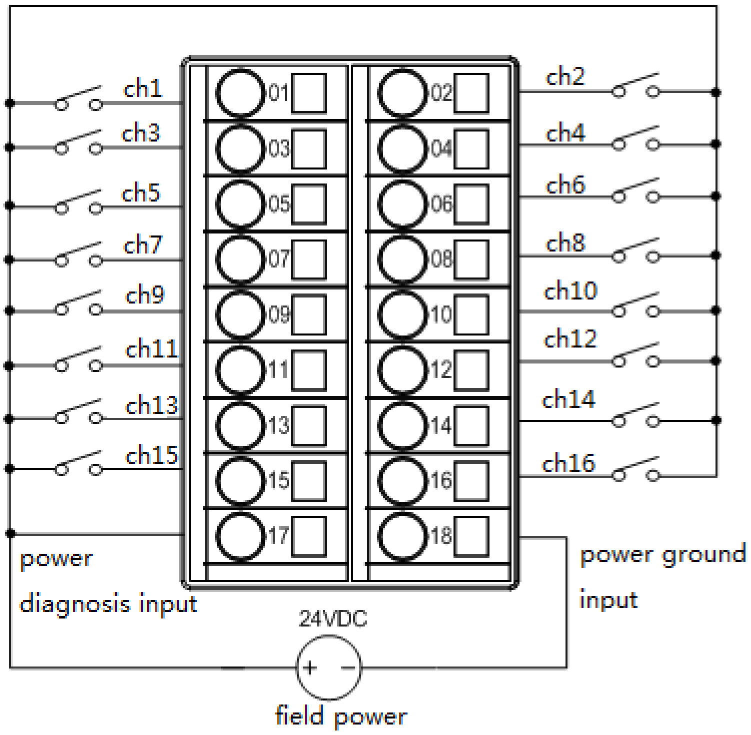


Figure 7-3　Corresponding Backboard Terminal Wiring Diagram

7.1.5　Diagnosis

LK610 can conduct field power loss detection. Such a diagnosis is a device diagnosis.

Whether to enable power loss detection can be selected via the user parameter **Field Power Loss Detection**, which is defaulted to Enable. The modification takes effect only upon full download.

As shown in Figure 7-4, Terminal 17 is connected to the positive terminal of the field power supply, with Terminal 18 to the negative terminal. LK610 conducts power loss diagnosis by detecting the changes in the input voltages between the two terminals. In case of a failure, report the fault status in form of diagnosis data to the CPU module.

In case, the field power supply voltage is between 10 and 31.2 VDC, when the optocoupler switch of the power loss detection channel is in ON status, it is determined that the field power supply works well. When the field power supply is less than 5 DVC, the optocoupler switch of the power loss detection channel is in OFF status, it is determined that the field power supply fails. In case, the field power supply voltage is between 5 and 10 VDC, the status of the optocoupler switch of the power loss detection channel cannot be determined.

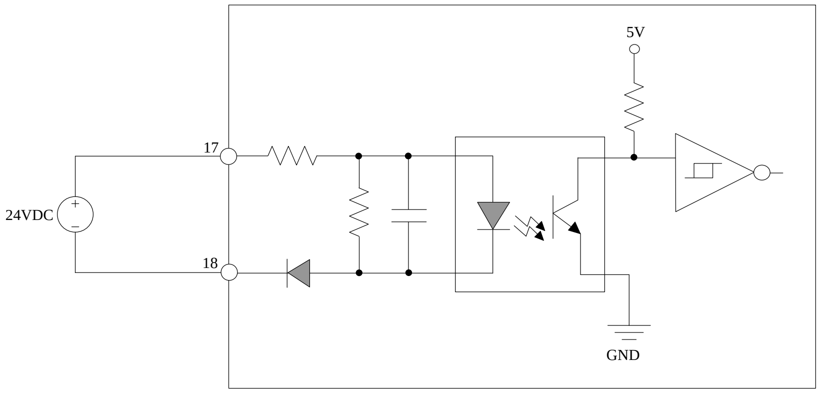


Figure 7-4 Electrical Schematic Diagram of LK610 Field Power Loss Detection

- When the 24 VDC field power supply is disconnected (the line is broken or the power output voltage is less than 5 VDC), the diagnosis data 0x04 (in the diagnosis bytes, Bit2=1) is generated in the device diagnosis data area of LK610. The diagnosis data is reported to the CPU module upon the arrival of the next scanning period.
- After the 24 VDC field power supply is recover to its normal status (output voltage: 10~31.2V DC), the new diagnosis data 0x00 is generated in the device diagnosis area of LK610 (in the diagnosis bytes, Bit2=1). The diagnosis data is reported to the CPU module upon the arrival of the next scanning period.
- LK610 only reports the diagnosis data once separately when a failure occurs and the fault recovered.

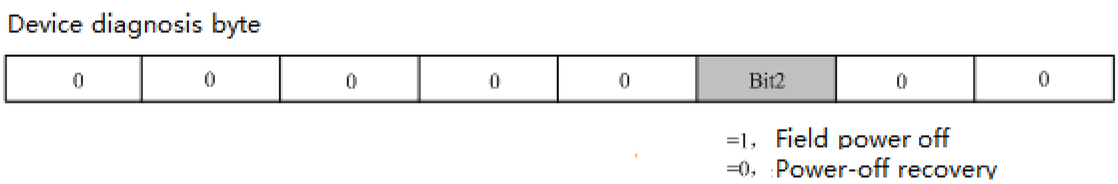


Figure 7-5 Diagnosis Byte of LK610

Field power loss detection is device diagnosis, refer to Figure 7-5 for the definition of diagnosis bytes. After calling the function block sysGetDPSlaveState (Get Diagnosis of DP Slave), the diagnosis data reported by LK610 is saved into output parameter **DiagData** in the function block, as shown in Table 7-2.

Table 7-2 Specifications for LK610 Diagnosis Message

Device diagnosis	Value	Meaning
DiagData [0]: DiagData [1]:	0x02: 0x04	Field power loss
	0x02: 0x00	The failure is recovered or there is no diagnosis data

7.1.6 Reverse Supply Protection

The LK610 module is connected to a diode in series at the negative terminal of the power input for reverse protection. By doing so, it can avoid preventing the polarity of the external power supply improperly, which can damage the module.

Max. reverse withstand voltage: 60 VDC.

7.1.7 Parameters

The [User parameter] is used to set the operation mode of the module. The CPU module written when downloading the user program may not be read in each scanning period. Each parameter has a default value, able to modify the parameter value according to the project requirements. After modifying the parameter value, it requires full download before taking effect.

Double-click the added LK610 module in the DP_MASTER node to open the dialog of **Device Properties** in AutoThink, as shown in Figure 7-6, there are 2 bytes in LK610 user parameter.

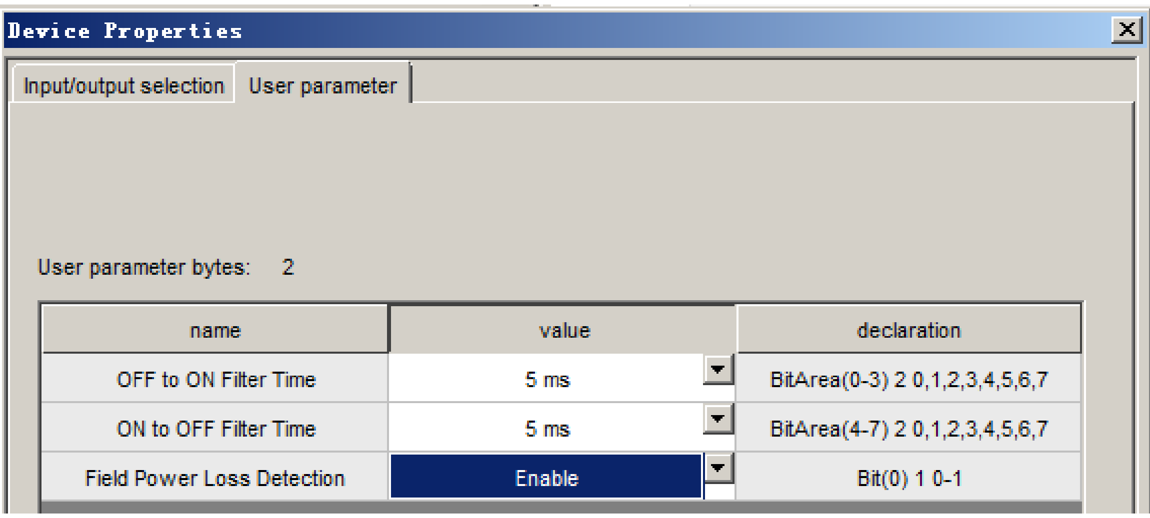


Figure 7-6 LK610 User Parameter Setting

Table 7-3 Definition of LK610 User Parameter

Parameter Name	Meaning	Value
OFF to ON Filter Time	OFF→ON filter time	0=1 ms 1=3 ms 2=5 ms (default) 3=10 ms 4=15 ms 5=20 ms 6=25 ms 7=30 ms
ON to OFF Filter Time	ON → OFF filter time	
Field Power Loss Detection	To enable field power loss detection	0=Disable, disable 1=Enable enable (default)

7.1.8 Technical Specifications

LK610 16-channel Leaking Type Digital Input Module	
System Power	
Operating Voltage	24VDC（-15%~20%）
System Power Consumption	50 mA max.@24 VDC, excluding field power consumption
Input channel	
Number of channels	16
Contact Type	Dry contact, leaking type input

LK610 16-channel Leaking Type Digital Input Module		
Rated Voltage of Field Power Supply		24 VDC
Threshold Level	ON	10 VDC (2 mA) ~31.2 VDC (10 mA)
	OFF	0~5 VDC (1.5 mA)
Dithering-removing Filter Time OFF→ON ON→OFF		1 ms,3 ms, 5 ms, 10 ms, 15 ms, 20 ms, 25 ms, 30 ms optional for configuration 1 ms,3 ms, 5 ms, 10 ms, 15 ms, 20 ms, 25 ms, 30 ms optional for configuration
Reverse Protection		Max. reverse withstand voltage: 60 VDC.
Isolation Voltage between Field and System		500 VAC@1 min, leaking current: 5 mA
Failure Diagnosis and Hot Plug		
Field Power Loss Diagnosis		Bit2 in the diagnosis bytes (Bit0~Bit7) reported to the module is used to indicate the information on field power supply detection. When Bit2=1 indicates field power loss, then Bit2=0 indicates field power recovery. The field power failure diagnosis only reports once separately when a failure occurs and the fault recovered.
Hot Plugging		Supported
Physical Property		
Protection Key		D0
Installation Position		Extension backboard
Module Dimension (W*H*D)		35 mm×100 mm×100 mm
Enclosure Protection Rating		IEC60529 IP20
Weight		180g

7.2 LK710 16-channel Source Type Digital Output Module

7.2.1 Basic Features

- 16-channel MOSFET source type output
- Output voltage range: 10 VDC~31.2 VDC
- Output read-back diagnosis
- Field power loss detection
- Over Current Protection
- Fault mode output
- Isolation between the system and the field
- Programming mode output
- Hot swapping

7.2.2 Operating Principle

As shown in Figure 7-7, one end of the load is connected to the negative pole of the field power supply, with the other end connected to LK710. After the MOSFET electronic switch is turn on, the current flowing from the switch is supplied to the load, with the 16-channel switches used the power supply commonly in the module.

The CPU module writes the output data and the preset time into the LK710 data storage area via the high-speed bus. The data controls the instructions to turn on or off the MOSFET electronic switch output. When the control signal is a high level, the diode side of the optocoupler is turned on, and the electronic switch is turned on to drive the load, thus realizing digital output.

The diode plays a role of follow current. When the external load is inductive, it can be the channel to discharge the induced current upon the moment of power failure.

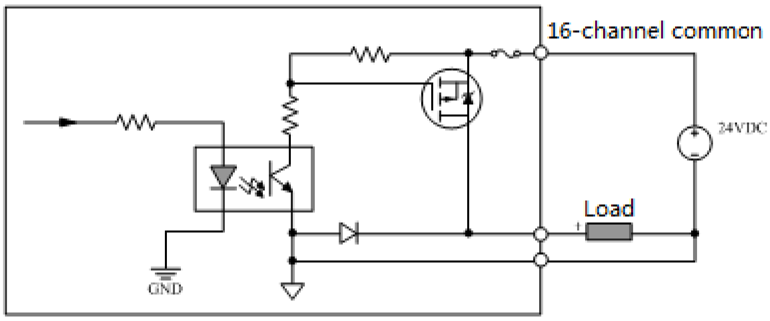


Figure 7-7 Circuit Diagram of LK710 Channel Interface

7.2.3 Indicator Lamps

Table 7-4 Definition of LK710 Indicator Lamps

Name	Status	Description
RUN indicator lamp (green)	On	The communication is established, the module works well
	Flash	The communication is not established or incorrect
	Off	The module is not powered on
01~16-channel indicator lamp (yellow)	On	The channel is turned on
	Off	The channel is disconnected

See the following for the specific description of the green RUN lamp:

- Immediately after being powered on, the green lamp flashes to wait for the initialized data, with a flashing frequency of 4 times/second.
- Upon the completion of initialization, the green lamp is turned normally on, which indicates that the module works well. In case of any error in the initialized data, communication cannot be established and the green lamp keeps flashing. Check whether the communication parameters are set correctly.
- When the communication is normal, the green lamp is normally on. When the communication is disconnected, the green lamp flashes. In this case, the module enters the fault mode automatically, outputting the value of the fault mode. When the communication is established again, the green lamp is turned on again. The module automatically exits from the fault mode.

7.2.4 Wirings

The LK710 output contact is of a dry type, which can drive the output of the electronic switch only when connected to the field power supply. The field power supply is a 10~30 VDC DC power supply.

LK710 is installed on the extension backboard. The extension backboard can provide both terminal connection and precast cable connection. Only the backboard terminal connection is discussed here.

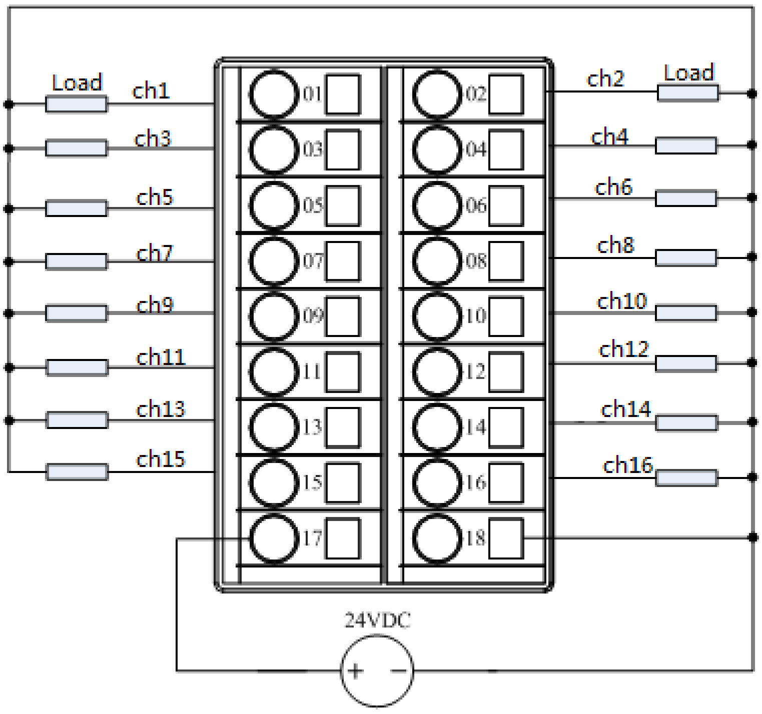


Figure 7-8　Wiring Diagram of Backboard Terminals Corresponding to LK710

Refer to Figure 7-8 for the corresponding relationship between each channel and the terminal. Pay attention to the following during wiring:

- The module is not provided with reverse voltage protection. **In case of improper wiring, it may burn down the internal circuit**.
- To ensure the isolation between the field and the system, the field power supply shall be configured separately and cannot be commonly used as the power supply for the backboard.
- The 16 channels use the 24 VDC field power supply commonly.
- Terminals 1~16 are separately the digital outputs for Channels 1~16.
- Terminal 17 is the positive terminal of the field power input commonly used by the DO signal of Channel 16.
- Terminal 18 is used for field power loss diagnosis and connected to the negative terminal of the field power supply.
- Do not crimp multiple cables on the same terminal. It can realize multipoint connection via a bus-bar or a conversion terminal.

7.2.5 Functions

7.2.5.1 Output Enable

After the output module is powered on, if the output instruction given from the CPU module is not received, then it is in the initial status, with no output. For a module in the initial status, the output cannot be enabled. In this case, it holds its initial status even when in the fault modes.

After running the user program, the CPU module sends the output instruction to the module via the PROFIBUS-DP bus. The module receives the control instruction and outputs. Once the instruction given from the CPU module is output, output is then enabled for the slave station module. When in the fault modes, the output enabled module outputs the values for the fault modes.

In summary, whether output has been enabled after powering on the output module, shall affect the output status in the fault modes.

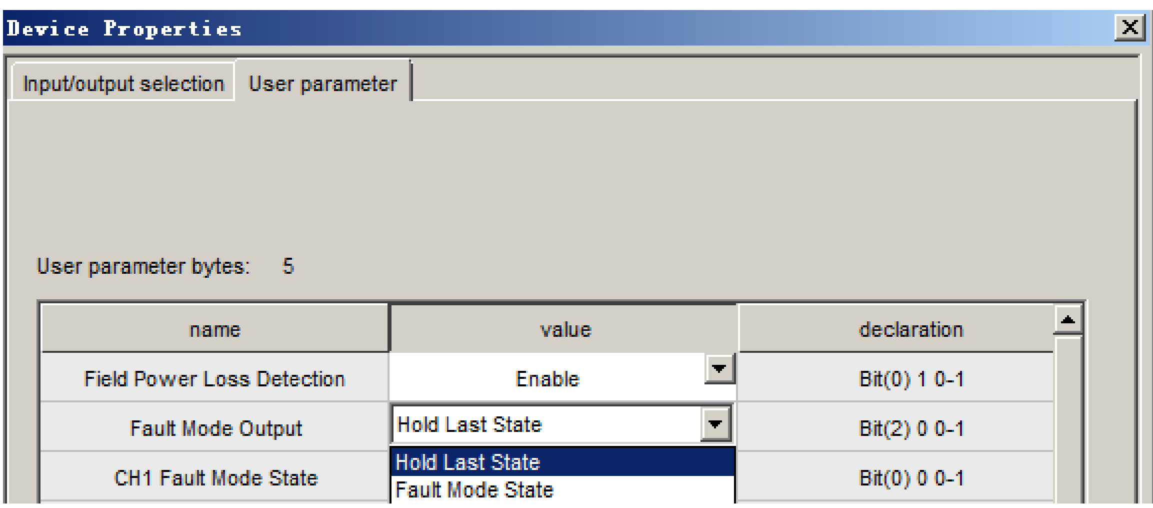
After the output is enabled, the module enters the plug module or is powered up again upon power failure. The module returns to the initial status, with the output disabled. After receiving the output instruction of the CPU module, the output is re-enabled.

7.2.5.2 Communication Fault

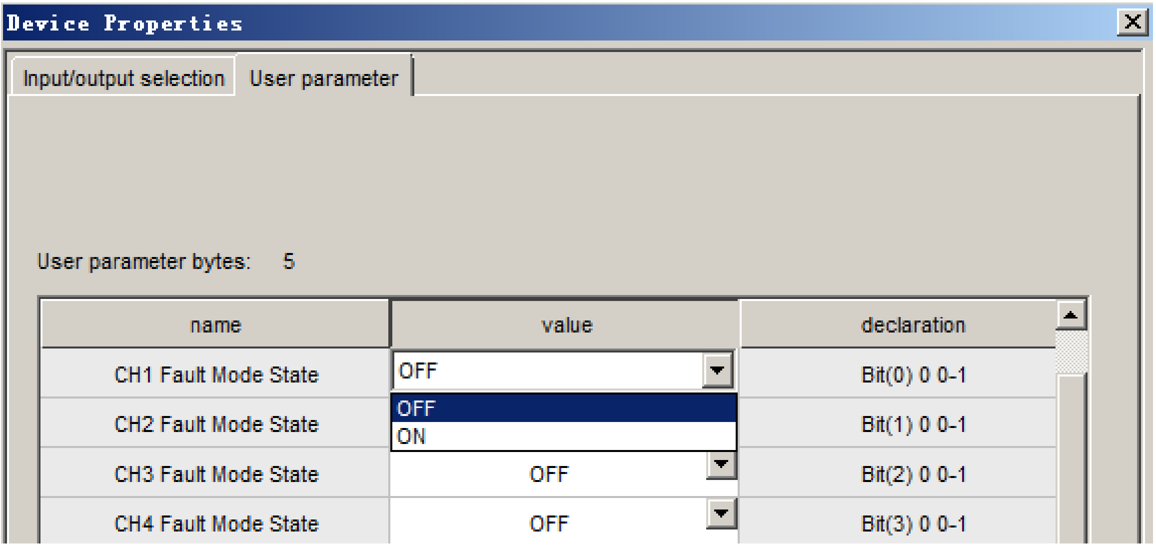
In case of a communication fault, the communication between the module and the CPU module is disconnected, with RUN lamp flashing. In case of a communication fault, the module status can be divided into the following cases:

- After the module is powered on, it cannot communicate with the CPU module. The module is in the initial status and the output is disabled.
- When a communication fault (offline) occurs during running: output Hold (Hold Last State) or output certain status (ON or OFF) that is specified in the configuration in advance, which is known as the fault mode settings (Fault Mode State). In case of a communication fault, Output Hold or Output Fault Mode Settings can be selected in the configuration.
- If the output has not been enabled, then it cannot output the fault mode status even in case of a communication fault.

In the fault mode, it can set output hold or output fault mode settings via the user parameter **Fault Mode Output**, defaulted to output hold. The fault mode settings are set via the user parameter **Fault Mode State**, defaulted to output OFF status (disconnected).



(a)



(b)

Figure 7-9 Output Setting of LK710 Fault Mode

7.2.5.3 Over Current Protection

The LK710 module is provided with over-current protection. It can protect the module in case the instant current is too great, such as output short circuit, etc. Over current protection can be realized by connecting to a self-recovery fuse in series in the loop, with each two points sharing a self-recovery fuse.

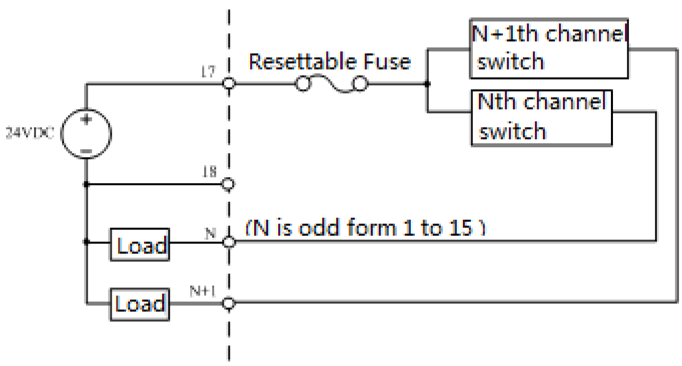


Figure 7-10 Electrical Schematic Diagram of LK710 Channel over Current Protection

7.2.6 Diagnosis

LK710 can conduct field power loss detection. Such a diagnosis is a device diagnosis.

Whether to enable power loss detection can be selected via the user parameter **Field Power Loss Detection**, which is defaulted to Enable. The modification takes effect only upon full download.

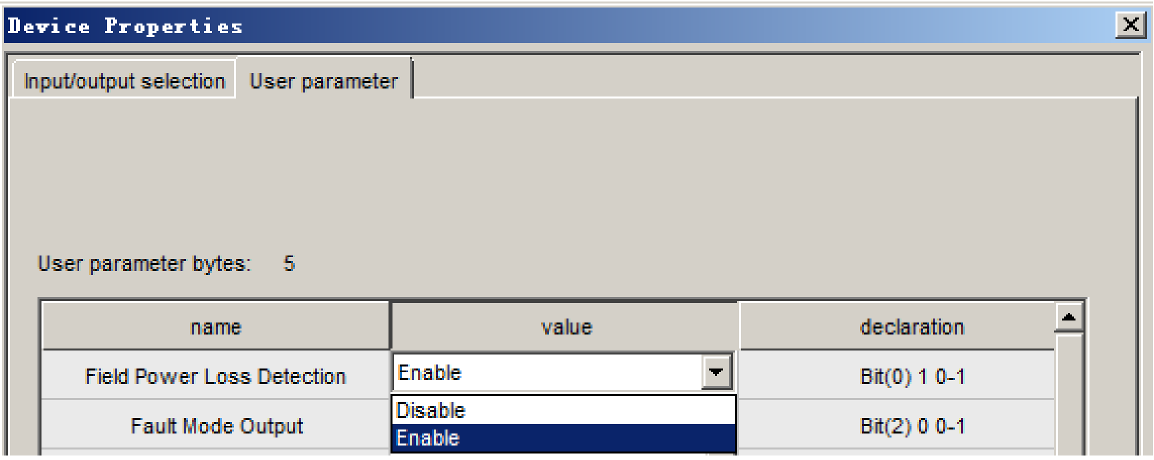


Figure 7-11 Setting of The LK710 Field Power Loss Detection

As shown in Figure 7-12, terminal 17 is connected to the positive terminal of the field power supply, with terminal 18 to the negative terminal. LK710 conducts power loss diagnosis by detecting the changes in the input voltages between the two terminals. In case of a failure, report the fault status in form of diagnosis data to the CPU module.

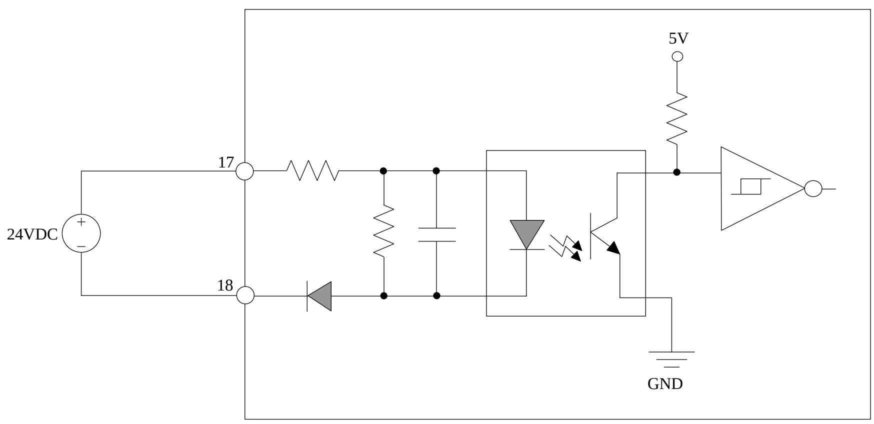


Figure 7-12 Electrical Schematic Diagram of LK710 Field Power Loss Detection

- When the 24 VDC field power supply is disconnected (the line is broken or the power output voltage is less than 5 VDC), the diagnosis data 0x04 (in the diagnosis bytes, Bit2=1) is generated in the device diagnosis data area of LK710. The diagnosis data is reported to the CPU module upon the arrival of the next scanning period.
- After the 24 VDC field power supply is recover to its normal status (output voltage: 10~31.2V DC), the new diagnosis data 0x00 is generated in the device diagnosis area of LK710 (in the diagnosis bytes, Bit2=1). The diagnosis data is reported to the CPU module upon the arrival of the next scanning period.
- LK710 only reports the diagnosis data once separately when a failure occurs and the fault recovered.

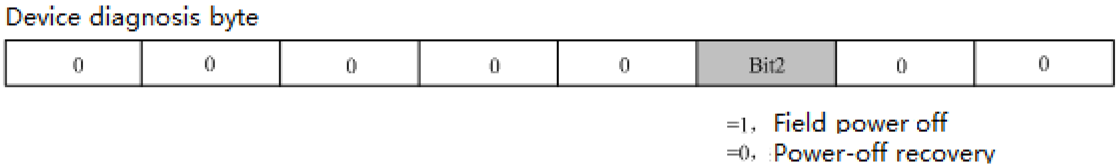


Figure 7-13 Diagnosis Byte of LK710

Field power loss detection is device diagnosis, refer to Figure 7-13 for the definition of diagnosis bytes. After calling the function block sysGetDPSlaveState (Get Diagnosis of DP Slave), the diagnosis data reported by LK710 is saved into output parameter **DiagData** in the function block, as shown in Table 7-5.

Table 7-5 Specifications for LK710 Diagnosis Message

Device diagnosis	Value	Meaning
DiagData [0]: DiagData [1]	0x02: 0x04	Field power loss
	0x02: 0x00	The failure is recovered or there is no diagnosis data (If the power failure has never happened, the diagnosis information is 0x00:0x00)

7.2.7 Parameters

The [User parameter] is used to set the operation mode of the module. The CPU module written when downloading the user program may not be read in each scanning period. Each parameter has a default, able to modify the parameter value according to the project requirements. The user parameter does not support online modification. The modification takes effect only upon full download.

The user parameter length of the LK710 module is up to 5 bytes.

Table 7-6 Table of LK710 User Parameters

Parameter Name	Meaning	Value
Field Power Loss Detection	To enable power loss detection	0: Disable 1: Enable (default)
Fault Mode Output	Fault mode output Setting	0: Hold Last State, output Hold (default) 1: Fault Mode State, output the failure mode settings
CH1~16 Fault Mode State	Fault mode settings for Channels 1~16	0: OFF (default) 1: ON

7.2.8 Data Area

The input data is the one that is updated data that is uploaded from the slave station in each scanning period. The output data is the one that is sent by the CPU module to the slave station in each scanning period, which can be modified online when running the user program.

The output data of LK710 occupies 2 bytes. The 2-byte output data controls the opening and closing of the 16-channel output. The input data is of 2 bytes, which is the current status of the feedback read-back data channel. Bit0~Bit15 separately correspond to Channels 1~16, as shown in Table 7-7.

The channel read-back data returns the channel output status to the CPU module, for user programming.

Table 7-7 Table of LK710 I/O Data

Definition of Areas	Data Length	Meaning	Value Range
Output Data (%Q)	1WORD	Output status of Channels 1~6 Bit0~Bit15 separately correspond to Channels 1~16, 1=ON, 0=OFF	0x0000~0xFFFF
Input Data (%I)	1WORD	Output status readback of Channels 1~16 Bit0~Bit15 separately correspond to Channels 1~16, 1=ON, 0=OFF	0x0000~0xFFFF

7.2.9 Technical Specifications

LK710 16-channelSource Type Digital Output Module	
System Power	
Operating Voltage	24VDC（-15%~20%）
Backboard Current	130 mA max.@24 VDC
Output channel	
The number of channels	16 channels
Output Switch	MOSFET
Isolation Voltage	500 VAC@1 min. between the system and the field, leaking current: 5 mA
Rated Output Voltage	24 VDC
Output Voltage Range	10 VDC~31.2 VDC
Rated output current Each Point Each Module	0.5 A@40℃&0.4 A@60℃ (linear decrease) 8 A@40℃& 6.4 A@60℃ (linear decrease)
Surge Current at Each Point	1 A, duration: 10 ms, period: 2 s@60℃
Over Current Protection	A self-recovery fuse protection device is shared for every two points
Min. Load Current	3 mA/Each Point
Max. On-status Voltage Drop	150 mV@0.5 A
Max. Off-status Leakage Current	1 mA/Each Point
Output Delay Time OFF→ON ON→OFF	1 ms (max.) 1 ms (max.)
Independent Configurable Fault Mode Output Value for Each Point	Output Hold (default), ON or OFF
Independent Configurable Program Mode Output Value for Each Point	Output Hold (default), ON or OFF
Failure Diagnosis and Hot Plug	
Field power loss detection	Field power loss: device diagnostic sampling word reporting 0x04, power loss recovery: reporting 0x00
Hot Plugging	Supported
Physical Property	

LK710 16-channelSource Type Digital Output Module	
Protection Key	E0
Installation	Extension backboard
Module Dimension (W*H*D)	35 mm×100 mm×100 mm
Enclosure Protection Rating	IEC60529 IP20
Weight	200 g

7.3 LK410 8-Channel Voltage Type Analog Input Module

7.3.1 Basic Features

- 8-channel voltage inputs
- Applicable range:10V / 0~10V / 0~5V
- Max. measurable range:10.25V / 0~10.25V / 0~5.125V
- Over-limit alarm
- Over range alarm
- Line broken detection
- Support PROFIBUS-DP slave station protocol
- Isolation between the system and the field channel
- Field calibration function
- Hot swapping

7.3.2 Operating Principle

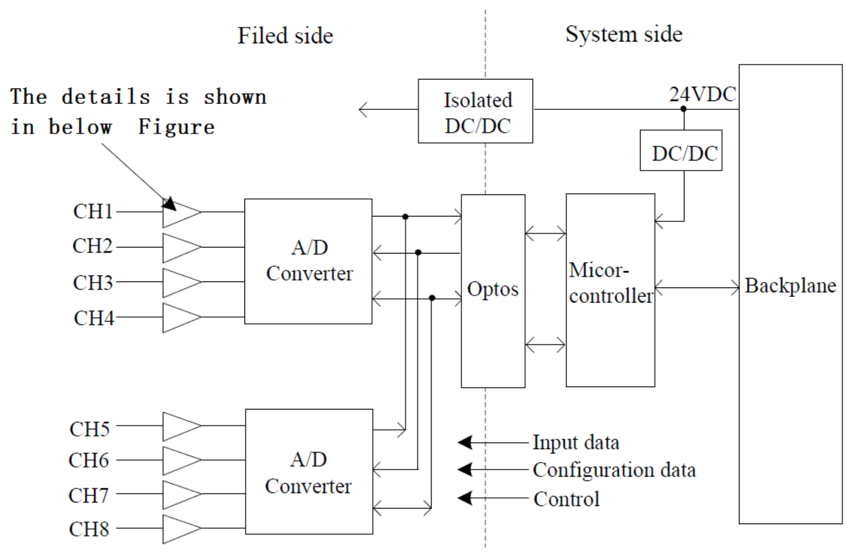


Figure 7-14 LK410 Input Circuit Block Diagram

The module is powered by 24VDC voltage which is converted to ±15VDC by isolated DC/DC converter.

As shown in Figure 7-15, the module converts an analog voltage into a digital value via voltage conversion, filtering, A/D, and signal is read by the module's microprocessor after photoelectric isolation, and sent to the controller via PROFIBUS-DP bus.

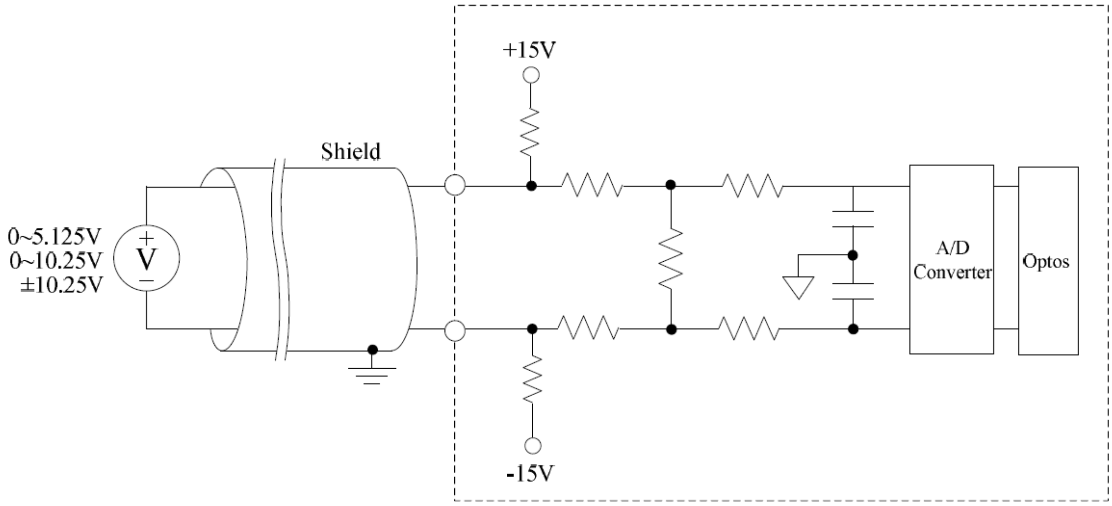


Figure 7-15 LK410 Input Simplified Circuit

7.3.3 Indicator Lamps

There are two status indicators on the front panel of the module: the green indicator RUN and the yellow indicator CAL. The RUN indicator indicates the communication status between the module and the controller. CAL indicator indicates the calibration process of the module.

LK410 analog module supports field calibration. The descriptions of indicator in the operating mode and calibration mode are different.

Table 7-8 Definition of LK410 Indicators

Type	Status	Instructions
RUN indicator (Green)	On	communication has been established and module working properly
	Flash	Communication has not been established or communication error
	Off	Module is not powered on or module’s faulty
CAL indicator (Yellow)	On	In calibration mode, in the process of calibration
	Flash	In calibration mode, but calibration is not conducted
	Off	No power on or no communication established or the module does not in calibration mode

- Running mode
  - When powered on, the module waits for initialization data, the green indicator flashes, and the flashing frequency is 4 times per second.
  - When the initialization is complete, the module is running normally and the green indicator is on. If the initialization data is incorrect, the communication cannot be established and the

green indicator will remain flashing. Inspect that if the DP connection is correct and the communication parameters (communication rate, communication station number) are set correctly.

- ☐ When the module is working normally, the green indicator is on; while the communication is interrupted and the green indicator flashes. After the communication is reestablished, the green indicator will turn on again.
- ☐ When the module is in running status, the yellow light is off.

Table 7-9 Definition of LK410 Indicators in Running Mode

	RUN light	CAL light	Description
Run mode	Off	Off	Not powered on
	Flash	Off	Communication is not established or communication error
	On	Off	The communication has been established and the module is working properly

- ■ Calibration mode
  - ☐ When powered on, the module waits for initialization data, the green light flashes, and the flashing frequency is 4 times per second.
  - ☐ When the initialization is complete, the green light is on; if the initialization data is wrong and communication cannot be established, the green light remains flashing. Inspect that if the DP connection is correct and the communication parameters (communication rate, communication station number) are set correctly.
  - ☐ After the initialization is complete, the calibration is not performed and the module waits for the calibration check command, the yellow light flashes and its flashing frequency is 4 times per second. When the calibration test program starts running and the module is in calibration test, the yellow light is on. After the calibration test, the yellow light flashes again.
  - ☐ The green light remains on during the calibration test. If the communication is interrupted, the green light flashes; after the communication is reestablished, the green light will turn on again.
  - ☐ When the communication is not established or communication is interrupted, the yellow light is off.

Table 7-10 Definition of LK410 Indicators in Calibration Mode

	RUN light	CAL light	Description
Calibration mode	Off	Off	No power
	Flash	Off	Communication is not established or communication error
	On	On	Calibrating is in progress
	On	Flash	No calibration conducted or calibration test has been completed

7.3.4 Wirings

The LK410 modules are mounted on the expansion backplane. There are terminal wiring and prefabricated cable wiring for LK backplane, here only the terminal wiring.

Table 7-11 Definition of LK410 Backboard Terminals

Channel number	Terminal number	
	Positive terminal	Negative terminal
1	01	02
2	03	04
3	05	06
4	07	08
5	09	10
6	11	12
7	13	14
8	15	16

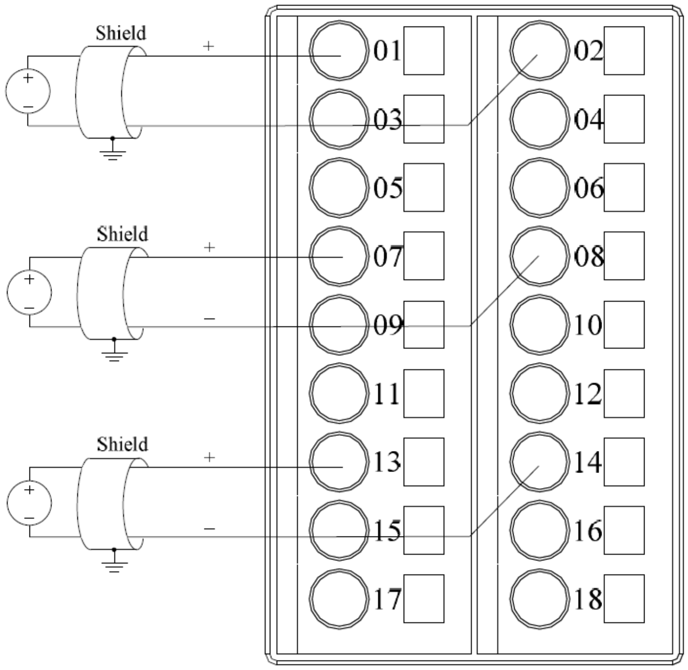


Figure 7-16 Backboard Terminal Wiring Schematic Diagram

When wiring, pay special attention to the following:

- Two-row 18 terminals are fixed on the backplane, just below the LK410 module's mounting position.
- Odd terminals are connected to the positive terminal of the voltage signal; even terminals are connected to the negative terminal of voltage signal.
- Each AI signal of field circuit is connected to the terminal with two wires (shielded cable).
- The terminal “17" and "18" are not use, which prohibited wiring.

7.3.5 Functions

7.3.5.1 Measured Data Output Format

As shown in Table 7-12, the measurement data of the AI channel reported by the LK410 is represented by 2-byte positive integer digital code (decimal 0 to 65535). The range (-10.25 ~ +10.25V) is divided into two sections, and positive voltage (0 ~ 10.25V) corresponds to the decimal digital code (0 ~ 32767), the negative voltage (-10.25V ~ 0) corresponds to the decimal digital code (32768 ~ 65535).

Table 7-12 Corresponding Relationship between LK410 Input Voltage and Digital Code

Max. measurable range		Decimal digital code
-10.25~+10.25V	0~10.25V	0~32767
	-10.25V~0V	32768~65535
0~10.25V		0~65535
0~5.125V		0~65535

The conversion formula between the measurement data of the range (-10.25 ~ + 10.25V) and the physical quantity is as follows:

Positive voltage 0 ~ + 10.25V: voltage value (V) = measurement data / 32767 × 10.25

Negative voltage -10.25 ~ 0V: Voltage value (V) = (measurement data -65535) /32767 × 10.25

By calling the function block HEX_ENGIN of the Analog signal Processing Functions library in the programming software AutoThink, it can convert the 2-byte measured data into the engineering data. Refer to the *HollySys Programmable Logic Controller PLC Instruction Manual* for the specific application of the function blocks.

When setting the upper alarm limit and lower alarm limit in the user parameter, it is needed to convert the voltage signal into decimal digital code and then fill in. Different ranges correspond to different conversion method of digital code.

- For the range of 0 ~ 10.25V, 0 ~ 5.125V, conversion formula of corresponding value of signal:

  Corresponding code value = voltage signal × 65535 / full scale value

  For example, the channel 1, if the range "0 ~ 10.25V" is selected and over-limit enables, the user defines the upper limit voltage as 10V, the lower limit voltage as 5V, then the alarm upper limit = 10 × 65535 / 10.25 = 63936, the alarm lower limit = 5 × 65535 / 10.25=31968, the relevant user parameter settings are shown in Figure 7-17.

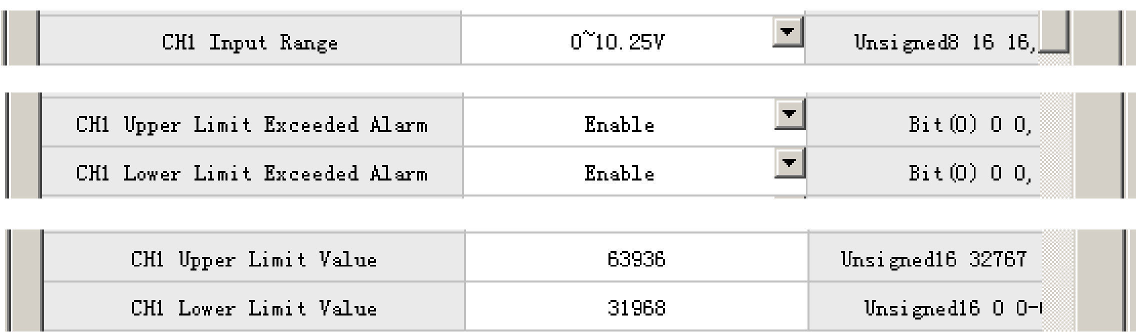


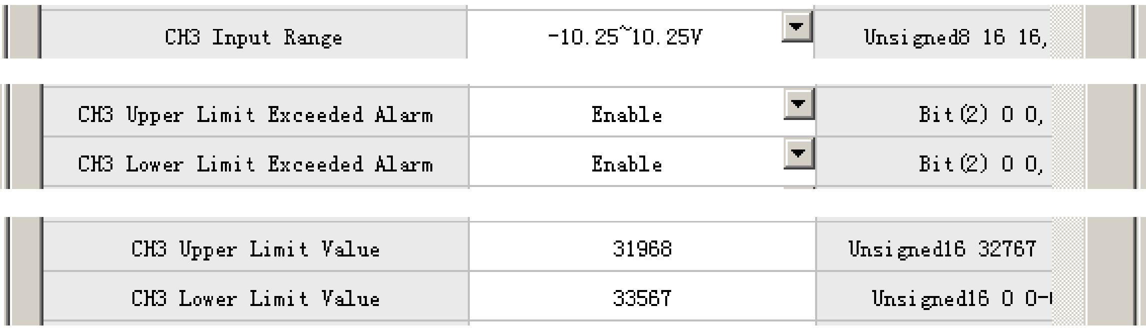
Figure 7-17 Example of Parameter Setting in the Programming Mode with Selected Range

- For range of -10.25 ~ +10.25V, the conversion formula of signal corresponding code value:

Positive voltage range (0 ~ 10.25V): Corresponding code value = Positive voltage signal × 32767 / 10.25

Negative voltage range (-10.25 ~ 0V): Corresponding code value = 65535 + (negative voltage signal × 32767 / 10.25)

For example, the channel 3, if the range of "-10.25 ~ +10.25V" is selected and the over-limit alarm enables, the user defines the upper limit voltage 10V, the lower limit voltage -10V, then the alarm upper limit = 10 × 32767 / 10.25 = 31968, the alarm lower limit = 65535 + (- 10 × 32767 / 10.25) V = 33567, the relevant user parameter settings are shown in Figure 7-18.



CH3 Input Range	-10.25~10.25V	Unsigned8 16 16,
CH3 Upper Limit Exceeded Alarm	Enable	Bit(2) 0 0,
CH3 Lower Limit Exceeded Alarm	Enable	Bit(2) 0 0,
CH3 Upper Limit Value	31968	Unsigned16 32767
CH3 Lower Limit Value	33567	Unsigned16 0 0-|

Figure 7-18 Example of Parameter Setting of Over-limit Alarm with Selected Range

7.3.6 Diagnosis

The input channel of LK410 can detect over range, over-limit and line broken, which are channel diagnosis features. Power input channel can implement field power down detection, which is device diagnosis. After calling the function block sysGetDPSlaveState (Get Diagnosis of DP Slave), the channel diagnosis data and the device diagnosis data reported by LK410 are saved into the output parameter **DiagData** in the function block.

Diagnostic information of LK410 up to 28 bytes, wherein 2 bytes are device-related diagnosis, 2 bytes are identification diagnosis and 24 bytes are channel diagnosis. For eight channel of LK410, The diagnosis information for each channel is 3 bytes.

- Device diagnosis information

  The device diagnosis data is 0x02,0x00 indicates that there is no fault on the current device.

  The device diagnosis data is 0x02, 0x01 indicates that the current device has channel fault.

  The device diagnosis data is 0x02, 0x03 indicates that the current device has both channel fault and calibration fault.

- Identification number diagnostic information

  When there is diagnosis information reported, the 2-byte identification number diagnosis information is 0x42, 0x01.

- Channel diagnosis information

  The channel diagnosis information is shown in Table 7-13.

Table 7-13 Specifications for LK410 Channel Diagnosis Information

Diagnosis Information					Meaning
Bit	Bit7	Bit6	Bit5	Bit4~ Bit0	

Diagnosis Information				Meaning
The first byte	Head	0x80		Decimal online value 128
The second byte	I/O type/channel	01 (Input)	（Channel）	Fault channel no. 1~8 Decimal online value 64~71
The third byte	Channel data type/fault type	101 (Word)	2	Under range, Decimal online value is 162
			3	Over range, Decimal online value is 163
			6	Line broken, Decimal online value is 166
			7	Upper limit exceeded, Decimal online value is 167
			8	Lower limit exceeded, Decimal online value is 168
			0	Channel fault recovery, Decimal online value is 160

Example:

Channel diagnosis data 0x80, 0x42, 0xA6 indicates that channel 3 has line broken alarm. Corresponding online value is 128, 66, 166.

7.3.6.1 Over range alarm

The LK410 module has the function of over range alarm. When the input signal is out of the selected range, the channel diagnostics area will report over range. When the signal is restored within the range, it reports fault recovery.

The LK410 module reports diagnostic data only when over range occurs and recovery.

It is important to note that for the LK410 module, the effective range is not the maximum measurable range. When the input signal is out of range, it does not necessarily exceed the maximum measurable range.

When over the range, if not beyond the maximum measurable range, the channel measurement data reports the current signal corresponding code value; If beyond the maximum measurable voltage, the channel measurement data reports the maximum measurable voltage corresponding code value within the range; if lower than the minimum measurable voltage, the channel measurement data reports the minimum measurable voltage corresponding code value within the range.

Table 7-14 Definition of LK410 Over Range

Range	Overrange	
	Over Range	Underrange
-10v~10v	＞10v	＜-10v
0~10v	＞10v	＜0v
0~5v	＞5v	＜0v

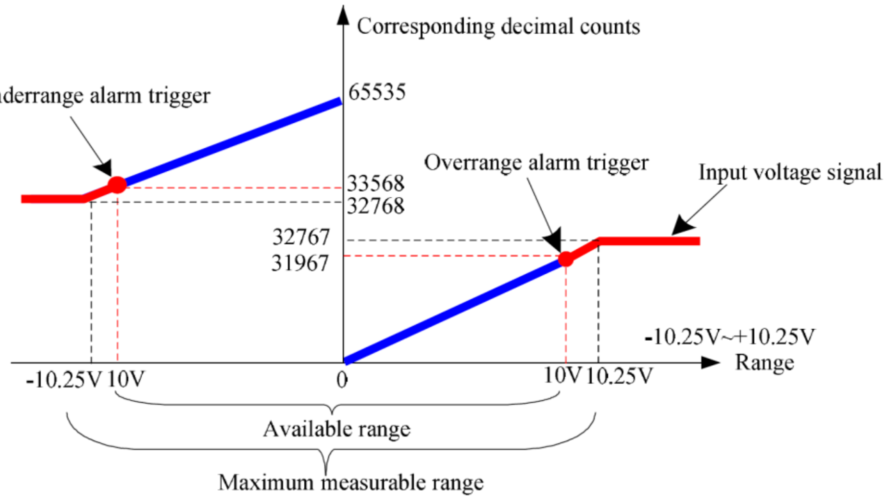


Figure 7-19 LK410 Over Range Alarm Diagram

As the selected range is different, the diagnostic processing of the modules is different when over range occurred, as shown in Table 7-15. When the signal is recovered to the normal range, the channel diagnosis byte reports 0xA0.

Table 7-15 Processing Method of LK410 Over Range Alarm under Different Ranges

Maximum measurable range	Effective range	Overrange type	Overrange processing
-10.25V~10.25V	-10V~10V	Over range	The channel diagnostic byte reports 0xA3 10 ~ 10.25V, channel measurement data reports the corresponding code value 31967 ~ 32767 > 10.25V, channel measurement data reports 32767
		Underrange	The channel diagnostic byte reports 0xA2 -10.25V ~ -10V, the channel measurement data reports the corresponding code value 32768 ~ 33568 <-10.25V, channel measurement data reports 32768
0~10.25V	0~10V	Over range	The channel diagnostic byte reports 0xA3 10 ~ 10.25V, channel measurement data reports the corresponding code value 63937 ~ 65535 > 10.25V, channel measurement data reports 65535
		Underrange	The channel diagnostic byte reports 0xA2 Channel measurement data reports 0
0~5.125V	0~5V	Over range	The channel diagnostic byte reports 0xA3 5 ~ 5.125V, the channel measurement data reports the corresponding code value 63937 ~ 65535 > 5.125V, channel measurement data reports 65535
		Under range	The channel diagnostic byte reports 0xA2 Channel measurement data reports 0

7.3.6.2 Over-limit alarm

LK410 module has the function of over-limit alarm. Within the selected range, the user can set the upper and lower alarm limits of the input signal. When the input signal is out of the limited range, that is, higher than the alarm upper limit or lower than the alarm lower limit, the channel diagnostic byte reports over-limit; When the signal is recovered to the limit range, it then reports fault recovery.

The LK410 module reports the diagnostic data once only when the over-limit occurred and recovery of over-limit . As shown in Table 7-16, the alarm upper limit voltage must be greater than the lower limit voltage; otherwise the LK410 module cannot correctly report the diagnostic information.

Table 7-16 Value Range of LK410 Over-limit Alarm

Range	Alarm Signal
-10v~10 V	10 V＞Upper Limit Voltage＞Lower Limit Voltage＞-10 V
0~10 V	10 V＞Upper Limit Voltage＞Lower Limit Voltage＞0 V
0~5 V	5 V＞Upper Limit Voltage＞Lower Limit Voltage＞0 V

The alarm value in the configuration is the digital code corresponding to the measured signal within the selected range, indicated by a two-byte positive integer code (decimal 0 to 65535). The value range of upper limit of alarm: 1 ~ 65535, the default 32767, the value range of lower limit of alarm: 0 ~ 65534, the default 0, the calculation formula as shown in Table 7-17:

Table 7-17 LK410 Alarm Digital Code Calculation

Range		Alarm upper limit(decimal)	Alarm lower limit (decimal)
±10.25V	-10.25~0V	65535+(Upper limit voltage×32767/10.25)	65535+(Lower limit voltage×32767/10.25)
	0~10.25V	Upper limit voltage×32767/10.25	Lower limit voltage×32767/10.25
0~10.25V		Upper limit voltage×65535/10.25	Lower limit voltage×65535/10.25
0~5.125V		Upper limit voltage×65535/5.125	Lower limit voltage×65535/5.125

Whether the over lower limit alarm function can be set by parameter CH1 ~ CH8 Lower Limit Exceeded Alarm and whether the over upper limit alarm function can be set by parameter CH1 ~ CH8 Upper Limit Exceeded Alarm, and default is disable. After the alarm is enabled, alarm lower limit and alarm upper limit are set by parameter CH1 ~ CH8 Lower Limit Value and CH1 ~ CH8 Upper Limit Value.

Over-limit alarm enable, alarm upper limit, alarm lower limit of 8 input channels shall be set respectively without interfere with each other. If the over-limit alarm enabled and over range occurred at the same time, LK410 reports over range.

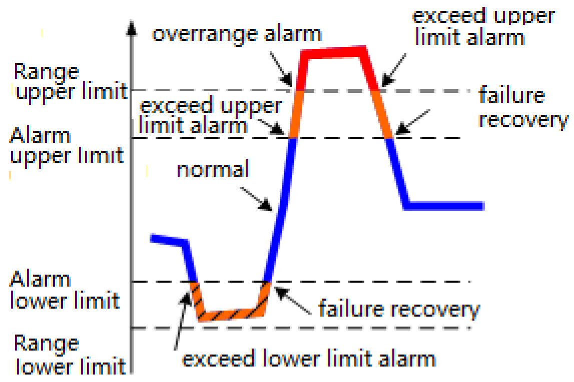


Figure 7-20 LK410 Over-limit Alarm Diagram

When an input channel signal beyond the limit:

- Beyond upper limit, channel diagnostic byte reports 0xA7
- Beyond lower limit, channel the diagnostic byte reports 0xA8
- The channel measurement data reports the current signal corresponding code value
- The signal is recovered to the normal range and the channel diagnostic byte reports 0xA0.

7.3.6.3 Line Broken Detection

The LK410 module has a line broken detection function.

As shown in Figure 7-21, the signal channel is connected with a 10MΩ pull-up resistor. The LK410 conduct the line broken diagnosis by detecting changes of input voltage between the two wiring terminals. If there is a fault, the fault status is reported to the controller in the form of diagnostic data.

When line broken occurs in the input channel, the positive voltage of the channel is pulled up to + 15V, the negative end of the channel is pulled down to -15V, the voltage difference at the input end of the AD converter reaches the maximum value, and the channel diagnostic byte reports line broken; after line broken recovery, it reports Fault recovery.

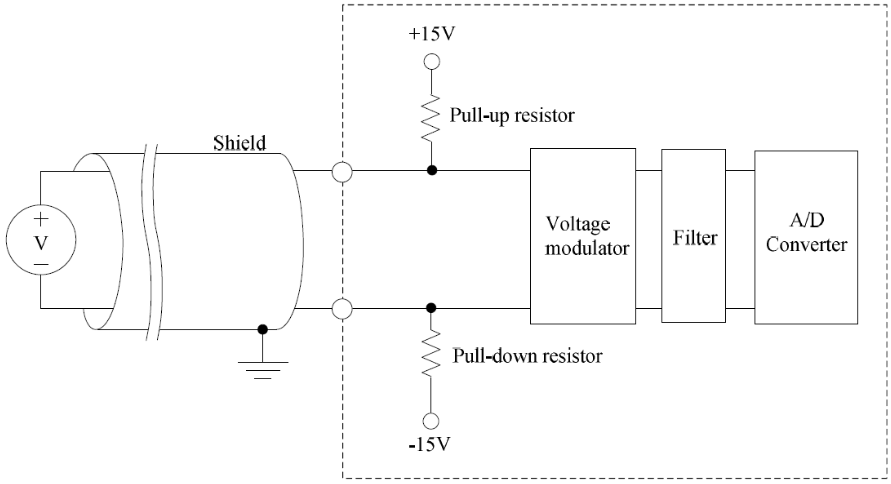


Figure 7-21 LK410 Line Broken detection schematic diagram

The LK410 module reports the diagnostic data only once when line broken occurred and line broken recovery. Whether conduct line broken alarm, configuration optional and the default is disable. If the input channel is not wired, it is considered as line broken. It is recommended to disable line broken alarm function for channel not used, that is, the default value of the Line Break Alarm is maintained and forbidden to modify.

When a channel is broken:

Channel diagnostic byte reports line broken value 0xA6

Channel measurement data reports 65535 or 32768 (-10.25 ~ 10.25V range)

After the line broken is recovered, the channel diagnostic byte reports 0xA0

7.3.7 Parameters

The user parameter is used to set the mode of operation of the module and is written into the controller when the user program is downloaded. It is not read by each scan cycle. Each parameter has a default value, which can be changed according to the engineering requirements. User parameters do not support online modification, modification takes effect only by full download.

The LK410 module has a total of 46 bytes of user parameters.

Table 7-18 LK410 User Parameter List

Parameter Name	Parameter Description	Parameter Value
Filter Mode	Digital filter mode selection parameters	0=No Filter, No filtering is performed 1=10Hz Filter, Interference filtering on 10Hz 2=50Hz Filter, Interference filtering on 50Hz(default) 3=60Hz Filter, Interference filtering on 60Hz 4=400Hz Filter, Interference filtering on 400Hz
Sample Rate	Sample rate selection	0: Fast, the fastest sample rate 1: Normal, Drift inhibit function enable, but the internal sampling time is doubled (default)
CH1 Input Range	CH1 Range Selection	16=-10.25~10.25V range(default) 17=0~10.25V range 18=0~5.125V range
CH2 Input Range	CH2 Range Selection	
CH3 Input Range	CH3 Range Selection	
CH4 Input Range	CH4 Range Selection	
CH5 Input Range	CH5 Range Selection	
CH6 Input Range	CH6 Range Selection	
CH7 Input Range	CH7 Range Selection	
CH8 Input Range	CH8 Range Selection	
CH1 Digital Filter	CH1 Software Filtering Selection	0＝None, no software filtering (default) 1＝4 Points, Choosing the latest four historical data 2＝8 Points, Choosing the latest eight historical data 3＝16 Points, Choosing the latest sixteen historical data
CH2 Digital Filter	CH2 Software Filtering Selection	
CH3 Digital Filter	CH3 Software Filtering Selection	
CH4 Digital Filter	CH4 Software Filtering Selection	
CH5 Digital Filter	CH5 Software Filtering Selection	
CH6 Digital Filter	CH6 Software Filtering Selection	

Parameter Name	Parameter Description	Parameter Value
CH7 Digital Filter	CH7 Software Filtering Selection	
CH8 Digital Filter	CH8 Software Filtering Selection	
CH1 Upper Limit Exceeded Alarm	CH1 Upper Limit Exceeded Alarm Enable	0:Disable,(default) 1:Enable
CH1 Lower Limit Exceeded Alarm	CH1 Lower Limit Exceeded Alarm Enable	
CH2 Upper Limit Exceeded Alarm	CH2 Upper Limit Exceeded Alarm Enable	
CH2 Lower Limit Exceeded Alarm	CH2 Lower Limit Exceeded Alarm Enable	
CH3 Upper Limit Exceeded Alarm	CH3 Upper Limit Exceeded Alarm Enable	
CH3 Lower Limit Exceeded Alarm	CH3 Lower Limit Exceeded Alarm Enable	
CH4 Upper Limit Exceeded Alarm	CH4 Upper Limit Exceeded Alarm Enable	
CH4 Lower Limit Exceeded Alarm	CH4 Lower Limit Exceeded Alarm Enable	
CH5 Upper Limit Exceeded Alarm	CH5 Upper Limit Exceeded Alarm Enable	
CH5 Lower Limit Exceeded Alarm	CH5 Lower Limit Exceeded Alarm Enable	
CH6 Upper Limit Exceeded Alarm	CH6 Upper Limit Exceeded Alarm Enable	
CH6 Lower Limit Exceeded Alarm	CH6 Lower Limit Exceeded Alarm Enable	
CH7 Upper Limit Exceeded Alarm	CH7 Upper Limit Exceeded Alarm Enable	

Parameter Name	Parameter Description	Parameter Value
CH7 Lower Limit Exceeded Alarm	CH7 Lower Limit Exceeded Alarm Enable	
CH8 Upper Limit Exceeded Alarm	CH8 Upper Limit Exceeded Alarm Enable	
CH8 Lower Limit Exceeded Alarm	CH9 Lower Limit Exceeded Alarm Enable	
CH1 Upper Limit Value	CH1 Alarm Upper Limit Setting	Alarm lower limit range:0~65534 Alarm upper limit range:1~65535 Alarm lower limit :0 Alarm upper limit:32767 The calculation method is shown in 7.3.5.1 Measured Data Output Format
CH1 Lower Limit Value	CH1 Alarm Lower Limit Setting	
CH2 Upper Limit Value	CH2 Alarm Upper Limit Setting	
CH2 Lower Limit Value	CH2 Alarm Lower Limit Setting	
CH3 Upper Limit Value	CH3 Alarm Upper Limit Setting	
CH3 Lower Limit Value	CH3 Alarm Lower Limit Setting	
CH4 Upper Limit Value	CH4 Alarm Upper Limit Setting	
CH4 Lower Limit Value	CH4 Alarm Lower Limit Setting	
CH5 Upper Limit Value	CH5 Alarm Upper Limit Setting	
CH5 Lower Limit Value	CH5 Alarm Lower Limit Setting	
CH6 Upper Limit Value	CH6 Alarm Upper Limit Setting	
CH6 Lower Limit Value	CH6 Alarm Lower Limit Setting	
CH7 Upper Limit Value	CH7 Alarm Upper Limit Setting	
CH7 Lower Limit Value	CH7 Alarm Lower Limit Setting	
CH8 Upper Limit Value	CH8 Alarm Upper Limit Setting	

Parameter Name	Parameter Description	Parameter Value
CH8 Lower Limit Value	CH8 Alarm Lower Limit Setting	
CH1 Line Break Alarm	CH1 Line Break Alarm Enable	0:Disable,(default) 1:Enable
CH2 Line Break Alarm	CH2 Line Break Alarm Enable	
CH3 Line Break Alarm	CH3 Line Break Alarm Enable	
CH4 Line Break Alarm	CH4 Line Break Alarm Enable	
CH5 Line Break Alarm	CH5 Line Break Alarm Enable	
CH6 Line Break Alarm	CH6 Line Break Alarm Enable	
CH7 Line Break Alarm	CH7 Line Break Alarm Enable	
CH8 Line Break Alarm	CH8 Line Break Alarm Enable	

7.3.8 Technical Specifications

LK410 8-Channel Voltage Type Analog Input Module				
System power supply				
Supply Voltage	24VDC(-15%~+20%)			
Power consumption	100mA@24VDC			
Input channel				
Channel number	8			
Range code	16		17	18
Maximum measurable range	-10.25~0V	0~10.25V	0~10.25V	0~5.125V
Reported data format	32768~65535	0~32767	0~65535	0~65535
ADC resolution rate	16 bits			
Sampling period (full channel scan time)	<480ms(No software filtering)			
Input resistance	>1MΩ			
Step response	It takes less than 1s to reach the 90% of the target value.			
Differential mode rejection ratio	80dB			
Common mode rejection ratio	100dB			

LK410 8-Channel Voltage Type Analog Input Module	
Measurement accuracy	0.1% F.S.@25℃
Calibration accuracy	0.03% F.S.@25℃
Temperature drift	±25ppm/℃
Field and system isolation voltage	500VAC@1min, leaking current 5mA
Fault diagnosis and hot swapping	
Overrange alarm	The signal range is exceed the upper limit of the range or the lower limit of the range. The diagnostic byte reports 0xA3 / 0xA2.
Over-limit alarm	The signal range exceeds the alarm upper limit / alarm limit and the diagnostic byte reports 0xA7 / 0xA8.
Disconnection detection	Fault occurs, diagnostic byte reports 0xA6, channel measurement data reports 65535 or 32767
Hot swapping	Supported
Communication bus	
Protocol	PROFIBUS-DP slave station, confirms to IEC61158-3/ EN50170 standard.
Baud rate	Selective Baud rate:1.5Mbps,500kbps,187.5kbps,93.75kbps,45.45kbps,31.25kbps,19.2kbps,9.6kbps
Medium	Through the European style connector, links the communication bus with the backplane, communication medium is hot backup redundancy.
physical characteristics	
Protection Key	A0
Installation position	LK expansion backplane
Module Dimension (W*H*D)	35mm×100mm×100mm
Enclosure protection class	IEC60529 IP20
Weight	190g

7.4 LK411 8-channel Current Type Analog Input Module

7.4.1 Basic Features

- 8-channel current input
- Applicable range: 0~20 mA/4~20 mA
- Max. measurable value: 0~20.58 mA/4~20.58 mA
- Field calibration
- Over-limit alarm
- Over range alarm
- Line broken detection

- Isolation between the system and the field channel
- Hot swapping

7.4.2 Operating Principle

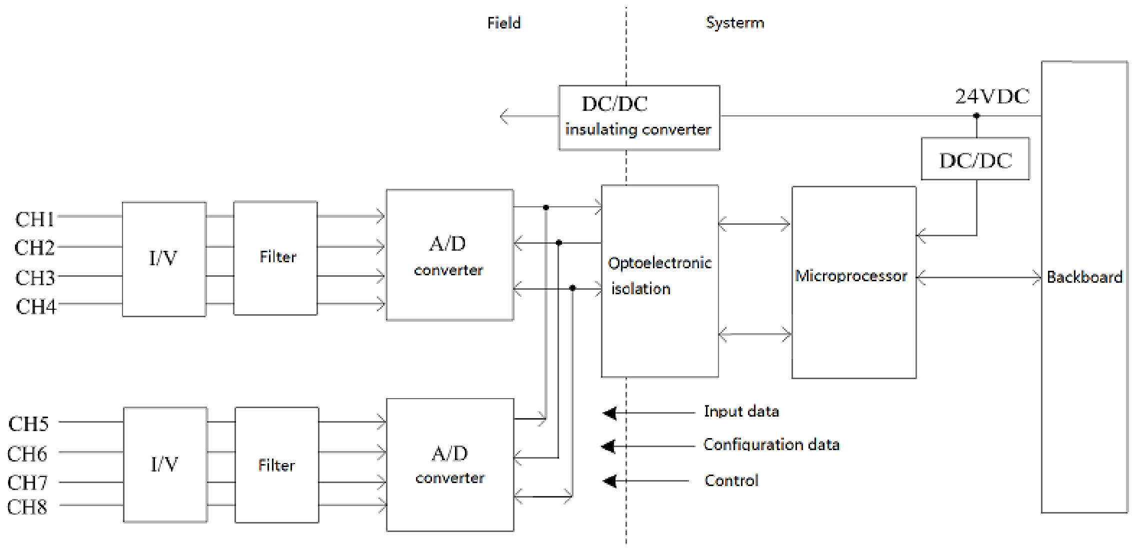


Figure 7-22 Internal Structure Block Diagram of LK411

The 24 VDC system power supply of the LK411 module supplies the power to the field interface circuit by outputting 5 VDC via isolated DC/DC. The interface circuit is connected to other circuits by using opto-isolators, thus realizing the isolation between the field circuit and the system.

For the channel interface as shown in Figure 7-23, the current signal is converted into a digital signal via current/voltage conversion, filtering and A/D conversion. Via optoelectronic isolation, it is read by the microprocessor of the module, and then uploaded to the CPU module via the DP bus.

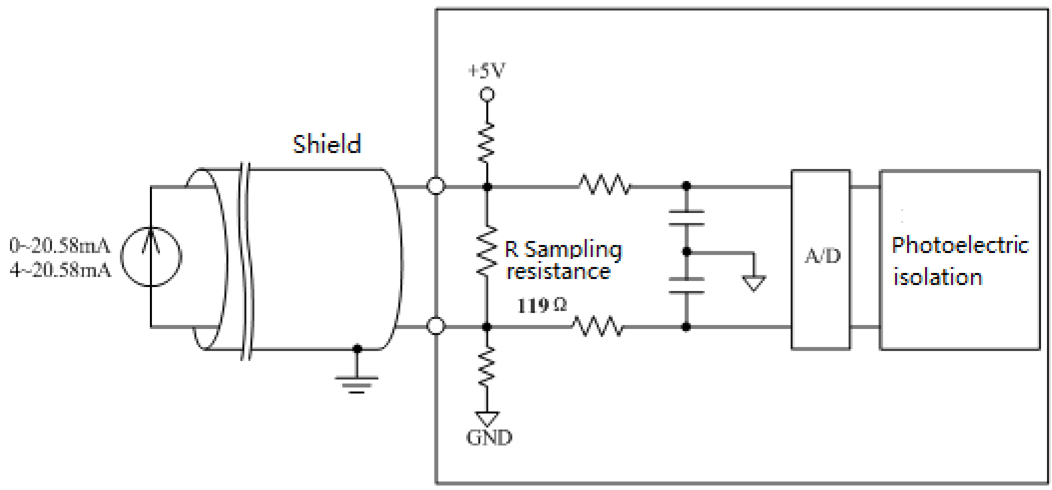


Figure 7-23 LK411 Channel Interface Circuit Diagram

7.4.3 Indicator Lamps

There are two status lamps on the front panel of the module: the green **RUN** lamp and the yellow **CAL** lamp. The **RUN** lamp is the run indicator lamp, indicating the communication status between the module and the CPU module. The **CAL** lamp is the calibration indicator lamp, indicating the calibration process.

The LK411 module supports field calibration. The meanings of the indicator lamp are different when in the running mode and the calibration mode.

Table 7-19 Definition of LK411 Status Indicator

Name	Status	Description
RUN indicator lamp (green)	On	The communication is established， and the module works well
	Flash	The communication is not established or incorrect
	Off	The module is not powered on or fault
CAL Calibration Indicator Lamp (yellow)	On	In the calibration and detection mode, undergoing calibration and detection
	Flash	In the calibration no detection mode, but undergoing no calibration and detection
	Off	It is not powered up or the communication is not established or the module does not in the calibration and detection mode

- Running Mode
  - Immediately after being powered on, the module waits for the initialized data, with a green lamp flashing based on a frequency of 4 times/second.
  - Upon the completion of initialization, the green lamp is turned normally on, which indicates that the module works well. In case of any error in the initialized data, communication cannot be established and the green lamp keeps flashing. Check whether the DP is connected properly and the communication parameters (communication rate, communication station No.) are set properly.
  - When the module works well, the green lamp is normally on. When the communication is disconnected, the green lamp flashes. When the communication is established again, the green lamp is turned normally on again.
  - The yellow lamp is normally off when the module is in the running mode.

Table 7-20 Definition of LK411 Indicators in Running Mode

	RUN Lamp	CAL Lamp	Meaning
Running Mode	Off	Off	Not powered up
	Flash	Off	The communication is not established or incorrect.
	On	Off	The communication is established, the module works well

- Calibration Mode
  - Immediately after being powered on, the module waits for the initialized data, with the green lamp flashing based on a frequency of 4 times/second.
  - Upon the completion of initialization, the green lamp is turned normally on. In case of any error in the initialized data, the green lamp keeps flashing. Check whether the DP is connected properly and the communication parameters (communication rate, communication station No.) are set properly.
  - Upon the completion of initialization, if the calibration and detection is not executed, the module then waits for the calibration and detection instruction, with the yellow lamp flashing based on a frequency of 4 times/second. When the calibration and detection program starts

to run and the module is undergoing calibration and detection, the yellow is turned on. Upon the completion of calibration and detection, the yellow lamp then flashes again.

- During calibration and detection, the green lamp is normally no. When the communication is disconnected, the green lamp flashes. When the communication is established again, the green lamp is turned normally on again.
- When the communication is not established or disconnected, the yellow lamp then goes out.

Table 7-21 Definition of LK411 Indicators in Calibration Mode

	RUN Lamp	CAL Lamp	Meaning
Calibration Mode	Off	Off	Not powered up
	Flash	Off	The communication is not established or incorrect.
	On	On	Under calibration and detection
		Flash	Calibration and detection is not conducted or is completed

7.4.4 Wirings

The output channel of LK411 does not supply power externally. When connected to a transmitter based on the two-wire system, a separate 24 DC field power supply is provided separately externally to the transmitter. To ensure the isolation between the field and the system, the field power supply shall be configured separately and cannot be commonly used as the power supply for the backboard.

The LK411 module is installed on the extension backboard. The LK backboard can provide both terminal connection and precast cable connection. Only the backboard terminal connection is discussed here.

Table 7-22 Definition of LK411 Backboard Terminals

Channel No.	Sequence of Terminals	
	Positive Terminal of Power input	Negative terminal of Power input
1	01	02
2	03	04
3	05	06
4	07	08
5	09	10
6	11	12
7	13	14
8	15	16

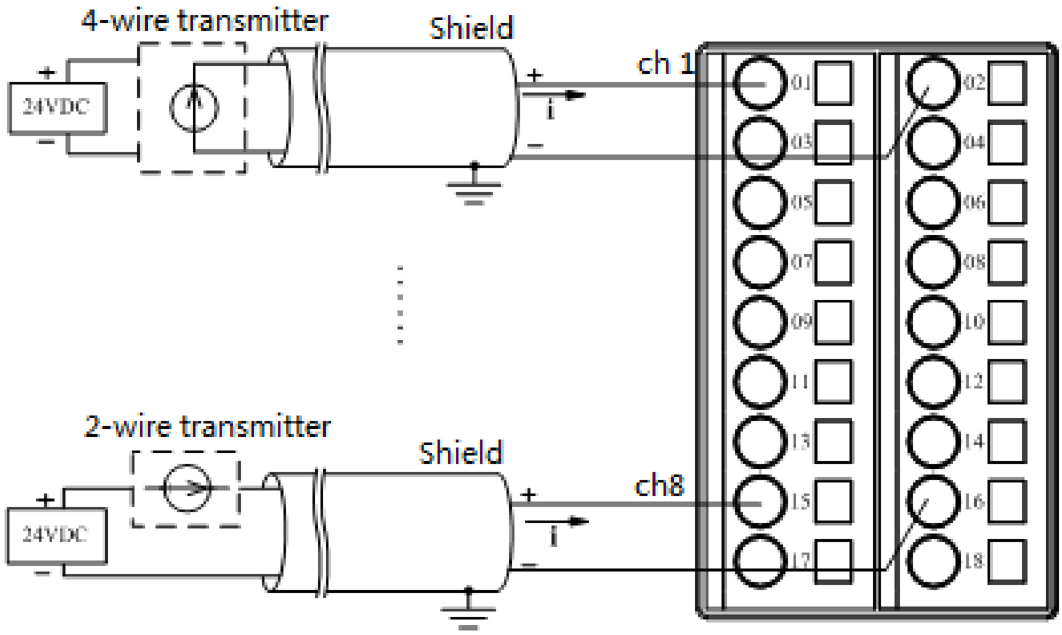


Figure 7-24 Backboard Terminal Wiring Schematic Diagram

Pay attention to the following during wiring:

- The two-row 18-channel terminals are fixed on the backboard, right located under the installation position of the LK411 module.
- Each AI signal is separately connected to the terminals via two conductors (shielded cable) in the field.
- The output channel does not supply power to the transmitter. When connected to a transmitter based on the two-wire system, a separate 24 DC field power supply is provided separately to the transmitter.
- To ensure the isolation between the field and the system, the field power supply shall be configured separately and cannot be commonly used as the power supply for the backboard.
- Terminals 17 and 18 are not used, with wiring forbidden.

7.4.5 Functions

7.4.5.1 Measured Data Output Format

As shown in Table 7-23, the measured data on the AI channel that is reported by the LK411 module, is expressed in form of 2-byte positive integer (decimal: 0~65,535) digital code.

Table 7-23 Corresponding Relationship between LK411 Input Current and Digital Code

Max. Measurable Range	Corresponding Decimal Digital Code
4~20.58 mA	0~65,535
0~20.58 mA	0~65,535

By calling the function block HEX_ENGIN of the Analog signal Processing Functions library in the programming software AutoThink, it can convert the 2-byte measured data into the engineering data.

Refer to the *HollySys Programmable Logic Controller PLC Instruction Manual* for the specific application of the function blocks.

Set the alarm upper limit and alarm lower limit in the [User parameters] in accordance with the formula set in Table 7-24, the current signal is converted to a decimal digital code to fill in.

Table 7-24 Data Conversion Formula of LK411 Module

Max. Measurable Range	Formula of Corresponding Digital Code
4≤I≤20.58 mA	(I—4) ×65,535/16.58
0≤I≤20.58 mA	I×65,535/20.58

Example : for Channel 3, in case the range is selected as 0~20.58mA, over-limit enabled, user defined upper current limit: 15mA, lower current limit: 4mA, then Upper Limit Value for Channel 3 =15×65,535/20.58=47,766, Lower Limit Value for Channel 3 =4×65,535/20.58=12,737. Refer to Figure 7-25 for the relevant user parameter settings.

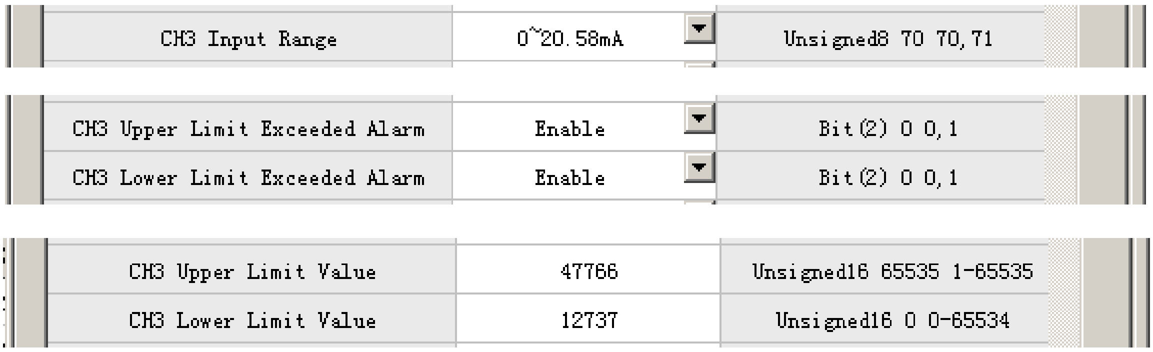
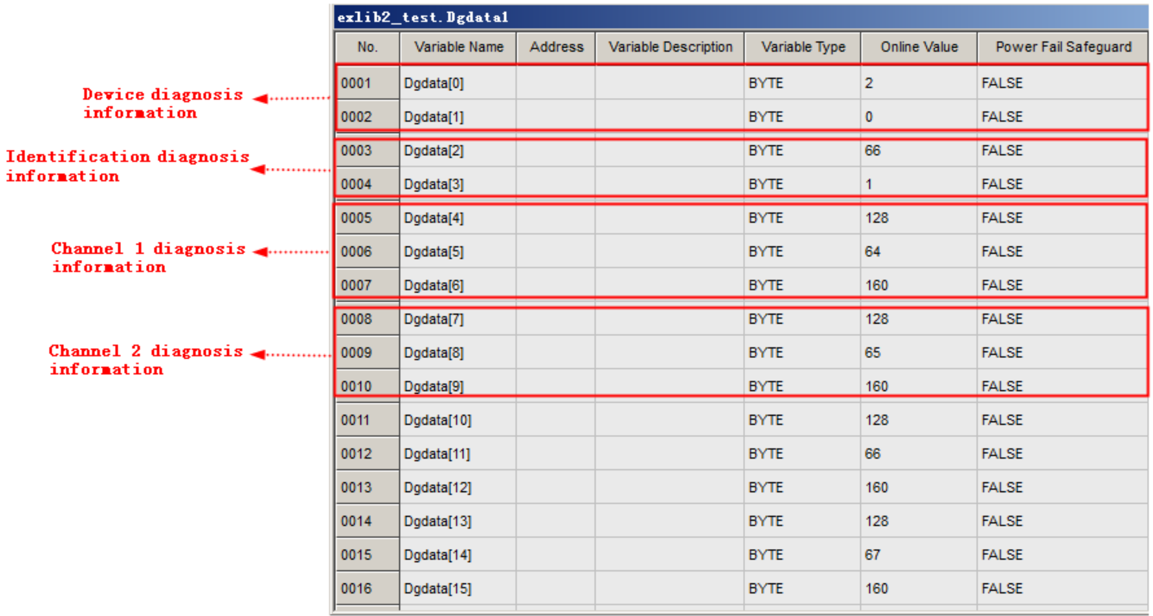


Figure 7-25 Examples of Over-limit Alarm Parameter Settings Based on Selected Range

7.4.6 Diagnosis

The input channel of LK411 can detect over range, over-limit and line broken, which are channel diagnosis features. After calling the function block sysGetDPSlaveState (Get Diagnosis of DP Slave), the diagnosis data and the device diagnosis data reported by LK411 are saved into the output parameter **DiagData** in the function block.

Diagnostic information of LK411 up to 28 bytes, wherein 2 bytes are device-related diagnosis, 2 bytes are identification diagnosis and 24 bytes are channel diagnosis. For eight channel of LK411, The diagnosis information for each channel is 3 bytes.



No.	Variable Name	Address	Variable Description	Variable Type	Online Value	Power Fail Safeguard
0001	Dgdata[0]			BYTE	2	FALSE
0002	Dgdata[1]			BYTE	0	FALSE
0003	Dgdata[2]			BYTE	66	FALSE
0004	Dgdata[3]			BYTE	1	FALSE
0005	Dgdata[4]			BYTE	128	FALSE
0006	Dgdata[5]			BYTE	64	FALSE
0007	Dgdata[6]			BYTE	160	FALSE
0008	Dgdata[7]			BYTE	128	FALSE
0009	Dgdata[8]			BYTE	65	FALSE
0010	Dgdata[9]			BYTE	160	FALSE
0011	Dgdata[10]			BYTE	128	FALSE
0012	Dgdata[11]			BYTE	66	FALSE
0013	Dgdata[12]			BYTE	160	FALSE
0014	Dgdata[13]			BYTE	128	FALSE
0015	Dgdata[14]			BYTE	67	FALSE
0016	Dgdata[15]			BYTE	160	FALSE

Figure 7-26 Diagnosis Information Diagram

- Device diagnosis information

  Device diagnosis data 0x02, 0x00 indicates the current device without any fault.

  Device diagnosis data 0x02, 0x01 indicates that the current device has channel fault.

- Identification diagnosis information

  The 2-byte identification diagnosis information is 0x42, 0x01 when diagnosis information is reported.

- Channel diagnosis information

  Channel diagnosis information as shown in Table 7-25.

Table 7-25 Specifications for LK411 Channel Diagnosis Information

<table>
<tr><th colspan="6">Diagnosis Information</th><th>Meaning</th></tr>
<tr><td colspan="2">Bit</td><td>Bit7</td><td>Bit6</td><td>Bit5</td><td>Bit4~Bit0</td><td></td></tr>
<tr><td>The first byte</td><td>Head</td><td colspan="4">0x80</td><td>Decimal online value 128</td></tr>
<tr><td>The second byte</td><td>I/O type/channel</td><td colspan="2">01 (Input)</td><td colspan="2">（Channel）</td><td>Fault channel no. 1~8
Decimal online value 64~71</td></tr>
<tr><td rowspan="4">The third byte</td><td rowspan="4">Channel data type/fault type</td><td colspan="3" rowspan="4">101 (Word)</td><td>2</td><td>Under range, Decimal online value is 162</td></tr>
<tr><td>3</td><td>Over range, Decimal online value is 163</td></tr>
<tr><td>6</td><td>Line broken, Decimal online value is 166</td></tr>
<tr><td>7</td><td>Upper limit exceeded, Decimal online value is 167</td></tr>
</table>

Diagnosis Information				Meaning
			8	Lower limit exceeded, Decimal online value is 168
			0	Channel fault recovery, Decimal online value is 160

Example:

Channel diagnosis data 0x80, 0x42, 0xA6 indicates that channel 3 has line broken alarm. Corresponding online value is 128, 66, 166.

7.4.6.1 Over Range Alarm

The LK411 module is capable of over range alarm. When the signal goes beyond the selected range, the channel diagnosis byte reports over range, when the signal is recovered, it then reports fault recovery.

The LK411 module only reports the diagnosis data once separately when over range occurs and is recovered.

- For the LK411 module, the effective range is not the max. measurable range. When the output signal exceeding the range, it may not exceed the Max. Measurable range.

In case of over range while within the max. measurable range, the measured channel data then reports the code value corresponding to the current signal. If more than the max. measurable current, the measured channel data reports the full range code value 0xFFFF. If less than the Min. measured current, the measured channel data reports the code value 0x0000.

Table 7-26 Over Range Definition of LK411

Range	Over Range	
	Over Range	Under Range
0~20 mA	＞20 mA	-
4~20 mA	＞20 mA	0＜…＜4mA

- No Under Range Alarm is available in the range of 0~20 mA, with a line break reported when the current is less than 0.

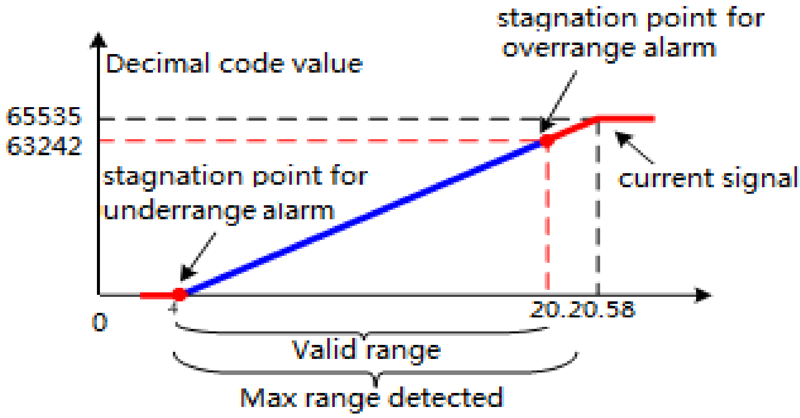


Figure 7-27 LK411 Over Range Alarm Schematic Diagram

Due to the different ranges selected, the diagnosis handling methods of the module may also differ in case of over range, as shown in Table 7-27. When the signal is recovered to the normal range, the channel diagnosis byte then reports 0xA0.

Table 7-27 Handling of LK411 Over Range Alarm Based on Different Ranges

Max. Measurable Range	Effective Range	Type of Over Range	Handling of Over Range
0~20.58mA	0~20mA	Over Range	The channel diagnosis byte reports 0xA3 20~20.58 mA, the measured channel data reports the code value ranging 63,688~65,535 of the current signal ＞20.58 mA, the measured channel data reports 65,535
4~20.58mA	4~20mA	Over Range	The channel diagnosis byte reports 0xA3 20~20.58 mA, the measured channel data reports the code value ranging 63,242~65,535 of the current signal >20.58 mA, the measured channel data reports 65,535
		Under Range	The channel diagnosis byte reports 0xA2 The measured channel data reports 0

7.4.6.2 Over-limit Alarm

The LK411 module is capable of over-limit alarm. In the selected range, the user can set Upper Limit Value and Lower Limit Value of the input signal by his or her own. When the input signal goes beyond the limit range, that is, higher than Upper Limit Value or lower than Lower Limit Value, the channel diagnosis byte then reports over-limit. When the signal is recovered to the limit range, it then reports fault recovery**.**

The LK411 module only reports the diagnosis data once separately when over-limit occurs and is recovered. It can select whether to give an over-limit alarm during configuration, defaulted to disabled. Upper Limit Value and Lower Limit Value for each channel are customized. The upper limit current must be more than the lower limit current. Otherwise, the LK411 module cannot report the diagnosis message properly.

If over-limit and over range occur simultaneously, only over range is reported.

Table 7-28 Settings Range of LK411 Over-limit Alarm Values

Range	Alarm Signal
0~20 mA	20 mA＞Upper Limit Current＞Lower Limit Current＞0 mA
4~20 mA	20 mA>Upper Limit Current>Lower Limit Current> 4 mA

The alarm value in the configuration is the digital code corresponding to the measured signal in the selected range, expressed in a two-byte decimal digital code (0~65,535). Range of upper limit value: 1~65,535, defaulted to 65,535, range of lower limit value: 0~65,534, defaulted to 0. Refer to Section 7.4.5.1 Measured Data Output Format for the specific calculation methods.

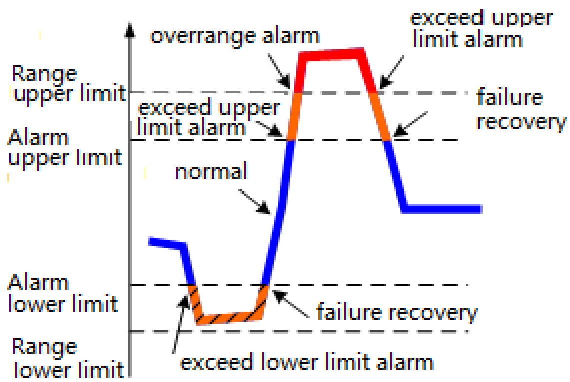


Figure 7-28 LK411 Over-Limit Alarm Schematic Diagram

When certain input channel signal over-limits:

- If going beyond the upper limit, the channel diagnosis byte then reports 0xA7.
- If going beyond the lower limit, the channel diagnosis byte then reports 0xA8.
- The measured channel data reports the code value corresponding to the current signal.
- If the signal is recovered to the normal range, the channel diagnosis byte then reports 0xA0.

7.4.6.3 Line Broken Detection

The LK411 module is capable of line broken detection.

As shown in Figure 7-29, the signal channel is connected to a 10 MΩ pull-up resistor. The LK411 makes an line broken diagnosis according to the input voltage change between the two terminals. In case of a failure, report the fault status in form of diagnosis data to the CPU module. When the input channel signal connection is broken, the voltage at the positive terminal of the channel is pulled up to +5V, the negative terminal of the channel is pulled down to GND, with the voltage difference at the input terminal of the AD converter reaching to the max. value. The channel diagnosis byte then reports line broken. After the line broken is recovered, the channel diagnosis area then reports fault recovery.

The LK411 module only reports the diagnosis data once separately when an line broken occurs and is recovered. It can select whether to give an line broken alarm during configuration, defaulted to disabled. If the input channel is not connected or connected reversely (with negative current), it can be considered as broken. It is suggested to disable line broken alarm for channels that are not used, that is, to hold the default parameter line broken alarm unchanged.

When certain channel is broken:

- The channel diagnosis byte reports Line broken fault value 0xA6.

- The measured channel data reports the code value 0x0000.
- After the line broken is recovered, the channel diagnosis byte reports 0xA0.

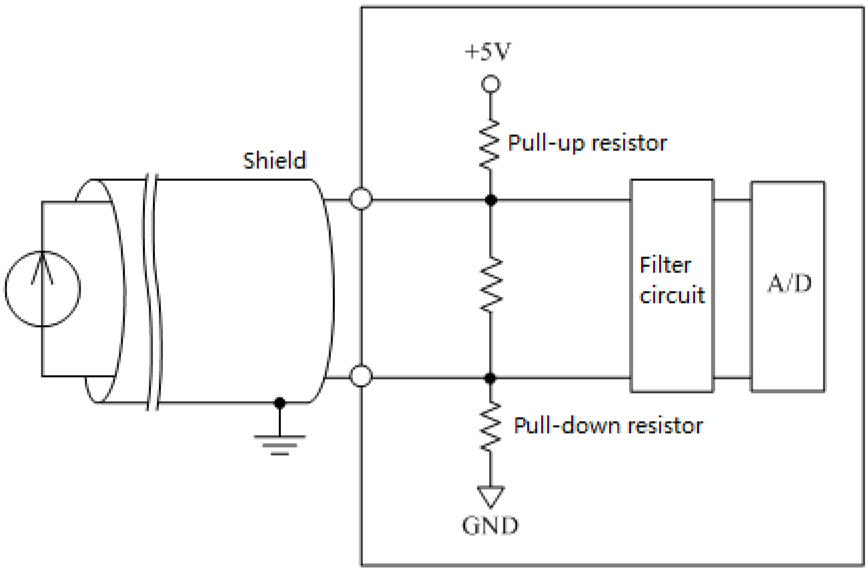


Figure 7-29 LK411 Line Broken Detection Schematic Diagram

7.4.7 Parameters

The user parameter is used to set the operation mode of the module. The CPU module written when downloading the user program may not be read in each scanning period. Each parameter has a default, able to modify the parameter value according to the project requirements. The user parameter does not support online modification. The modification takes effect only upon full download.

The user parameter of the LK411 module occupies 46 bytes.

Table 7-29 LK411 User Parameters

Parameter Name	Meaning	Value
Filter Mode	Parameter for selecting a digital filtering mode	0=No Filter, not to filter 1=10 Hz Filter, to filter the 10 Hz interference 2=50 Hz Filter, to filter 50 Hz interference (default) 3=60 Hz Filter, to filter the 60 Hz interference 4=400 Hz Filter, to filter the 400 Hz interference
Sample Rate	To select the sampling rate	0: Fast, fastest sampling rate 1: Normal (default, drift suppression enabled, but with the internal sampling time doubled)
CH1 Input Range	To select the range of Channel 1	70=0~20.58 mA (default) 71=4~20.58 mA
CH2 Input Range	To select the range of Channel 2	
CH3 Input Range	To select the range of Channel 3	
CH4 Input Range	To select the range of	

Parameter Name	Meaning	Value
	Channel 4	
CH5 Input Range	To select the range of Channel 5	
CH6 Input Range	To select the range of Channel 6	
CH7 Input Range	To select the range of Channel 7	
CH8 Input Range	To select the range of Channel 8	
CH1 Digital Filter	To select software filtering of Channel 1	0=None, without software filtering (default) 1=4 Points, to select the latest 4 historical data 2=8 Points, to select the latest 8 historical data 3=16 Points, to select the latest 16 historical data
CH2 Digital Filter	To select software filtering of Channel 2	
CH3 Digital Filter	To select software filtering of Channel 3	
CH4 Digital Filter	To select software filtering of Channel 4	
CH5 Digital Filter	To select software filtering of Channel 5	
CH6 Digital Filter	To select software filtering of Channel 6	
CH7 Digital Filter	To select software filtering of Channel 7	
CH8 Digital Filter	To select software filtering of Channel 8	
CH1 Upper Limit Exceeded Alarm	To enable Upper Limit Exceeded Alarm of Channel 1	0: Disable (default) 1: Enable
CH1 Lower Limit Exceeded Alarm	To enable Lower Limit Exceeded Alarm of Channel 1	
CH2 Upper Limit Exceeded Alarm	To enable Upper Limit Exceeded Alarm of Channel 2	
CH2 Lower Limit Exceeded Alarm	To enable Lower Limit Exceeded Alarm of Channel 2	
CH3 Upper Limit Exceeded Alarm	To enable Upper Limit Exceeded Alarm of Channel 3	
CH3 Lower Limit Exceeded Alarm	To enable Lower Limit Exceeded Alarm of Channel 3	
CH4 Upper Limit Exceeded Alarm	To enable Upper Limit Exceeded Alarm of Channel 4	
CH4 Lower Limit Exceeded Alarm	To enable Lower Limit Exceeded Alarm of Channel 4	

Parameter Name	Meaning	Value
CH5 Upper Limit Exceeded Alarm	To enable Upper Limit Exceeded Alarm of Channel 5	
CH5 Lower Limit Exceeded Alarm	To enable Lower Limit Exceeded Alarm of Channel 5	
CH6 Upper Limit Exceeded Alarm	To enable Upper Limit Exceeded Alarm of Channel 6	
CH6 Lower Limit Exceeded Alarm	To enable Lower Limit Exceeded Alarm of Channel 6	
CH7 Upper Limit Exceeded Alarm	To enable Upper Limit Exceeded Alarm of Channel 7	
CH7 Lower Limit Exceeded Alarm	To enable Lower Limit Exceeded Alarm of Channel 7	
CH8 Upper Limit Exceeded Alarm	To enable Upper Limit Exceeded Alarm of Channel 8	
CH8 Lower Limit Exceeded Alarm	To enable Lower Limit Exceeded Alarm of Channel 8	
CH1 Upper Limit Value	To set Upper Limit Value of Channel 1	Range of Lower Limit Values: 0~65,534 Range of Upper Limit Values: 1~ 65,535 Default of lower limit value: 0 Default of upper limit value: 65,535 Refer to Section 7.4.5.1 Measured Data Output Format for the calculation method
CH1 Lower Limit Value	To set Upper Limit Value of Channel 1	
CH2 Upper Limit Value	To set Upper Limit Value of Channel 2	
CH2 Lower Limit Value	To set Upper Limit Value of Channel 2	
CH3 Upper Limit Value	To set Upper Limit Value of Channel 3	
CH3 Lower Limit Value	To set Upper Limit Value of Channel 3	
CH4 Upper Limit Value	To set Upper Limit Value of Channel 4	
CH4 Lower Limit Value	To set Upper Limit Value of Channel 4	
CH5 Upper Limit Value	To set Upper Limit Value of Channel 5	
CH5 Lower Limit Value	To set Upper Limit Value of Channel 5	
CH6 Upper Limit Value	To set Upper Limit Value of Channel 6	
CH6 Lower Limit Value	To set Upper Limit Value of Channel 6	
CH7 Upper Limit	To set Upper Limit Value of	

Parameter Name	Meaning	Value
Value	Channel 7	
CH7 Lower Limit Value	To set Upper Limit Value of Channel 7	
CH8 Upper Limit Value	To set Upper Limit Value of Channel 8	
CH8 Lower Limit Value	To set Upper Limit Value of Channel 8	
CH1 Line Break Alarm	To enable Line Break Alarm of Channel 1	0: Disable (default) 1: Enable
CH2 Line Break Alarm	To enable Line Break Alarm of Channel 2	
CH3 Line Break Alarm	To enable Line Break Alarm of Channel 3	
CH4 Line Break Alarm	To enable Line Break Alarm of Channel 4	
CH5 Line Break Alarm	To enable Line Break Alarm of Channel 5	
CH6 Line Break Alarm	To enable Line Break Alarm of Channel 6	
CH7 Line Break Alarm	To enable Line Break Alarm of Channel 7	
CH8 Line Break Alarm	To enable Line Break Alarm of Channel 8	

7.4.8 Technical Specifications

LK411 8-channel Current Type Analog Input Module		
System Power		
Power Voltage	24VDC（-15%~20%）	
Power consumption	60 mA@24 VDC	
Input channel		
Number of channels	8	
Range Code	70	71
Max. Measurable Range	0-20.58 mA	4-20.58 mA
Reported Data Format	0x0000~0xFFFF	0x0000~0xFFFF
ADC Resolution	16-bit	
Sampling Period (Full-channel Scanning Time)	<480 ms (with no software filtering)	
Input Impedance	243 Ω	
Step Response Time	The time reaching to 90% of the target value is better than 1s	

LK411 8-channel Current Type Analog Input Module	
Differential Mode Rejection Ratio	80 dB
Common Mode Rejection Ratio	100 dB
Measurement Accuracy	<0.1% F.S.@25℃
Calibration Accuracy	<0.03% F.S.@25℃
Temperature drift	±25 ppm/℃
Isolation Voltage between Field and System	500 VAC@1 min, leaking current: 5 mA
Failure Diagnosis and Hot Plug	
Over Range Alarm	When the signal exceeds the upper/lower limit of the range, the diagnosis byte then reports 0xA3/0xA2
Over-limit Alarm	When the signal range exceeds the upper/lower limit of the alarm, the diagnosis byte then reports 0xA7/0xA8
Line broken Detection	When the channel is broken, the diagnosis then reports 0x06. When the fault recovered, it then reports 0xA0
Hot Plugging	Supported
Physical Property	
Protection Key	A1
Installation Position	Extension backboard
Module Dimension (W*H*D)	35 mm×100 mm×100 mm
Enclosure Protection Rating	IEC60529 IP20
Weight	190 g

7.5 LK412 6-channel Isolation Analog Input Module

7.5.1 Basic Features

- 6-channel analog input, inter-channel isolation
- Applicable ranges: 0~20 mA/4~20 mA/-10 V~10 V/0~10 V/0~5 V
- Max. measurable range: 0~20.58 mA/4~20.58 mA/-10.25 V~10.25 V/0~10.25 V/0~5.125 V
- Field calibration
- Over-limit alarm
- Over range alarm
- Line broken detection
- Isolation between the system and the field channel
- Hot swapping

7.5.2 Operating Principle

The LK412 adopts a 24 VDC power supply as the input power supply. The 24V DC power supply output ±15 VDC via isolated DC/DC to power supply separately to the interface circuit of each channel (field circuit), based on inter-channel electrical isolation. The interface circuit is connected via magnetic coupling with other circuits, thus realizing the isolation between the field and the system.

The current signal is converted into a digital signal via I/V, filtering, A/D, uploaded to the CPU module via the DP bus. The voltage signal is converted into a digital signal via voltage conversion, filtering and A/D, uploaded to the CPU module via the DP bus.

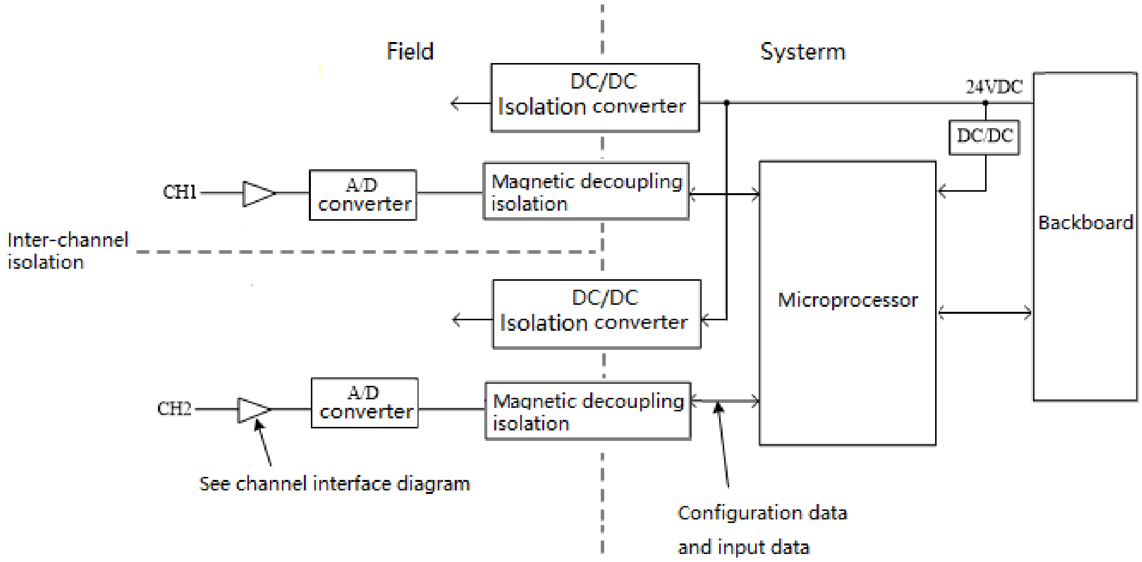


Figure 7-30 Internal Structure Block Diagram of LK412

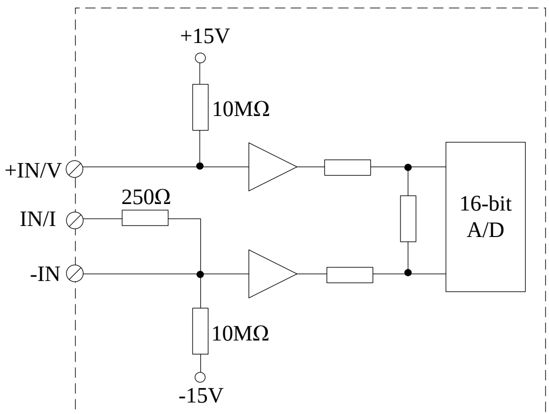


Figure 7-31 Channel Interface Circuit of LK412 Module

7.5.3 Status Indicator

There are two status lamp on the front panel of the module: the green **RUN** lamp and the yellow **CAL** lamp. The **RUN** lamp is the run indicator lamp, indicating the communication status between the module and the CPU module. The **CAL** lamp is the calibration indicator lamp, indicating the calibration process.

The LK412 module supports field calibration. The meanings of the indicator lamp are different when in the running mode and the calibration mode.

Table 7-30 Definition of LK412 Indicator Lamps

Name	Status	Description
RUN indicator lamp (green)	On	The communication is established, and the module works well
	Flash	The communication is not established or incorrect.
	Off	The module is not powered on or fault.
CAL Calibration Indicator Lamp (yellow)	On	In the calibration and detection mode, undergoing calibration and detection
	Flash	In the calibration no detection mode, but undergoing no calibration and detection
	Off	It is not powered up or the communication is not established or the module does not in the calibration and detection mode

- Running Mode
  - Immediately after being powered on, the module waits for the initialized data, with the green lamp flashing based on a frequency of 4 times/second.
  - Upon the completion of initialization, the green lamp is turned normally on, which indicates that the module works well. In case of any error in the initialized data, communication cannot be established and the green lamp keeps flashing. Check whether the DP is connected properly and the communication parameters are set properly.
  - When the module works well, the green lamp is normally on. When the communication is disconnected, the green lamp flashes. When the communication is established again, the green lamp is turned normally on again.
  - The yellow lamp is normally off when the module is in the running mode.

Table 7-31 Definition of LK412 Indicators in Running Mode

	RUN Lamp	CAL Lamp	Meaning
Running Mode	Off	Off	Not powered up
	Flash	Off	The communication is not established or incorrect.
	On	Off	The communication is established, the module works well

- Calibration Mode
  - Immediately after being powered on, the module waits for the initialized data, with the green lamp flashing based on a frequency of 4 times/second.
  - Upon the completion of initialization, the green lamp is turned normally on. In case of any error in the initialized data, the green lamp keeps flashing. Check whether the DP is connected properly and the communication parameters are set properly.
  - Upon the completion of initialization, if the calibration and detection is not executed, the module then waits for the calibration and detection instruction, with the yellow lamp flashing based on a frequency of 4 times/second. When the calibration and detection program starts to run and the module is undergoing calibration and detection, the yellow is turned on. Upon the completion of calibration and detection, the yellow lamp then flashes again.

- ☐ During calibration and detection, the green lamp is normally no. When the communication is disconnected, the green lamp flashes. When the communication is established again, the green lamp is turned normally on again.
- ☐ When the communication is not established or disconnected, the yellow lamp then goes out.

Table 7-32 Definition of LK412 Indicators in Calibration Mode

	RUN Lamp	CAL Lamp	Meaning
Calibration Mode	Off	Off	Not powered up
	Flash	Off	The communication is not established or incorrect
	On	On	Under calibration and detection
		Flash	Calibration and detection is not conducted or is completed

7.5.4 Wirings

The LK412 module is connected with a transmitter based on the two-wire system, and it does not supply power externally. Each input channel is required to supply a separate external 24 VDC field power supply to the transmitter. To ensure the isolation between the field and the system, the field power supply shall be configured separately and cannot be commonly used as the power supply for the backboard.

The LK412 module be installed on the extension backboard. The LK backboard can provide both terminal connection and precast cable connection. Only the backboard terminal connection is discussed here.

Table 7-33 Definition of LK412 Backboard Terminals

Channel No.	Terminal No.		
	Positive Terminal of Voltage Input (+IN/V) (+IN/V)	Current Input Terminal (+IN/I)	Common Negative Terminal (-In)
1	01	03/01	05
2	02	04/02	06
3	07	09/07	11
4	08	10/08	12
5	13	15/13	17
6	14	16/14	18

Pay attention to the following during wiring:

- The two-row 18-channel terminals are fixed on the backboard, right located under the installation position of the LK412 module.
- It is non-interfering when selecting each channel range, with an access to both a voltage signal and a current signal.
- For a current signal, Terminals 03 and 01 is short-circuited as the current input terminal of Channel 1, with Terminals 04 and 02 short-circuited as the current input terminal of Channel 2, and so on.
- Each AI signal is separately connected to the terminals via two conductors (shielded cable) in the field.

- The output channel does not supply power to the transmitter. When connected to a transmitter based on the two-wire system, a separately 24 DC field power supply is provided separately to the transmitter.
- Upon the wiring, check whether the cable is connected properly. Do not hold the naked line exposed in order to avoid a short-circuit hazard.

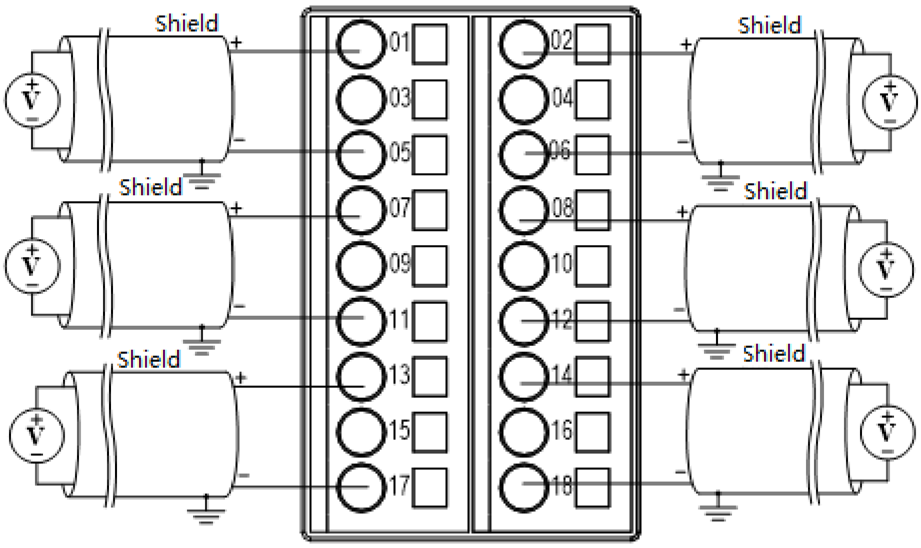


Figure 7-32 LK412 Voltage Channel Terminal Wiring Diagram

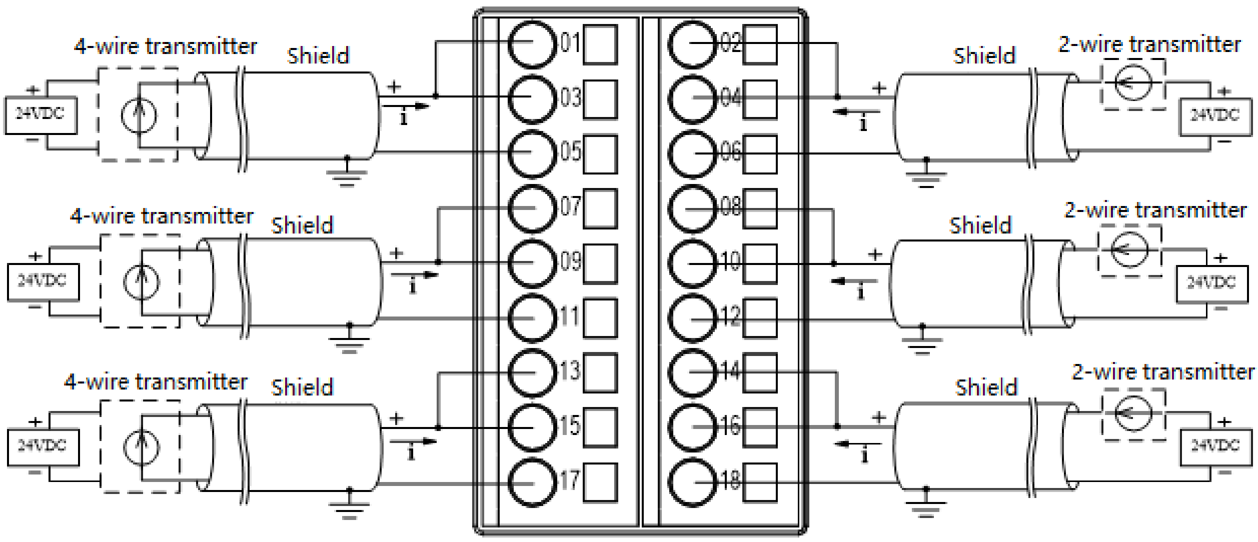


Figure 7-33 LK412 Current Channel Terminal Wiring Diagram

7.5.5 Functions

7.5.5.1 Measured Data Output Format

As shown in Table 7-34, the measured data on the AI channel that is reported by the LK412 module, is expressed in form of 2-byte positive integer (decimal: 0~65,535) digital code. Notably, the voltage range (-10.25~+10.25 V) has two segments, including the positive voltage (0~10.25 V) corresponding to the decimal digital code (0~32,767) and the negative voltage (-10.25 V~0) corresponding to the decimal digital code (32,768~65,535).

Table 7-34 Corresponding Relationship between LK412 Input Signal and Digital Code

Max. Measurable Range		**Corresponding Decimal Digital Code**
-10.25~+10.25 V	0~10.25 V	0~32,767
	-10.25~0 V	32,768~65,535
0~10.25 V		0~65,535
0~5.125 V		0~65,535
0~20.58 mA		0~65,535
4~20.58 mA		0~65,535

See the following for the conversion formula between the measured data and the physical quantity of the voltage range (-10.25~10.25V):

Positive voltage: 0~+10.25 V: Voltage (V) =measured data/32,767×10.25

Negative voltage: -10.25~0 V: Voltage (V) = (measured data －65,535)/32,767×10.25

By calling the function block HEX_ENGIN of the Analog signal Processing Functions library in the programming software AutoThink, it can convert the 2-byte measured data into the engineering data. Refer to the *HollySys Programmable Logic Controller PLC Instruction Manual* for the specific application of the function blocks.

When setting Upper Limit Value and Lower Limit Value in the user parameters, according to the formula listed in Table 7-35, convert the electrical signal (voltage or current) into a decimal digital code and then input it. For different ranges, the digital code may be converted in different ways.

Table 7-35 Data Conversion Formula of LK412 Module

Max. Measurable Range		**Formula of Corresponding Digital Code**
-10.25~+10.25 V	0 V≤U≤10.25 V	U×32,767/10.25
	-10.25V≤U≤0 V	65,535＋ (U×32,767/10.25)
0 V≤U≤10.25 V		U×65,535/10.25
0 V≤U≤5.125 V		U×65,535/5.125
4 mA≤I≤20.58 mA		(I－4) ×65,535/16.58(I-4) ×65,535/16.58
0 mA≤I≤20.58 mA		I×65,535/20.58

Example 1: for Channel 1, in case the range is selected as 0~10.25 V, over-limit enabled, user-defined upper voltage limit: 10 V, lower voltage limit: 5 V, then Upper Limit Value for Channel 1 =10×65,535/10.25=63,936, Lower Limit Value for Channel 1 ＝5×65,535/10.25=31,968. Refer to Figure 7-34 for the relevant [User parameter] settings.

CH1 Input Range	0~10.25V	Unsigned8 16 16,17,18,
CH1 Upper Limit Exceeded Alarm	Enable	Bit(0) 0 0,1
CH1 Lower Limit Exceeded Alarm	Enable	Bit(0) 0 0,1
CH1 Upper Limit Value	63936	Unsigned16 32767 1-65535
CH1 Lower Limit Value	31968	Unsigned16 0 0-65534

Figure 7-34 Examples of Over-limit Alarm Parameter Settings Based on Selected Range

Example 2: for Channel 3, in case the range is selected as -10.25~+10.25 V, over-limit enabled, user-defined upper voltage limit: 10 V, lower voltage limit: -10 V, then Upper Limit Value for Channel 1 =10×32,767/10.25=31,968, Lower Limit Value for Channel 1 =65,535+ (-10×32,767/10.25)V=33,567. Refer to Figure 7-35 for the relevant user parameter settings.

CH3 Input Range	-10.25~10.25V	Unsigned8 16 16,17,18,70,71
CH3 Upper Limit Exceeded Alarm	Enable	Bit(2) 0 0,1
CH3 Lower Limit Exceeded Alarm	Enable	Bit(2) 0 0,1
CH3 Upper Limit Value	31968	Unsigned16 32767 1-65535
CH3 Lower Limit Value	33567	Unsigned16 0 0-65534

Figure 7-35 Examples of Over-limit Alarm Parameter Settings Based on Selected Range

7.5.6 Diagnosis

LK412 can conduct calibration data error diagnosis. Such a diagnosis is a device diagnosis. LK412 can also detect over range, over-limit and line broken, which are channel diagnosis. After calling the function block sysGetDPSlaveState (Get Diagnosis of DP Slave), the diagnosis data and the device diagnosis data reported by LK412 are saved into the output parameter **DiagData** in the function block.

Diagnostic information of LK412 up to 22 bytes, wherein 2 bytes are device-related diagnosis, 2 bytes are identification diagnosis and 18 bytes are channel diagnosis. For six channel of LK412, the diagnosis information of each channel is 3 bytes, the diagnosis information for each channel 3 bytes. Diagnosis information diagram refer to Figure 7-26.

- Device diagnosis information

  Device diagnosis data 0x02, 0x00 indicates the current device without any fault.

  Device diagnosis data 0x02, 0x01 indicates that the current device has channel fault.

  Device diagnosis data 0x02, 0x02 indicates that the current device has checking data fault.

  Device diagnosis data 0x02, 0x03 indicates that the current device have both channel fault and checking data fault.

- Identification diagnosis information

The 2-byte identification diagnosis information is 0x42, 0x01 when diagnosis information is reported.

- Channel diagnosis information

Channel diagnosis information as shown in Table 7-36.

Table 7-36 Specifications for LK412 Diagnosis Information

Diagnosis Information						**Meaning**
Bit		Bit7	Bit6	Bit5	Bit4~ Bit0	
The first byte	Head	0x80				Decimal online value 128
The second byte	I/O type/channel	01 (Input)		（Channel）		Fault channel no. 1~6 Decimal online value 64~69
The third byte	Channel data type/fault type	101 (Word)			2	Under range, Decimal online value is 162
					3	Over range, Decimal online value is 163
					6	Line broken, Decimal online value is 166
					7	Upper limit exceeded, Decimal online value is 167
					8	Lower limit exceeded, Decimal online value is 168
					0	Channel fault recovery, Decimal online value is 160

Example:

Channel diagnosis data 0x80, 0x42, 0xA6 indicates that channel 1 has line broken alarm.

Channel diagnosis data 0x80, 0x42, 0xA7 indicates that channel 1 has upper limit exceeded alarm.

Channel diagnosis data 0x80, 0x42, 0xA8 indicates that channel 1 has lower limit exceeded alarm.

7.5.6.1 Over Range Alarm

The LK412 module is capable of over range alarm. When the signal goes beyond the selected range, the channel diagnosis byte reports over range, when the signal is recovered, it then reports fault recovery.

The LK412 module only reports the diagnosis data once separately when over range occurs and is recovered.

- For the LK412 module, the effective range is not the max. measurable range. When the output signal exceeding the range, it may not exceed the Max. Measurable range.

Channel data then reports the code value corresponding to the max. measurable signal in the range. If less than the Min. measured current, the measured channel data then reports the code value corresponding to the Min. measurable signal in the range.

Table 7-37 Over Range Definition of LK412

Range	Over Range	
	Over Range	Under Range
0~20 mA	＞20 mA	＜0 mA
4~20 mA	＞20 mA	＜4 mA
-10 V~10 V	＞10 V	＜-10 V
0~10 V	＞10 V	＜0 V
0~5 V	＞5 V	＜0 V

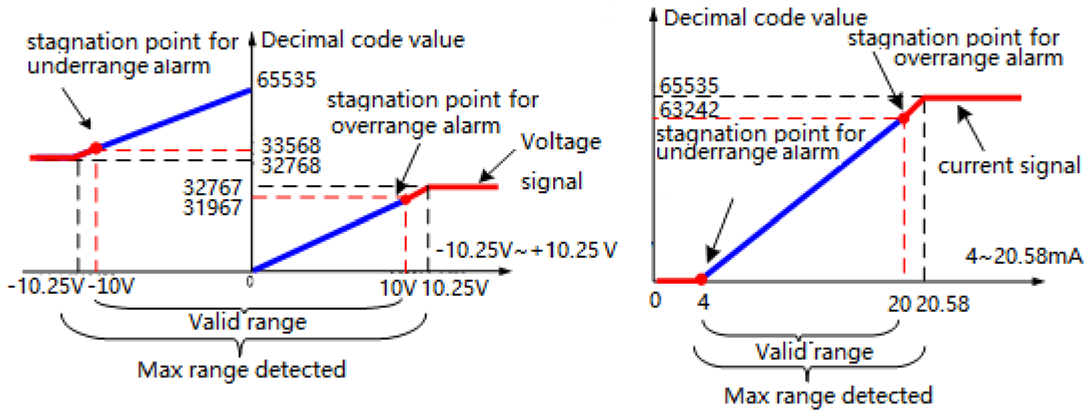


Figure 7-36 LK412 Over Range Alarm Schematic Diagram

Due to the different ranges selected, the diagnosis handling methods of the module may also differ in case of over range, as shown in Table 7-38. When the signal is recovered to the normal range, the channel diagnosis byte then reports 0xA0.

Table 7-38 Handling of LK412 Over Range Alarm Based on Different Ranges

Max. Measurable Range	Range	Type of Over Range	Handling of Over Range
0~20.58 mA	0~20 mA	Over Range	The channel diagnosis byte reports 0xA3 20~20.58mA, the measured channel data reports the corresponding code value ranging 63,688~65,535 >20.58mA, the measured channel data reports 65,535
		Under Range	The channel diagnosis byte reports 0xA2 The measured channel data reports 0
4~20.58 mA	4~20 mA	Over Range	The channel diagnosis byte reports 0xA3 20~20.58mA, the measured channel data reports the corresponding code value ranging 63,242~65,535 >20.58mA, the measured channel data reports 65,535
		Under Range	The channel diagnosis byte reports 0xA2 The measured channel data reports 0
-10.25 V~10.25 V	-10 V~10 V	Over Range	The channel diagnosis byte reports 0xA3 10~10.25 V, the measured channel data reports the corresponding code value ranging 31,967~32,767 ＞10.25V, the channel reports 32,767
		Under Range	The channel diagnosis byte reports 0xA2

Max. Measurable Range	Range	Type of Over Range	Handling of Over Range
			-10.25V~-10V, the measured channel data reports the corresponding code value ranging 32,768~33,568 ＜-10.25V, the measured channel data reports 32,768
0~10.25 V	0~10 V	Over Range	The channel diagnosis byte reports 0xA3 10~10.25 V, the measured channel data reports the corresponding code value ranging 63,937~ 65,535 ＞10.25V, the measured channel data reports 65,535
		Under Range	The channel diagnosis byte reports 0xA2 The measured channel data reports 0
0~5.125 V	0~5 V	Over Range	The channel diagnosis byte reports 0xA3 5~ 5.125 V, the measured channel data reports the corresponding code value ranging 63,937~ 65,535 > 5.125V, the measured channel data reports 65,535
		Under Range	The channel diagnosis byte reports 0xA2 The measured channel data reports 0

7.5.6.2 Over-limit Alarm

The LK412 module is capable of over-limit alarm. When the input signal goes beyond the limit range, that is, higher than Upper Limit Value or lower than Lower Limit Value, the channel diagnosis byte then reports over-limit. When the signal is recovered to the limit range, it then reports fault recovery.

The LK412 module only reports the diagnosis data once separately when over-limit occurs and is recovered.

Upper Limit Value must be more than Lower Limit Value. Otherwise, the LK412 module cannot report the diagnosis message properly.

If over-limit and over range occur simultaneously, only over range is reported.

Table 7-39 Range of LK412 Over-limit Alarm Value

Range	Alarm Value Settings
0~20 mA	20 mA>Upper Limit for Current>Lower Limit for Current>0 mA
4~20 mA	20 mA>Upper Limit for Current>Lower Limit for Current> 4 mA
-10 V~10 V	10 V>Upper Limit for voltage>Lower Limit for Voltage> -10 V
0~10 V	10 V>Upper Limit for voltage>Lower Limit for Voltage> 0 V
0~5 V	5 V>Upper Limit for voltage>Lower Limit for Voltage> 0 V

The alarm value in the configuration is the digital code corresponding to the measured signal in the selected range, expressed in a two-byte decimal digital code (0~65,535). Range of upper limit value: 1~65,535, defaulted to 32,767, range of lower limit value: 0~65,534, defaulted to 0. The formula of the digital code value corresponding to the electrical signal is shown in Table 7-40.

Table 7-40 Calculation of LK412 Alarm Limit Digital Code

Input Signal		Upper Limit Digital Code (Decimal)	Lower Limit Digital Code(Decimal)
0~20.58 mA		Upper limit current ×65,535/20.58	Lower limit current×65,535/20.58
4~20.58 mA		(Upper limit current-4)×65,535/16.58	(Lower limit current-4) ×65,535/16.58
-10.25~10.25	-10.25~0	65,535+(Lower Limit voltage × 32,767/	65,535+(Lower Limit

Input Signal		Upper Limit Digital Code (Decimal)	Lower Limit Digital Code(Decimal)
V	V	10.25)	voltage×32,767/10.25)
	0~10.25 V	Upper limit voltage × 32,767/ 10.25	Upper limit voltage × 32,767/ 10.25
0~10.25 V		Upper limit voltage × 65,535/ 10.25	Lower limit voltage×65,535/10.25
0~5.125V		Upper limit voltage × 65,535/ 5.125	Lower limit voltage×65,535/5.125

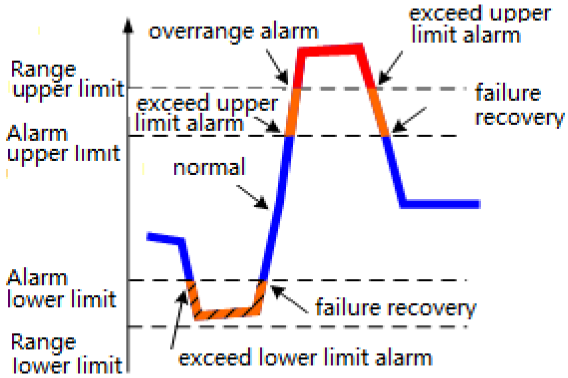


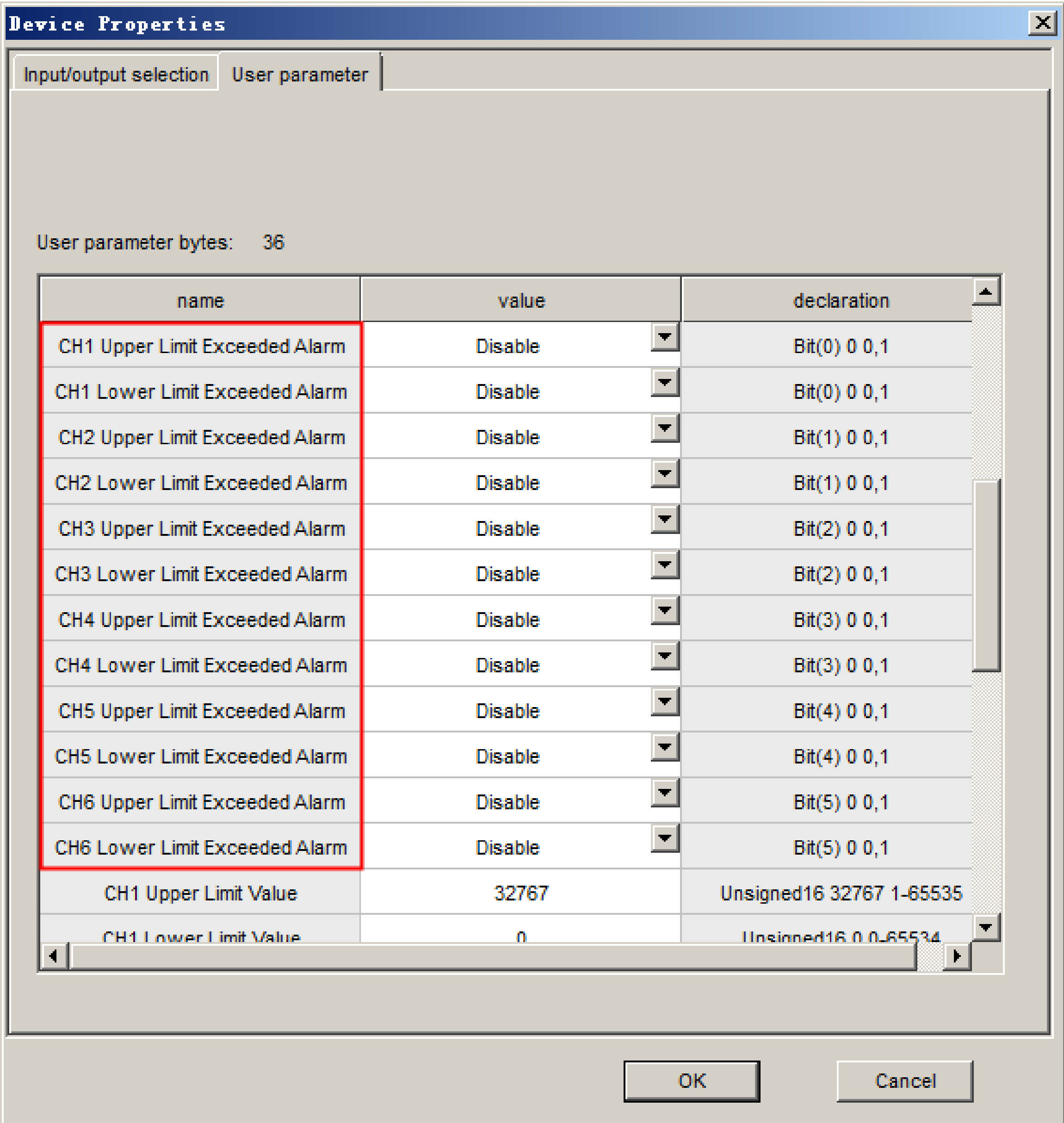
Figure 7-37 LK412 Over-limit Alarm Diagnosis

When certain input channel signal over-limits:

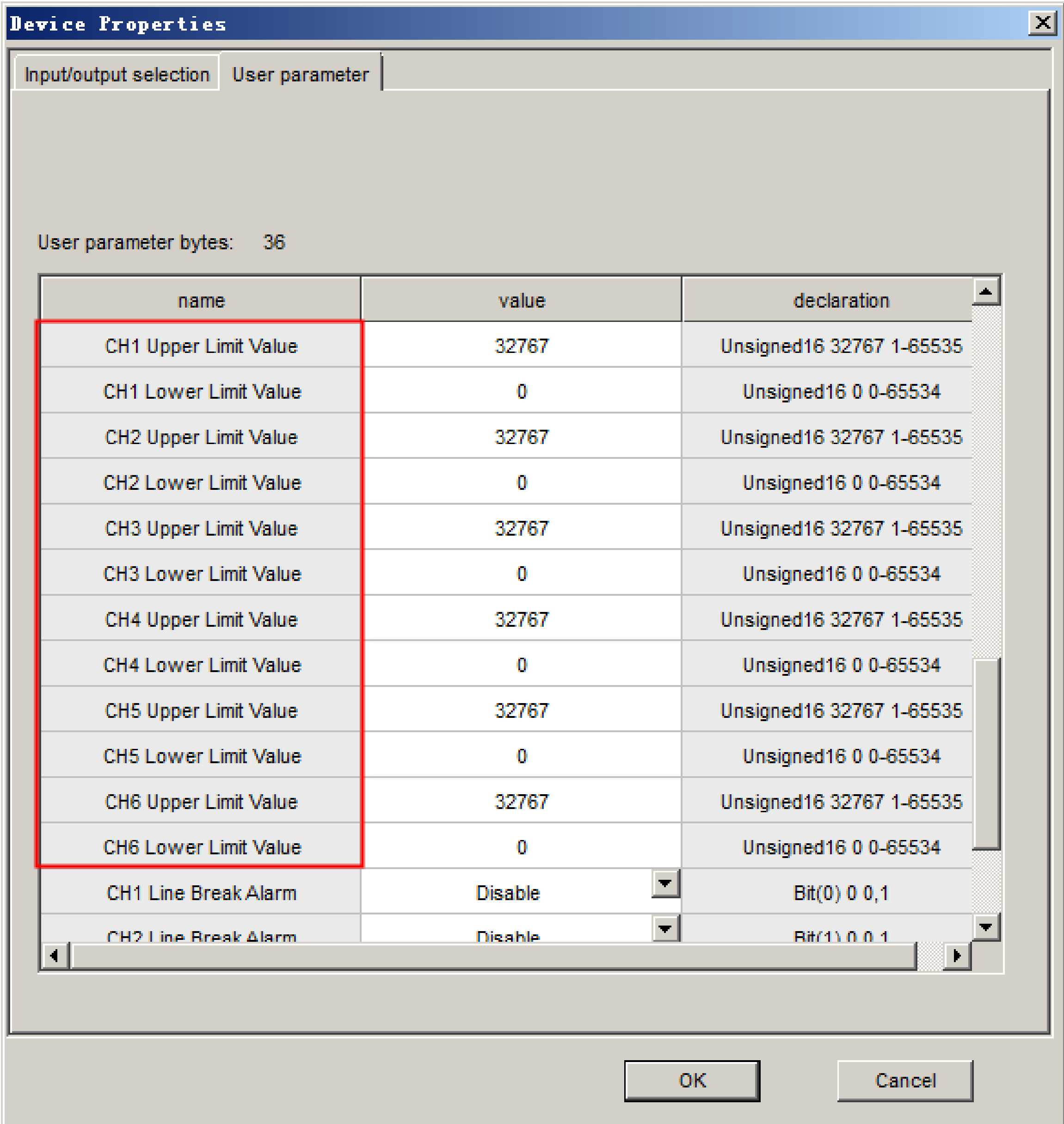
- If going beyond the upper limit, the channel diagnosis byte then reports 0xA7.
- If going beyond the lower limit, the channel diagnosis byte then reports 0xA8.
- The measured channel data reports the digital code corresponding to the current signal.
- If the signal is recovered to the normal range, the channel diagnosis byte then reports 0xA0.

Whether Lower Limit Exceeded Alarm Enable is set by the parameter CH1~CH6 Lower Limit Exceeded Alarm, whether Upper Limit Exceeded Alarm Enable is set by the parameter CH1~CH6 Upper Limit Exceeded Alarm, defaulted to disabled. After enabling the alarm, set Lower Limit Value and Upper Limit Value according to the parameters CH1~CH6 Lower Limit Value and CH1~CH6 Upper Limit Value.

Over-limit Alarm Enable, Upper Limit Value and Lower Limit Value of the 6 channels are set separately, without interfering each other.


Device Properties
Input/output selection
User parameter
User parameter bytes: 36
name
value
declaration
CH1 Upper Limit Exceeded Alarm
Disable
Bit(0) 0 0,1
CH1 Lower Limit Exceeded Alarm
Disable
Bit(0) 0 0,1
CH2 Upper Limit Exceeded Alarm
Disable
Bit(1) 0 0,1
CH2 Lower Limit Exceeded Alarm
Disable
Bit(1) 0 0,1
CH3 Upper Limit Exceeded Alarm
Disable
Bit(2) 0 0,1
CH3 Lower Limit Exceeded Alarm
Disable
Bit(2) 0 0,1
CH4 Upper Limit Exceeded Alarm
Disable
Bit(3) 0 0,1
CH4 Lower Limit Exceeded Alarm
Disable
Bit(3) 0 0,1
CH5 Upper Limit Exceeded Alarm
Disable
Bit(4) 0 0,1
CH5 Lower Limit Exceeded Alarm
Disable
Bit(4) 0 0,1
CH6 Upper Limit Exceeded Alarm
Disable
Bit(5) 0 0,1
CH6 Lower Limit Exceeded Alarm
Disable
Bit(5) 0 0,1
CH1 Upper Limit Value
32767
Unsigned16 32767 1-65535
OK
Cancel

(a)



(b)

Figure 7-38 LK412 Over-limit Alarm Parameters

7.5.6.3 Line Broken Detection

The LK412 module is capable of line broken detection.

As shown in Figure 7-39, the signal channel is connected to a 10 MΩ pull-up resistor. The LK412 detect the line broken diagnosis according to the input voltage change between the two terminals. In case of a failure, report the fault status in form of diagnosis data to the CPU module. When the input channel signal connection is broken, the voltage at the positive terminal of the channel is pulled up to +15V, the negative terminal of the channel is pulled down to -15 V, with the voltage difference at the input terminal of the AD converter reaching to the max. value, the channel diagnosis byte reports line broken. After the line broken is recovered, the channel diagnosis byte reports fault recovery.

The LK412 module only reports the diagnosis data once separately when an line broken occurs and is recovered. It can select whether to give an line broken alarm during configuration, defaulted to disabled. If the input channel is not connected, it can be considered as broken. It is suggested to disable line broken alarm for channels that are not used, that is, to hold the default parameter unchanged.

When certain channel is broken, refer to Table 7-41 for the diagnosis and handling of various signal types. After the line broken is recovered, the channel diagnosis byte reports 0xA0.

Table 7-41 Handling of Broken LK412 of Various Types

Signal Type	Type of Line Broken	Handling of Line Broken
Current signal	The short line (+IN/V) is broken.	The channel diagnosis byte reports line broken fault value 0xA6. The measured channel data reports 65,535
	The field signal line (+IN/I, -IN) is broken	The channel diagnosis byte reports line broken fault value 0xA6. The measured channel data reports 0
Voltage Signal	The field signal line (+IN/V, -IN) is broken.	The channel diagnosis byte reports line broken fault value 0xA6. The measured channel data reports 65,535 or 32,767 (with a range of -10.25~10.25 V)

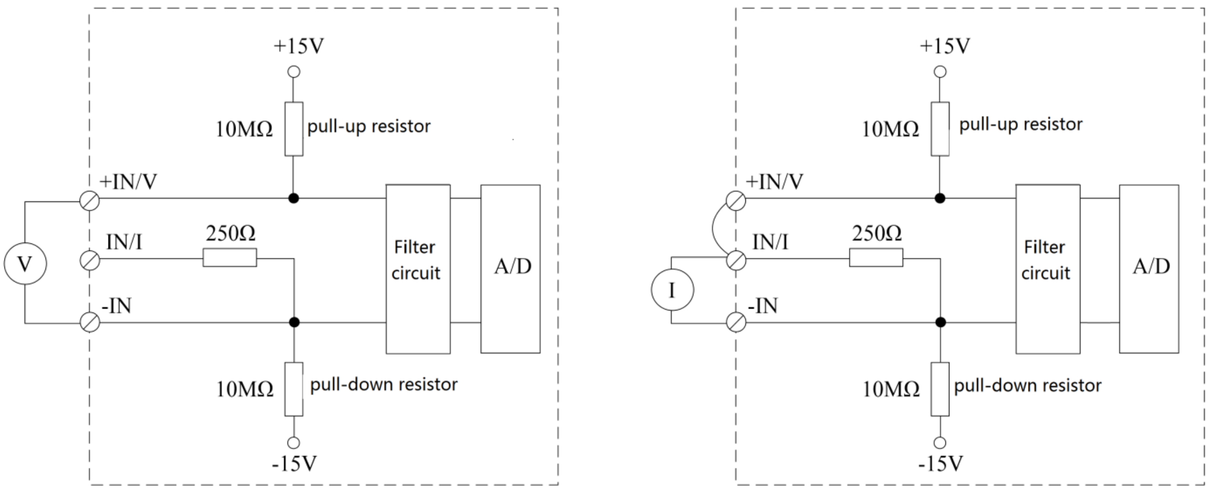


Figure 7-39 LK412 Channel Line Broken Detection Circuit Diagram

7.5.7 Parameters

The user parameter is used to set the operation mode of the module. The CPU module written when downloading the user program may not be read in each scanning period. Each parameter has a default, able to modify the parameter value according to the project requirements. The user parameter does not support online modification. The modification takes effect only upon full download.

The user parameter length of the LK412 module is up to 36 bytes.

Table 7-42 Table of LK412 User Parameters

Parameter Name	Meaning	Value
Filter Mode	To select the digital filtering mode	0=50 Hz Filter, to filter 50 Hz interference (default) 1=60 Hz Filter, to filter the 60 Hz interference
CH1 Input Range	To select the range of Channel 1	16= -10.25~10.25 V (default) 17=0~10.25 V
CH2 Input Range	To select the range of Channel 2	

Parameter Name	Meaning	Value
CH3 Input Range	To select the range of Channel 3	18=0~5.125 V 70=0~20.58 mA 71=4~20.58 mA
CH4 Input Range	To select the range of Channel 4	
CH5 Input Range	To select the range of Channel 5	
CH6 Input Range	To select the range of Channel 6	
CH1 Digital Filter	To set software filtering of Channel 1	0=None, without software filtering (default) 1=4 Points, to select the latest 4 historical data 2=8 Points, to select the latest 8 historical data 3=16 Points, to select the latest 16 historical data
CH2 Digital Filter	To set software filtering of Channel 2	
CH3 Digital Filter	To set software filtering of Channel 3	
CH4 Digital Filter	To set software filtering of Channel 4	
CH5 Digital Filter	To set software filtering of Channel 5	
CH6 Digital Filter	To set software filtering of Channel 6	
CH1 Upper Limit Exceeded Alarm	To enable Upper Limit Exceeded Alarm of Channel 1	0=Disable (default) 1=Enable
CH1 Lower Limit Exceeded Alarm	To enable Lower Limit Exceeded Alarm of Channel 1	
CH2 Upper Limit Exceeded Alarm	To enable Upper Limit Exceeded Alarm of Channel 2	
CH2 Lower Limit Exceeded Alarm	To enable Lower Limit Exceeded Alarm of Channel 2	
CH3 Upper Limit Exceeded Alarm	To enable Upper Limit Exceeded Alarm of Channel 3	
CH3 Lower Limit Exceeded Alarm	To enable Lower Limit Exceeded Alarm of Channel 3	
CH4 Upper Limit Exceeded Alarm	To enable Upper Limit Exceeded Alarm of Channel 4	
CH4 Lower Limit Exceeded Alarm	To enable Lower Limit Exceeded Alarm of Channel 4	
CH5 Upper Limit Exceeded Alarm	To enable Upper Limit Exceeded Alarm of Channel 5	
CH5 Lower Limit Exceeded Alarm	To enable Lower Limit Exceeded Alarm of Channel 5	
CH6 Upper Limit Exceeded Alarm	To enable Upper Limit Exceeded Alarm of Channel 6	
CH6 Lower Limit Exceeded Alarm	To enable Lower Limit Exceeded Alarm of Channel 6	
CH1 Upper Limit Value	To set Upper Limit Value of Channel 1	Range of Lower Limit Values: 0~65,534 Range of Upper Limit Values: 1~ 65,535 Default of lower limit value: 0 Default of upper limit value: 32,767 Refer to 7.5.5.1 Measured Data Output Format for the calculation method.
CH1 Lower Limit Value	To set Upper Limit Value of Channel 1	
CH2 Upper Limit Value	To set Upper Limit Value of Channel 2	
CH2 Lower Limit Value	To set Upper Limit Value of Channel 2	
CH3 Upper Limit Value	To set Upper Limit Value of Channel 3	

Parameter Name	Meaning	Value
CH3 Lower Limit Value	To set Upper Limit Value of Channel 3	
CH4 Upper Limit Value	To set Upper Limit Value of Channel 4	
CH4 Lower Limit Value	To set Upper Limit Value of Channel 4	
CH5 Upper Limit Value	To set Upper Limit Value of Channel 5	
CH5 Lower Limit Value	To set Upper Limit Value of Channel 5	
CH6 Upper Limit Value	To set Upper Limit Value of Channel 6	
CH6 Lower Limit Value	To set Upper Limit Value of Channel 6	
CH1 Line Break Alarm	To enable Line Break Alarm of Channel 1	0=Disable 1=Enable
CH2 Line Break Alarm	To enable Line Break Alarm of Channel 2	
CH3 Line Break Alarm	To enable Line Break Alarm of Channel 3	
CH4 Line Break Alarm	To enable Line Break Alarm of Channel 4	
CH5 Line Break Alarm	To enable Line Break Alarm of Channel 5	
CH6 Line Break Alarm	To enable Line Break Alarm of Channel 6	

- The selection of each channel range does not interfere with each other and can be different ranges separately.
- The software filtering of each channel does not interfere with each other and can be different modes separately.

7.5.8 Technical Specifications

<table>
<tr><th colspan="6">LK412 6-channel Isolation Analog Input Module</th></tr>
<tr><td colspan="6">Power supply</td></tr>
<tr><td colspan="2">Operating Voltage</td><td colspan="4">24VDC（-15%~20%）</td></tr>
<tr><td colspan="2">Power Consumption (max.)</td><td colspan="4">150 mA@24 VDC</td></tr>
<tr><td colspan="6">Input channel</td></tr>
<tr><td colspan="2">Number of channels</td><td colspan="4">6</td></tr>
<tr><td colspan="2">Range Code</td><td colspan="2">16</td><td>17</td><td>18</td></tr>
<tr><td>Max. Measurable Range</td><td>Voltage Signal</td><td>-10.25~0 V</td><td>0~10.25 V</td><td>0~10.25 V</td><td>0~5.125 V</td></tr>
</table>

LK412 6-channel Isolation Analog Input Module					
	Data Format	32768~65,535	0~32,767	0~65,535	0~65,535
Range Code		70		71	
Max. Measurable Range	Current signal	0~20.58 mA		4~20.58 mA	
	Data Format	0~65,535		0~65,535	
Input Impedance	Voltage Signal	＞1 MΩ			
	Current signal	250 Ω			
ADC Resolution		16-bit			
Full-channel Scanning Time (with no software filtering)		＜50 ms (with no software filtering)			
Differential Mode Rejection Ratio		＞60 dB			
Common Mode Rejection Ratio		＞90dB			
Measurement Accuracy		0.1% F.S.@25℃			
Repeatability precision		0.02% F.S.@25℃			
Calibration Accuracy		0.03% F.S.@25℃			
Step Response		The time reaching to 90% of the target value below 1 s			
Temperature Drift		±25 ppm/℃			
Failure Diagnosis and Hot Plug					
Calibration Data Error Detection		When powered on, if the calibration data is wrong, the device diagnosis byte then reports 0xA2. If the data is correct, it then does not report			
Over range alarm		When the signal exceeds the upper/lower limit of the range, the diagnosis byte then reports 0xA3/0xA2			
Over-limit alarm		When the signal exceeds the upper/lower limit of the alarm, channel the diagnosis byte then reports 0xA7/0xA8			
Line broken detection		When the channel is broken, the channel diagnosis byte then reports 0xA6. When the fault recovered, it then reports 0xA0			
Hot Plugging		Supported			
Isolated and voltage withstand					
Channel-to-system		To test for 1 minute based on 500 VAC, with a leaking current 5 mA			
Channel-to-channel		To test for 1 minute based on 500 VAC, with a leaking current 5 mA			
Physical Property					
Protection Key		A0			
Installation Position		Extension backboard			
Module Dimension (W*H*D)		35 mm×100 mm×100 mm			
Enclosure Protection Rating		IEC60529 IP20			
Weight		190 g			

7.6 LK430 6-channel Thermal Resistance Analog Input Module

7.6.1 Basic Features

- 6-channel RTD input, in form of constant current source
- RTD measurement can report the temperature or resistance value
- RTD Type: Copper427, Chinese_Cu, Nikel618, Nikel672, Platinum385, Platinum3916
- Resistance measurement range : 1~4020 Ω
- Upper Limit Exceeded Alarm
- Lower Limit Exceeded Alarm
- Line broken detection
- Isolation between the system and the field
- Hot swapping
- Field calibration

7.6.2 Operating Principle

The 24 VDC system power supply of the LK412 module supplies the power to the interface circuit by outputting 5 VDC via isolated DC/DC. An opto-isolator is between the interface circuit and the system, thus realizing the electrical isolation between the system and the field channel.

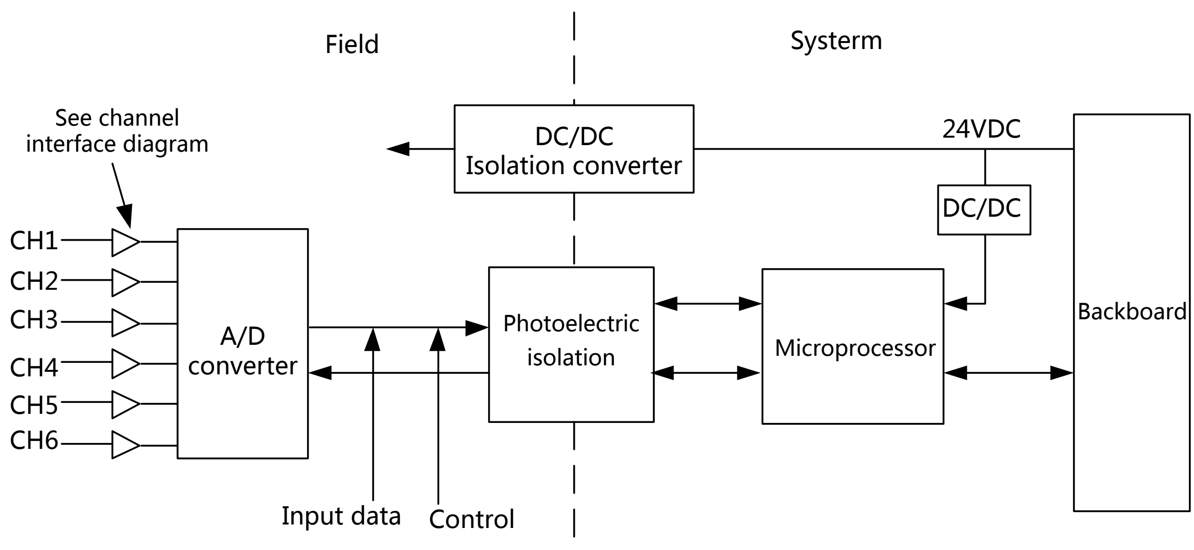


Figure 7-40 Internal Structure Block Diagram of LK430

LK430 adopts a measurement method based on constant current source excitation. As compared to the conventional bridge measurement, it can eliminate the impact exerted by the line resistance of the long RTD conductor on measurement accuracy in case of imbalanced electric bridge. Of course, no matter of constant current source measurement or bridge measurement, the line resistance values of the three RTD conductors are equal. Otherwise, the conductor resistance deviation may affect measurement accuracy. Refer to Figure 7-41 for the interface circuit.

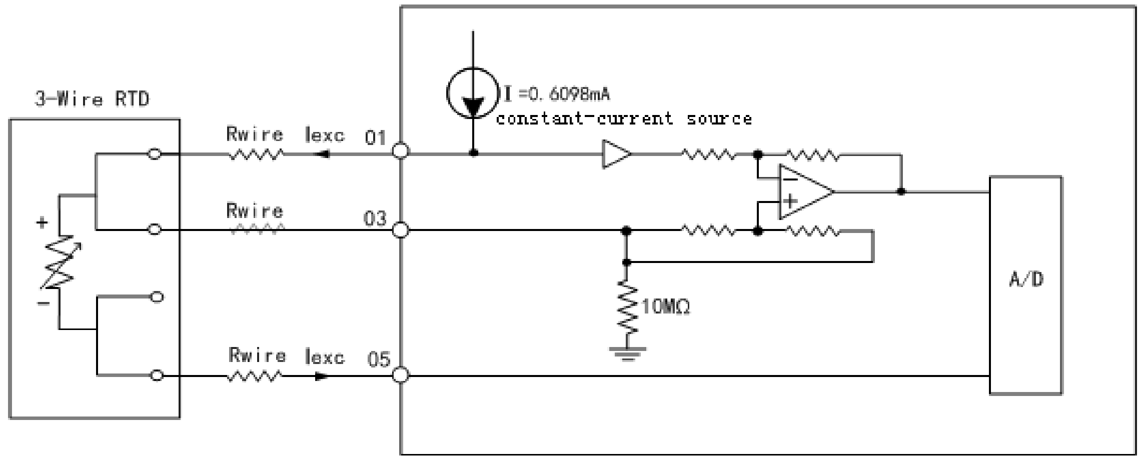


Figure 7-41 LK430 Channel Interface Circuit Diagram (Taking Channel 1 for Example)

7.6.3 Status Indicator

There are two status lamps on the front panel of the module: the green RUN lamp and the yellow CAL lamp. The RUN lamp is the run indicator lamp, indicating the communication status between the module and the CPU module. The CAL lamp is the calibration indicator lamp, indicating the calibration process.

Table 7-43 Definition of LK430 Status Indicator

Name	Status	Description
RUN indicator lamp (green)	On	The communication is established
	Flash	The communication is not established or incorrect.
	Off	The module is not powered on.
CAL Calibration Indicator Lamp (yellow)	On	In the calibration and detection mode, undergoing calibration and detection
	Flash	In the calibration no detection mode, but undergoing no calibration and detection
	Off	It is not powered up or the communication is not established or the module does not in the calibration and detection mode

- Running Mode
  - Immediately after being powered on, the module waits for the initialized data, with the green lamp flashing based on a frequency of 4 times/second.
  - Upon the completion of initialization, the green lamp is turned normally on, which indicates that the module works well. In case of any error in the initialized data, communication cannot be established and the green lamp keeps flashing. Check whether the DP is connected properly and the communication parameters (communication rate, communication station No.) are set properly.

- ☐ When the module works well, the green lamp is normally on. When the communication is disconnected, the green lamp flashes. When the communication is established again, the green lamp is turned normally on again.
- ☐ The yellow lamp is normally off when the module is in the running mode.

Table 7-44 Definition of LK430 Indicators in Running Mode

	RUN Lamp	CAL Lamp	Meaning
Running Mode	Off	Off	Not powered up
	Flash	Off	The communication is not established or incorrect.
	On	Off	The communication is established, the module works well

- ■ Calibration Mode
  - ☐ Immediately after being powered on, the module waits for the initialized data, with the green lamp flashing based on a frequency of 4 times/second.
  - ☐ Upon the completion of initialization, the green lamp is turned normally on. In case of any error in the initialized data, the green lamp keeps flashing. Check whether the DP is connected properly and the communication parameters (communication rate, communication station No.) are set properly.
  - ☐ Upon the completion of initialization, if the calibration and detection is not executed, the module then waits for the calibration and detection instruction, with the yellow lamp flashing based on a frequency of 4 times/second. When the calibration and detection program starts to run and the module is undergoing calibration and detection, the yellow is turned on. Upon the completion of calibration and detection, the yellow lamp then flashes again.
  - ☐ During calibration and detection, the green lamp is normally no. When the communication is disconnected, the green lamp flashes. When the communication is established again, the green lamp is turned normally on again.
  - ☐ When the communication is not established or disconnected, the yellow lamp then goes out.

Table 7-45 Definition of LK430 Indicators in Calibration Mode

	RUN Lamp	CAL Lamp	Meaning
Calibration Mode	Off	Off	Not powered up
	Flash	Off	The communication is not established or incorrect.
	On	On	Under calibration and detection
		Flash	Calibration and detection is not conducted or is completed

7.6.4 Wirings

The LK430 module is installed on the extension backboard. The LK backboard can provide both terminal connection and precast cable connection. Only the backboard terminal connection is discussed here.

Table 7-46 Definition of LK430 Backboard Terminals

Channel No.	Sequence of Terminals		
1	01	03	05
2	02	04	06

Channel No.	Sequence of Terminals		
3	07	09	11
4	08	10	12
5	13	15	17
6	14	16	18

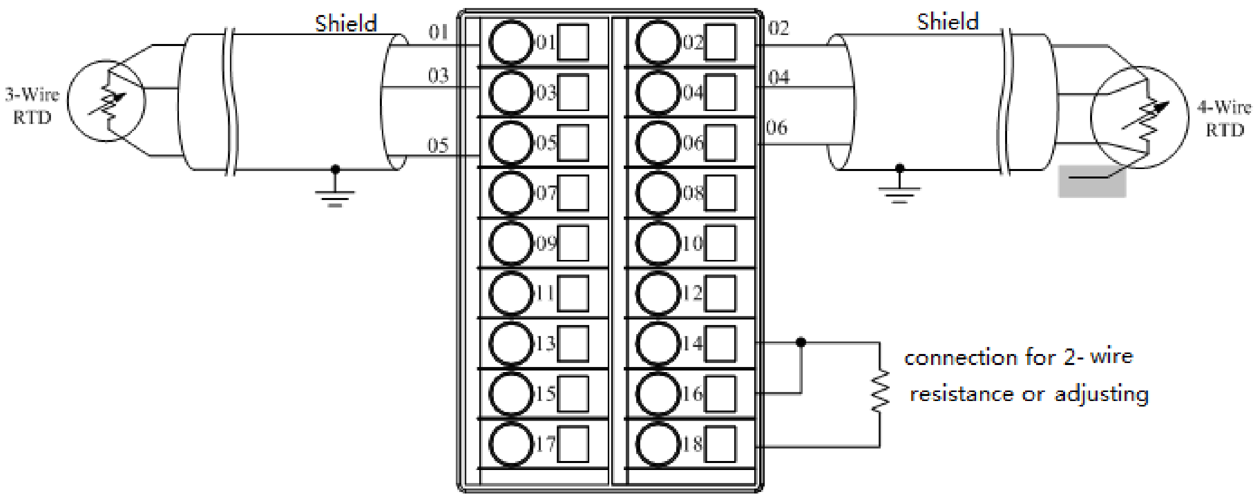


Figure 7-42   LK430 Backboard Terminal Wiring Diagram

Pay attention to the following during wiring:

- The two-row 18-channel terminals are fixed on the backboard, located right under the installation position of the LK430 module.
- Each RTD Number in the field is separately connected to the terminals via three conductors (shielded cable) in the field.
- Do not crimp multiple cables on the same terminal. It can realize multipoint connection via a busbar or a conversion terminal.

7.6.5 Functions

7.6.5.1 Measured Data Output Format

The measured data of each channel of the LK430 module is expressed in a 2-byte positive integer (decimal: 0~65,535). There are two output formats available for configuration: the output resistance digital code or the output temperature digital code. See the following for the formula of conversion between the measured data and the physical quantity:

- Output resistance value for configuration selection:

  Resistance Value (Ω)=(Resistance Digital Code/65,535)× Full Range Resistance Value +Min. Measurable Resistance Value in Range, notably, the full range resistance value is equal to the value obtained by subtracting the Min. measurable resistance with the max. measurable resistance. For example, in Table 5-31, the max. measurable resistance range for Cu50 is 1~121.75 Ω, then the full range resistance value=121.75-1=120.75.

- Output temperature value for configuration selection:

  Temperature Value (℃/℉)=(Temperature Digital Code-10000)/10

Select the output format of the measured data according to the parameter **Data Format**, with default temperature digital code. The user can obtain the actual field temperature value or resistance value upon simple operation according to the conversion formula in the programming software AutoThink.

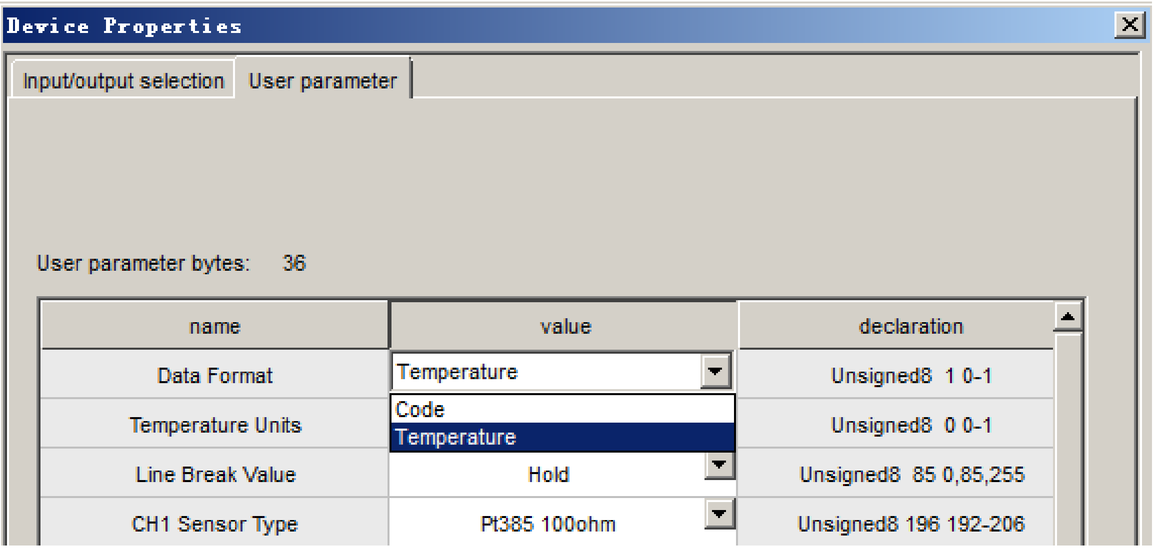


Figure 7-43 LK430 Output Data Format Selection

7.6.5.2 Measurement Range

Refer to Table 7-47 for various standard LK430-supported thermal resistances and their measurement ranges.

Table 7-47 Table of LK430-supported Standard Thermal Resistances and Their Measurement Ranges

Type of Thermal Resistance	Thermal Resistance Temperature Measurement Range (℃)	Corresponding Resistance Value Range of Thermal Resistance (Ω)	Range Code	Max. Measurable Resistance Range (Ω)
Copper427 10 Ω	-200℃~260℃	3.69980~21.1574	192	1~121.75
Chinese_Cu 50 Ω	-50℃~150℃	39.243~82.136	193	
Nikel618 100 Ω	-60℃~250℃	69.5204~343.584	194	1~487
Nikel618 120 Ω	-60℃~250℃	83.4245~412.301	195	
Platinum385 100 Ω	-200℃~870℃	18.5201~396.311	196	
Platinum3916 100 Ω	-200℃~630℃	16.9960~327.744	197	
Nikel618 200 Ω	-60℃~250℃	139.041~687.168	198	2~1000
Nikel672 120 Ω	-80℃~320℃	66.6000~568.407	199	
Platinum385 200 Ω	-200℃~870℃	37.0402~792.622	200	
Platinum3916 200 Ω	-200℃~630℃	33.992~655.488	201	
Nikel618 500 Ω	-60℃~250℃	347.602~1717.92	202	4~2000

Type of Thermal Resistance	Thermal Resistance Temperature Measurement Range (℃)	Corresponding Resistance Value Range of Thermal Resistance (Ω)	Range Code	Max. Measurable Resistance Range (Ω)
Platnium385 500 Ω	-200℃~870℃	92.6005~1981.56	203	
Platnium3916 500 Ω	-200℃~630℃	84.98~1638.72	204	
Platnium385 1000 Ω	-200℃~870℃	185.201~3963.11	205	8~4020
Platnium3916 1000 Ω	-200℃~630℃	169.960~3277.44	206	

- When using a special resistance not listed in the above list, it can be measured by selecting Measured Data Output Format as Resistance Value. In case of range configuration, select from the above table a standard thermal resistance close to the value range of the special resistance as a substitution range. For example, when measuring a 350Ω resistance, it can select one from Ni618 100Ω, Ni618 120Ω, Pt385 100Ω or Pt3916 100Ω as the substitution range.

7.6.6 Diagnosis

The LK430 module can also diagnose over-limit and line broken, which are channel diagnosis. After calling the function block sysGetDPSlaveState (Get Diagnosis of DP Slave), the channel diagnosis data reported is sent into the output parameter **DiagData**.

Diagnostic information of LK430 up to 22 bytes, wherein 2 bytes are device-related diagnosis, 2 bytes are identification diagnosis and 18 bytes are channel diagnosis. For six channels LK430, the diagnosis information of each channel is 3 bytes. Diagnosis information diagram refer to Figure 7-26.

- Device diagnosis information

  Device diagnosis data 0x02, 0x00 indicates the current device without any fault.

  Device diagnosis data 0x02, 0x01 indicates that the current device has channel fault.

  Device diagnosis data 0x02, 0x02 indicates that the current parameter read error.

  Device diagnosis data 0x02, 0x03 indicates that the current device have both channel fault and reading parameter error.

- Identification diagnosis information

  The 2-byte identification diagnosis information is 0x42, 0x01 when diagnosis information is reported.

- Channel diagnosis information

  Channel diagnosis information as shown in Table 7-48.

Table 7-48 Specifications for LK430 Diagnosis Information

Diagnosis Information					Meaning
Bit	Bit7	Bit6	Bit5	Bit4~ Bit0	

<table>
<tr><th colspan="4">Diagnosis Information</th><th>Meaning</th></tr>
<tr><td>The first byte</td><td>Head</td><td colspan="2">0x80</td><td>Decimal online value 128</td></tr>
<tr><td>The second byte</td><td>I/O type/channel</td><td>01 (Input)</td><td>（Channel）</td><td>Fault channel no. 1~6
Decimal online value 64~69</td></tr>
<tr><td rowspan="4">The third byte</td><td rowspan="4">Channel data type/fault type</td><td rowspan="4">101 (Word)</td><td>6</td><td>Line broken, Decimal online value is 166</td></tr>
<tr><td>7</td><td>Upper limit exceeded, Decimal online value is 167</td></tr>
<tr><td>8</td><td>Lower limit exceeded, Decimal online value is 168</td></tr>
<tr><td>0</td><td>Channel fault recovery, Decimal online value is 160</td></tr>
</table>

Example:

Channel diagnosis data 0x80, 0x41, 0xA6 indicates that channel 2 has line broken alarm.

Channel diagnosis data 0x80, 0x45, 0xA7 indicates that channel 6 has upper limit exceeded alarm.

Channel diagnosis data 0x80, 0x42, 0xA8 indicates that channel 3 has lower limit exceeded alarm.

Channel diagnosis data 0x80, 0x43, 0xA0 indicates that channel 4 fault recovery.

7.6.6.1 Over-limit Alarm

The LK430 module is capable of over-limit alarm. In the selected range, the user can set Upper Limit Value and Lower Limit Value of the input signal by his or her own. When the input signal goes beyond the limit range, that is, higher than Upper Limit Value or lower than Lower Limit Value, the channel diagnosis byte then reports over-limit. When the signal is recovered to the limit range, it then reports fault recovery.

For various standard thermal resistances that can be measured by LK430, as shown in Table 7-47, LK430 can support over-limit alarm. For other special non-standard thermal resistances or resistance measurement, LK430 does not support over-limit alarm.

For a standard thermal resistance, no matter whether the output data format of LK430 is of a temperature value or a resistance value, Upper Limit Value and Lower Limit Value for an over-limit alarm are set to be a positive integer digital code, with the formula for the temperature digital code of upper and lower limits given below:

- Upper Limit Digital Code=Upper Limit Value Temperature Value×10+10000
- Lower Limit Digital Code= Lower Limit Value Temperature Value×10+10000

The temperature unit of Upper Limit Value Temperature and Lower Limit Value Temperature (℃ or ℉), conform to the temperature unit selected for the module (to select via the parameter **Temperature Units**, defaulted to ℃)

The set range of Upper Limit Value and Lower Limit Value: 6720~25,980. Upper Limit Value must be more than Lower Limit Value. Otherwise, the LK430 cannot report the diagnosis message properly.

The LK430 module only reports the diagnosis data once separately when over-limit occurs and is recovered. Whether the LK430 module can give an overall alarm, Upper Limit Value and Lower Limit Value of each channel can be selected during configuration.

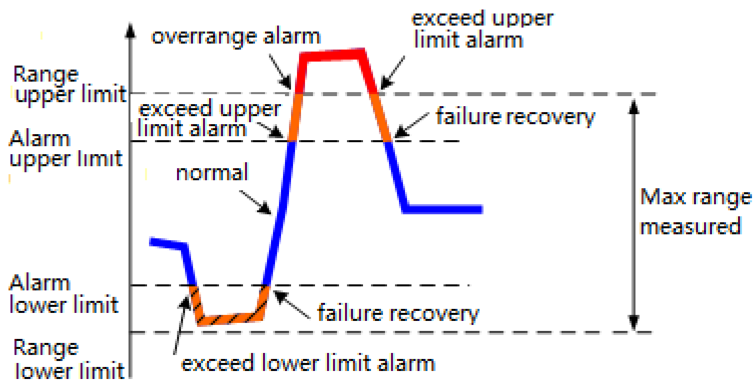


Figure 7-44　LK430 Over-limit Alarm Schematic Diagram

Due to the different measured data formats for LK430 configuration, the diagnosis and handling methods for the module in case of over-limit may also differ, as shown in Table 7-49. When the signal is recovered to the normal range, the channel diagnosis area then reports 0xA0.

Table 7-49　Handling of LK430 Over Range Alarm

Measured Data Format	Type of Over-limit	Handling of Over-limit
Output Temperature Value	Upper limit exceeded	The channel diagnosis area reports the fault value 0xA7 ≤Upper Range Limit, the measured channel data reports the current temperature digital code ＞Upper Range Limit, the measured channel data reports the max. measurable temperature value code allowed in the range
	Lower limit exceeded	The channel diagnosis area reports the fault value 0xA8 ≥ Lower Range Limit, the measured channel data reports the current temperature digital code ＜Lower Range Limit, the measured channel data reports the Min. measurable temperature value code allowed in the range
Output Resistance Value	Upper limit exceeded	The channel diagnosis area reports the fault value 0xA7 ≤Upper Range Limit, the measured channel data reports the current resistance digital code > Upper Range Limit, the measured channel data reports 0xFFFF
	Lower limit exceeded	The channel diagnosis area reports the fault value 0xA8 ≥ Lower Range Limit, the measured channel data reports the current resistance digital code ＜ Lower Range Limit, the measured channel data reports 0x0000

7.6.6.2　Line Broken Detection

The LK430 module is capable of line broken detection. When any signal cable of the input channel falls off, the module then gives an line broken alarm to the CPU module.

When certain channel is broken:

- The channel diagnosis area reports the fault value 0xA6.
- The measured channel data reports the selected value for configuration. Due to different selected data formats, the measured channel data to be reported in case of an line broken may differ, as shown in Table 7-50.

After the line broken is recovered, the channel diagnosis area reports 0xA0. The LK430 module only reports the diagnosis data once separately when an line broken occurs and is recovered.

Table 7-50　Specifications for Reported Channel Data in Case of Line Broken

User Parameter		Specifications for Measured Data
Data Format (data format)	Line broken Value (reported line broken value)	
Code	0x0000	The measured channel data reports 0x0000
	0xFFFF	The measured channel data reports 0xFFFF
	Hold (default)	The measured channel data hold the normal data prior to the line broken
Temperature	0x0000	Take Channel 1 for example, Terminals 1, 3 and 5: When an line broken occurs to Terminal 1 or/and Terminal 3, the channel measurement reports the Min. temperature code value in the range When an line broken occurs to Terminal 5, the measured channel data reports the Max. temperature code value in the range
	0xFFFF	
	Hold (default)	The measured channel data hold the normal data prior to the line broken

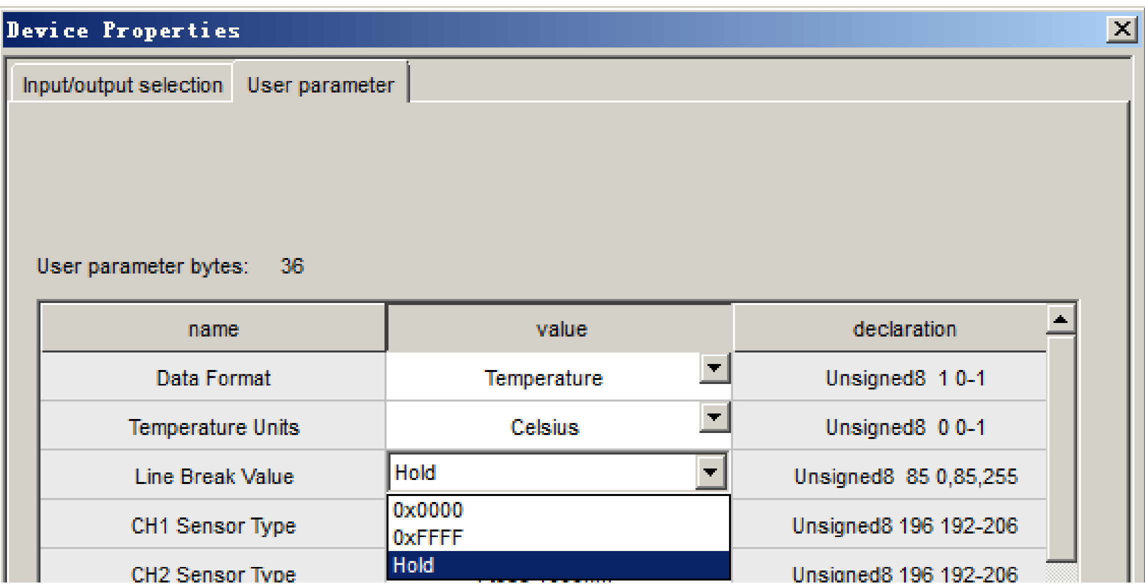


Figure 7-45　LK430 Line Broken Detection Settings

7.6.7　Parameters

The user parameter length of the LK430 module is up to 36 bytes.

Table 7-51　Table of LK430 User Parameters

Parameter Name	Meaning	Value	Default
Data Format	To select the 6-channel measured channel data output format of the module	0=Code, to report the resistance code value 1=Temperature, to report the temperature code value	1
Temperature Units	To select the temperature scale for the	0=Celsius, Celsius temperature scale	0

Parameter Name	Meaning	Value	Default
	measured temperature of the module	1=Fahrenheit, Fahrenheit scale	
Line broken Value	To select the code value to be reported by the line broken alarm channel data	0=0x0000 85=Hold, to hold the line broken 255=0xFFFF Refer to Section 7.6.6.2 Line Broken Detection detailed specifications	85
CH1 Sensor Type CH2 Sensor Type CH3 Sensor Type CH4 Sensor Type CH5 Sensor Type CH6 Sensor Type	To select thermal resistance type for Channels 1~6	192=Cu427:10 Ω 193=Chinese_Cu:50 Ω 194=Ni618:100 Ω 195=Ni618:120 Ω 196=Pt385:100 Ω 197=Pt3916:100 Ω 198=Ni618:200 Ω 199=Ni672:120 Ω 200=Pt385:200 Ω 201=Pt3916:200 Ω 202=Ni618:500 Ω 203=Pt385:500 Ω 204=Pt3916:500 Ω 205=Pt385:1000 Ω 206=Pt3916:1000 Ω	196
CH1 Digital Filter CH2 Digital Filter CH3 Digital Filter CH4 Digital Filter CH5 Digital Filter CH6 Digital Filter	To enable digital filtering	0=None, no filtering 1=8 Points, filtering (to select the latest 8 historical data)	0
CH1 Upper Limit Exceeded Alarm CH1 Lower Limit Exceeded Alarm CH2 Upper Limit Exceeded Alarm CH2 Lower Limit Exceeded Alarm CH3 Upper Limit Exceeded Alarm CH3 Lower Limit Exceeded Alarm CH4 Upper Limit Exceeded Alarm CH4 Lower Limit Exceeded Alarm CH5 Upper Limit Exceeded Alarm CH5 Lower Limit Exceeded Alarm CH6 Upper Limit Exceeded Alarm CH6 Lower Limit Exceeded Alarm	To enable Upper Limit Exceeded Alarm, Low Limit Exceeded Alarm for Channels 1~6	0=Disable 1=Enable	0
CH1 Upper Limit Value CH1 Lower Limit Value CH2 Upper Limit Value CH2 Lower Limit Value	To set Upper Limit Value and Lower Limit Value for Channels 1~6	Range of Lower Limit Values: 6,720~ 25,980 Range of Upper Limit Values: 6,720~ 25,980 Refer to Section 7.6.6.1 Over-limit	Lower Limit Value: 8000 Upper Limit Value: 18700

Parameter Name	Meaning	Value	Default
CH3 Upper Limit Value		Alarm for setting and calculating the alarm limits	
CH3 Lower Limit Value			
CH4 Upper Limit Value			
CH4 Lower Limit Value			
CH5 Upper Limit Value			
CH5 Lower Limit Value			
CH6 Upper Limit Value			
CH6 Lower Limit Value			
CH7 Upper Limit Value			
CH7 Lower Limit Value			
CH8 Upper Limit Value			
CH8 Lower Limit Value			
CH1 Line Break Alarm	To enable the line broken alarm for Channels 1~6	0=Disable 1=Enable	0
CH2 Line Break Alarm			
CH3 Line Break Alarm			
CH4 Line Break Alarm			
CH5 Line Break Alarm			
CH6 Line Break Alarm			
CH7 Line Break Alarm			
CH8 Line Break Alarm			

- The temperature conversion value adopts the temperature scale selected for module configuration. Upper Limit Value must be more than Lower Limit Value.

7.6.8 Technical Specifications

LK430 6-channel Thermal Resistance Type Analog Input Module			
System Power			
Power Voltage	24VDC（-15%~20%）		
Power consumption	65 mA max.@24 VDC		
Input channel			
Number of channels	6-channel		
Measurement Method	3-wire thermal resistance input, three-wire connection, constant current source measurement		
Thermal Resistance Type and Temperature Measurement Accuracy	Thermal Resistance Type Code	Temperature Measurement Range	Absolute Error
	Copper427: 10 Ω	-200℃~260℃	1.4℃

LK430 6-channel Thermal Resistance Type Analog Input Module			
	Chinese_Cu: 50 Ω	-50℃~150℃	0.6℃
	Nickel618: 100 Ω/120 Ω/200 Ω/500 Ω	-60℃~250℃	0.9℃
	Nickel672: 120 Ω	-80℃~320℃	1.4℃
	Platinum385: 100 Ω/200 Ω/500 Ω/1000 Ω	-200℃~870℃	1.3℃
	Platinum3916: 100 Ω/200 Ω/500 Ω/1000 Ω	-200℃~630℃	1.3℃
Resistance Measurement Range	1~4020 Ω		
Resistance Measurement Accuracy	0.1% F.S.@25℃		
Sampling Period (Full-channel Scanning Time) The measured data is a resistance value The measured data is a temperature value	Max.: 1.5 s Max.: 2 s		
Differential Mode Rejection Ratio	60 dB		
Common Mode Rejection Ratio	100 dB		
Temperature drift	±50 ppm/℃		
Calibration Accuracy	0.05% of resistance, full range		
Calibration Period	12 months		
Isolation Voltage between Field and System	500 VAC@1 min, leaking current: 5 mA		
Upload Data Format (0~65,535)			
Uploaded Resistance for Configuration Selection	65,535×(resistance value-Min. measurable resistance value in the range)/full range resistance value		
Uploaded Temperature for Configuration Selection	Acquisition temperature ×10+10000		
Failure Diagnosis and Hot Plug			
Diagnosis line broken detection Over-limit alarm	When an line broken occurs, the diagnosis byte reports 0xA6, with the value reported by the measured channel data optional for configuration When the signal range exceeds Upper Limit Value/Lower Limit Value, the diagnosis byte then reports 0xA7/0xA8		
Hot Plugging	Supported		
Physical Property			
Protection Key	A2		
Installation	Extension backboard		
Module Dimension (W*H*D)	35 mm×100 mm×100 mm		
Enclosure Protection Rating	IEC60529 IP20		
Weight	180 g		

7.7 LK441 8-channel Thermocouple Analog Input Module

7.7.1 Basic Features

- 8-channel thermocouple or millivolt input
- Thermocouple type: B, E, J, K, R, S, T, N, C
- Range of millivolt signals: -12~32mV/-12~78mV
- Directly reported temperature value of a thermocouple signal type
- RTD cold junction temperature compensation
- Over-limit alarm
- Over range alarm
- Open wire alarm
- Isolation between the system and the field
- Field calibration
- Hot swapping

7.7.2 Operating Principle

The 24 VDC system power supply of the LK441 module supplies the power to the interface circuit by outputting 2.5 VDC via isolated DC/DC. An opto-isolator is between the interface circuit and the system, realizing the electrical isolation between the system and the field channel. The field signal is converted into a digital signal via an A/D converter. Via optoelectronic isolation, it is read by the microprocessor in the module, then uploaded to the CPU module via the PROFIBUS-DP bus.

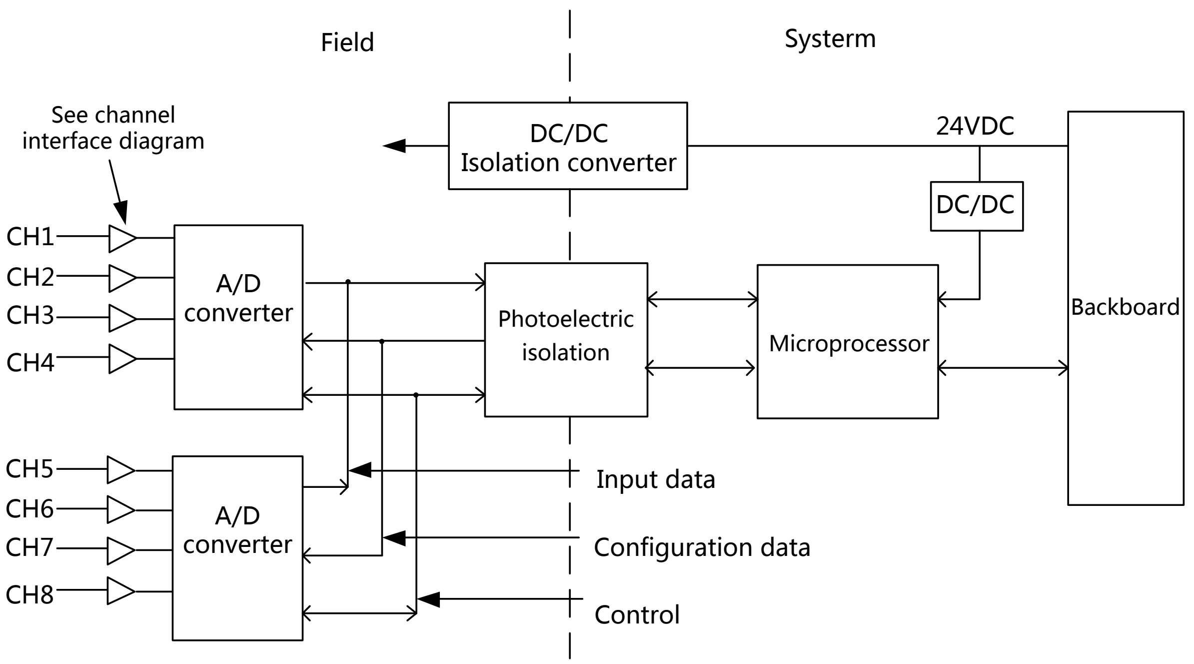


Figure 7-46 Internal Structure Block Diagram of LK441

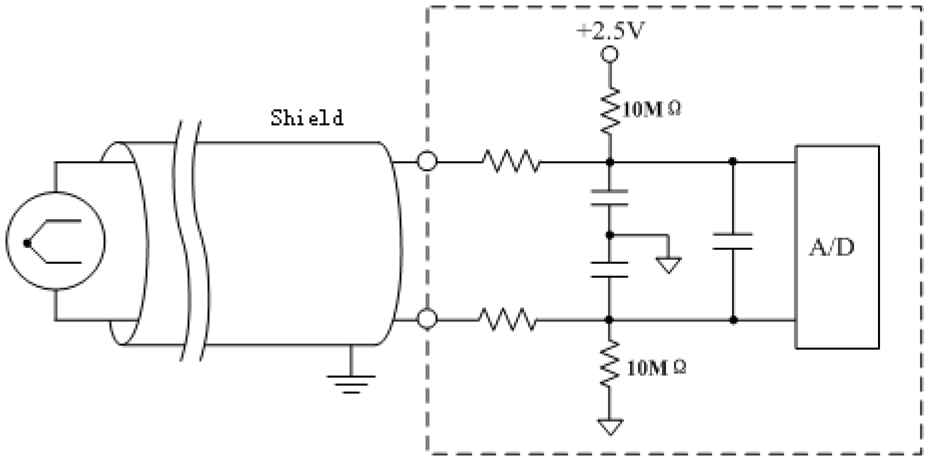


Figure 7-47 LK441 Channel Interface Circuit Diagram

7.7.3 Status Indicator

There are two status lamps on the front panel of the module: the green RUN lamp and the yellow CAL lamp. The RUN lamp is the run indicator lamp, indicating the communication status between the module and the CPU module. The CAL lamp is the calibration indicator lamp, indicating the calibration process.

The LK441 module supports field calibration. The meanings of the indicator lamp are different when in the running mode and the calibration mode.

Table 7-52 Definition of LK441 Status Indicator

Name	Status	Description
RUN indicator lamp (green)	On	The communication is established, and the module works well
	Flash	The communication is not established or incorrect
	Off	The module is not powered on
CAL Calibration Indicator Lamp (yellow)	On	In the calibration and detection mode, undergoing calibration and detection
	Flash	In the calibration no detection mode, but undergoing no calibration and detection
	Off	It is not powered up or the communication is not established or the module does not in the calibration and detection mode

- Running Mode
  - Immediately after being powered on, the module waits for the initialized data, with the green lamp flashing based on a frequency of 4 times/second.
  - Upon the completion of initialization, the green lamp is turned normally on, which indicates that the module works well. In case of any error in the initialized data, communication cannot be established and the green lamp keeps flashing. Check whether the DP is connected properly and the communication parameters are set properly.

- ☐ When the module works well, the green lamp is normally on. When the communication is disconnected, the green lamp flashes. When the communication is established again, the green lamp is turned normally on again.
- ☐ The yellow lamp is normally off when the module is in the running mode.

Table 7-53　Definition of LK441 Indicators in Running Mode

Name	Status	Description
RUN indicator lamp (green)	On	The communication is established
	Flash	The communication is not established or incorrect
	Off	The module is not powered on
CAL Calibration Indicator Lamp (yellow)	On	In the calibration and detection mode, undergoing calibration and detection
	Flash	In the calibration no detection mode, but undergoing no calibration and detection
	Off	It is not powered up or the communication is not established or the module does not in the calibration and detection mode

- ■ Calibration Mode
  - ☐ Immediately after being powered on, the module waits for the initialized data, with the green lamp flashing based on a frequency of 4 times/second.
  - ☐ Upon the completion of initialization, the green lamp is turned normally on. In case of any error in the initialized data, the green lamp keeps flashing. Check whether the DP is connected properly and the communication parameters (communication rate, communication station No.) are set properly.
  - ☐ Upon the completion of initialization, if the calibration and detection is not executed, the module then waits for the calibration and detection instruction, with the yellow lamp flashing based on a frequency of 4 times/second. When the calibration and detection program starts to run and the module is undergoing calibration and detection, the yellow is turned on. Upon the completion of calibration and detection, the yellow lamp then flashes again.
  - ☐ During calibration and detection, the green lamp is normally no. When the communication is disconnected, the green lamp flashes. When the communication is established again, the green lamp is turned normally on again.
  - ☐ When the communication is not established or disconnected, the yellow lamp then goes out.

Table 7-54　Definition of LK441 Indicators in Calibration Mode

	RUN Lamp	CAL Lamp	Meaning
Calibration Mode	Off	Off	Not powered up
	Flash	Off	The communication is not established or incorrect.
	On	On	Under calibration and detection
		Flash	Calibration and detection is not conducted or is completed

7.7.4 Wirings

The LK441 module is installed on the extension backboard. The LK backboard can provide both terminal connection and precast cable connection. Only the backboard terminal connection is discussed here.

Table 7-55 Definition of LK441 Backboard Terminals

Channel No.	Sequence of Terminals	
	Positive Terminal of TC/Millivolt Signal Input	Negative terminal of TC/Millivolt Signal Input
1	01	02
2	03	04
3	05	06
4	07	08
5	09	10
6	11	12
7	13	14
8	15	16
Cold-conjunction Compensation Channel	To connect the RTD temperature measurement element	
9	17	18

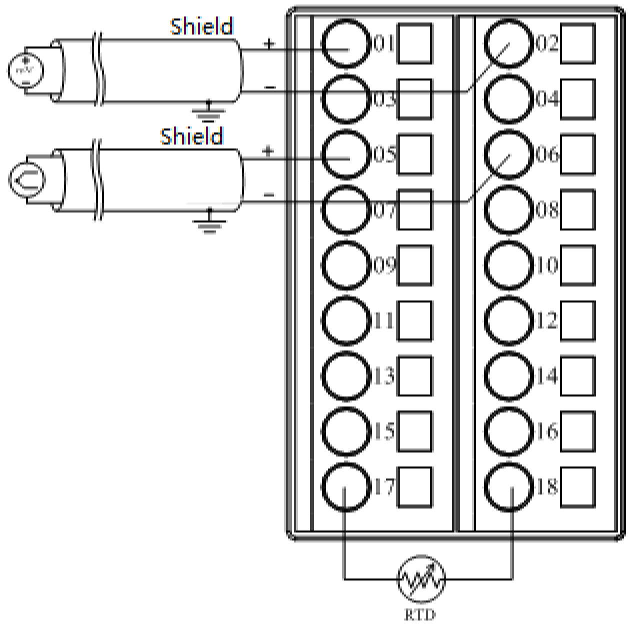


Figure 7-48 LK441 Backboard Terminal Wiring Diagram

Pay attention to the following during wiring:

- The two-row 18-channel terminals are fixed on the backboard, right located under the installation position of the LK441 module.

- Each thermocouple or millivolt signal is separately connected to the terminals via two conductors (shielded cable) in the field.
- The odd terminal is connected to the positive terminal of thermocouple/millivolt signal. The even terminal is connected to the negative terminal of thermocouple/millivolt signal.
- When adopting set cold junction temperature compensation, Terminals 17 and 18 cannot be used.

7.7.5 Functions

7.7.5.1 Measured Data Output Format

LK441 can be connected to a thermocouple element of B, E, J, K, R, S, T, N and C type to acquire the field temperature signal, or it can acquire the millivolt voltage signal within a range of -12~78 mV or -12~+32 mV.

The measured data on each channel that is reported by LK441, is expressed in form of 2-byte positive integer (decimal: 0~65,535) digital code. For different ranges, the output format of measured data may differ. The millivolt range outputs the millivolt digital code corresponding to the field signal. Thermocouple range outputs the temperature digital code corresponding to the field signal. See the following for the formula of conversion between the measured data and the physical quantity:

- Millivolt range of configuration selection: Millivolt Value mV＝(Millivolt digital code/65,535)×Range-12, notably, for -12~78 mV, Range＝90 mV, for -12~32 mV, Range＝44 mV.
- Thermocouple Range of configuration selection: Temperature Value (℃/℉) ＝(Temperature digital code-10000)/10.

For a millivolt range, by calling the function block HEX_ENGIN of the Analog signal Processing Functions library in the programming software AutoThink, it can convert the 2-byte millivolt code value into the engineering data. For a thermocouple range, it can obtain the actual temperature value upon simple operation according to the above formula.

7.7.5.2 Cold-conjunction Compensation

LK441 can adopt the following two methods for cold junction compensation. Both methods require configuring LK441 with a thermocouple range, with the measured data reported to the CPU module representing a temperature value (that is, to report the temperature digital code).

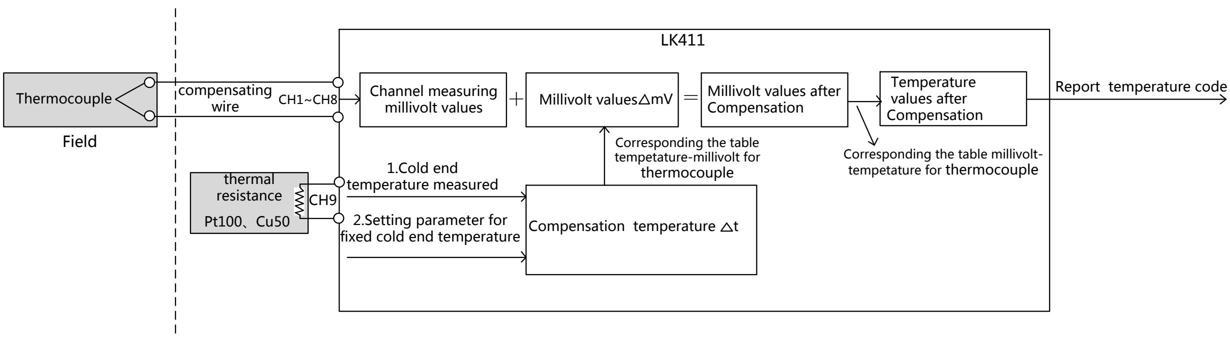


Figure 7-49 LK441 Cold-conjunction Temperature Compensation Block Diagram

- RTD measured cold junction temperature compensation

  Each LK441 uses a RTD temperature measurement element to measure the actual temperature at the cold junction of thermocouple, via the "temperature→millivolt" table corresponding to thermocouple, automatically verifies the millivolt value corresponding to the cold junction temperature value. Then it sums up such a cold junction millivolt value and the measured channel millivolt value of LK441 to obtain the actual compensation millivolt value, further by looking up in "millivolt-temperature" table according to the compensation millivolt value to obtain the actual temperature value at the field terminal of thermocouple, finally reporting the measured temperature digital code to the CPU module. The specific compensation algorithm is completed automatically in LK441. The CPU module obtains the compensation temperature directly.

The external RTD temperature measurement element of LK441 occupies Channel 9 that is inside. The RTD allows using such three thermal resistances as Chinese_Cu50 ohm, Pt385 100 ohm and Pt3916 100 ohm, with the cold junction temperature compensation ranging 0~60℃. It is recommended of using Pt385 100 ohm or Pt3916 100 ohm. The installation position of thermal resistance is close to the cold junction of thermocouple as closely as possible (that is, close to the outgoing terminal of LK441).

See the following for the steps to adopt RTD temperature measurement to configure automatic cold junction compensation:

Step 1. The cold junction compensation of a corresponding channel enables to select Enable for the parameter CHn Cold Junction Compensation, thus enabling cold junction temperature compensation of the channel.

Step 2. Select RTD for the cold junction compensation mode parameter Cold Junction Comp.Source.

Step 3. Select the connected thermal resistance type as Chinese_Cu 50 ohm, Pt385 100 ohm or Pt3916 100 ohm for the RTD temperature measurement element parameter Cold Junction Comp.RT Type.

Select whether the RTD temperature measurement channel is capable of line broken detection according to the parameter **RTD Line Break Alarm**, defaulted to Disable. After enabling line broken detection, if an line broken occurs to the RTD temperature measurement channel (Channel 9), the channel data holds the normal data prior to the line broken, with the channel diagnosis reporting the line broken fault value 0xA6.

- Set cold junction temperature compensation

When the dynamic compensation accuracy requirement is low or the cold junction ambient temperature changes slightly, the cold junction temperature can also be pre-input in the configuration and kept unchanged. LK441 compensates according to the set cold junction temperature.

Each LK441 via the **temperature→millivolt** table corresponding to thermocouple, automatically verifies the millivolt value corresponding to the cold junction temperature. Then it sums up such a cold junction millivolt value and the measured channel millivolt value of LK441 to obtain the actual compensation millivolt value, further by looking up in "millivolt-temperature" table according to the compensation millivolt value to obtain the actual temperature value at the field terminal of thermocouple, finally reporting the measured temperature digital code to the CPU module. The specific compensation algorithm is completed automatically in LK441. The CPU module obtains the compensation temperature directly.

See the following for the steps to adopt a set cold junction temperature to configure cold junction compensation:

Step 1. The cold junction compensation of a corresponding channel enables to select Enable for the parameter CHn Cold Junction Compensation, thus enabling cold junction temperature compensation of the channel.

Step 2. Select Cold Junction Compensation for the cold junction compensation mode parameter Cold Junction Comp.Source.

Step 3. Input the temperature compensation value in the cold junction temperature compensation value parameter Cold Junction Compensation Value, with temperature compensation value=compensation temperature ×10.

The temperature scale of the compensation temperature conforms to the temperature scale (Temperature Units) selected by the LK441. When the temperature scale is of a degree Celsius, the cold junction temperature compensation ranges 0~60℃, with the corresponding temperature compensation value of 0~600. When the temperature scale is of a degree Fahrenheit, the cold junction temperature compensation ranges 32~ 140℉, with the corresponding temperature patch compensation value of 320~1400.

7.7.6 Diagnosis

The LK441 module can diagnose over range, over-limit and line broken, which are of a channel diagnosis. After calling the function block sysGetDPSlaveState (Get Diagnosis of DP Slave), the channel diagnosis data reported is sent into the i output parameter **DiagData** in the function block.

Diagnostic information of LK441 up to 31 bytes, wherein 2 bytes are device-related diagnosis, 2 bytes are identification diagnosis and 27 bytes are channel diagnosis. nine channels in LK441, wherein, the forward 8-channel as thermocouple or millivolt signal input, channel 9 for the cold junction compensation terminal. The diagnosis information for each channel 3 bytes. Diagnosis information diagram refer to Figure 7-26.

- Device diagnosis information

  Device diagnosis data 0x02, 0x00 indicates the current device without any fault.

  Device diagnosis data 0x02, 0x01 indicates that the current device has channel fault.

  Device diagnosis data 0x02, 0x02 indicates that the current device has checksum fault.

  Device diagnosis data 0x02, 0x03 indicates that the current device have both channel fault and checksum fault.

- Identification diagnosis information

  The 2-byte identification diagnosis information is 0x42, 0x01 when diagnosis information is reported.

- Channel diagnosis information

  Channel diagnosis information as shown in Table 7-56.

Table 7-56 Specifications for LK441 Channel Diagnosis Information

<table>
<tr><th colspan="6">Diagnosis Information</th><th>Meaning</th></tr>
<tr><td colspan="2">Bit</td><td>Bit7</td><td>Bit6</td><td>Bit5</td><td>Bit4~ Bit0</td><td></td></tr>
<tr><td>The first byte</td><td>Head</td><td colspan="4">0x80</td><td>Decimal online value 128</td></tr>
<tr><td>The second byte</td><td>I/O type/channel</td><td colspan="2">01 (Input)</td><td colspan="2">（Channel）</td><td>Fault channel no. 1~8
Decimal online value 64~72</td></tr>
<tr><td rowspan="3">The third byte</td><td rowspan="3">Channel data type/fault type</td><td colspan="3" rowspan="3">101 (Word)</td><td>2</td><td>Under range, Decimal online value is 162</td></tr>
<tr><td>3</td><td>Over range, Decimal online value is 163</td></tr>
<tr><td>6</td><td>Line broken, Decimal online value is</td></tr>
</table>

Diagnosis Information				Meaning
				166
			7	Upper limit exceeded, Decimal online value is 167
			8	Lower limit exceeded, Decimal online value is 168
			0	Channel fault recovery, Decimal online value is 160

Example:

Channel diagnosis data 0x80, 0x40, 0xA2 indicates that channel 1 has under range alarm.

Channel diagnosis data 0x80, 0x41, 0xA3 indicates that channel 2 has over range alarm.

Channel diagnosis data 0x80, 0x42, 0xA6 indicates that channel 3 has line broken alarm.

Channel diagnosis data 0x80, 0x43, 0xA7 indicates that channel 4 has upper limit exceeded alarm.

7.7.6.1 Optional Alarms

The alarms that are provided by each range for the LK441 module are different, as shown in Table 7-57.

Table 7-57 LK441 Alarm List Based on Different Ranges

Range Limit	Thermocouple Type	Internal Range Code	Alarm Type
-12 mV~78 mV	—	13	Over-limit alarm, over range alarm
-12 mV~32 mV	—	14	Over-limit alarm, over range alarm
300~1820°C	Type B	207	Over-limit alarm, line broken alarm
0~1725°C	Type C	208	Over-limit alarm, over range alarm
0~2315°C	Type C	209	Over-limit alarm, line broken alarm
-270~415°C	Type E	210	Over-limit alarm, over range alarm
-270~1000°C	Type E	211	Over-limit alarm, line broken alarm
-210~550°C	Type J	212	Over-limit alarm, over range alarm
-210~1200°C	Type J	213	Over-limit alarm, line broken alarm
-270~725°C	Type K	214	Over-limit alarm, over range alarm
-270~1372°C	Type K	215	Over-limit alarm, line broken alarm
-270~840°C	Type N	216	Over-limit alarm, over range alarm
-270~1300°C	Type N	217	Over-limit alarm, line broken alarm
-50~1768°C	Type R	218	Over-limit alarm, line broken alarm
-50~1768°C	Type S	219	Over-limit alarm, line broken alarm
-270~400°C	Type T	220	Over-limit alarm, line broken alarm

Note: when using a thermocouple range, if thermocouples of a same type has two temperature ranges available, for example, for Type C thermocouples, the two ranges are 0~1725℃ and 0~2315℃. When configuring in a smaller temperature range, for example, if a Type C thermocouple selects a range of 0~1725℃, the module does not provide line broken detection directly. However, if a broken thermocouple occurs, the channel consequently gives an over range alarm. In this case, if an over range alarm is received, the channel may be over range, or broken thermocouple.

7.7.6.2 Over Range Alarm

The LK441 module is capable of over range alarm. When an input signal exceeds the selected range, for a thermocouple, it means to exceed the millivolt value corresponding to the temperature range selected by thermocouple. The channel diagnosis byte reports over range. When the signal is recovered, it reports fault recovery.

For the LK441, not all the ranges are capable of over range alarm. Each range supports different alarm types. Refer to chapter 7.7.6.1 Optional Alarms.

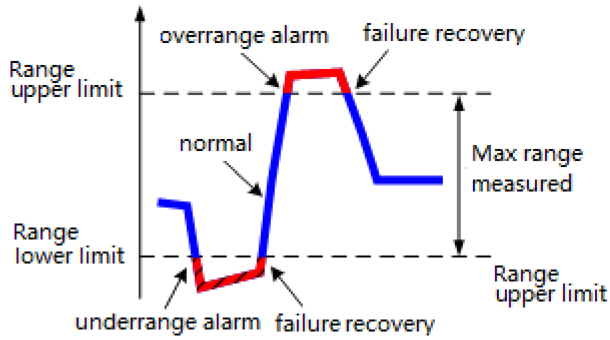


Figure 7-50 LK441 Over Range Alarm Schematic Diagram

Due to the different ranges selected, the diagnosis handling methods of the module may also differ in case of over range, as shown in Table 7-58. When the signal is recovered to the normal range, the channel diagnosis byte then reports 0xA0.

The LK441 module only reports the diagnosis data once separately when over range occurs and is recovered.

Table 7-58 Handling of LK441 Over Range Alarm

Range Type	Type of Over Range	Handling of Over Range
Thermocouple	Over Range	1. The channel diagnosis area reports the fault value 0xA3 2. The measured channel data reports the max. temperature code value in the range
	Under Range	1. The channel diagnosis area reports the fault value 0xA2 2. The measured channel data reports the Min. temperature code value in the range
Millivolt Signal	Over Range	1. The channel diagnosis area reports the fault value 0xA3 2. The measured channel data reports 0xFFFF
	Under Range	1. The channel diagnosis area reports the fault value 0xA2 2. The measured channel data reports 0x0000

7.7.6.3 Over-limit Alarm

The LK441 module is capable of limit exceeded alarm. It can set the alarm boundary line flexibly according to different industrial fields, detects field temperature signal changes, and timely gives an limit exceeded alarm, thus well improving security in industrial control.

In the selected range, the user can set Upper Limit Value and Lower Limit Value of the input signal by his or her own. When the input signal goes beyond the limit range, that is, higher than Upper Limit Value or lower than Lower Limit Value, the channel diagnosis byte then reports limit exceeded. When the signal is recovered to the limit range, it then reports fault recovery.

Whether the LK441 module can give an overall alarm, Upper Limit Value and Lower Limit Value of each channel can be selected during configuration, defaulted to Over-limit Alarm Disable. The alarm limit set in the user parameter is a 16-bit positive integer digital code, which is divided into a temperature digital code (when thermocouple is selected for the range) and a millivolt digital code (when millivolt is selected for the range). Refer to Table 7-59 for the conversion formula.

Table 7-59 Calculation of LK441 Alarm Limit Digital Code

Range Type	Upper Limit Value (Decimal)	Lower Limit Value (Decimal)
Thermocouple	Upper Limit Temperature value ×10+10000	Lower Limit Temperature value ×10+10000
-12 mV~78 mV	65,535×(Upper Millivolt Value+12)/90	65,535×(Lower Millivolt Value+12)/90
-12 mV~32 mV	65,535×(Upper Millivolt Value+12)/ 44	65,535×(Lower Millivolt Value+12)/ 44

For a thermocouple signal, the temperature units for Upper Limit Value Temperature and Lower Limit Value Temperature (℃ or ℉) conform to those selected for the module (to select via the parameter **Temperature Units**, defaulted to ℃)

Range of Lower Limit Values 0~65534, defaulted to 0. Range of Upper Limit Values: 1~ 65,535, defaulted to 65,535. Upper Limit Value must be more than Lower Limit Value. Otherwise, the LK441 module cannot report the diagnosis message properly.

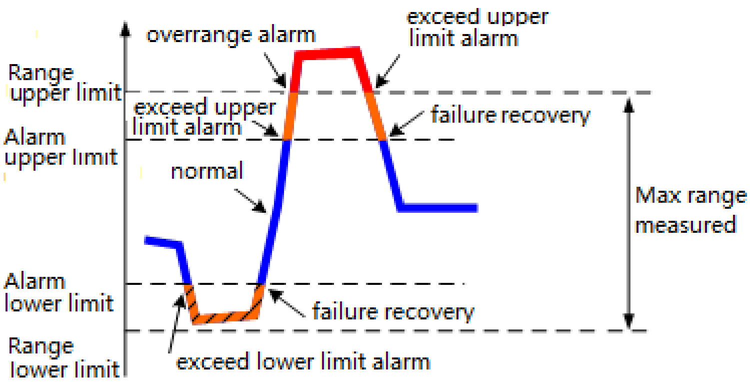


Figure 7-51 LK441 Over-limit Alarm Schematic Diagram

Due to the different ranges selected, the diagnosis handling methods of the module may also differ in case of over-limit, as shown in Table 7-60. When the signal is recovered to the normal range, the channel diagnosis area then reports 0xA0.

The LK441 module only reports the diagnosis data once separately when occurrence over-limit occurs and is recovered.

Table 7-60 Handling of LK441 Over-limit Alarm

Range Type	Type of Over-limit	Handling of Over-limit
Thermocouple	Upper limit exceeded	1. The channel diagnosis area reports the fault value 0xA7 2.The measured channel data reports the current temperature digital code
	Lower limit exceeded	1. The channel diagnosis area reports the fault value 0xA8

Range Type	Type of Over-limit	Handling of Over-limit
		2. The measured channel data reports the current temperature digital code
Millivolt Signal	Upper limit exceeded	1. The channel diagnosis area reports the fault value 0xA7 2. The measured channel data reports the current millivolt digital code
	Lower limit exceeded	1. The channel diagnosis area reports the fault value 0xA8 2. The measured channel data reports the current millivolt digital code

For a range with both over range alarm and over-limit alarm, when over-limit is enabled and occurs in synchronism with the over range, the LK441 module then reports the over range.

7.7.6.4 Line Broken Detection

The LK441 module is connected to a 10 MΩ pull-up resistor at the signal input terminal, used to detect a line broken to the channel.

When the input channel signal connection is broken, the voltage at the positive terminal of the channel is pulled up to +2.5 V, the negative terminal voltage of the channel is pulled down to GND, with the voltage difference at the input terminal of the AD converter reaching to the max. value. The channel diagnosis area then reports line break. After the line broken is recovered, the channel diagnosis area then reports fault recovery.

For a thermocouple range, not all the ranges are capable of line broken detection. Refer to Section 7.7.6.1 Optional Alarms. For a millivolt signal range, the LK441 module does not support line broken detection.

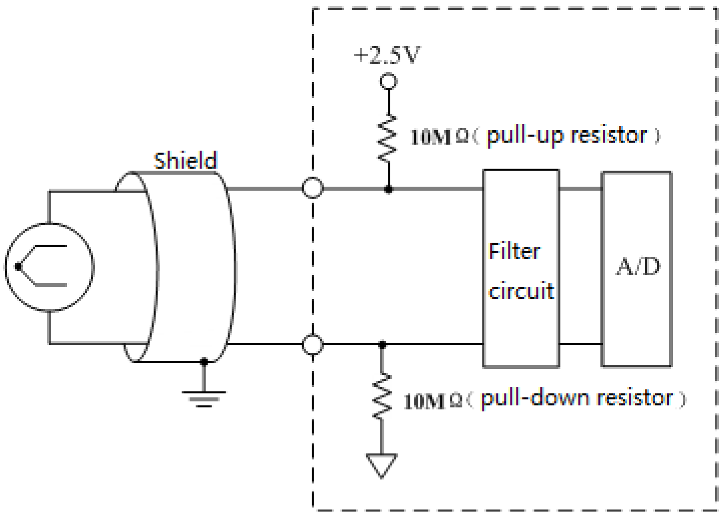


Figure 7-52 LK441 Line Broken Detection Schematic Diagram

When certain measured channel thermocouple signal is broken:

- The channel diagnosis area reports line broken fault value 0xA6.
- The measured channel data holds the data prior to the line broken or reports the max. temperature digital code in the range, which is optional for configuration.
- After the line broken is recovered, the channel diagnosis area reports 0xA0.

When the RTD temperature measurement channel is broken:

- Channel 9 diagnosis area (ChDiag.Module.Channel[9].Error) reports line broken fault value 0xA6.
- The temperature measurement channel holds the data prior to the line broken.

■ After the line broken is recovered, Channel 9 diagnosis area reports 0xA0.

7.7.7 Parameters

The user parameter is used to set the operation mode of the module. The CPU module written when downloading the user program may not be read in each scanning period. Each parameter has a default, which can be modified according to the project requirements. The user parameter does not support online modification. The modification takes effect only upon full download.

The user parameter length LK441 is up to 49 bytes.

Table 7-61 Table of LK441 User Parameters

Parameter Name	Meaning	Value
Temperature Units	To select the temperature scale of thermocouple	0: Celsius, celsius temperature scale (default) 1: Fahrenheit, fahrenheit scale
Filter Mode	To select the hardware filtering mode	0: No Filter, with no filtering (Full-channel Scanning Time: 85 ms) 1: 10Hz Filter, 10 with no filtering (Full-channel Scanning Time: 1500 ms) 2: 50Hz Filter, 50 Hz filtering, Full-channel Scanning Time: 490 ms (default) 3: 60Hz Filter, 60 Hz filtering, Full-channel Scanning Time: 420 ms 4: 400H Filter, 400 Hz filtering, Full-channel Scanning Time: 85 ms
TC Line Break Value	To select the value to be reported by thermocouple line broken channel	0: Hold, to report the normal value prior to the line broken (default) 1: Rang Maximum Value, to report the Max. value in the range
CH1 Input Range	To select the range [1] of Channel 1	13: -12 mV~+78 mV (default) 14: -12 mV~+32 mV 207: Type B thermocouple, 300~1820°C 208: Type C thermocouple, 0~ 1725°C 209: Type C thermocouple, 0~ 2315°C 210: Type E thermocouple, -270~415°C 211: Type E thermocouple, -270~1000°C 212: Type J thermocouple, -210~550°C 213: Type J thermocouple, -210~1200°C 214: Type K thermocouple,-270~725°C 215 Type K thermocouple, -270~1372°C 216: Type N thermocouple, -270~840°C 217: Type N thermocouple, -270~1300°C 218: Type R thermocouple,-50~1768°C 219: Type S thermocouple,-50~1768°C 220: Type T thermocouple,-270~400°C
CH2 Input Range	To select the range of Channel 2	
CH3 Input Range	To select the range of Channel 3	
CH4 Input Range	To select the range of Channel 4	
CH5 Input Range	To select the range of Channel 5	
CH6 Input Range	To select the range of Channel 6	
CH7 Input Range	To select the range of Channel 7	
CH8 Input Range	To select the range of Channel 8	

[1] The range of each channel does not interfere with each other and can be different ranges separately. In voltage range, the channel reports code value corresponding to millivolt signal. In temperature range, the channel reports code value corresponding to current thermocouple temperature.

Parameter Name	Meaning	Value
CH1 Cold Junction Compensation	To enable cold junction compensation for Channel 1[2]	0: Disable (default) 1: Enable
CH2 Cold Junction Compensation	To enable cold junction compensation for Channel 2	
CH3 Cold Junction Compensation	To enable cold junction compensation for Channel 3	
CH4 Cold Junction Compensation	To enable cold junction compensation for Channel 4	
CH5 Cold Junction Compensation	To enable cold junction compensation for Channel 5	
CH6 Cold Junction Compensation	To enable cold junction compensation for Channel 6	
CH7 Cold Junction Compensation	To enable cold junction compensation for Channel 7	
CH8 Cold Junction Compensation	To enable cold junction compensation for Channel 8	
Cold Junction Comp. Source	To select the cold junction compensation mode	0: RTD, RTD measured cold junction temperature compensation for Channel 9 (default) 1: Cold Junction Compensation, fixed cold junction temperature compensation
Cold Junction Comp. RTD Type	To select the RTD temperature measurement element type	0: To select Chinese_Cu50 ohm (default) 1: To select Pt385 100 ohm 2: To select Pt3916 100 ohm
RTD Line Break Alarm	To enable RTD line broken alarm	0: Disable (default) 1: Enable
Cold Junction Compensation Value	To set the cold junction temperature compensation value	The temperature scale is of a degree celsius, with a range of 0~600 (representing 0~60℃) The temperature scale is of a degree fahrenheit, with a range of 320~ 1400 (representing 32~ 140 ℉) Compensation=Compensation Temperature×10, defaulted to 0
CH1 Digital Filter	To select software filtering of Channel 1[3]	0: None, without software filtering (default) 1: 3 Points, to select the latest 3 historical data for software filtering 2: 5 Points, to select the latest 5 historical data for software filtering 3: 7 Points, to select the latest 7 historical data for software filtering
CH2 Digital Filter	To select software filtering of Channel 2	
CH3 Digital Filter	To select software filtering of Channel 3	
CH4 Digital Filter	To select software filtering of Channel 4	
CH5 Digital Filter	To select software filtering of Channel 5	

[2] After enabling cold junction compensation, when selecting a compensation mode subsequently, whether adopting fixed value compensation or external RTD temperature measurement compensation? In case of RTD compensation, it shall select the temperature measurement element, whether Cu50 or Pt100. In case of fixed temperature compensation, it shall set the cold junction temperature compensation value.

[3] The software filtering of each channel does not interfere with each other and can be different modes separately.

Parameter Name	Meaning	Value
CH6 Digital Filter	To select software filtering of Channel 6	
CH7 Digital Filter	To select software filtering of Channel 7	
CH8 Digital Filter	To select software filtering of Channel 8	
CH1 Upper Limit Exceeded Alarm	To enable Upper Limit Value for Channel 1	0: Disable (default) 1: Enable
CH1 Lower Limit Exceeded Alarm	To enable Lower Limit Value for Channel 1	
CH2 Upper Limit Exceeded Alarm	To enable Upper Limit Value for Channel 2	
CH2 Lower Limit Exceeded Alarm	To enable Lower Limit Value for Channel 2	
CH3 Upper Limit Exceeded Alarm	To enable Upper Limit Value for Channel 3	
CH3 Lower Limit Exceeded Alarm	To enable Lower Limit Value for Channel 3	
CH4 Upper Limit Exceeded Alarm	To enable Upper Limit Value for Channel 4	
CH4 Lower Limit Exceeded Alarm	Channel 4	
CH5 Upper Limit Exceeded Alarm	To enable Upper Limit Value for Channel 5	
CH5 Lower Limit Exceeded Alarm	To enable Lower Limit Value for Channel 5	
CH6 Upper Limit Exceeded Alarm	To enable Upper Limit Value for Channel 6	
CH6 Lower Limit Exceeded Alarm	To enable Lower Limit Value for Channel 6	
CH7 Upper Limit Exceeded Alarm	To enable Upper Limit Value for Channel 7	
CH7 Lower Limit Exceeded Alarm	To enable Lower Limit Value for Channel 7	
CH8 Upper Limit Exceeded Alarm	To enable Upper Limit Value for Channel 8	
CH8 Lower Limit Exceeded Alarm	To enable Lower Limit Value for Channel 8	
CH1 Upper Limit Value	To set Upper Limit Value of Channel 1	Range of Lower Limit Value: 0 (default)~65,534 Range of Upper Limit Value: 1~ 65,535 (default) Millivolt Voltage Ranges 13 and 14: Alarm Limit＝65,535×(Millivolt Value + 12)/Range, notably, for -12 mV~78 mV, Range＝90 mV, for -12 mV~+32 mV, Range ＝44 mV Thermocouple range 207~220: Alarm Limit＝ Temperature Value ×10+10000
CH1 Lower Limit Value	To set Upper Limit Value of Channel 1	
CH2 Upper Limit Value	To set Upper Limit Value of Channel 2	
CH2 Lower Limit Value	To set Upper Limit Value of Channel 2	

Parameter Name	Meaning	Value
CH3 Upper Limit Value	To set Upper Limit Value of Channel 3	
CH3 Lower Limit Value	To set Upper Limit Value of Channel 3	
CH4 Upper Limit Value	To set Upper Limit Value of Channel 4	
CH4 Lower Limit Value	To set Upper Limit Value of Channel 4	
CH5 Upper Limit Value	To set Upper Limit Value of Channel 5	
CH5 Lower Limit Value	To set Upper Limit Value of Channel 5	
CH6 Upper Limit Value	To set Upper Limit Value of Channel 6	
CH6 Lower Limit Value	To set Upper Limit Value of Channel 6	
CH7 Upper Limit Value	To set Upper Limit Value of Channel 7	
CH7 Lower Limit Value	To set Upper Limit Value of Channel 7	
CH8 Upper Limit Value	To set Upper Limit Value of Channel 8	
CH8 Lower Limit Value	To set Upper Limit Value of Channel 8	

7.7.8 Technical Specifications

LK441 8-channel Thermocouple Analog Input Module		
System Power		
Operating Voltage	24VDC（-15%~20%）	
Power consumption	60 mA max. @ 24 VDC	
Input channel		
Number of Input Channels	9 (8-channel thermocouple or millivolt signals, plus 1-channel RTD cold junction compensation)	
Signal type	B, C, E, J, K, N, R, S, T thermocouple or -12 mV~78 mV / -12 mV~32 mV	
Thermocouple Temperature Range	-12 mV~+78 mV Range	-12 mV~+ 32 mV Range
Type B		300~1820°C(572~3308°F)
Type C	0~2315°C(32~4199°F)	0~1725°C(32~3137°F)
Type E	-270~1000°C(-454~1832°F)	-270~415°C(-454~779°F)
Type J	-210~1200°C(-346~2192°F)	-210~550°C(-346~1022°F)
Type K	-270~1372°C(-454~2502°F)	-270~725°C(-454~1337°F)
Type N	-270~1300°C(-454~2372°F)	-270~840°C(-454~1544°F)

LK441 8-channel Thermocouple Analog Input Module		
Type R		-50~1768°C(-58~3215°F)
Type S		-50~1768°C(-58~3215°F)
Type T		-270~400°C(-454~752°F)
Temperature Resolution of Thermocouple (B, C, E, J, K, N, R, S, T)	0.05°C (0.09°F)	0.03°C (0.05°F)
A/D Converter Resolution	16-bit	
Voltage Measurement Accuracy	0.1% F.S. @ 25℃	
Temperature Drift	±15 ppm/℃	
Differential Mode Rejection Ratio	60 dB	
Common Mode Rejection Ratio	100 dB	
Input Impedance	10 MΩ min.	
Sampling Period (Full-channel Scanning Time)	85 ms, 420 ms, 490 ms, 1500 ms, optional for configuration	
Setting Time for full-scall 1％	1 s max., in the ±1% error range of the full-scall	
Channel Bandwidth	15 Hz	
Voltage Calibration Accuracy	<0.04% F.S.@ 25℃	
Calibration Period	12 months	
Isolation Voltage between Field and System	500 VAC@1 min, leaking current: 5 mA	
Uploaded Data Format (0~65,535)		
Millivolt Range	65,535×(Millivolt Voltage+12)/Range	
Thermocouple range	Acquisition temperature ×10+10000	
Cold-conjunction Compensation Channel		
Implementation Method	To acquire the cold junction temperature of thermal resistance (RTD)	
Type of Thermal Resistance	Chinese_Cu 50 ohm, Pt385 100 ohm, Pt3916 100 ohm	
Temperature Value Accuracy in Working Range (0~60°C)	Chinese_Cu 50 ohm	The absolute deviation is ± 0.3℃
	Pt385 100 ohm	The absolute deviation is ± 0.3℃
	Pt3916 100 ohm	The absolute deviation is ± 0.3℃
Line broken detection	RTD line broken alarm	
Failure Diagnosis and Hot Plug		
Over range alarm[4]	When the signal exceeds the upper/lower limit of the range, the diagnosis byte then reports 0xA3/0xA2	
Over-limit alarm	When the signal exceeds Upper Limit Value/Lower Limit Value that is set in the configuration, the diagnosis byte then reports 0xA7/0xA8	

[4]Refer to the chapter 7.7.6.1 Optional Alarms for the range supporting Over Range Alarm.

LK441 8-channel Thermocouple Analog Input Module	
Line broken detection[5]	When an line broken occurs, the diagnosis byte reports 0xA6. The measured channel data reports the full-range value or the normal value prior to the line broken
Line broken Detection of Cold Junction Compensation Thermal Resistance	When an line broken occurs to the RTD temperature compensation channel, Channel 9 diagnosis byte reports 0xA6, taking the normal value prior to the line brea as the compensated value
Hot Plugging	Supported
Physical Property	
Protection Key	B1
Installation Position	Extension backboard
	35 mm×100 mm×100 mm
Enclosure Protection Rating	IEC60529 IP20
Weight	180 g

7.8 LK620 2-channel counting module

The LK620 is an ordinary counting module that can be mounted on an expansion backplane.

7.8.1 Basic Features

- Double circuit counters
- Two-way counting, frequency measurement
- Z signal inversion
- Function of store count value
- Debounce filtering
- Function of disable counter
- Programming mode output
- Fault mode output
- Field power failure detection
- System and field isolation
- Support for PROFIBUS-DP slave station protocol
- Hot swapping

7.8.2 Operating Principle

The dual channel counting module has two independent counters, each with three-way inputs (A, B, Z) and two-way digital outputs.

[5]Refer to the chapter 7.7.6.1 Optional Alarms for the range supporting Line Break Alarm.

Input signal effective voltage range is 10 ~ 26.4VDC, the current range is 2.2mA (10VDC) ~ 7mA (26.4VDC). As shown in Figure 7-53, the output channel is common to the module power supply. After the MOSFET electronic switch is closed, the current flows from the switch to the load.

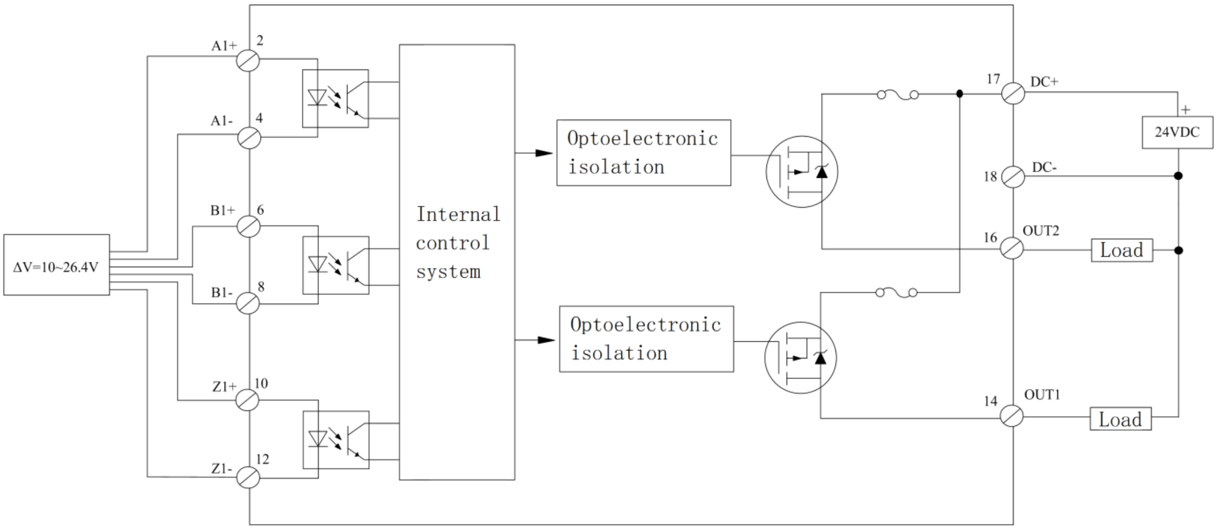


Figure 7-53 Channel Interface Circuit Diagram (counter 1 as an example)

7.8.3 Operating Mode

The counting module is mainly used for pulse input measurement of photoelectric encoders and proximity sensors. There are four modes of operation, counter mode, encoder × 1 mode, encoder × 4 mode and frequency measurement mode. Among them, the frequency measurement mode can implement frequency measurement for 0.1Hz ~ 1MHz signal.

The operating mode of counter 1 is selected by parameter **Counter1_OperationalMode**; the operating mode of counter 2 is selected by parameter **Counter2_OperationalMode** and the default selection is counter mode.

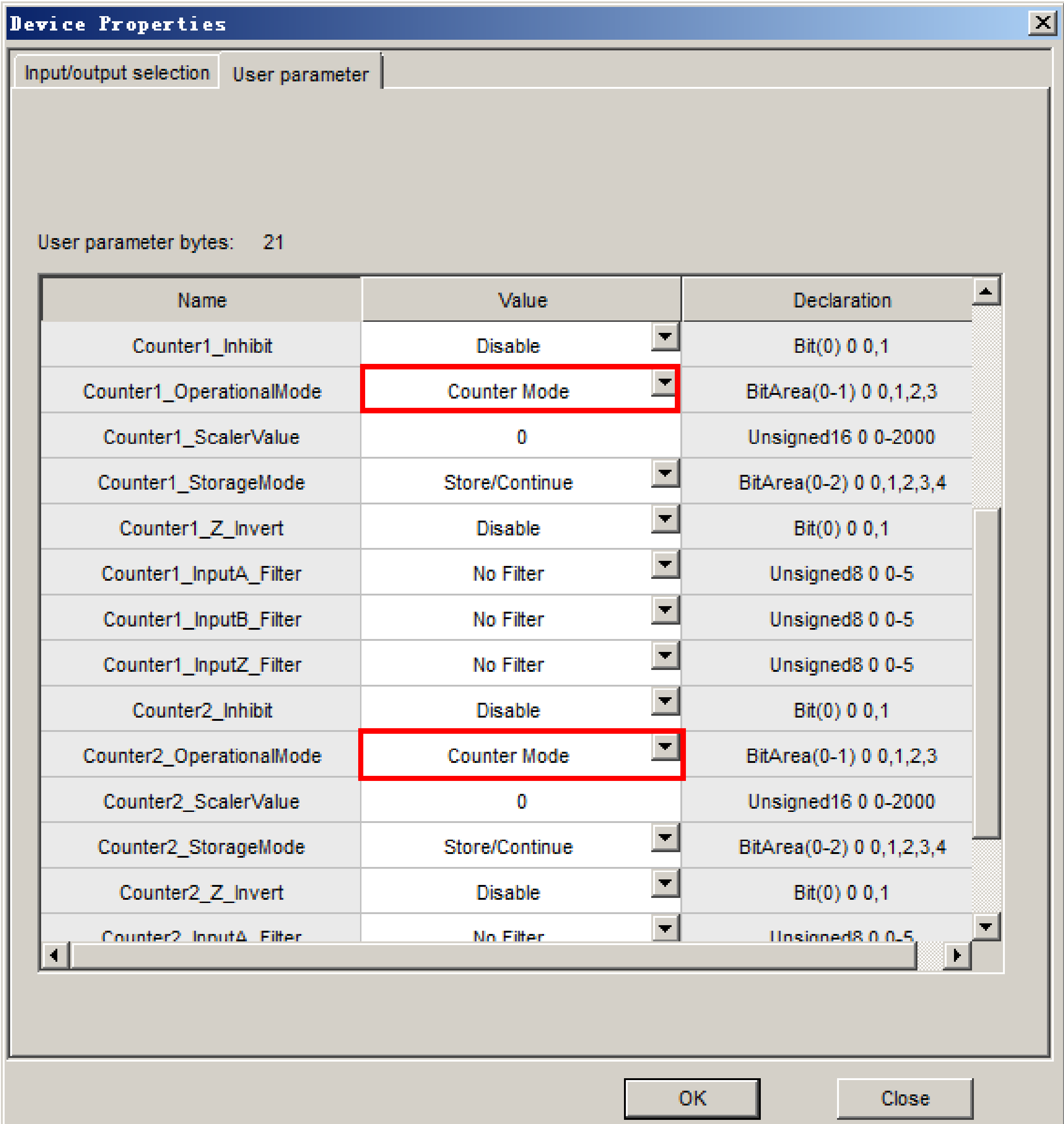


Figure 7-54 Counting Module Operation Mode Selection

7.8.3.1 Counter mode

Under counter mode, the A-end input pulse signal and allowed the maximum input signal frequency is 1MHz. B-end input direction signal. The counter counts when the rising edge of the A-end signal arrives, and the counting direction depends on the B-end signal. B-end signal is low level, addition count; B-end signal is high level, subtraction count.

Table 7-62 The Counting Direction in Counter Mode

B-end	Counting Direction
High level	Subtraction count
Low level(or disconnection)	Addition count

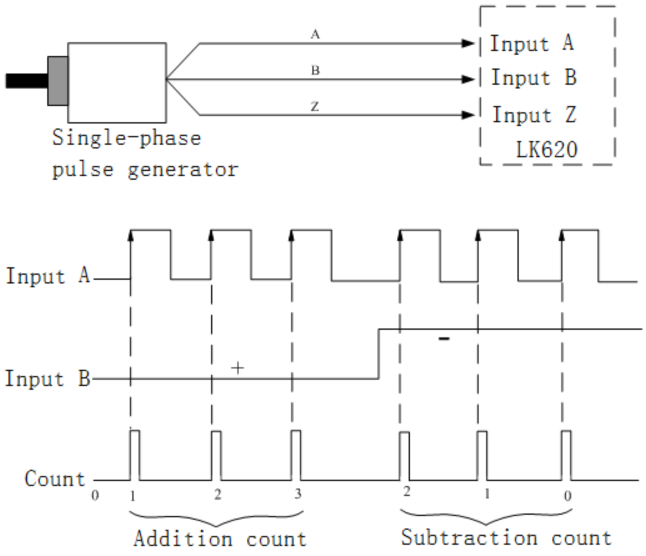


Figure 7-55　Counter Mode

7.8.3.2　Encoder × 1 Mode

In encoder × 1 mode, A-end and B-end input signal maximum allowable frequency are 1MHz with 90° phase difference. When the A-end is ahead of the B-end, addition count and counts when the rising edge of the A-end signal arrives. When the B-end signal is 90°ahead of the A-end signal, subtraction count and counts when the falling edge of the A-end signal arrives.

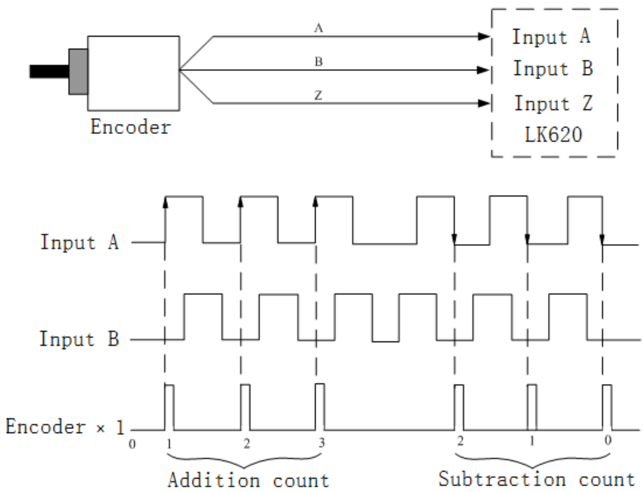


Figure 7-56　Encoder × 1 Mode of the Counting Module

7.8.3.3 Encoder × 4 Mode

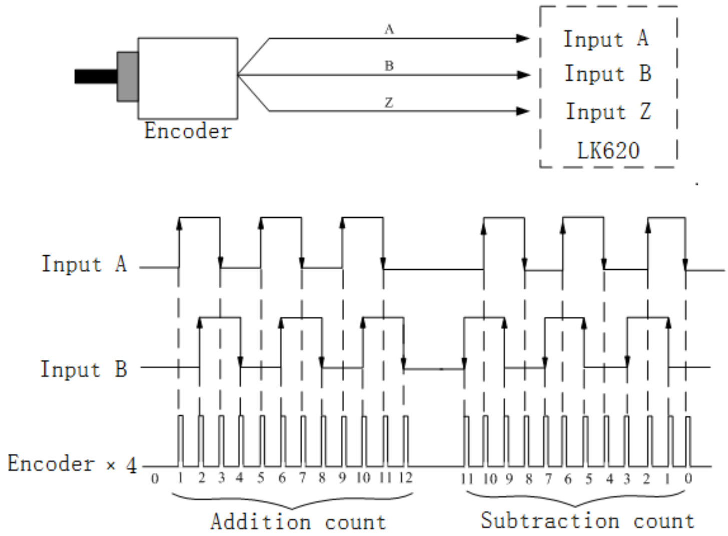


Figure 7-57 Encoder × 4 Mode of the Counting Module

In encoder × 4 mode, A-end and B-end input signal maximum allowable frequency are 1MHz with 90° phase difference. Using the frequency multiplication can achieves double edge the count, and count when the A-end signal rising edge, falling edge and B-end signal rising edge and the falling edge arrive.

When the A-end is 90° ahead of the B-end, addition count. When the B-end is 90°ahead of the A-end, subtraction count.

7.8.3.4 Frequency Measurement Mode

In frequency measurement mode, A-end input frequency signal, B-end and Z-end do not. The counter records the number of pulses of the A-end frequency signal within a given frequency measurement period and report to the controller as the current count value. In the configuration, the pulse frequency is calculated by the frequency count value and the frequency measurement time.

The frequency measurement time is specified by the user. With 10ms as the reference time unit, the values of the parameters **Counter1_ScalerValue** and **Counter2_ScalerValue** indicate how many time bases within frequency measurement time. For example, if **Counter1_ScalerValue** is set as 4, the frequency measurement time of the counter 1 is 4 × 10ms = 40ms. Assuming that the counter 1 receives three pulses in the 40ms frequency measurement time and the pulse frequency = 3 / 40ms = 75Hz obtained from configuration with division operation.

The maximum time for the frequency measurement can be set as 20s. Correspondingly, the maximum value of the parameters **Counter1_ScalerValue** and **Counter2_ScalerValue** is 2000. The frequency measurement time should not be set as zero.

In frequency measurement mode, the maximum measurable frequency is 1MHz, the minimum measurable frequency is 0.1Hz.

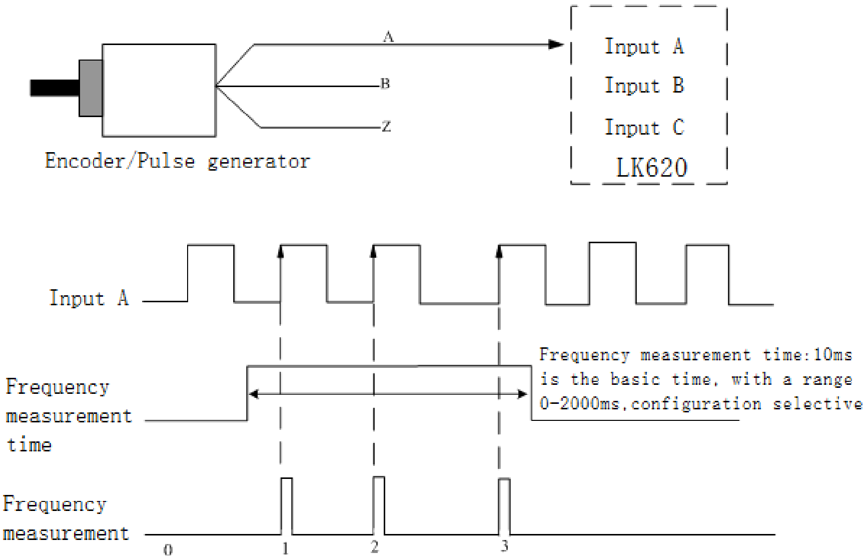


Figure 7-58 Frequency Measurement Mode of the Counting Module

7.8.4 Status Indicator

Table 7-63 LK620 Indicators Definition

Type	Status	Description
RUN	On	The module is working normally
	Flash	Communication is not established
	Off	No powered on or module fault
CH1.1	On	The first output channel of counter 1 is cloesd
	Off	The first output channel of counter 1 is disconnected
CH1.2	On	The second output channel of counter 1 is cloesd
	Off	The second output channel of counter 1 is disconnected
CNT1	On	Counter 1 works in counter mode
Freq1	On	Counter 1 works in frequency measurement mode
CH2.1	On	The first output channel of counter 2 is cloesd
	Off	The first output channel of counter 2 is disconnected
CH2.2	On	The second output channel of counter 2 is cloesd
	Off	The second output channel of counter 2 is disconnected
CNT2	On	Counter 2 works in counter mode
Freq2	On	Counter 2 works in frequency measurement mode

Details of RUN Green indicator is as follows:

- When powered on, the green indicator flashes to wait for the initialization data, the flashing frequency is 4 times / s.
- After initialization, the green indicator is on, which indicates that the module is running normally. If the initialization data is incorrect, the communication cannot be established and the green

indicator will remain flashing. Checking whether the address of the communication station is set correctly.

- Communication is normal, the green indicator is on; communication is interrupted and the green indicator is flashing; after the communication is reestablished, the green indicator will turn on again.

7.8.5 Wirings

Counting module is installed on the LK backplane, there are terminal wiring and prefabricated cable wiring, here only describes the backplane terminal wiring.

The counting module is connected to the terminal via the backplane mounting slot. The relationship between each channel and the terminal is shown in Table 7-64. A1 + / A1-, B1 + / B1-, Z1 + / Z1- are the three inputs of the counter 1, OUT1 and OUT2 are the two outputs of the counter 1; A2 + / A2-, B2 + / B2-, Z2 + / Z2- are three inputs of counter 2, OUT3 and OUT4 are the two outputs of counter 2.

Table 7-64 Definition of Backplane Terminals

Signal Type		Counter 2		Cunter 1	
		Signal definition	Terminal number	Signal definition	Terminal number
Input	A+	A2+	01	A1+	02
	A-	A2-	03	A1-	04
	B+	B2+	05	B1+	06
	B-	B2-	07	B1-	08
	Z+	Z2+	09	Z1+	10
	Z-	Z2-	11	Z1-	12
Output	The first route	OUT3	13	OUT1	14
	The second route	OUT4	15	OUT2	16
10~31.2VDC power supply	DC+	17			
	DC-	18			

When wiring, pay special attention to the following:

- Each counter has 2-way switching outputs.
- External independent 10 ~ 31.2VDC field power supply, to ensure that the field and the system are isolated.
- 4-way DO outputs circuit share a 10 ~ 31.2VDC field power supply.
- The output channel does not have reverse voltage protection, and if the wiring is wrong, it may burn the internal circuit.
- Terminal "17" is connected to the positive end of the field power supply.
- Terminal "18" is connected to the negative end of the field power supply, and used for field power down detection.
- Do not connect multiple cables on the same terminal at the same time. You can achieve multipoint connection via bus bar or conversion terminal.

The following three examples of typical field devices describe the wiring mode of counting module. Input the range of signal voltage difference: 10-26.4V, that is, for differential signal, (U +) - (U -) = 10 ~ 26.4V; for single-end signal, U = 10 ~ 26.4V. Output channel connect externally DC supply voltage range: 10 ~ 31.2VDC.

7.8.5.1 Connection with Incremental Encoder

As shown in Figure 7-59 , the corresponding relationship between output of the incremental encoder and the input of the counting module: A—A, B—B, 0—Z.

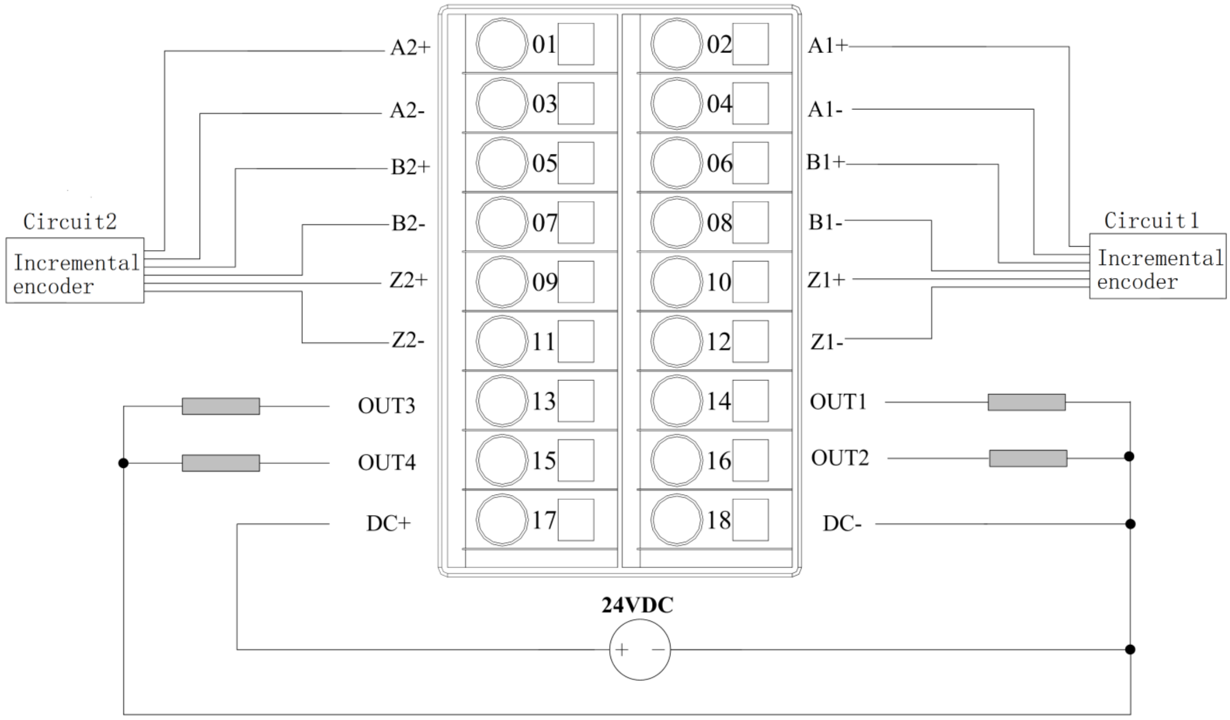


Figure 7-59 Connection of the Counting Module with the Incremental Encoder

7.8.5.2 Connection to Photoelectric Sensor

As shown in Figure 7-60, the output of the photoelectric sensor is connected to the A and Z input end of the counting module respectively, B-end short circuit.

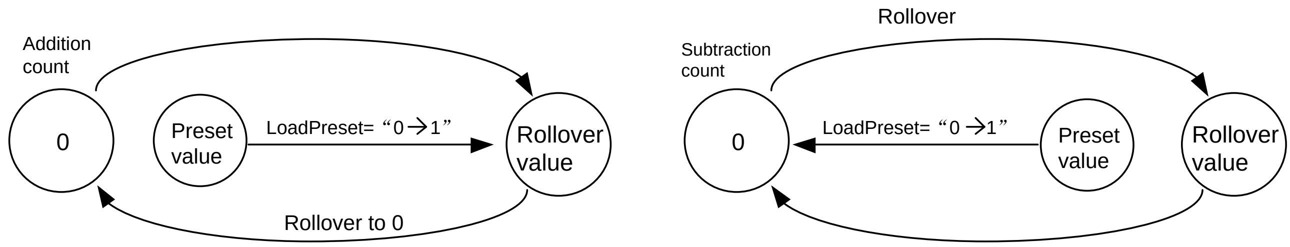


Figure 7-60 Connection of the Counting Module with the Photoelectric Sensor

7.8.5.3 Connection to Proximity Sensor

As shown in Figure 7-61, the input of proximity sensor connect to the A input end, B-end, Z-end short circuit.

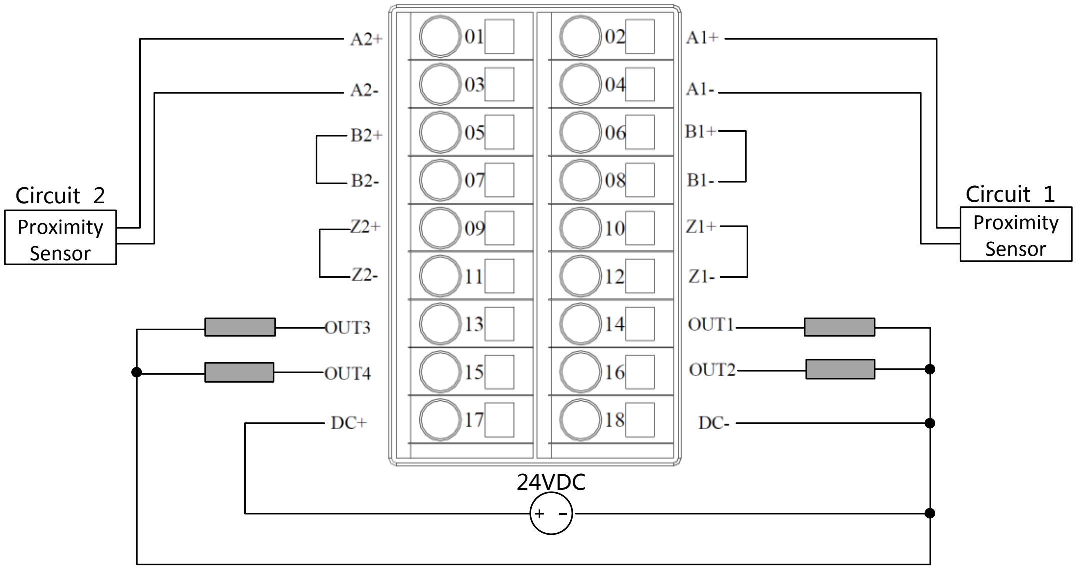


Figure 7-61 Connection of the Counting Module with the Proximity Sensor

7.8.6 Function Description

7.8.6.1 Rollover Value

In counter mode, you need to set a rollover value for the counter as the upper limit of the count with a range 1 to 4,294,967,295.

During the counting process, when the count value = (rollover value -1), the counter returns to 0 and restarts counting. If the set rollover value is 1500, the counting order is: ... 1498, 1499, 0, 1, 2 ....

The rollover value of counter 1 is set by the output data **Counter1_RolloverValue**, and the rollover value of counter 2 is set by the output data **Counter2_RolloverValue**.

The Rolled mark in the input data (Counter_Rolled) indicates whether the counter has reached the rollover value and rolled over. If Counter 1 has been rolled, **Counter1_Rolled** = 0x01; if it is not rolled or the mark is cleared, **Counter1_Rolled** = 0x00.

The user can clear the rolled flag through the clear rolled flag (Counter_ClearRolledFlag) in the output data to record the next rollover.

Details of relevant data see 7.8.10 Data Area.

In frequency measurement mode, rollover value should be set as 0.

7.8.6.2 Preset Value

In counter mode, you can set a preset value for the counter and make counter counts from that value. Preset value's range is 0 to 4,294,967,295. In frequency measurement mode, the preset value is meaningless.

The preset value must be less than the rollover value. If the value is greater than the rollover value, count error will occur.

It is important to note that when the current count value reaches the rollover value, the counter roll back to zero and restarts counting from 0, not starting from the preset value, as shown in Figure 8-10.

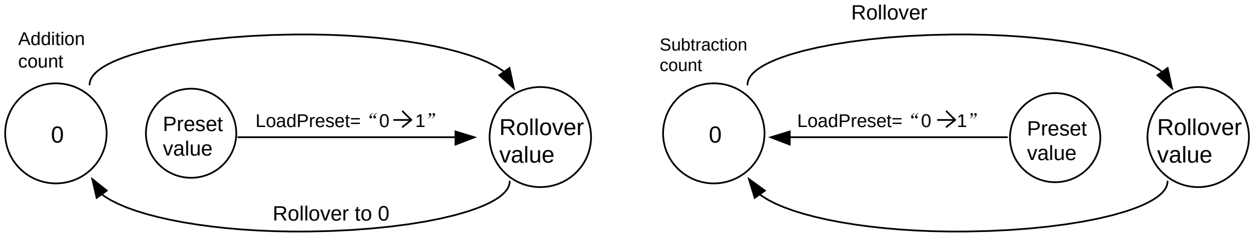


Figure 7-62 Counter Preset and Rollover Value

Whether or not the counter loads the preset value and counts from the preset value is controlled by the output data **Counter_LoadPreset**. Writing into the rising edge signal (0 → 1), the counter loads the preset value and starts counting from the preset value.

Whether or not to reset the counter is controlled by the output data **Counter_Reset.** Writing into the rising edge signal (0 → 1), the counter is reset and counts from zero. When **Counter_Reset** = 1, the two output channels of the counter are output OFF and are not output according to the configuration settings.

If **Counter_Reset** and **Counter_LoadPreset** are simultaneously written to the rising edge signal, the counter loads the preset value and counts from the preset value.

The preset value of counter 1 is set by the output data of **Counter1_PresetValue**, and the preset value of counter 2 is set by the output data of **Counter2_PresetValue**.

Details of relevant data see 7.8.10 Data Area.

7.8.6.3 Frequency Measurement Time

In frequency measurement mode, you need to set a frequency measurement time, called the frequency measurement time. The counter will count the number of pulses received within the specified frequency measurement time.

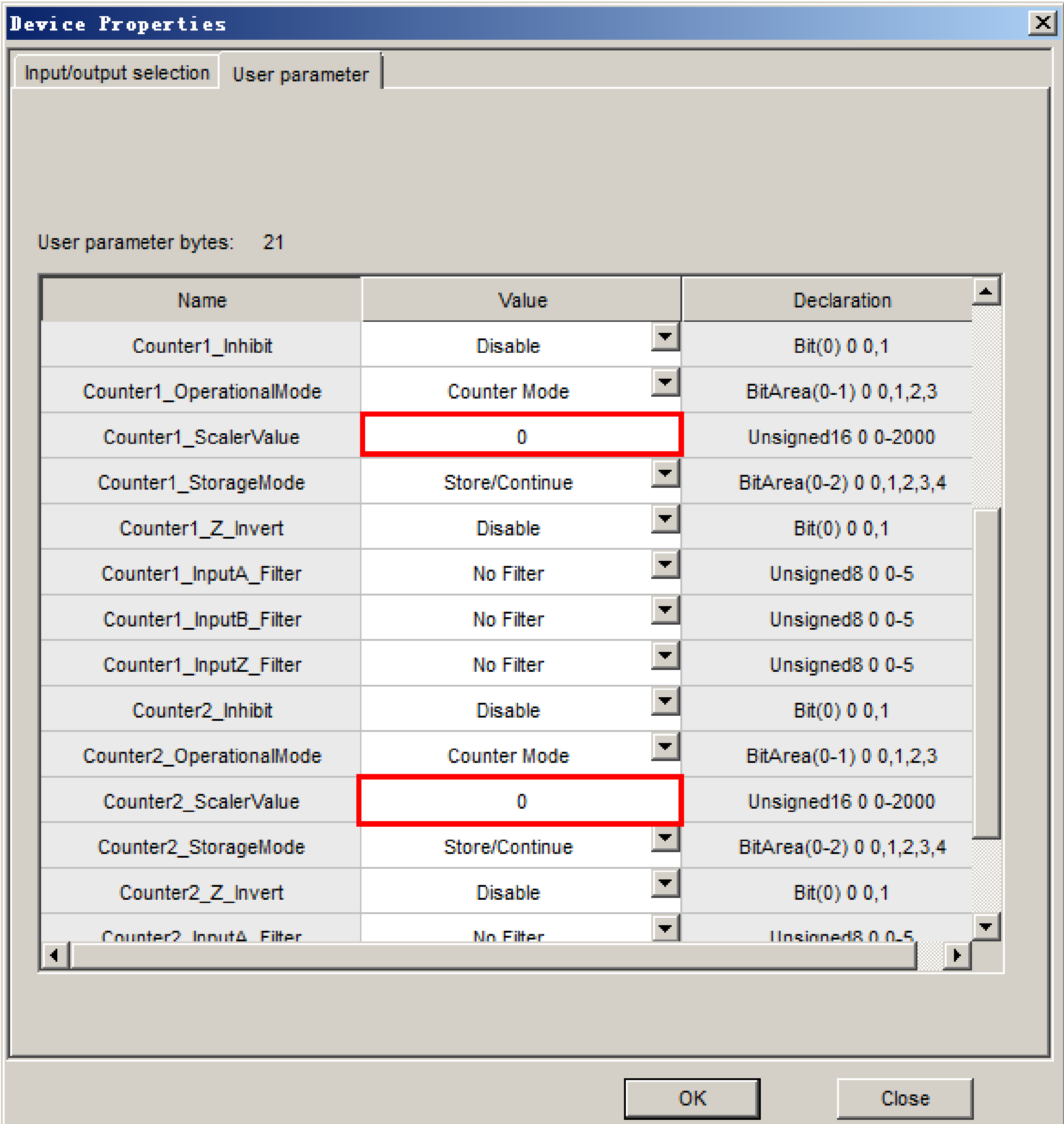


Figure 7-63 Counter Frequency Measurement Time Setting

The two counter frequency measurement time is set respectively by the parameters **Counter1_ScalerValue** and **Counter2_ScalerValue**, the default is 0, the value range: 0 ~ 2000, which indicates that how many time base in the frequency measurement time (10ms). For example: counter 1 works in frequency measurement mode, parameter Counter1_ScalerValue = 6, then the counter 1 frequency measurement time = 6 × 10ms = 60ms. Assuming that the counter 1 receives six pulses in the frequency measurement time, the pulse frequency = 6 / 60ms = 100 Hz.

If the counter is not operating in the frequency measurement mode, the parameter should be set as 0.

Maximum parameter value= 2000, that is, the maximum allowable frequency measurement time = 2000 × 10ms = 20s.

7.8.6.4 Output ON

You can set a count value for each output. When the current count value of the counter reaches this value, the output channel is ON (the channel is closed). This value is called the output ON trigger value (Output_ON_Value).

The output ON trigger value of each output (OUT1 / OUT2 / OUT3 / OUT4) is set by the parameters **Output1_ON_Value**, **Output2_ON_Value**, **Output3_ON_Value** and **Output4_ON_Value** respectively, and double word variable (DWord) with a range of 0 ~ 4,294,967,295.

The output ON trigger value should be less than the rollover value. If the output ON trigger value is no less than rollover value, the count value cannot reach the output ON trigger value, the output channel will not output ON.

The output data **Output_Control** is used to control the status of the counter's outputs. For example, setting **Output1_Control** = 0x03, indicates that the current output value of the modified output channel 1 (OUT1) is "ON" and the forced channel 1 is closed, regardless of whether the current count value of counter 1 reaches the output ON trigger value (Output1_ON_Value) and output channel 1 output and remain "ON" status. Setting Output1_Control = 0x00, indicates that output is based on the count result, and output channel 1 will output ON when the ON trigger value of counter 1 arrives.

Details of relevant data see 7.8.10 Data Area.

7.8.6.5 Output OFF

When powered on, the output channel remains in its original status. After output enable, the status of the user program is output. When restarted, the output channel outputs OFF. After establish the communication and re-download the parameters, output a configured status.

A count value can be set for each output. When the current count value of the counter reaches this value, the output channel outputs OFF (the channel is disconnected and the output is stopped). This value is called the output OFF trigger value (Output_OFF_Value).

The output OFF trigger value should be less than the rollover value. If the output OFF trigger values are no less than rollover value, the count value cannot reach the output OFF trigger value, the output channel will not output OFF.

The output OFF trigger values of each output(OUT1 / OUT2 / OUT3 / OUT4) are set by the parameters **Output1_OFF_Value**, **Output2_OFF_Value**, **Output3_OFF_Value** and **Output4_OFF_Value** respectively, DWORD, with a range of 0 to 4,294,967,295.

The output data **Output_Control** is used to control the status of the counter's outputs. For example, setting **Output3_Control** = 0x02, indicates that the current output value of the modified output channel 3 (OUT3) is "OFF" and the forced channel 3 is disconnected, regardless of whether the current count value of counter 2 reaches the output OFF trigger value or not (Output3_OFF_Value). Output channel 3 outputs and remains "OFF". Setting **Output1_Control** = 0x00, indicates that output is based on the count result, and output channel 3 will output OFF when OFF value of counter 2 arrives.

Details of relevant data see 7.8.10 Data Area.

It outputs OFF when output OFF trigger value equals to output ON trigger value.

Channel Output Priority: Fault Mode Value> Programming Mode Value> Force Output ON / OFF> Output OFF Trigger Value> Output ON Trigger Value.

Take OUT1 of counter1 as example, when **Output1Control**＝0x00 (output based on counting result), **Output1_ON_Value** = 3000, **Output1_OFF_Value** = 8000, the output status of output point OUT1 is shown in the figure. If **Output1Control** = 0x02 (modify OUT1 output value is OFF) or = 0x03 (modify

OUT1 output value is ON), **Output1_ON_Value** = 3000, **Output1_OFF_Value** = 8000, the output status of output point OUT1 is shown in Figure 7-64.

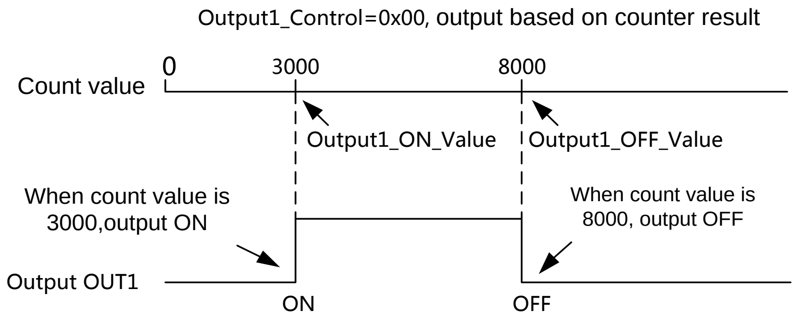


Figure 7-64　Output Timing of OUT1 When Output According to the Count Result

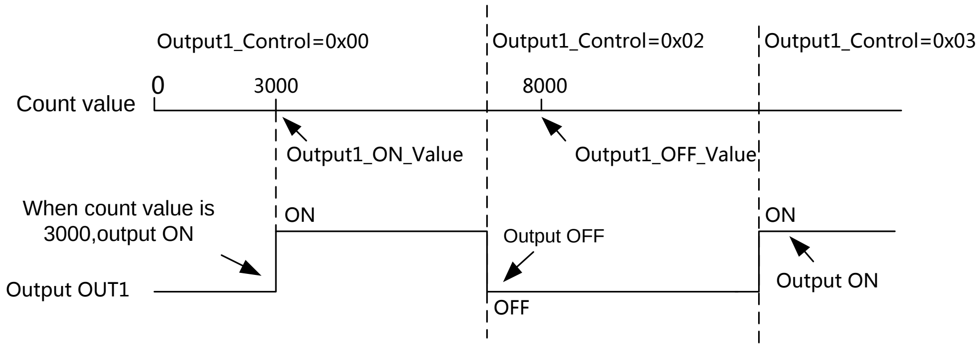


Figure 7-65　Output Timing of the OUT1 after the Output Value is Forcefully Modified

7.8.6.6　Store the count value

When the Z signal (the default rising edge is valid, when the "Z Inversion" function is enabled, the falling edge is valid), the counter can store the current count value until the next Z signal arrives, storing the new count value and covering the old value.

Whether or not to store the count value and select which kind of storage mode for counter 1, counter 2 depends on the parameters **Counter1_StorageMode** and **Counter2_StorageMode** set, the default **Store / Continue**. The count status of the counter in different memory modes is described below.

Selecting a storage mode means that the stored count value function is enabled and the counter will store the current count value in that mode when the Z signal arrives. Select **No Store Mode**, store count value function is disenabled.

When the store count value function is enabled, the counter module not only reports the current counter value of the two counters (Counter_PresentValue) in the input data, but also reports the stored count value (Counter_StoredValue).

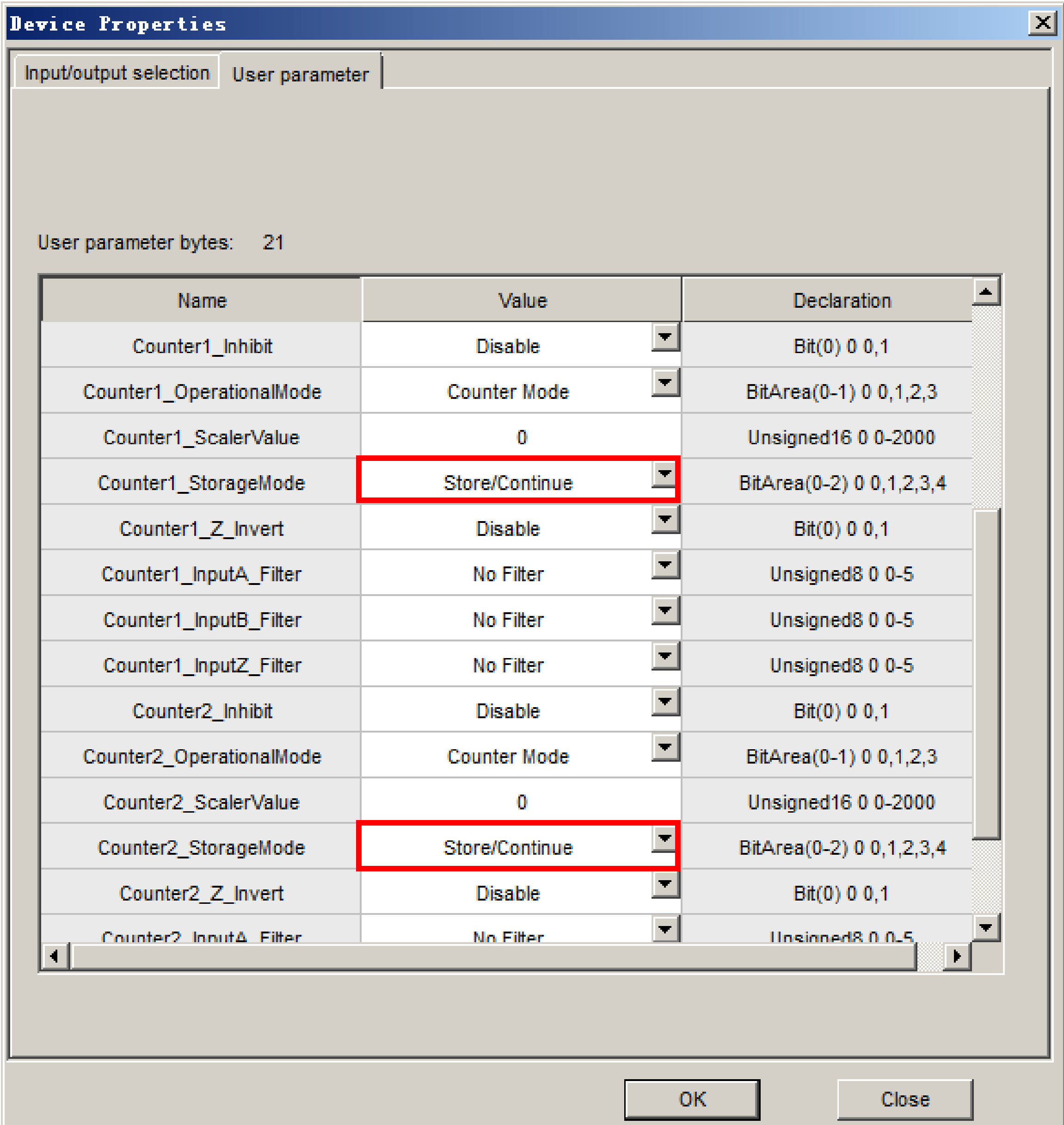


Figure 7-66 Counting Module Storage Mode Setting

7.8.6.7 Storage mode

When the counter stores count values, four different memory modes are supported:

- Store/Continue (default): The counter stores the current count value and continues counting.

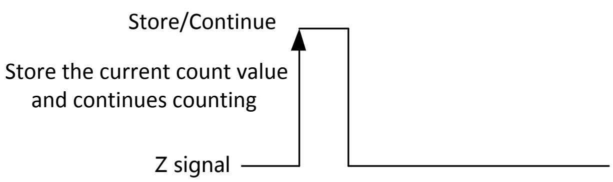


Figure 7-67 Counting Module Store/Continue Mode

- Store/Wait/Resume: The counter stores the current count value and stops counting. Until the Z signal falling edge arrives, it continues to count.

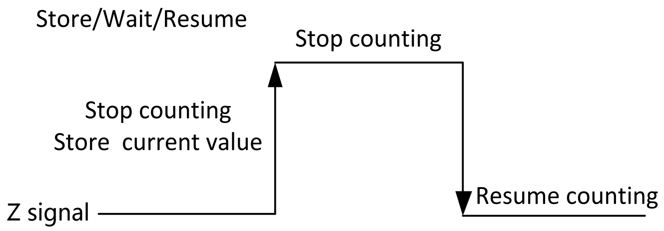


Figure 7-68 Counting Module Store/Wait/ Resume Mode

- Store-Reset/Wait/Start: The counter stores the current count value, zero clearing, and stops counting. Until the Z signal falling edge arrives, it starts counting from zero.

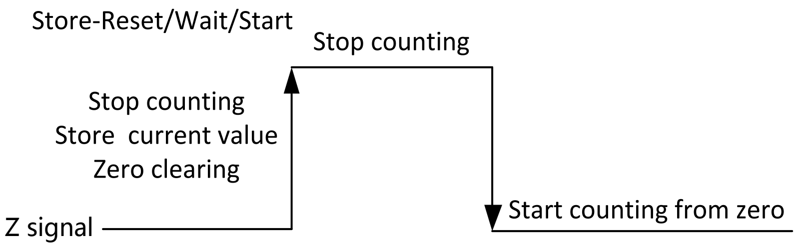


Figure 7-69 Counting Module Store-Reset /Wait/ Start Mode

- Store-Reset/Start: The counter stores the current count value, zero clearing, and recounts from 0.

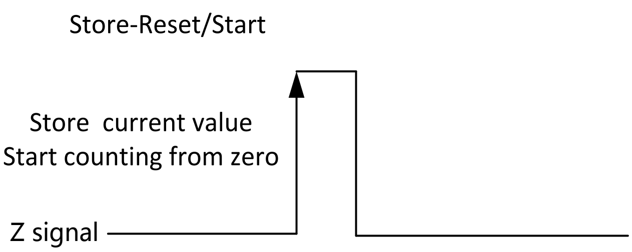


Figure 7-70 Counting Module Store-reset / start Mode

7.8.6.8 Z Signal inversion

By default, the rising edge of the Z signal input is valid. The Z signal inversion function can be selected so that the Z signal input falling edge will be effective, the Z interrupt will be triggered when the falling edge of the Z signal arrives, and the count value is stored when the falling edge of the Z signal arrives.

After the Z signal inversion enable, the trigger condition for storing the count value is shown in Figure 7-71.

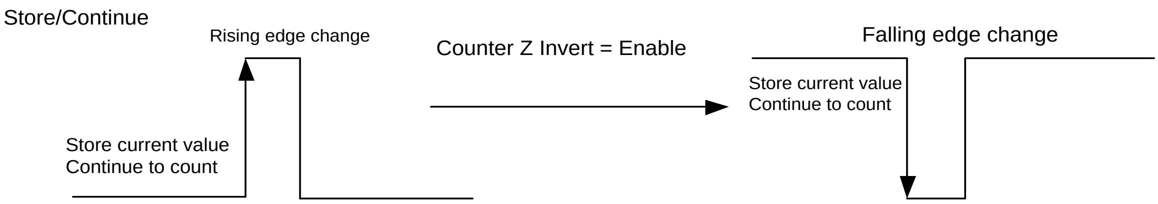


Figure 7-71　Z Signal Inversion of the Counting Module

Whether or not the Z signal of counter 1 inverted is set by parameter **Counter_Z_Invert**. Whether or not the Z signal of counter 2 inverted is set by parameter **Counter2_Z_Invert**. The default set is Disable.

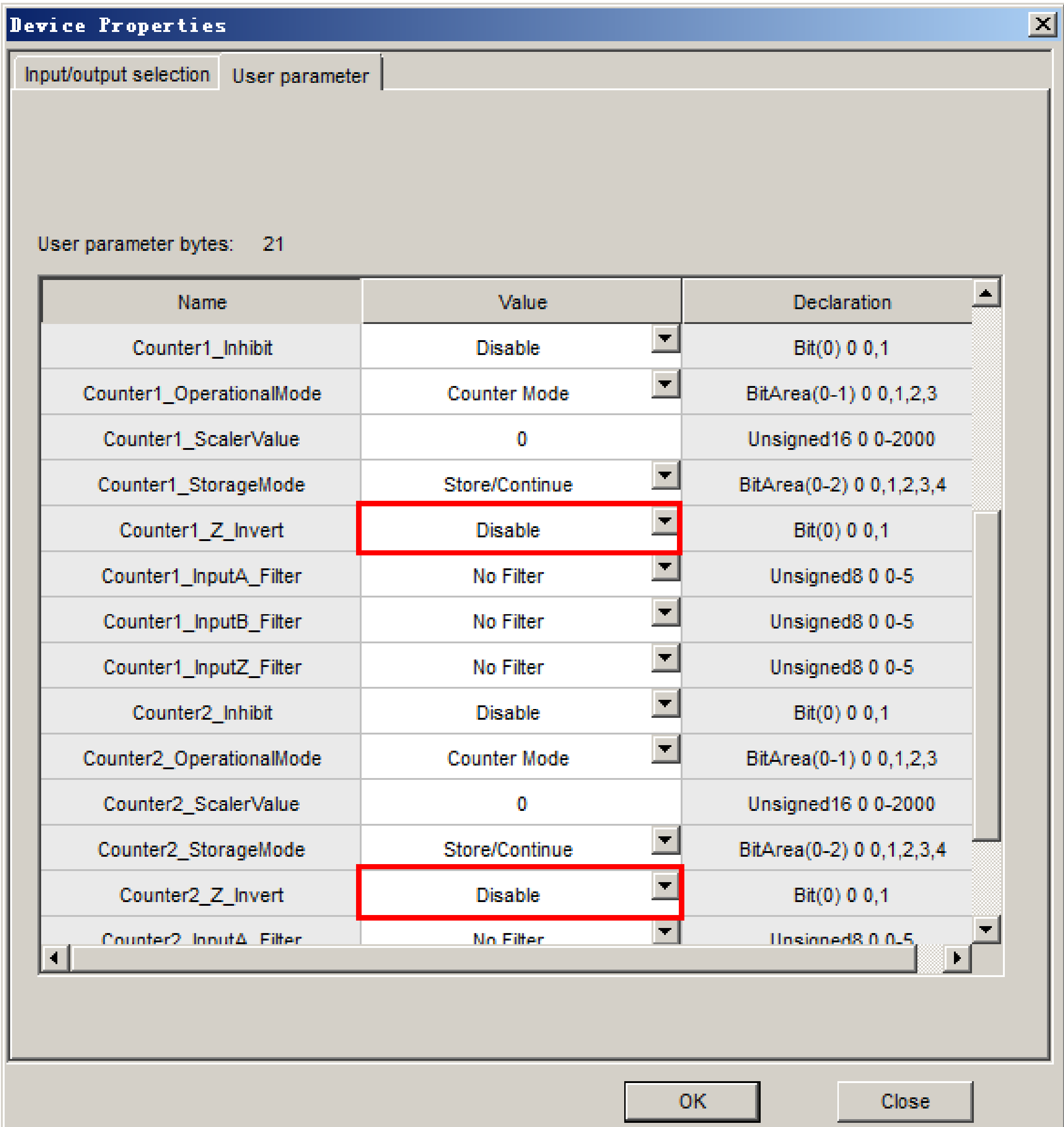


Figure 7-72　Counting Module Z Signal Inversion Enable Setting

7.8.6.9 Programming mode

First, introduce the working status of the module output channel. For the output channel of the counting module, there are five possible output states, in order of priority from high to low. The sequence is:

(1) Forbidden: output programming value, RUN indicator flashes, the highest priority.

(2) Fault mode: output fault value, RUN indicator flashes, priority second.

(3) Programming mode: output programming value, RUN indicator is on.

(4) Output controller command, RUN indicator is always on.

(5) In other cases, the output remains.

The disabled module always outputs the programming value until enabled.

Module enabled: When communication is normal, the module receives the control commands issued by the controller and outputs them. If the module receives the programming mode command issued by the controller, the module outputs the programming value. Any time a communication failure occurs, the module automatically enters the fault mode and outputs the fault value.

In other cases (other status except the forbid, output, programming mode, communication failure), the module output remains.

LK620 does not have the forbid module function. During the use of LK620, there is no need to consider the forbid module function.

- Note that when the module is reset due to its own cause, the RUN light flashes but does not be determined as a communication fault, does not output the fault value, the module holds output during reset process.

According to the status flow indicated by Figure 7-73, you can determine the next working status of the module output channel. For example, under programing mode, communication failure occurs, the module will enter the fault mode and output fault value. After the fault is restored, the module has different outputs depending on the current status of the controller: If the controller is still in programming mode, the module returns to the programming mode and outputs the programming value. If the controller is under RUN mode (exits the programming mode and starts running), the module outputs command value issued by the controller. In other cases (such as the controller exits the programming mode and stop running), the module keeps outputting and remains the fault value.

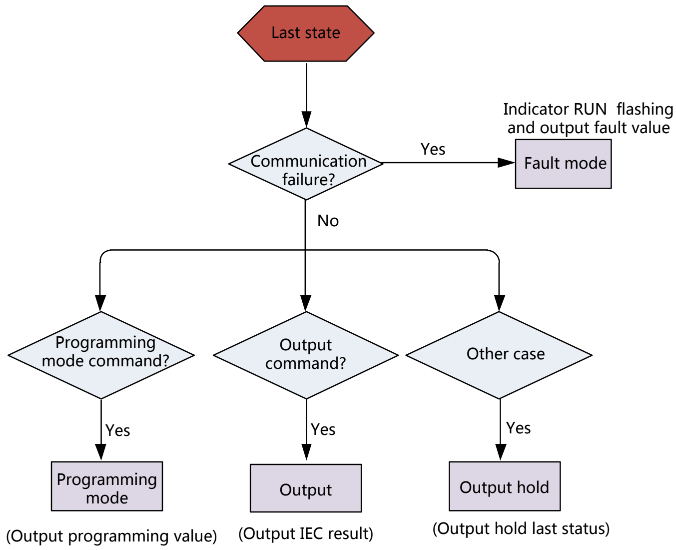


Figure 7-73 Module Output Channel Operating Status Flow Diagram

The programming mode is an operation mode for the controller, used to modify, edit, and download the user program. In programming mode, the user program is stopped and cannot be run by the configuration software, the module outputs a status (programming value) configured: output holding (Hold Last Status) or the program mode setting value (Program Mode Status).

The controller enters the program mode or exits the program mode via the following method:

- Set the key switch to the "PRG" position, the controller enters the program mode, stops the user program, and the module outputs the programming value.
- Set the key switch to the "RUN" position, the controller exits the programing mode and runs the user program.

It should be noted that: after the user program is fully downloaded, whether the key switch is located in the "PRG" position, the controller automatically enters the programing mode and stops running, the module output programming value.

In programing mode, the module holds last status or outputs the programmed mode set value, selected by the user parameter **Programing Mode Output**, and the default output is held. The programing mode setting value is set by the user parameter **Programing Mode Status** and the default output is OFF (disconnected). After re-modify the parameters, need to be fully downloaded to take effect. When fully downloaded, the module enters the programing mode and outputs the old programming value. After the new parameter is effective, the new value will replace the old value.

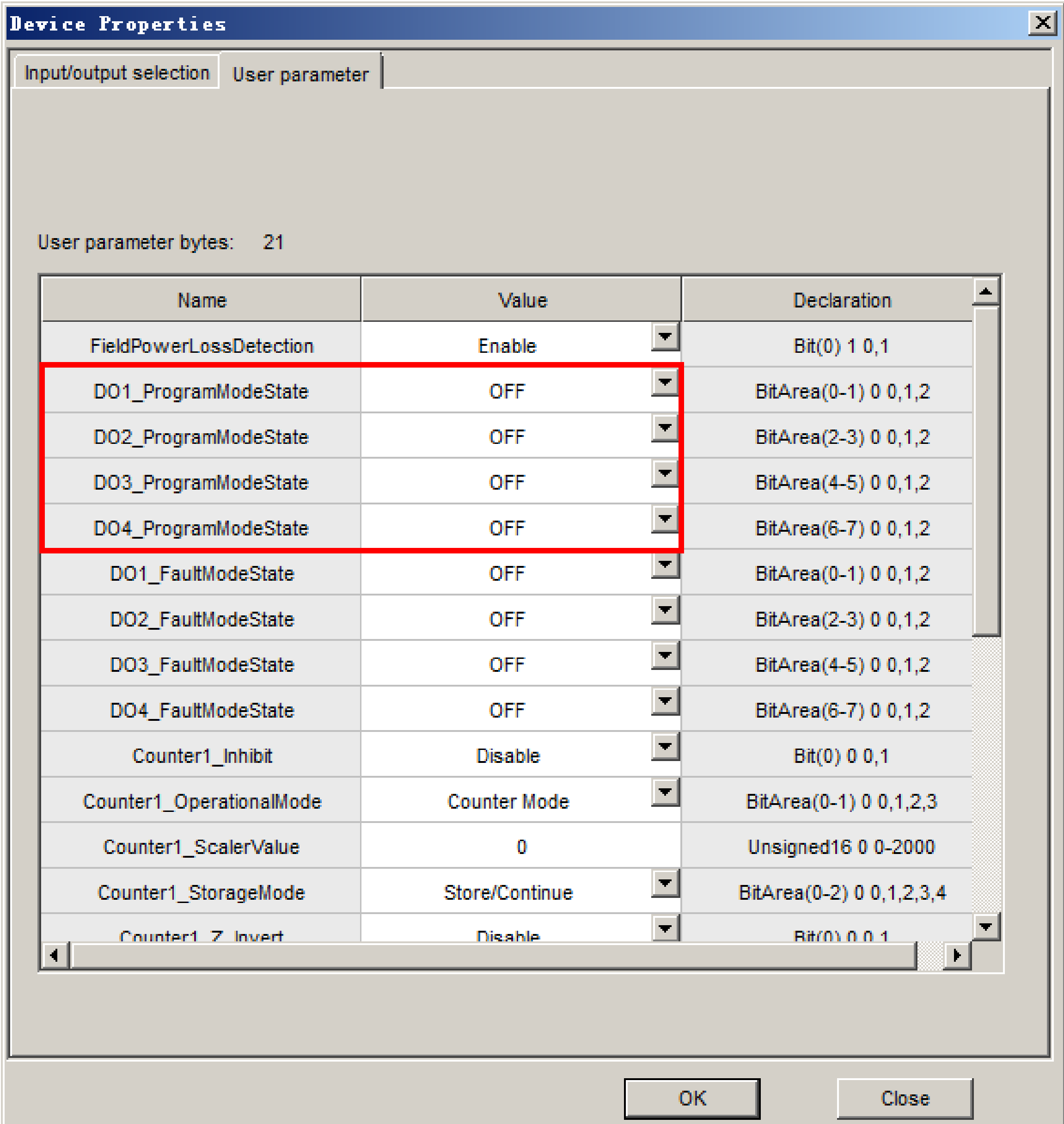


Figure 7-74 Output Value in the Programing Mode

7.8.6.10 Communication Failure

When the communication is normal, the LK620 exchanges data with the controller via the PROFIBUS-DP bus. The output points (OUT1 / OUT2 / OUT3 / OUT4) are output according to the control commands issued by the controller.

In the event of a communication failure, communication between the module and the controller is interrupted and the "RUN" light flashes.

When the module is powered on, the module automatically enters the fault mode when any communication fault occurs and outputs a status (fault value) configured in advance: output holding (Hold Last Status) or the output fault mode setting value (Fault Mode Status, ON or OFF).

A communication fault occurs in the programing mode, the fault mode is automatically entered and the fault value is output.

In fault mode, the output holding or the output fault mode setting value is selected by the user parameter **Fault Mode Output** and the default output is held. The fault mode setting value is set by the user parameter **Fault Mode Status** and the default output is OFF (disconnected).

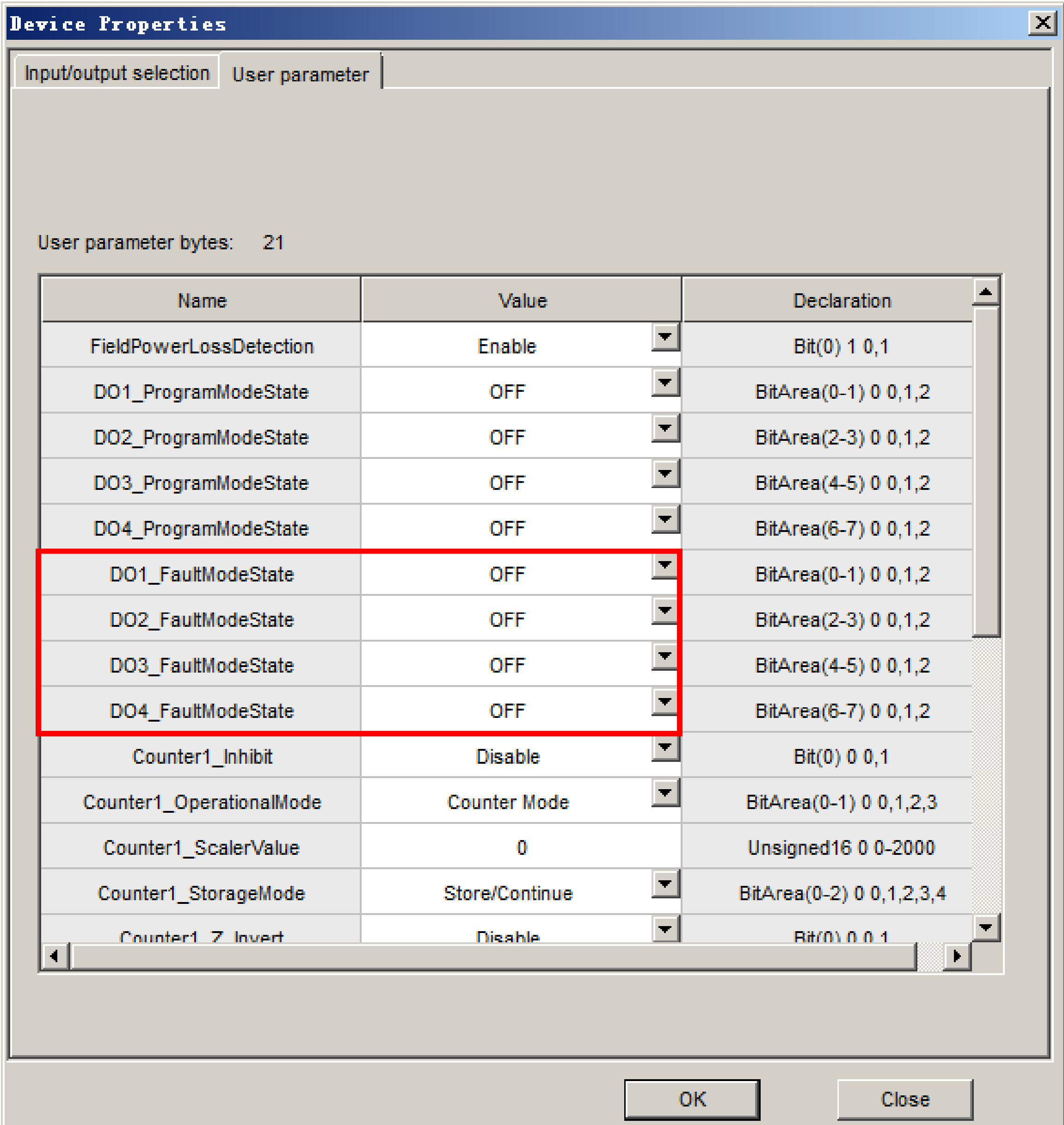
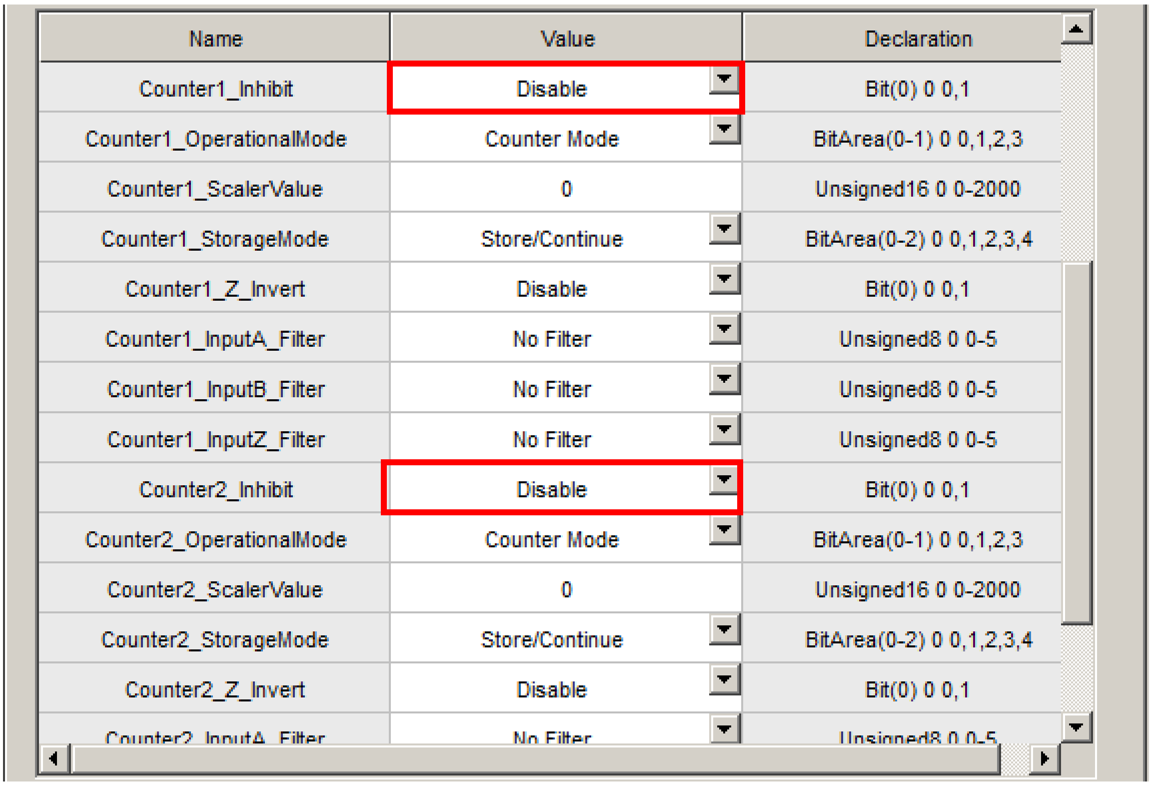


Figure 7-75 LK620 Output Point's Output Value in Failure Mode

7.8.6.11 Disable Counter

After the counter is disabled, it is not counted and reports the count value before disabled. Whether or not to disable the counter 1 depends on the parameter **Counter1_Inhibit**, and whether or not to disable the counter 2 depends on the parameter **Counter2_Inhibit**, the default value is Disable.

When a counter is disabled, it does not affect the output channel of the counter, only the counter does not work.



Name	Value	Declaration
Counter1_Inhibit	Disable	Bit(0) 0 0,1
Counter1_OperationalMode	Counter Mode	BitArea(0-1) 0 0,1,2,3
Counter1_ScalerValue	0	Unsigned16 0 0-2000
Counter1_StorageMode	Store/Continue	BitArea(0-2) 0 0,1,2,3,4
Counter1_Z_Invert	Disable	Bit(0) 0 0,1
Counter1_InputA_Filter	No Filter	Unsigned8 0 0-5
Counter1_InputB_Filter	No Filter	Unsigned8 0 0-5
Counter1_InputZ_Filter	No Filter	Unsigned8 0 0-5
Counter2_Inhibit	Disable	Bit(0) 0 0,1
Counter2_OperationalMode	Counter Mode	BitArea(0-1) 0 0,1,2,3
Counter2_ScalerValue	0	Unsigned16 0 0-2000
Counter2_StorageMode	Store/Continue	BitArea(0-2) 0 0,1,2,3,4
Counter2_Z_Invert	Disable	Bit(0) 0 0,1
Counter2_InputA_Filter	No Filter	Unsigned8 0 0-5

Figure 7-76 Counter Inhibit Setting

7.8.7 Diagnostic Instructions

LK620 can implement field power loss detection, the diagnosis belongs to the device diagnosis.

Whether or not to enable power-down detection is selected by the user parameter **FieldPowerLoss Detection**. The default value is Enable. After modification, you need to fully download to take effect.

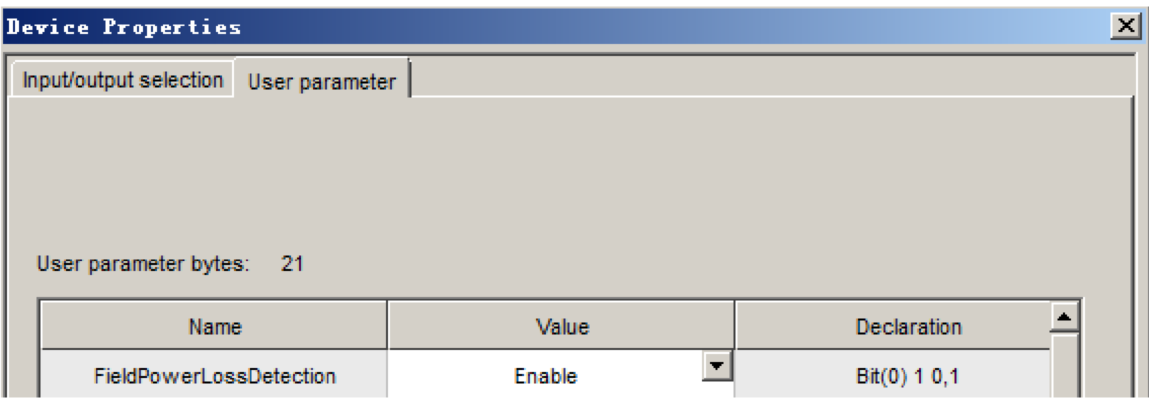


Figure 7-77 LK620 Power Loss Detection Enable Selection

As shown in Figure 7-78, the "17" terminal is connected to the positive terminal of the field power supply and the "18" terminal is connected to the negative terminal of the field power supply. The LK620 performs power loss diagnosis by detecting changes of the input voltage between the two terminals. If there is a fault, the fault status is reported to the controller in the form of diagnostic data.

The field power supply voltage is between 10 ~ 31.2VDC, the optocoupler switch of the power loss detection channel is ON, and it is judged that the field power supply is normal. When the field power supply voltage is less than 5VDC, the optocoupler switch of the power loss detection channel is OFF, and it is judged that the field power supply is in power loss status. the field power supply voltage is between 5 ~ 10VDC, the power failure detection channel of the optocoupler switch status is uncertain.

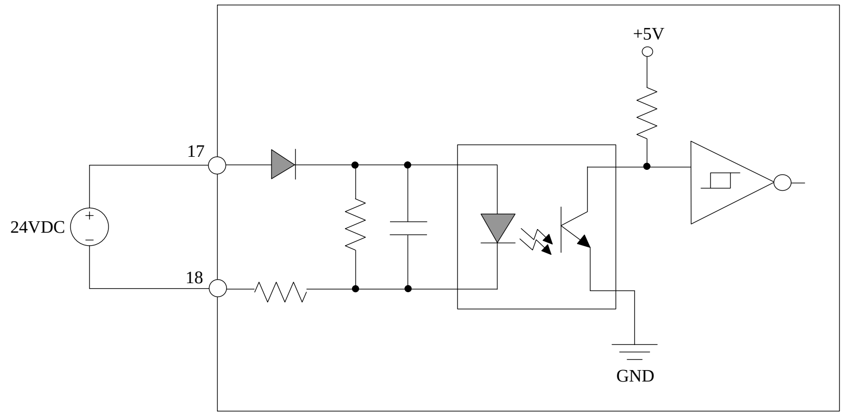


Figure 7-78 LK620 Field Power Loss Detection Circuit Diagram

- When the 24VDC power supply is disconnected (disconnection or power supply output voltage is less than 5VDC), the device diagnostic data area of the LK620 generates the diagnostic data "0x04" (Bit2 = 1 in the diagnostic byte). When the next scan cycle arrives, it is reported to the controller.
- When the 24VDC power supply is restored to normal (output voltage 10 ~ 31.2VDC), LK620 device diagnostic area generates a new diagnostic data "0x00" (Bit2 = 0 in the diagnostic byte), when the next scan cycle arrives, it is reported to the controller.
- Only in the event of failure and fault recovery, the diagnostic data of LK620 is reported once respectively.

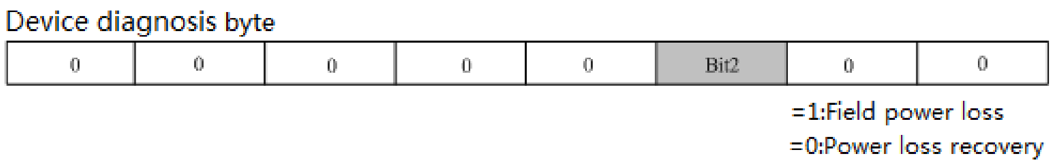


Figure 7-79 LK620 Diagnostic Byte

Field power loss detection belongs to device diagnosis, diagnostic byte definition is shown in Figure 7-79. After calling the function block sysGetDPSlaveState (Get Diagnosis of DP Slave), diagnosis data reported by LK620 are saved into the output parameter **DiagData** in the function block. as shown in Table 7-65.

Table 7-65 LK620 Diagnostic Information

Device diagnosis	Value	Description
DiagData [0]:DiagData [1]	0x02:0x04	Field power loss
	0x02:0x00	Fault recovery or no diagnostic data

7.8.8 Debounce Filtering

The module has a debounce filter function, which can effectively filter out the edge jitter and clutter interference of the input pulse. It provides multi-file filter frequency of 460kHz, 230kHz, 115kHz, 57kHz and 28kHz. After selecting a filter frequency, the input signal greater than the frequency will be filtered out.

Whether or not to filter out the input signal of counter1, 2, is set by **Counter1_InputA (B/Z)_Filter** and **Counter2_InputA(B/Z)_Filter**. The default mode is no filter (No Filter).

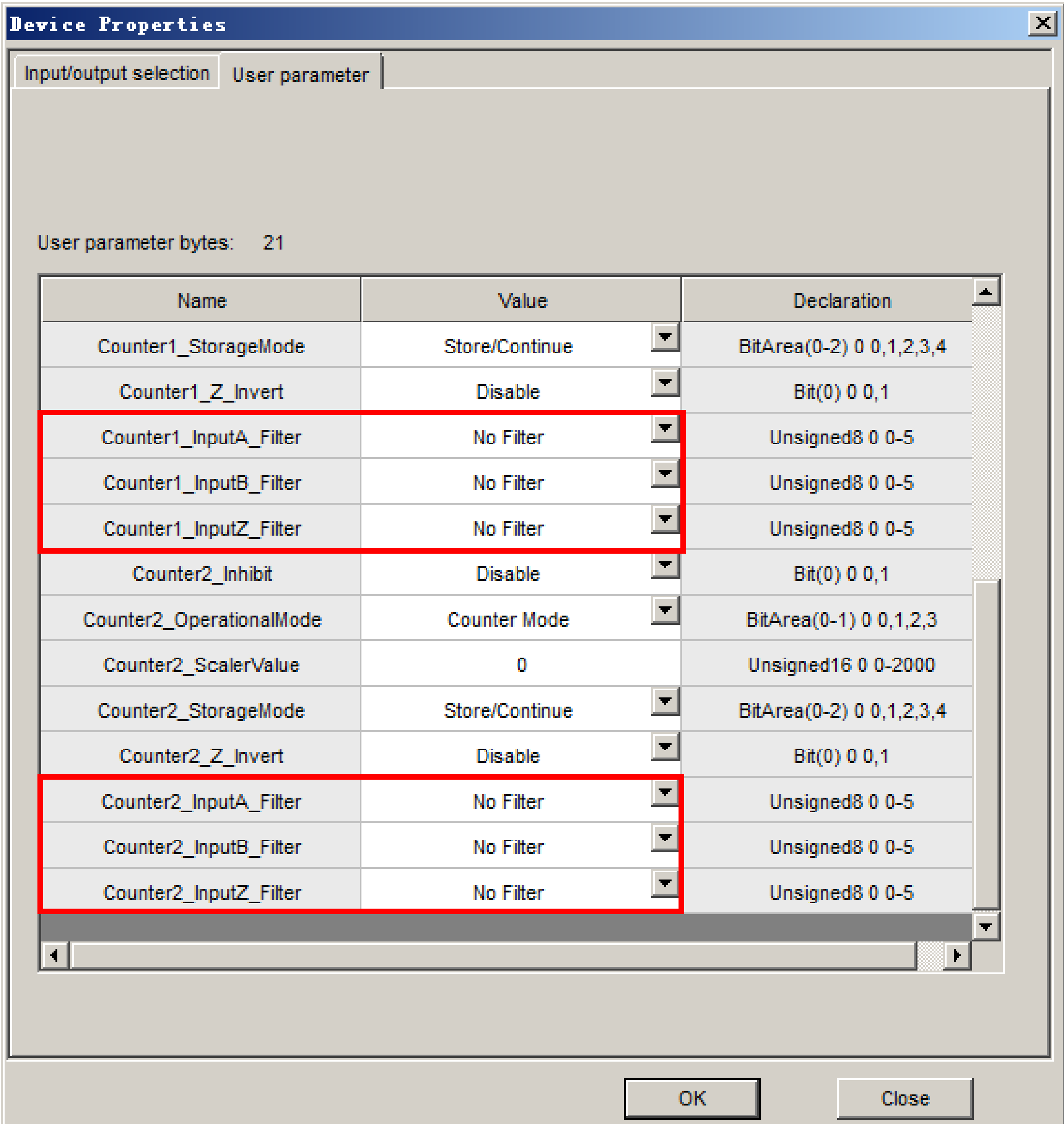


Figure 7-80 LK620 Debounce Filter Enable Setting

7.8.9 Parameter Specifications

The user parameter is used to determine the module operation mode and is written into controller when downloading, and it is not read by every scan cycle. Each module parameter has a default value, which can be changed according to the engineering requirements. When the parameter value is changed, user parameter needs to be fully downloaded to take effect.

The length of the user parameter is 21 bytes. Details are shown in Table 7-66.

Table 7-66 LK620 User Parameter List

Parameter name	Parameter description
FieldPowerLossDetection	Field power loss detection or not =Enable (default) =Disable
DO1_ProgramModeState DO2_ProgramModeState DO3_ProgramModeState DO4_ProgramModeState	Output channel 1 ~ channel 4 program mode output settings: =OFF, output channel disconnected (default) =ON, output channel closed =Depend on the counter value
DO1_FaultModeState DO2_FaultModeState DO3_FaultModeState DO4_FaultModeState	Output channel 1 ~ channel 4 fault mode output settings: =OFF, output channel disconnected (default) =ON, output channel closed =Depend on the counter value
Counter1_Inhibit	Inhibit counter 1 or not =Disable, counter 1 allowed (default) =Enable, counter 2 inhibited
Counter1_OperationalMode	Counter 1 operational mode =Counter mode (default) =Encoder×1 Mode =Encoder×4 Mode =Frequency Mode
Counter1_ScalerValue	Frequency time of Counter 1 is selectd from the range of 0 ~ 2000, 10ms is the reference unit. If it is not working in frequency mode, the value is set to 0
Counter1_StorageMode	Counter 1 storage mode =Store/Continue =Store/Wait/Resume =Store-Reset/Wait/Start =Store-Reset/Start =No Store Mode,no value stored
Counter1_Z_Invert	Counter1 Z value Invert enabled =Disable (default) =Enable
Counter1_InputA_Filter	Counter 1 input A Fliter set ＝No Filter (default) ＝460kHz ＝230kHz ＝115kHz ＝57kHz ＝28kHz
Counter1_InputB_Filter	Counter 1 input B fliter set ＝No Filter (default) ＝460kHz ＝230kHz ＝115kHz ＝57kHz

Parameter name	Parameter description
	＝28kHz
Counter1_InputZ_Filter	Counter 1 input Z filter set ＝No Filter (default) ＝460kHz ＝230kHz ＝115kHz ＝57kHz ＝28kHz
Counter2_Inhibit	Inhibit counter 2 or not =Disable, counter 2 allowed (default) =Enable, counter 2 inhibited
Counter2_OperationalMode	Counter 2 operating mode =Counter Mode (default) =Encoder×1 Mode =Encoder×4 Mode =Frequency Mode
Counter2_ScalerValue	Frequency time of Counter 2 is selectd from the range of 0 ~ 2000, 10ms is the reference unit. If it is not working under frequency mode, the value is set to 0
Counter2_StorageMode	Storage mode of counter 2 =Store/Continue =Store/Wait/Resume =Store-Reset/Wait/Start =Store-Reset/Start =No Store Mode, no value stored
Counter2_Z_Invert	Counter 2 Z value reversal enabled =Disable =Enable
Counter2_InputA_Filter	Counter 2 input A flitering set ＝No Filter (default) ＝460kHz ＝230kHz ＝115kHz ＝57kHz ＝28kHz
Counter2_InputB_Filter	Counter 2 input B flitering set ＝No Filter (default) ＝460kHz ＝230kHz ＝115kHz ＝57kHz ＝28kHz
Counter2_InputZ_Filter	Counter 2 input Z flitering set ＝No Filter (default) ＝460kHz ＝230kHz ＝115kHz ＝57kHz

Parameter name	Parameter description
	=28kHz

7.8.10 Data Area

The data area stores data that is updated for each scan cycle and exists as a variable in the user program.

The input data is the LK620 data uploaded to the controller's counter record, including the current count value, the stored value and the status backward read of output channel. The output data is the configuration and control commands issued by the controller to the LK620, including the preset value, the rollover value, the channel output force mark and the rollover clearing mark. When the user program is running, the input data and the output data are updated once in each scan cycle.

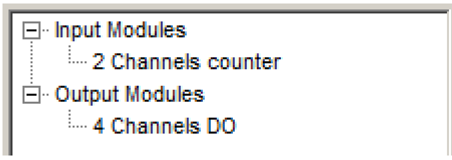


Figure 7-81 LK620 Input and Output Data Area

7.8.10.1 Input data

As shown in Table 7-67, the input data occupies 11 words (22 bytes). The output status of each output point is sent back to the controller (Output1to2_State, Output3to4_State), available for user programming.

Table 7-67 LK620 Input Data Specification

Data type	Address offset(byte)	Data name	Data description
DWORD	0~3	Counter1_PresentValue	Counter 1 current count value(0~4,294,967,295)
DWORD	4~7	Counter1_StoredValue	Counter 1 stored count value(0~4,294,967,295)
DWORD	8~11	Counter2_PresentValue	Counter 2 current count value(0~4,294,967,295)
DWORD	12~15	Counter2_StoredValue	Counter 2 stored count value(0~4,294,967,295)
WORD	16	Output1to2_State	Bit0: output 1 status backward read =1, ON (channel closed) =0, OFF (channel disconnected) Bit1: output 2 status backward read =1, ON (channel closed) =0, OFF (channel disconnected)
	17	Output3to4_State	Bit0:output 3 status backward read =1, ON (channel closed) =0, OFF (channel disconnected) Bit1: output 4 status backward read =1, ON (channel closed) =0, OFF (channel disconnected)

Data type	Address offset(byte)	Data name	Data description
WORD	18	Channel1_Z_State	Bit0:counter 1 Z status =0, low level =1, high level
	19	Channel2_Z_State	Bit0: counter 2 Z status =0, low level =1, high level
WORD	20	Counter1_Rolled	Bit0: counter 1 has reached the rollover value and rollover or not =0, not rollover =1, rollovered
	21	Counter2_Rolled	Bit0: counter 2 has reached the rollover value and rollovered or not =0, not rollover =1, rollovered

7.8.10.2 Output data

As shown in Table 7-68, the output data occupies 29 words (58 bytes).

Table 7-68 LK620 Input and Output Data List

Data Type	Address Offset (byte)	Data Name	Instructions
DWORD	0~3	Counter1_PresetValue	Counter 1 preset value (0~4,294,967,295), the value must be less than the rollover value
DWORD	4~7	Counter1_RolloverValue	Counter 1 rollover value (0~4,294,967,295),frequency measurement mode, rollover value is 0.
WORD	8	Counter1_Reset	Counter 1 is reset and starts counting 0x00→0x01: Reset counter 1, counting from zero =0x01: Output channel OUT1 / OUT2 output OFF Other: no action
	9	Counter1_LoadPreset	counter 1 loading the preset value and starting counting or not 0x00→0x01: loading the preset value and counting from the preset value Other: no action
WORD	10	Output1_Control	Output 1 current output value is modified =0x00, output according to the counting result =0x02, change OUT1 output value to OFF =0x03, change OUT1 output value to ON
	11	Output2_Control	Output 2 current output value is modified =0x00, output according to the counting result =0x02, change OUT2 output value to OFF =0x03, change OUT2 output value to ON

Data Type	Address Offset (byte)	Data Name	Instructions
DWORD	12~15	Output1_ON_Value	Output 1 Output ON trigger value (0~4,294,967,295)
DWORD	16~19	Output1_OFF_Value	Output 1 Output OFF trigger value (0~4,294,967,295)
DWORD	20~23	Output2_ON_Value	Output 2 Output ON trigger value (0~4,294,967,295)
DWORD	24~27	Output2_OFF_Value	Output 2 Output OFF trigger value (0~4,294,967,295)
DWORD	28~31	Counter2_PresetValue	Counter 2 preset value (0~4,294,967,295), the value must be less than the rollover value
DWORD	32~35	Counter2_RolloverValue	Counter 2 rollover value (0~4,294,967,295), frequency measurement mode, rollover value is 0.
WORD	36	Counter2_Reset	Counter 2 is reset and starts counting 0x00→0x01: Reset counter 2, counting from zero =0x01: Output channel OUT3 / OUT4 output OFF Other: no action
	37	Counter2_LoadPreset	counter 2 loading the preset value and starting counting or not 0x00→0x01: loading the preset value and counting from the preset value Other: no action
WORD	38	Output3_Control	Output 3 current output value is modified =0x00, outputing according to the result of the count =0x02 , change out 3 output value to OFF =0x03, change OUT 3 output value to ON
	39	Output4_Control	Output 4 The current output value is modified =0x00, outputing according to the result of the count =0x02, change OUT 4 output value to OFF =0x03, change OUT 4 output value to ON
DWORD	40~43	Output3_ON_Value	Output 3 Output ON trigger value (0~4,294,967,295)
DWORD	44~47	Output3_OFF_Value	Output 3 Output OFF trigger value (0~4,294,967,295)
DWORD	48~51	Output4_ON_Value	Output 4 Output ON trigger value (0~4,294,967,295)
DWORD	52~55	Output4_OFF_Value	Output 4 Output OFF trigger value (0~4,294,967,295)
WORD	56	Counter1_ClearRolledFlag	Counter 1 clearing rollover mark 0x00→0x01: remove the rollover mark Other: no action
	57	Counter2_ClearRolledFlag	Counter 2 remove the rollover mark 0x00→0x01: remove the rollover mark Other: no action

7.8.11 Technical specifications

Table 7-69 LK620 Technical Specifications

LK620 2-Channel Counting Module	
System power supply	
Voltage	24VDC (-15%~+20%)
Power consumption	80mA@24VDC

LK620　2-Channel Counting Module	
counter	
Counter quantity	2
Counting range	0~4,294,967,295 (32 bits)
Counting error	±1counting code value
Counter input channel number	Each counter has 3-way voltage pulse signal (A, B, Z), a total of 6 pulse input
Counter output channel number	Each channel has 2-way source MOSFET output, a total of 4 DO output (OUT1 ~ OUT4)
Counter input (A1,B1,Z1,A2,B2,Z2)	
High level pulse rated voltage	24VDC
High level pulse (ON) voltage range	10~26.4VDC
High level pulse current range	2mA~7mA
Low level pulse (OFF) voltage range	0~2VDC
Low level pulse leakage current	250μA max.
Maximum input frequency	1MHz (Do not use debounce filtering)
Counter output (OUT1~OUT4)	
Output type	Source type
Output voltage range	10VDC~31.2VDC
Maximum output current	1.0A@10VDC~31.2VDC
Minimum load current	40mA/per point
Maximum on-state voltage drop	550mV
Maximum off-state leakage current	300μA/per point
Output delay time OFF→ON ON→OFF	 20μs (nomal), 50μs (longest) 60μs (nomal), 300μs (longest)
Over-current protection	Each current is protected by (Self-) Resettable fuse.
Reverse voltage protection	none, if the wiring is wrong, the output may be damaged
Isolation voltage	
Input channel and system	500VAC@1min., leakage current 5mA
Output channel and system	500VAC@1min., leakage current 5mA
Fault diagnosis and hot swapping	
Field power failure detection	Field power down: device diagnostic byte reports 0x04; recovery, reportes 0x00
Hot swapping	Yes
Comunication bus	
Protocol	Profibus-DP
Medium	the communication bus is connected with backplane by the European style connector
Physical characteristics	

LK620 2-Channel Counting Module	
The mixed pin	F2
Installation position	LK expansion backplane
Module Dimension (W*H*D)	35mm×100mm×100mm
Enclosure protection class	IEC60529 IP20
Weight	185g

7.9 LK510 4-channel Inter-channel Isolated Voltage Type Analog Output Module

7.9.1 Basic Features

- 4 channel voltage outputs, channel isolation
- Output voltage: 0~5.125V/0~10.25V/±10.25V
- Program mode output
- Communication fault output
- Output over current protection
- Calibration data error detection
- Support for PROFIBUS-DP slave station protocol
- System and field isolation
- Hot swapping

7.9.2 Operating Principle

The controller sends the output data to the LK510 via the PROFIBUS-DP bus, and converts to the voltage signal through DAC. The driver circuit receives the voltage signal from the DAC and adjusts the amplified output to control the field actuator.

The output channels are electrically isolated and the 24VDC power supply is supplied separately to each channel via isolated DC / DC conversion. At the same time, the channel interface circuit and the rest of the circuit part are connected by opto-isolator to achieve the isolation between field and system.

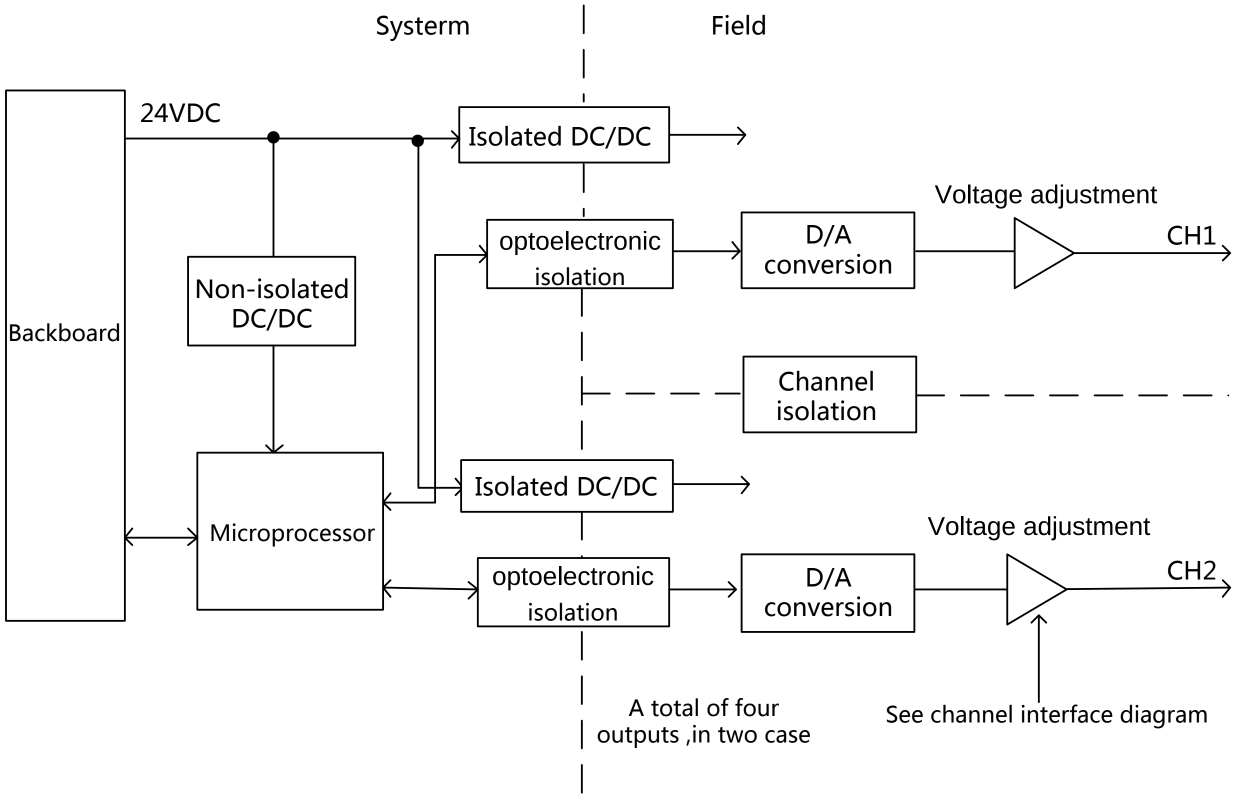


Figure 7-82　Internal Structure Block Diagram

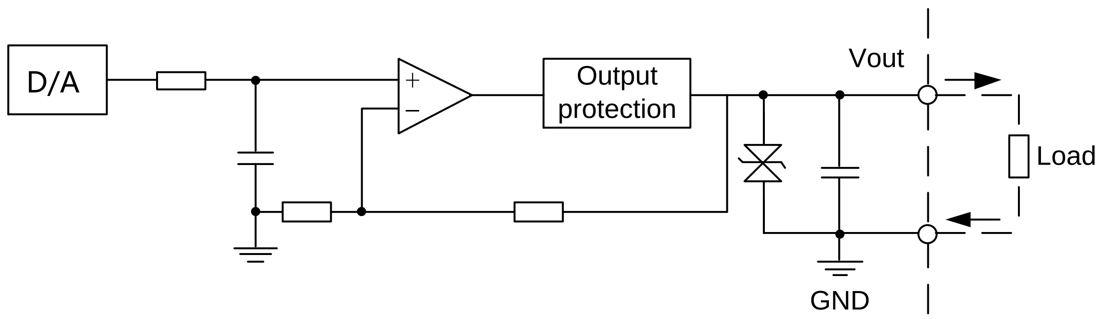


Figure 7-83　LK510 Channel Interface Circuit Diagram

7.9.3　Wirings

The LK510 modules are mounted on the expansion backplane. There are terminal wiring and prefabricated cable wiring for LK backplane, here only the terminal wiring.

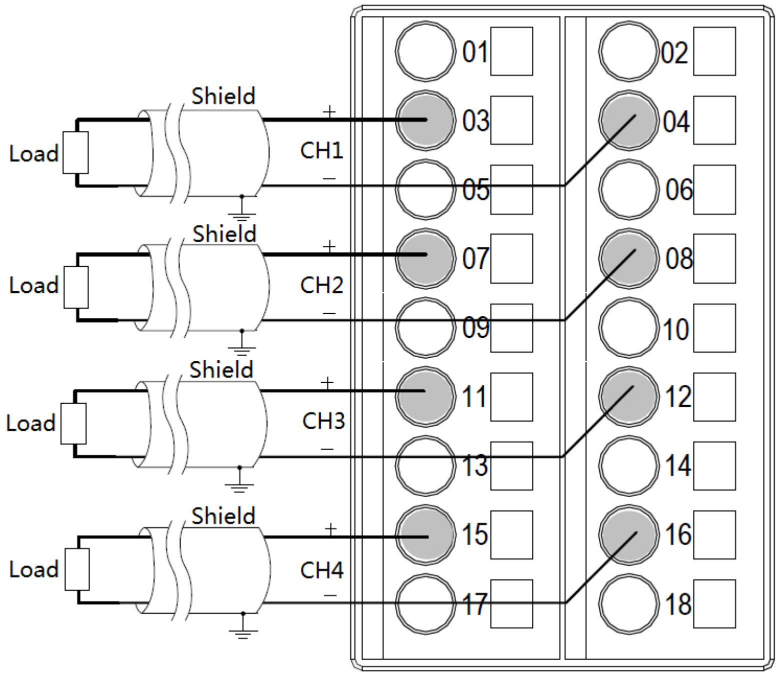


Figure 7-84 LK510 Backplane Terminal Wiring Diagram

LK510 is connected with field signal through the terminal under backplane installation slot. And the corresponding relationship between the channel and the terminal is shown in Figure 7-84. Wiring, pay attention to the following:

- The AO signal of each way is connected to the terminals with two wires (shielded cable).
- Odd terminal is connected to voltage positive terminal, even terminal is connected to voltage negative terminal.
- The terminals that are not connected in the figure are prohibited wiring.
- Do not connect multiple cables on the same terminal at the same time. You can achieve multipoint connection via bus-bar or conversion terminal.

7.9.4 Functions

7.9.4.1 Data format

As shown in Table 7-70, the output data sent to the AO channel of LK510 from controller is represented by a 2-byte positive integer (decimal 0 to 65535) digital code, where the range (-10.25 to + 10.25V) is divided into two sections. The positive voltage (0 ~ 10.25V) corresponds to the decimal digital code (0 ~ 32767), and the negative voltage (-10.25V ~ 0) corresponds to the decimal digital code (32768 ~ 65535).

Table 7-70 Corresponding Relationship between Output Voltage and Digital Code

Output Range		Decimal Digital Code
-10.25~+10.25V	0~10.25V	0~32767
	-10.25V~0V	32768~65535
0~10.25V		0~65535

Output Range	Decimal Digital Code
0~5.125V	0~65535

The conversion formula between the output data of the voltage range (-10.25 ~ + 10.25V) and the physical quantity is as follows:

- Positive voltage 0 ~ + 10.25V: Voltage value (V) = Output data /32767 × 10.25
- Negative voltage -10.25 ~ 0V: Voltage value (V) = (output data -65535) / 32767 × 10.25

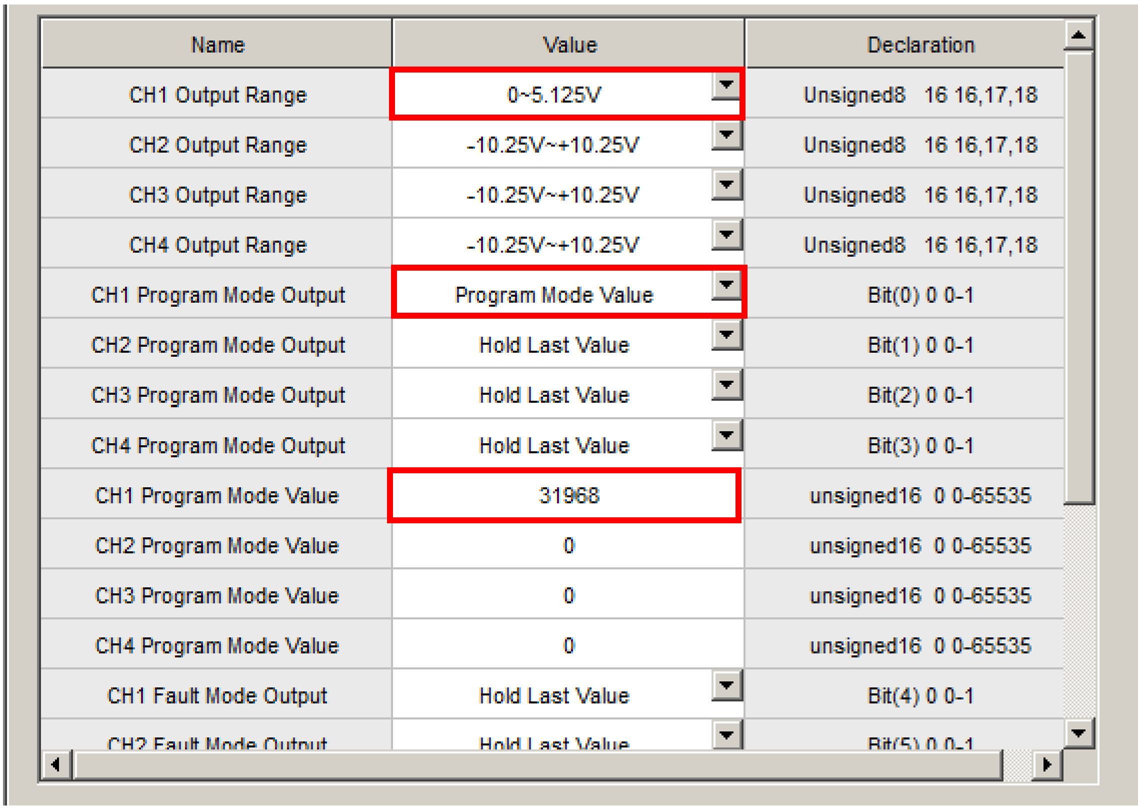
By calling the function block ENGIN_ HEX of the Analog signal Processing Functions library in the programming software AutoThink, it can convert the engineering data into the 2-byte digital code. Refer to the *HollySys Programmable Logic Controller PLC Instruction Manual* for the specific application of the function blocks.

When setting the fault mode setting value and the programming mode setting value in the user parameter, the voltage signal needs to be converted into decimal digital code and then fill in. The digital code conversion method varies from ranges.

- For 0 ~ 10.25V, 0 ~ 5.125V range, conversion formula of the signal corresponding code value:

  Corresponding code value = voltage signal × 65535 / full scale value[6]

  For example, channel 1, if the range "0 ~ 10.25V" is selected and the user-defined programming mode output is 5V, the full-range voltage is 10.25V, programming mode set value = 5 × 65535 / 10.25 = 31968, the relevant user parameters settings are shown in Figure 7-85.



Name	Value	Declaration
CH1 Output Range	0~5.125V	Unsigned8 16 16,17,18
CH2 Output Range	-10.25V~+10.25V	Unsigned8 16 16,17,18
CH3 Output Range	-10.25V~+10.25V	Unsigned8 16 16,17,18
CH4 Output Range	-10.25V~+10.25V	Unsigned8 16 16,17,18
CH1 Program Mode Output	Program Mode Value	Bit(0) 0 0-1
CH2 Program Mode Output	Hold Last Value	Bit(1) 0 0-1
CH3 Program Mode Output	Hold Last Value	Bit(2) 0 0-1
CH4 Program Mode Output	Hold Last Value	Bit(3) 0 0-1
CH1 Program Mode Value	31968	unsigned16 0 0-65535
CH2 Program Mode Value	0	unsigned16 0 0-65535
CH3 Program Mode Value	0	unsigned16 0 0-65535
CH4 Program Mode Value	0	unsigned16 0 0-65535
CH1 Fault Mode Output	Hold Last Value	Bit(4) 0 0-1
CH2 Fault Mode Output	Hold Last Value	Bit(5) 0 0-1

Figure 7-85 Example of Program Mode Parameter Setting under Selected Range

[6] full scale value equals to the Max. measurable vaule subtracting Min. measurable vaule.

- For -10.25 ~ +10.25V range, the conversion formula of signal corresponding code value:

  Positive voltage range (0 ~ 10.25V): Corresponding code value = Positive voltage signal × 32767 / 10.25

  Negative voltage range (-10.25 ~ 0V): Corresponding code value = 65535 + (negative voltage signal × 32767 / 10.25)

  For example, channel 3, if the range "-10.25 ~ +10.25V" is selected and the user-defined fault mode output is -9V, the output value of fault mode = 65535 + (- 9 × 32767 / 10.25) V = 36764, the relevant user parameters settings are shown in Figure 7-86.

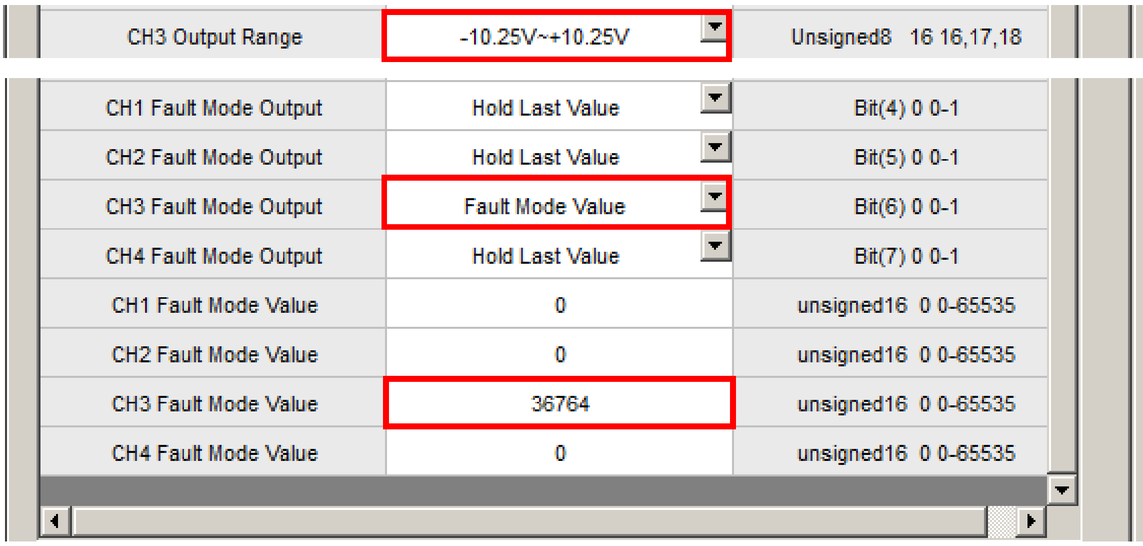


Figure 7-86 Example of Over-limit Alarm Parameter Setting under Selected Range

7.9.4.2 Over-current protection

The output channel has over-current protection function. When the circuit is shorted, the channel maximum output current is less than 25mA, which effectively protect the module internal circuit from being damaged.

7.9.5 Parameter

The user parameter is used to set the operation mode of the module and is written into the controller when the user program is downloaded. It is not read by each scan cycle. Each parameter has a default value that can be changed according to the engineering requirements. User parameters do not support online changes, modification takes effect when it is complete downloaded.

The LK 510 user parameter occupies 21 bytes.

Table 7-71 LK510 User Parameter List

<table>
<tr><th>Parameter Name</th><th>Parameter Description</th><th>Value</th></tr>
<tr><td>CH1 Output Range</td><td>CH1 Range Selection</td><td rowspan="4">16: -10.25~+10.25V(default)
17: 0~10.25V
18: 0~5.125V</td></tr>
<tr><td>CH2 Output Range</td><td>CH2 Range Selection</td></tr>
<tr><td>CH3 Output Range</td><td>CH3 Range Selection</td></tr>
<tr><td>CH4 Output Range</td><td>CH4 Range Selection</td></tr>
</table>

Parameter Name	Parameter Description	Value
CH1 Program Mode Output	CH1 Program Mode Output Selection	0:Hold Last Value, output hold (default) 1: Program Mode Value, Output program mode setting value
CH2 Program Mode Output	CH2 Program Mode Output Selection	
CH3 Program Mode Output	CH3 Program Mode Output Selection	
CH4 Program Mode Output	CH4 Program Mode Output Selection	
CH1 Program Mode Value	CH1 Programming Mode Set Value	0 (default)~65535 See 7.9.4.1Data format for calculation method
CH2 Program Mode Value	CH2 Programming Mode Set Value	
CH3 Program Mode Value	CH3 Programming Mode Set Value	
CH4 Program Mode Value	CH4 Programming Mode Set Value	
CH1 Fault Mode Output	CH1 Fault Mode Output Selection	0: Hold Last Value, output hold (default) 1: Fault Mode Value,output fault mode setting value
CH2 Fault Mode Output	CH2 Fault Mode Output Selection	
CH3 Fault Mode Output	CH3 Fault Mode Output Selection	
CH4 Fault Mode Output	CH4 Fault Mode Output Selection	
CH1 Fault Mode Value	CH1 Fault Mode Set Value	0(default)~65535 See 7.9.4.1Data format for calculation method
CH2 Fault Mode Value	CH2 Fault Mode Set Value	
CH3 Fault Mode Value	CH3 Fault Mode Set Value	
CH4 Fault Mode Value	CH4 Fault Mode Set Value	

7.9.6 Technical Specifications

Table 7-72 Technical Specifications

LK510 4 Channel isolation voltage analog output module				
Backplane power supply				
Supply Voltage	24VDC(-15%~+20%)			
Power consumption	125mA max. @ 24VDC			
Output channel				
Number of channels	4			
Range code	18	17	16	
Range	0~5.125V	0~10.25V	-10.25~0V	0~+10.25V
Output data format	0~ 65535	0~65535	32768~65535	0~32767

LK510　4 Channel isolation voltage analog output module	
Setting time	＜2ms
DAC resolution ratio	14bits
Loading capability	≥2KΩ
Power-on reset output (cold start)	0V
Elevtricity reset output (hot start)	Keep the output before resetting
Output accuracy	0.2% F.S.
Stability	0.05% F.S.
Temperature drift	25ppm/℃
Isolation voltage	
Field and system	500VAC@1min, leaking current 5mA
Channel and channel	500VAC@1min, leaking current 5mA
Fault diagonsis	
Calibration data error diagnosis	At power-up, calibrate the data error and the device diagnostic byte reports 0xA2; no error, no report.
Communication bus	
Protocal	PROFIBUS-DP
Redundancy	Dual network redundancy
Baud rate	Selectable Baud rate: 1.5Mbps, 500kbps, 187.5kbps, 93.75kbps, 45.45kbps, 31.25kbps, 19.2kbps, 9.6kbps
Physical characteristics	
Installation method	Backplane slot mounting
Installation position	LK expansion backplane
Protection Key	C0
Module Dimension (W*H*D)	35mm×100mm×100m
Hot swapping	Supported
Enclosure protection class	IEC60529 IP20
Weight	180g

7.10 LK511　4-channel Inter-channel Isolated Current Type Analog Output Module

7.10.1 Basic Features

■ 4-channel current output, inter-channel isolation

- Output signal range: 4~20 mA/0~21 mA
- Electrical isolation between the channel and the system
- Fault mode output
- Programming mode output
- Self-diagnosis of the output read-back channel
- Line broken detection
- Field calibration
- Hot swapping

7.10.2 Operating Principle

The CPU module sends the output data to LK511 via the PROFIBUS-DP bus, which is converted into a voltage signal via DAC. The drive circuit receives the voltage signal output from DAC and then output it after voltage-current conversion and regulation to control the operation of the field actuator.

Electrical isolation is provided between the output channels. The 24 VDC power supply supplies power to each channel separately upon isolated DC/DC conversion. In the meantime, the interface circuit of each channel is connected via opto-isolators with other circuits, thus realizing the isolation between the field and the system.

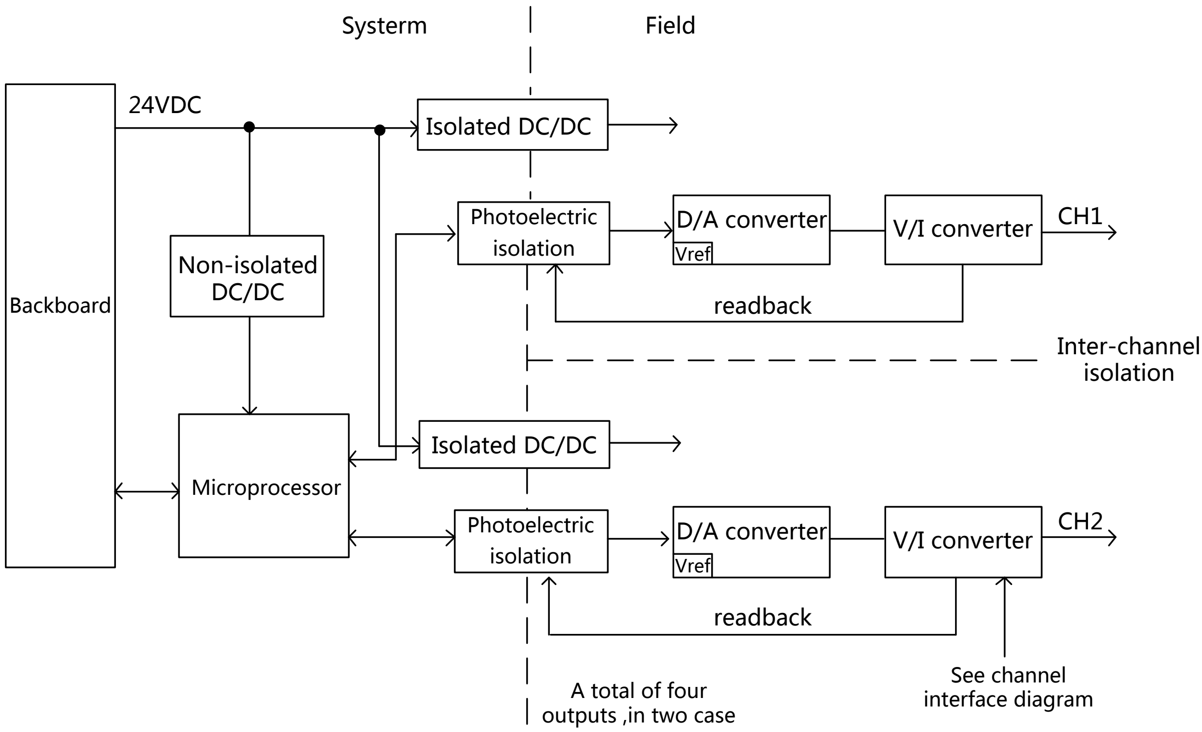


Figure 7-87 Internal Structure Block Diagram of LK511

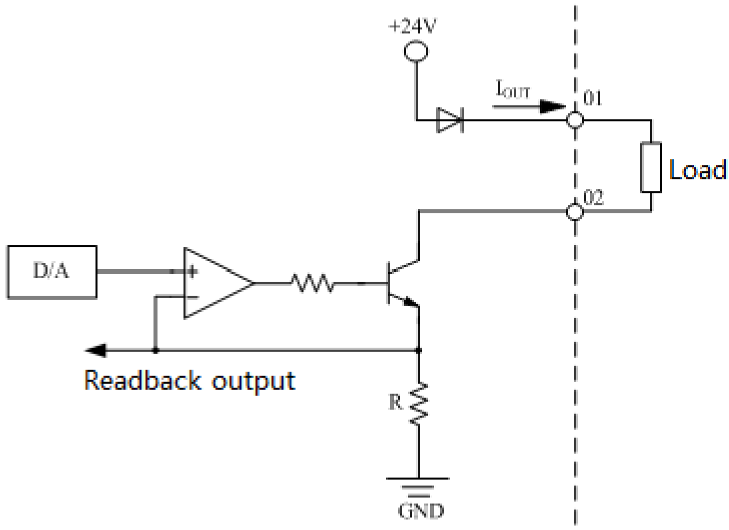


Figure 7-88 LK511 Channel Interface Circuit Diagram

7.10.3 Status Indicator

There are two status lamps on the front panel of the module: the green RUN lamp and the yellow CAL lamp. The RUN lamp is the run indicator lamp, indicating the communication status between the module and the CPU module. The CAL lamp is the calibration indicator lamp, indicating the calibration process.

The LK511 module supports field calibration. The meanings of the indicator lamp are different when in the running mode and the calibration mode.

- Running Mode
  - Immediately after being powered on, the module waits for the initialized data, with the green lamp flashing based on a frequency of 4 times/second.
  - Upon the completion of initialization, the green lamp is turned normally on, which indicates that the module works well. In case of any error in the initialized data, communication cannot be established and the green lamp keeps flashing. Check whether the communication parameters are set correctly.
  - When the communication is normal, the green lamp is normally on. When the communication is disconnected, the green lamp flashes. When the communication is established again, the green lamp is turned on again.
  - The yellow lamp is normally off when in the running mode.

Table 7-73 Definition of LK511 Status Indicator in Running Mode

	RUN Lamp	CAL Lamp	Meaning
Running Mode	Off	Off	Not powered up
	Flash	Off	The communication is not established or incorrect.
	On	Off	The communication is established, the module works well

- Calibration Mode
  - Immediately after being powered on, the module waits for the initialized data, with the green lamp flashing based on a frequency of 4 times/second.

- Upon the completion of initialization, if the calibration and detection is not executed, the module then waits for the calibration and detection instruction, with the yellow lamp flashing based on a frequency of 4 times/second. When the CPU module gives the calibration and detection instruction and the module is undergoing calibration and detection, the yellow is turned normally on. Upon the completion of calibration and detection, the yellow lamp then flashes again.
- During calibration and detection, the green lamp is normally no. When the communication is disconnected, the green lamp flashes. When the communication is established again, the green lamp is turned normally on again
- When the communication is not established or disconnected, the yellow lamp then goes out.

Table 7-74 Definition of LK511 Indicator Light in Calibration Mode

	RUN Lamp	CAL Lamp	Meaning
Calibration Mode	Off	Off	Not powered up
	Flash	Off	The communication is not established or incorrect.
	On	On	Under calibration and detection
		Flash	Calibration and detection is not conducted or is completed

7.10.4 Wirings

The LK511 module be installed on the extension backboard. The LK backboard can provide both terminal connection and precast cable connection. Only the backboard terminal connection is discussed here.

Table 7-75 Definition of LK511 Backboard Terminals

Channel No.	Sequence of Terminals	
	Current Output Terminal (Positive)	Current Input Terminal (Negative)
1	01	02
2	05	06
3	09	10
4	13	14

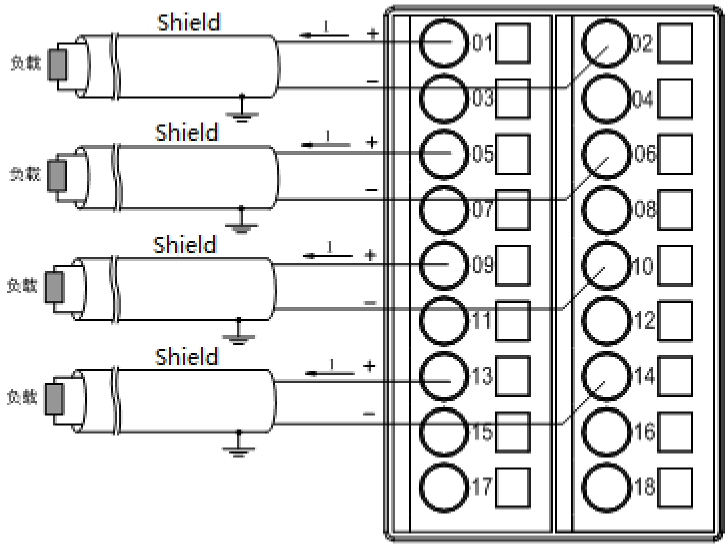


Figure 7-89 LK511 Backboard Terminal Wiring Schematic Diagram

Pay attention to the following during wiring:

- The two-row 18-channel terminals are fixed on the backboard, right located under the installation position of the LK511 module.
- The terminals that are not listed in Table 7-75 cannot be used, with wiring forbidden.
- The 4-channel current type AO only uses the 4 terminal pairs as shown in Figure 7-89, with other terminals not used and wiring forbidden.
- Each signal is separately connected to the field device via two conductors (shielded cable).
- Upon the wiring, check whether the cable is connected properly. Do not hold the naked line exposed in order to avoid a short-circuit hazard.

7.10.5 Data Format

As shown in Table 7-76, the AO channel output data that is sent by the CPU module to LK411, is expressed in form of 2-byte positive integer (decimal: 0~65,535) digital code.

Table 7-76 Corresponding Relationship between LK511 Output Current and Digital Code

Output Range	Corresponding Decimal Digital Code
4~20mA	0~65,535
0~21mA	0~65,535

By calling the function block ENGIN_ HEX of the Analog signal Processing Functions library in the programming software AutoThink, it can convert the engineering data into the 2-byte code value data. Refer to the *HollySys Programmable Logic Controller PLC Instruction Manual* for the specific application of the function blocks.

When setting the fault mode and the program mode in the [User parameters], input the current after converting it into a decimal digital code according to the formula listed in Table 7-77.

Table 7-77 Data Conversion Formula LK511 Module

Output Range	Formula of Corresponding Code Values

Output Range	Formula of Corresponding Code Values
4 mA≤I≤20 mA	(I—4) ×65,535/16(I-4) ×65,535/ 16
0 mA≤I≤21 mA	I×65,535/21

Example 1: for Channel 1, in case the range is selected as 4~ 20 mA, the user-defined fault mode outputs 15mA, then the Channel 1 Fault Mode Output setting=(15-4)×65,535/16=45,055. Refer to Figure 7-90 for the relevant user parameter settings.

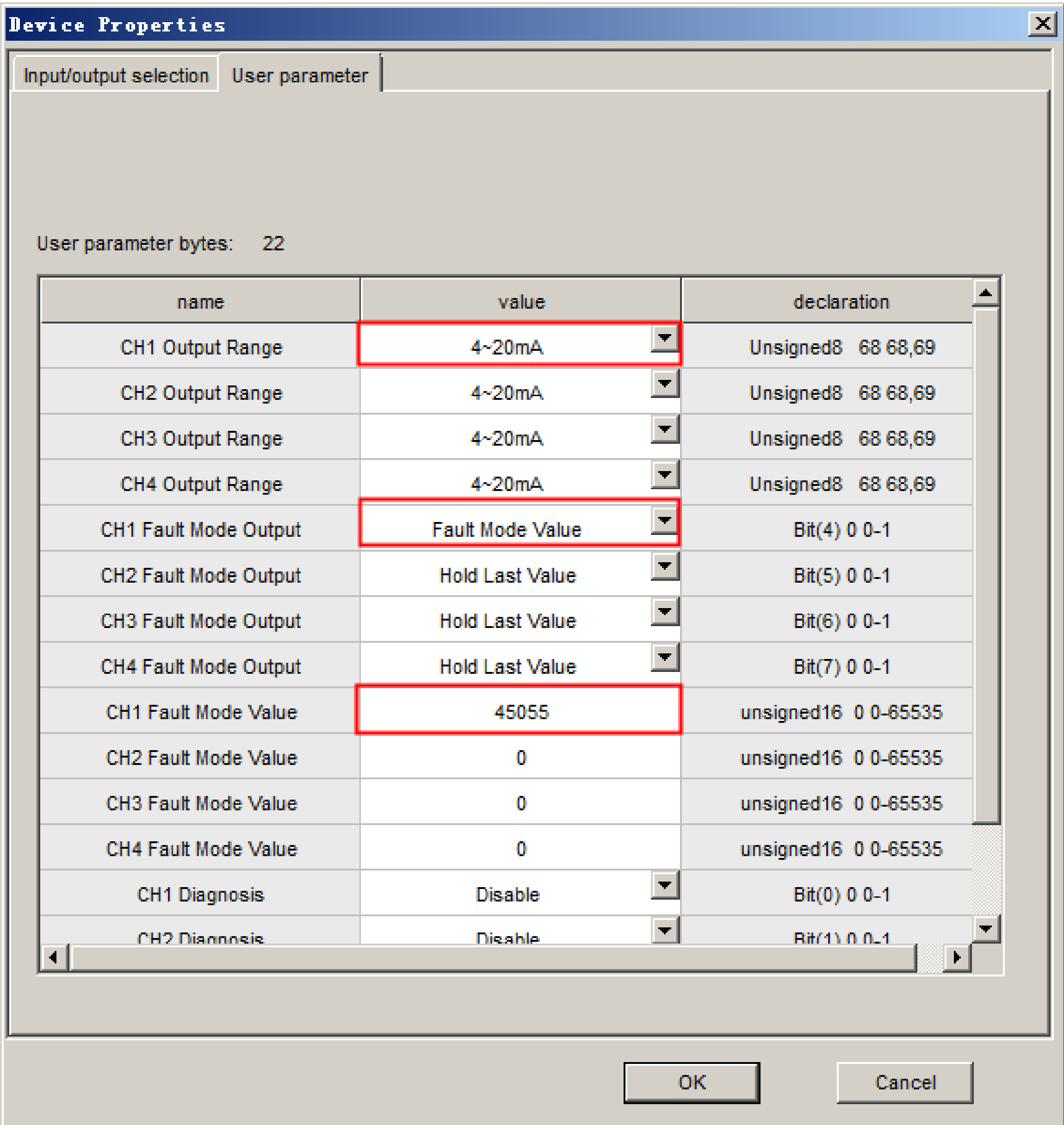


Figure 7-90 Examples of Fault Mode Parameter Settings Based on Selected Range

7.10.6 Functions

7.10.6.1 Output Enable

After the output module is powered on, if the output instruction given from the CPU module is not received, then it is in the initial status, with no output. For a module in the initial status, the output cannot be enabled. In this case, it holds its initial status even when in the fault modes.

After running the user program, the CPU module sends the output instruction to the module via the PROFIBUS-DP bus. The module receives the control instruction and outputs. Once the instruction given from the CPU module is output, output is then enabled for the slave station module. When in the fault modes, the output enabled module outputs the values for the fault modes.

In summary, whether output has been enabled after powering on the output module, shall affect the output status in the fault modes.

After the output is enabled, the module goes on with the plug module or is powered up again upon power failure. The module returns to the initial status, with the output disabled. After receiving the output instruction of the CPU module, the output is re-enabled.

7.10.6.2 Communication Fault

In case of a communication fault, the communication between the module and the CPU module is disconnected, with the **RUN** lamp flashing.

After the module is powered up, whenever a communication fault occurs, the module then enters the fault mode automatically, outputting certain status (default value) pre-set in the configuration: Output Hold (Hold Last State) or the output fault mode settings (Fault Mode State).

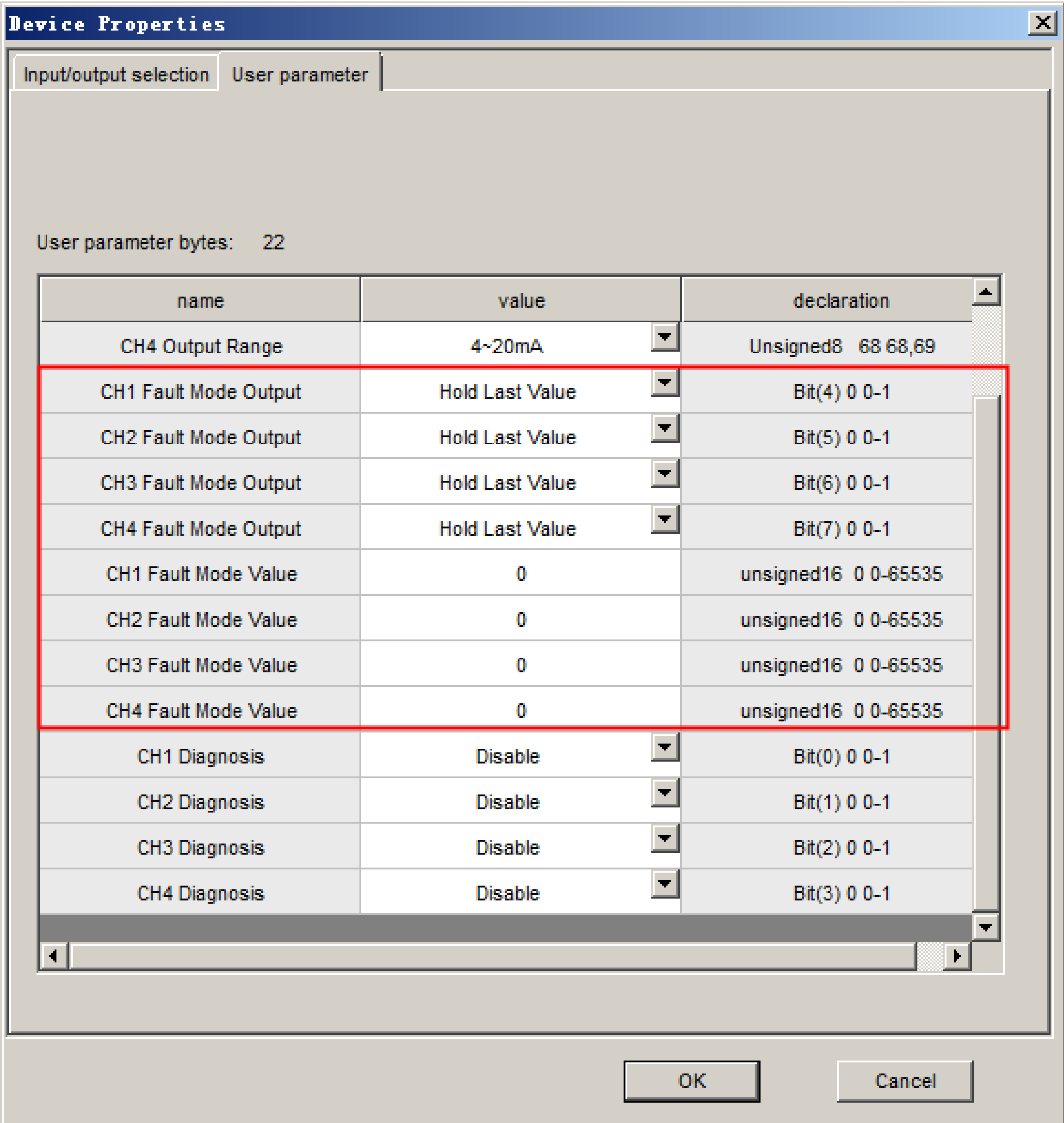


Figure 7-91 Fault Mode Output Settings

In the fault mode, it can select Output Hold or Output Program Fault Mode Settings via the user parameter **Fault Mode Output**, defaulted to Output Hold (Hold Last Value). The fault mode settings are set via the user parameter **Fault Mode Value**, defaulted to Output 0 V. Refer to Section 7.10.5 Data Format for the fault mode settings.

Each channel parameter is set separately, without interfering each other. The modification takes effect only upon full download.

7.10.7 Diagnosis

The output channel of LK511 module is capable of line broken diagnosis and channel output fault diagnosis, which are of a channel diagnosis. After calling the function block sysGetDPSlaveState (Get Diagnosis of DP Slave), the channel diagnosis data reported by LK511 is saved into the output parameter **DiagData** in the function block.

Diagnostic information of LK511 up to 16 bytes, wherein 2 bytes are device-related diagnosis, 2 bytes are identification diagnosis and 12 bytes are channel diagnosis. The four channels in LK511, the diagnosis information for each channel 3 bytes. Diagnosis information diagram refer to Figure 7-26.

- Device diagnosis information

  Device diagnosis data 0x02, 0x00 indicates the current device without any fault.

  Device diagnosis data 0x02, 0x01 indicates that the current device has channel fault.

  Device diagnosis data 0x02, 0x02 indicates that the current device checking data error.

  Device diagnosis data 0x02, 0x03 indicates that the current device have both channel fault and checking data error.

- Identification diagnosis information

  The 2-byte identification diagnosis information is 0x42, 0x01 when diagnosis information is reported.

- Channel diagnosis information

  Channel diagnosis information as shown in Table 7-78.

Table 7-78 Specifications for LK511 Channel Diagnosis Information

<table>
<tr><th colspan="6">Diagnosis Information</th><th>Meaning</th></tr>
<tr><td colspan="2">Bit</td><td>Bit7</td><td>Bit6</td><td>Bit5</td><td>Bit4~ Bit0</td><td></td></tr>
<tr><td>The first byte</td><td>Head</td><td colspan="4">0x80</td><td>Decimal online value 128</td></tr>
<tr><td>The second byte</td><td>I/O type/channel</td><td colspan="2">10 (Output)</td><td colspan="2">（Channel）</td><td>Fault channel no. 1~4
Decimal online value 128~131</td></tr>
<tr><td rowspan="3">The third byte</td><td rowspan="3">Channel data type/fault type</td><td colspan="3" rowspan="3">101 (Word)</td><td>6</td><td>Line broken, Decimal online value is 166</td></tr>
<tr><td>18</td><td>Channel output fault, Decimal online value is 178</td></tr>
<tr><td>0</td><td>Channel fault recovery, Decimal online value is 160</td></tr>
</table>

Example:

Channel diagnosis data 0x80, 0x82, 0xA6 indicates that channel 3 has line broken fault.

The LK511 module is designed for a channel read-back diagnosis circuit for its hardware. The channel output data is uploaded to the CPU module by means of read-back. The user can access to and check the output signal at any time, thus further improving the reliability in AO control. In the meantime, the LK511 module automatically detects the output status of the channel via the read-back data, realizing fault diagnosis.

The 0~4 mA range of each channel is the read-back circuit dead zone. Therefore, for the 0~21 mA range, the effective read-back diagnosis range is 4~21 mA. For the current in the 0~4 mA range, the read-back diagnosis of the module becomes invalid automatically. For a 4~20 mA range, read-back diagnosis holds valid in the full range.

The LK511 can conduct line broken and output fault diagnosis to the output channel via the read-back value. The CPU module compares the read-back value and theoretical one, diagnoses the channel status and reports the diagnosis data. The rules are given below:

- When the read-back current is ＜4 mA, the output loop is disconnected, the channel is broken and the channel diagnosis byte reports line broken.
- When the error between the read-back value and theoretical one is more than 5% of the full range, the channel diagnosis byte reports channel output fault.
- When all the faults of the channel are recovered, the channel diagnosis byte reports fault recovery.
- When the channel is not loaded, it is considered as that the channel is broken, with line broken reported.

The LK511 module only reports the diagnosis data once separately when a fault occurs and is recovered. Due to the different output ranges selected by the user, the handling methods of the module may also differ in case of a fault, as shown in Table 7-79. When all the channel faults are recovered and outputs normally, the channel diagnosis byte reports 0xA0.

Table 7-79 LK511 Channel Fault Handling Based on Different Ranges

Output Range	Effective Diagnosis Range	Fault Type	Handling, Read-back Data and Diagnosis Byte
4~20 mA	4~20 mA	Line broken	The channel read-back data reports 0xA0 The channel diagnosis byte reports the line broken fault value 0xA6
		Output fault	1. The error between the actual read-back value and theoretical one is more than 5% of the full range 2. The channel diagnosis byte reports the output fault value 0xB2
0~21 mA	4~21 mA	Line broken	1. The code value reported by the channel read-back data is ≈0X22 (that is, not zero) 2. The channel diagnosis byte reports the line broken fault value 0xA6
		Output fault	1. The error between the actual read-back value and theoretical one is more than 5% of the full range 2. The channel diagnosis byte reports the output fault value 0xB2

It can select whether to conduct line broken diagnosis and output fault diagnosis in the configuration, defaulted to disable. If the channel is not connected, it can be considered as broken. It is suggested to disable the diagnosis function for channels that are not used, that is, to hold the default parameter **Diagnosis** unchanged.

7.10.8 Parameters

The [User parameter] is used to set the operation mode of the module. The CPU module written when downloading the user program may not be read in each scanning period. Each parameter has a default, which can be modified according to the project requirements. The user parameter does not support online modification. The modification takes effect only upon full download.

The user parameter length of the LK511 module is up to 22 bytes, used to set change range, fault mode output, and fault mode output value, channel diagnosis enable.

Table 7-80 Table of LK511 User Parameters

Parameter Name	Meaning	Value

Parameter Name	Meaning	Value
CH1 Output Range	To select the range of Channel 1	68: 4~ 20 mA (default) 69: 0~21 mA
CH2 Output Range	To select the range of Channel 2	
CH3 Output Range	To select the range of Channel 3	
CH4 Output Range	To select the range of Channel 4	
CH1 Fault Mode Output	Fault mode output value for Channel 1	0: Hold Last Value, Output Hold (default) 1: Fault Mode Value, Output fault Mode Settings.
CH2 Fault Mode Output	Fault mode output value for Channel 2	
CH3 Fault Mode Output	Fault mode output value for Channel 3	
CH4 Fault Mode Output	Fault mode output value for Channel 4	
CH1 Fault Mode Value	Fault mode settings for Channel 1	0 (fault) ~65,535 Refer to Section 7.10.5 Data Format for the calculation method.
CH2 Fault Mode Value	Fault mode settings for Channel 2	
CH3 Fault Mode Value	Fault mode settings for Channel 3	
CH4 Fault Mode Value	Fault mode settings for Channel 4	
CH1 Diagnosis	To enable Channel 1 diagnosis	0: Disable 1: Enable
CH2 Diagnosis	To enable Channel 2 diagnosis	
CH3 Diagnosis	To enable Channel 3 diagnosis	
CH4 Diagnosis	To enable Channel 4 diagnosis	

- Channel Diagnosis Enable includes Channel Line Break Diagnosis Enable and Output Fault Diagnosis Enable.

7.10.9 Data Area

The LK511 data area is divided for input data and output data. The output data is the current signal that is sent by the CPU module to the LK511 output channel, which occupies four character variables, with each character variable (0~65,535) corresponding to one channel output data. The input data is the channel read-back data uploaded to the CPU module via LK511, which occupies four character variables, with each character variable (0~255) corresponding to one channel read-back data.

Table 7-81 Table of LK511 Input/output Data

Definition of Areas	Data Length	Data Definition	Value Range	Corresponding Current Value
Output Data	1WORD	Output data for Channel 1	0x0000~0xFFFF	0x0000 corresponds to 4 mA or 0 mA 0xFFFF corresponds to 20 mA or 21 mA
	1WORD	Output data for Channel 2	0x0000~0xFFFF	
	1WORD	Output data for Channel 3	0x0000~0xFFFF	

Definition of Areas	Data Length	Data Definition	Value Range	Corresponding Current Value
	1WORD	Output data for Channel 4	0x0000~0xFFFF	
Input Data	1BYTE	Read-back data for Channel 1	0x00~0xFF	0x00 corresponds to 4 mA or 0 mA 0xFF corresponds to 20 mA or 21 mA
	1BYTE	Read-back data for Channel 2	0x00~0xFF	
	1BYTE	Read-back data for Channel 3	0x00~0xFF	
	1BYTE	Read-back data for Channel 4	0x00~0xFF	

7.10.10 Technical Specifications

<table>
<tr><th colspan="5">LK511 4-channel Inter-channel Isolated Current Type Analog Output Module</th></tr>
<tr><td colspan="5">System Power</td></tr>
<tr><td colspan="3">Operating Voltage</td><td colspan="2">24VDC（-15%~20%）</td></tr>
<tr><td colspan="3">Power</td><td colspan="2">180 mA max.@24 VDC (that is, all the 4 channels output based on 20 mA)</td></tr>
<tr><td colspan="5">Output channel</td></tr>
<tr><td colspan="3">Number of channels</td><td colspan="2">4</td></tr>
<tr><td colspan="3">Range Code</td><td>68</td><td>69</td></tr>
<tr><td colspan="3">Output Range</td><td>4~20 mA</td><td>0~21 mA</td></tr>
<tr><td colspan="3">Output Data Format</td><td>0x0000~0xFFFF</td><td>0x0000~0xFFFF</td></tr>
<tr><td colspan="3">Readback Data Format</td><td>0x00~0xFF</td><td>0x00~0xFF</td></tr>
<tr><td colspan="3">Output Setup Time</td><td colspan="2">＜2 ms</td></tr>
<tr><td colspan="3">Load Capacity</td><td colspan="2">750 Ω max.</td></tr>
<tr><td colspan="3">DAC Resolution</td><td colspan="2">12-bit</td></tr>
<tr><td colspan="3">Readback ADC Resolution</td><td colspan="2">8-bit</td></tr>
<tr><td colspan="3">Channel Output Temperature Drift</td><td colspan="2">±50 ppm/℃</td></tr>
<tr><td colspan="3">Isolation Voltage between Channel and System</td><td colspan="2">500 VAC@1 min, leaking current: 5 mA</td></tr>
<tr><td colspan="3">Isolation Voltage between Channels</td><td colspan="2">500 VAC@1 min, leaking current: 5 mA</td></tr>
<tr><td rowspan="2">Reset Output</td><td colspan="2">Power On Reset (cold start)</td><td colspan="2">0 mA</td></tr>
<tr><td colspan="2">Charged Reset (warm start)</td><td colspan="2">Output Hold</td></tr>
<tr><td rowspan="3">Accuracy</td><td rowspan="2">Output</td><td>0~4 mA Range</td><td colspan="2">0.6% F.S.@ 25℃</td></tr>
<tr><td>4~21 mA Range</td><td colspan="2">0.3% F.S.@ 25℃</td></tr>
<tr><td colspan="2">Readback</td><td colspan="2">In the 4~21 mA range, the 0~4 mA range is the readback dead zone, with the readback data in the range approximating to 4 mA</td></tr>
</table>

LK511 4-channel Inter-channel Isolated Current Type Analog Output Module		
Stability	Output	0.05% F.S.@ 25℃
	Readback	2.5% F.S.@ 25℃
Failure Diagnosis and Hot Plug		
Line broken detection		When the channel is broken (Configure Enable), the diagnosis then reports 0xA6. When the fault recovered, it then reports 0xA0
Output Fault Detection		In case of a channel output fault (Configure Enable), the diagnosis then reports 0xB2. When the fault recovered, it then reports 0xA0
Hot Plugging		Supported
Physical Property		
Protection Key		C1
Installation Position		Extension backboard
Module Dimension (W*H*D)		35 mm×100 mm×100 mm
Enclosure Protection Rating		IEC60529 IP20
Weight		180 g

Chapter 8 Accessory

8.1 LKA101 PROFIBUS-DP Bus Connector Module

LKA101 is the PROFIBUS-DP bus connector module. It switches the redundancy DP signal of the previous backboard to the next one. In the meantime, it also provides the active terminal matching resistance for the PROFIBUS-DP bus. The matching resistance is selected via the DIP switch. If the connector is at the end point of the bus, it must be connected to the matching resistance.

The DB9 plug of LKA101 matches the DB9 receptacle on the backboard that is used as the DP communication extension interface. Each LKA101 is installed with one receptacle.

8.1.1 Appearance and Size

8.1.1.1 Appearance

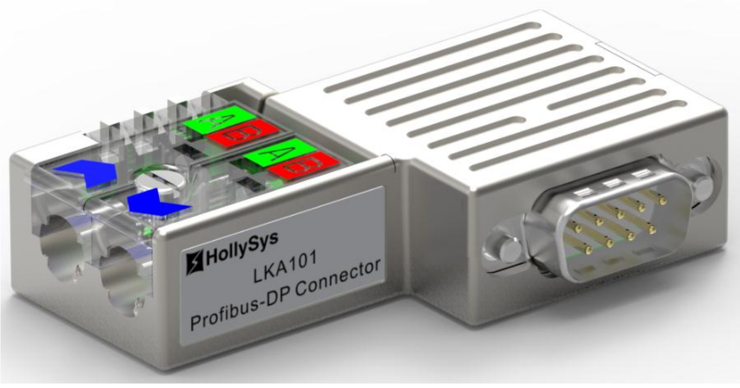


Figure 8-1 External View of LKA101 Module

8.1.1.2 Module Dimension

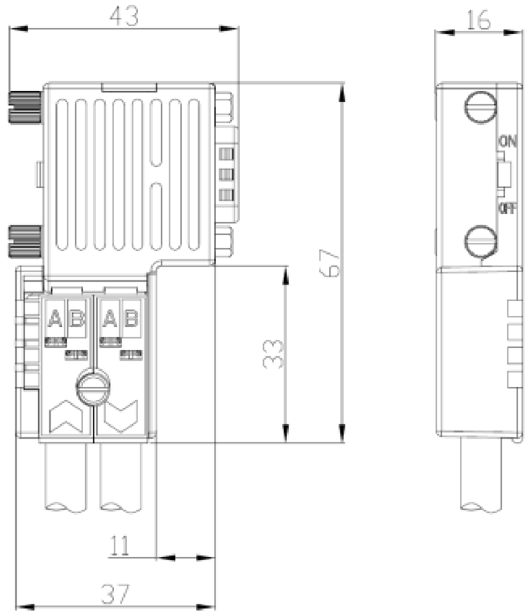


Figure 8-2 LKA101 Dimension Figure

8.1.2 Operating Principle

The LKA101 bus connector is as shown in Figure 8-3. The DP input signal is input to the backboard via the DPIN pin. The DP output signal is output via the DPOUT pin, and connected to the next backboard. You can set whether to connect matched resistors by selecting positions ON, OFF of dial switch.

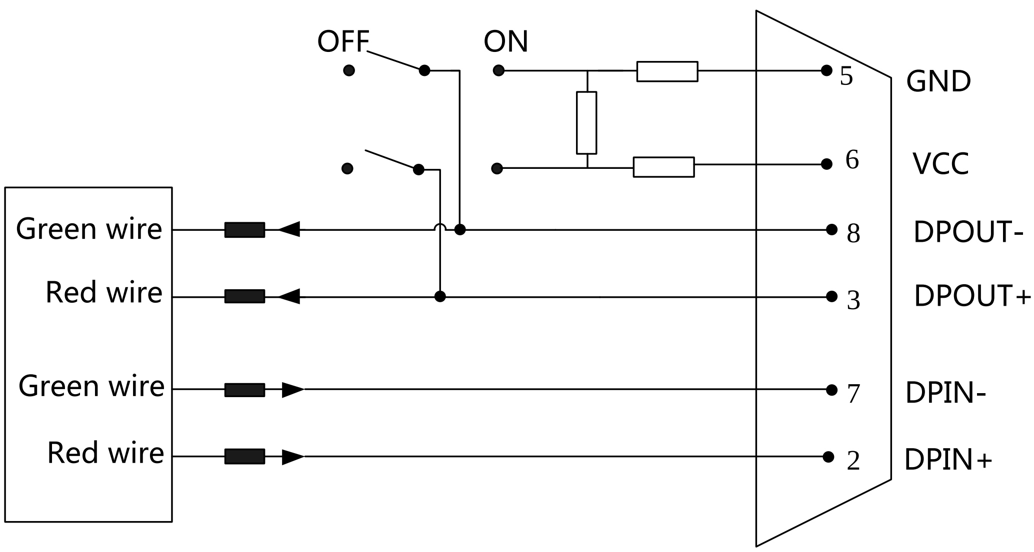


Figure 8-3 LKA101 PROFIBUS-DP Bus Connector Schematic Diagram

8.1.3 Terminal Matching Resistance

At the terminal node of the DP bus, a matched resistance is bridged over for impedance matching. The node in the middle cannot be connected with a matched resistance.

For the LK system, the matched resistance at one end of the DP bus is provided by the local backboard with no user settings. The matched resistance of the other end can be provided by the LKA101 connector or the communication module, which can be set by the user according to the actual situation.

It can connect only one terminal resistance on LKA101 or the communication module, with no repeated settings allowed. To facilitate operation, it is recommended of using the matched resistance on the LKA101 connector.

Select the matched resistance on LKA101 by dial switch, which has two positions such as ON, OFF, as shown in Figure 8-4.

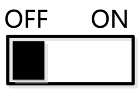


Figure 8-4 DIP Switch Schematic Diagram

- Switched to ON: connect the matched resistance
- Switched to OFF: disconnect the matched resistance

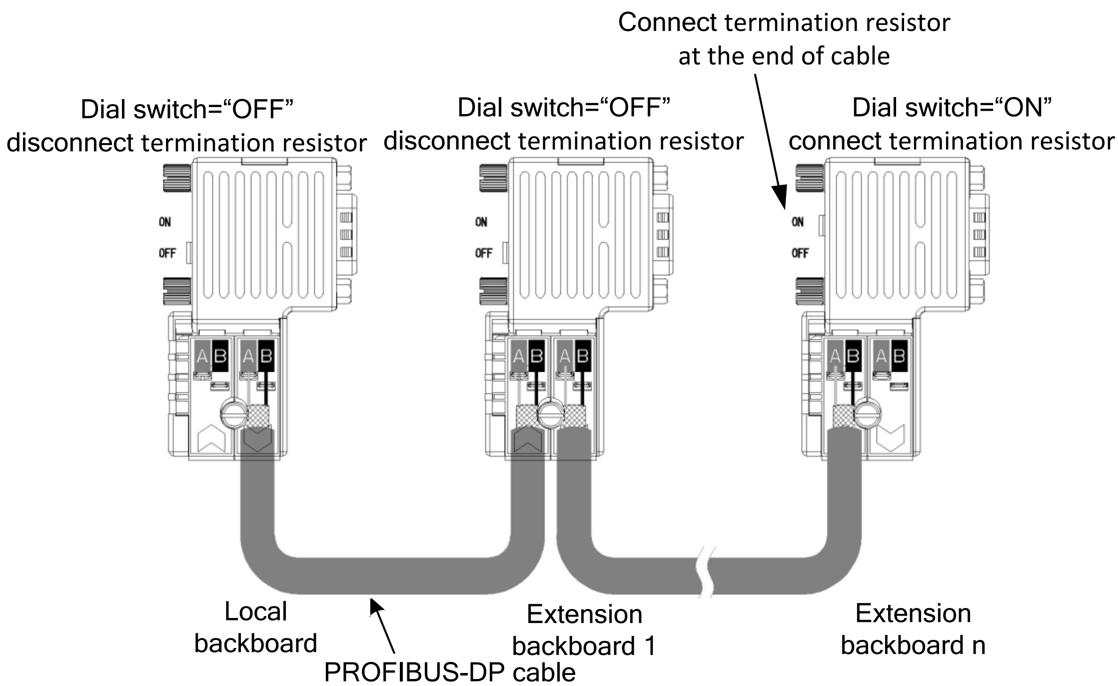


Figure 8-5 DIP Switch Settings for Backboard Cascade Connection

8.1.4 Wiring

Signal definition of LKA101 as follows:

Table 8-1 DP Signal Definition

Cable Identification		Signal Definition
Input wire	Green wire A	DP negative (DPIN-)
	Red wire B	DP positive (DPIN+)

Cable Identification		Signal Definition
Output wire	Green wire A	DP negative (DPOUT-)
	Red wire B	DP positive (DPOUT+)

See LKA104 wiring in chapter 3.2.3.3 for the cable requirements and wiring steps.

When multiple LKA101 connectors realize cascade connection between backboards, it shall observe the following rules:

When located on the master control backboard and dial switch in OFF, there are only outgoing lines.

When located on the extension backboard in the middle and dial switch in OFF, there are both incoming and outgoing lines.

When located on the last extension backboard and dial switch in ON, there are only incoming lines.

8.1.5 Installation

Refer to chapter 3.1.6 Installation of LKA104.

8.1.6 Technical Specifications

LKA101 PROFIBUS-DP Bus Connector Module		
Connector	D-sub 9 pin	
Cable outer diameter	8mm±0.4mm	
Screw specification	Shell screw	M3, mechanical screw
	DB9 screw	4-40UNC-2A
	Wiring bracket screw	M3, mechanical tooth free screw
Maximum torque（Nm）	Shell screw	0.5Nm
	DB9 screw	0.4Nm
	Wiring bracket screw	0.22~0.25Nm
Cross-sectional area of core	Rigid wire	0.14~1.5mm2
	Flexible wire	0.14~1mm2
AWG	26~16	
Termination resistance	220Ω	
Module Dimension (W*H*D)	43mm×67mm×16mm	
Protection class	EN60529 IP20	

8.2 LKA102 LK220 Battery Power Box Module

LKA102 provides the backup battery for RTC of the LK220 module.

When LK220 is powered off, LKA102 supplies power to RTC via Springs A and C to keep RTC in the standby mode. The battery voltage is 3.0 V, the capacity is 1,000mAh, which can keep the typical standby value of RTC for 1 year.

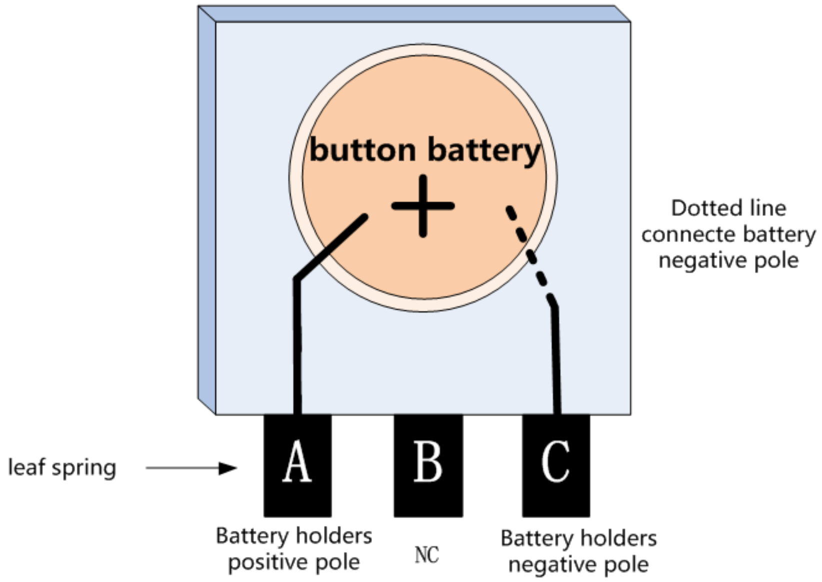


Figure 8-6　LKA102 Battery Power Box Schematic Diagram

8.2.1　Appearance

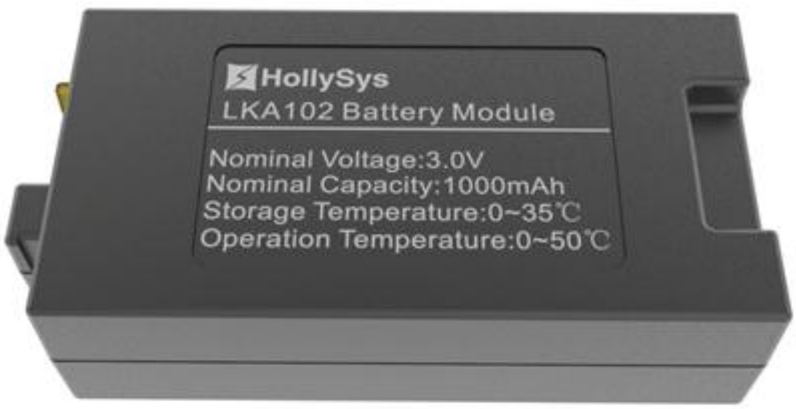


Figure 8-7　LKA102 Module Schematic Diagram

8.2.2 Installation Dimension

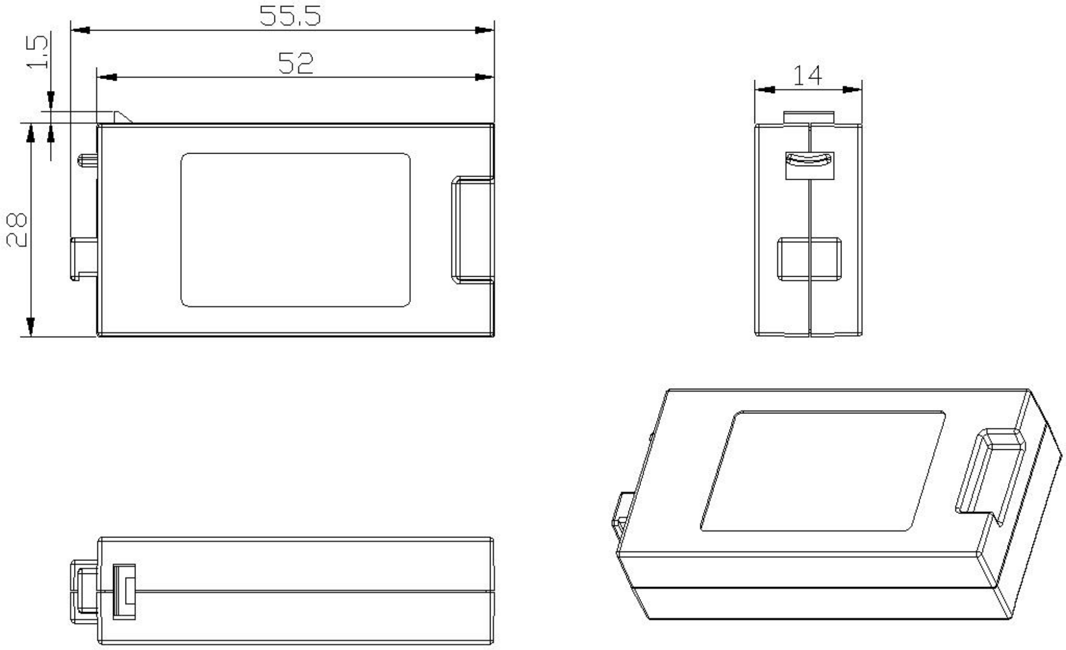


Figure 8-8 Installation Dimension of LKA102 Module

8.2.3 Installation

See chapter 3.1.7 Installation of Power Supply Box.

8.2.4 Battery Replacement

When the BAT indicator lamp on the CPU module panel goes out, it shall replace the battery module.

Steps to replace the battery are as follows:

(1) Take the used battery out from the battery slot of the CPU module.

(2) Hold the upper and lower edges from the front of the module, insert into the battery in the indicated direction.

(3) After being inserted, the BAT indicator lamp turns on and the battery is replaced.

8.2.5 Technical specifications

LKA102 LK220 Battery Power Box Module	
Physical Property	
Installation Pattern	Clip
Protection key position	Rear right
Module Dimension (W*H*D)	55.5 mm*28 mm*14 mm

8.3 LKA103 LK220 Capacitance Power Box Module

LKA103 provides the backup battery for RTC of the LK220 module.

When LK220 is powered off, LKA103 supplies power to RTC via Springs A and C to keep RTC in the standby mode. The max. voltage for capacitance charging is 5.0V and the capacity is 0.94F. It can keep RTC in the standby mode for about 7 days when fully charged once.

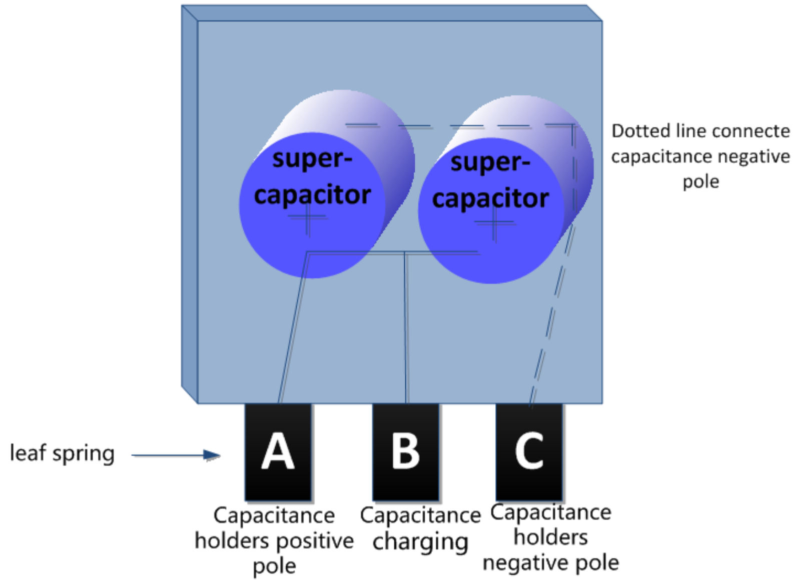


Figure 8-9 LKA103 Capacitance Power Box Schematic Diagram

8.3.1 Appearance

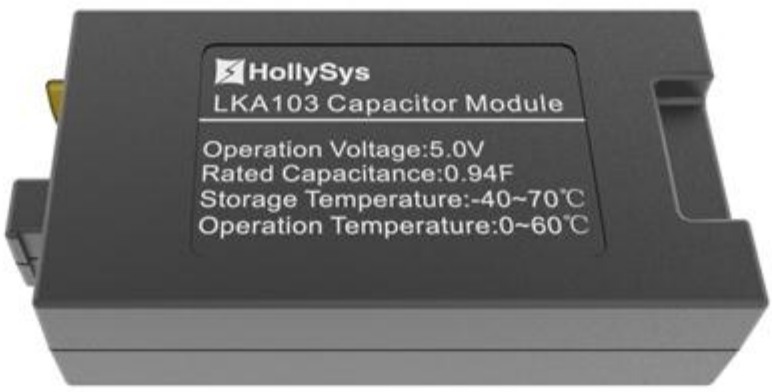


Figure 8-10 LKA103 Module Schematic Diagram

8.3.2 Installation Dimension

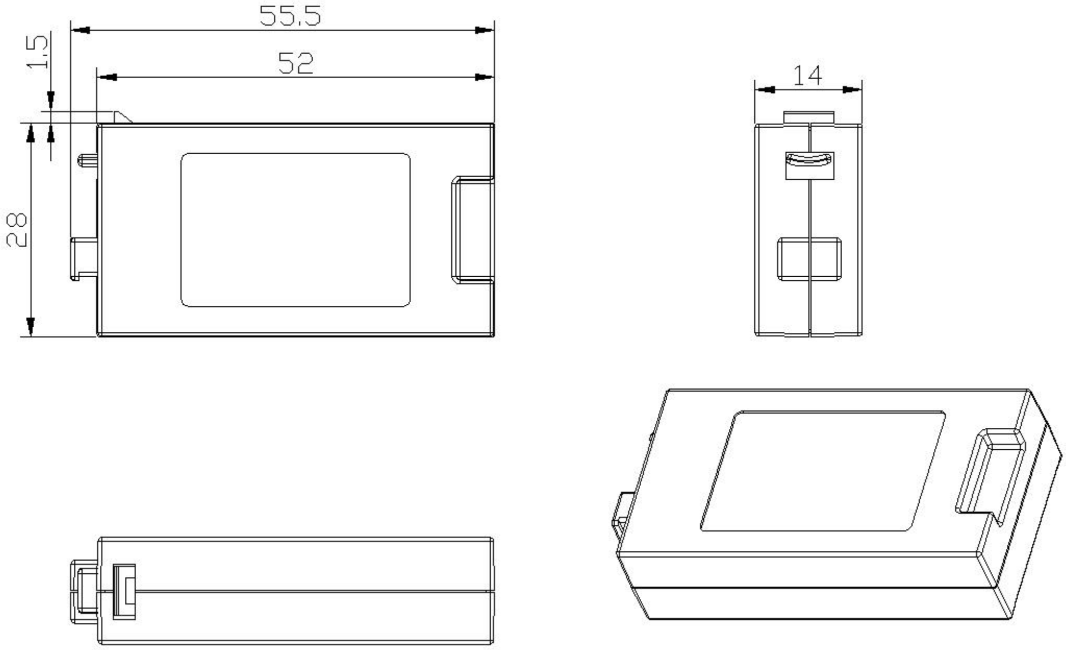


Figure 8-11 Installation Dimension of LKA103 Module

8.3.3 Installation

See chapter 3.1.7 Installation of Power Supply Box.

8.3.4 Battery Replacement

See chapter 8.2.4 Battery Replacement.

8.3.5 Technical Specifications

LKA103 LK220 Capacitance Power Box Module	
Physical Property	
Installation Pattern	Clip
Protection key position	Rear right
Module Dimension (W*H*D)	55.5 mm*28 mm*14 mm

8.4 LKA104 PROFIBUS-DP Bus Connector Module

LKA104 is a PROFIBUS-DP bus connector module. It switches the redundancy DP signal of the previous backboard to the next one. It provides the terminal matching resistance for the PROFIBUS-DP bus. The matched resistance is selected via the DIP switch. If the connector is at the both ends of the bus, it must be connected to the matching resistance.

The DB9 plug of LKA104 matches the DB9 receptacle on the DP communication extension interface of the backboard and the communication module. Each LKA104 is installed with one receptacle. The LKA104 modules are connected via the DP cable, and DP cable is inserted into wiring holes and pressed.

8.4.1 Appearance and Size

8.4.1.1 Appearance

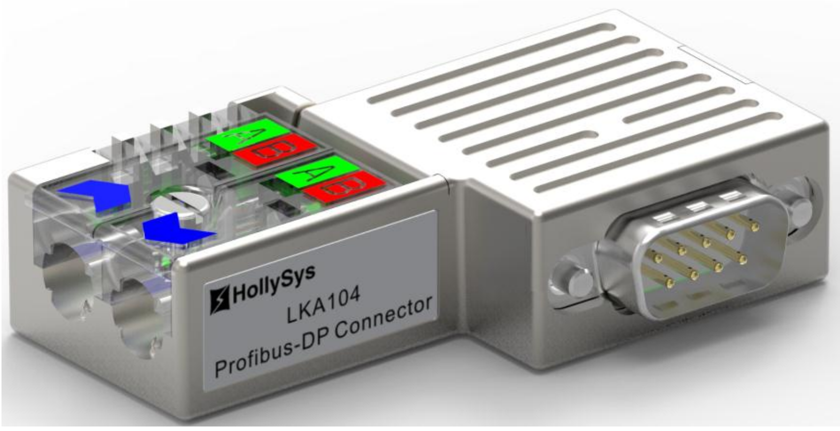


Figure 8-12 External View of LKA104 Module

8.4.1.2 Module Dimension

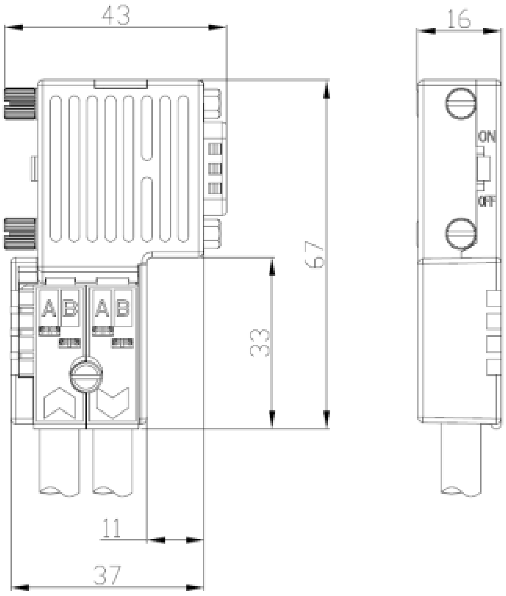


Figure 8-13 Dimension Figure of LKA104 Module

8.4.2 Operating Principle

The LKA104 bus connector is shown in Figure 8-14. The DP input signal is input to the backboard via the DPIN pin. In the meantime, the DP signal is connected to the next backboard. You can set whether to connect matched resistors by selecting positions ON, OFF of dial switch.

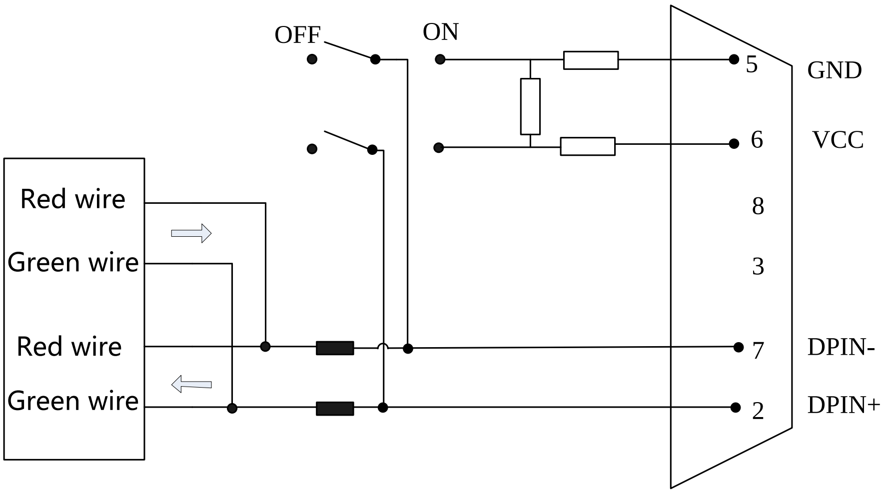


Figure 8-14 LKA104 Module Schematic Diagram

8.4.3 Terminal Matching Resistance

At the terminal node of the DP bus, a matched resistance is bridged over for impedance matching. The node in the middle cannot be connected with a matched resistance.

For the LK system, the matched resistance at one end of the DP bus is provided by LKA104. The matched resistance of the other end can be provided by the LKA104 connector or the communication module, which can be set by the user according to the actual situation.

It can connect only one terminal resistance on LKA104 or the communication module, with no repeated settings allowed. To facilitate operation, it is recommended of using the matched resistance on the LKA104 connector.

Select the matched resistance on LKA104 by dial switch, which has two positions such as ON, OFF, as shown in Figure 8-15.

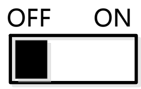


Figure 8-15 Dial Switch Schematic Diagram

- Switched to ON: connect the matched resistance
- Switched to OFF: disconnect the matched resistance

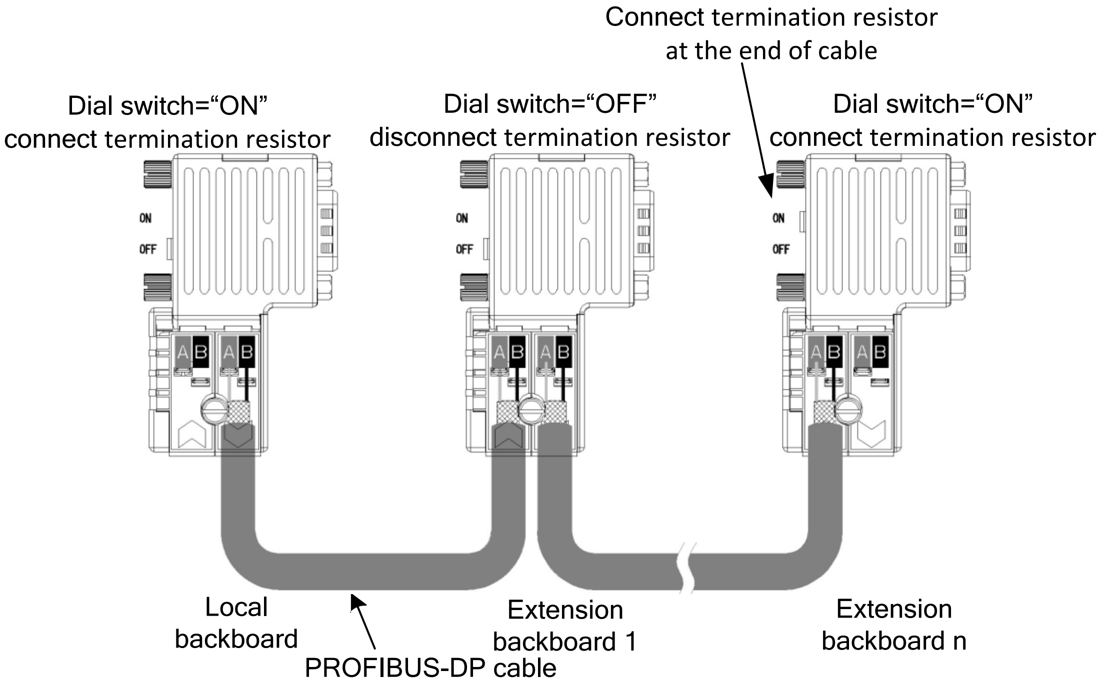


Figure 8-16 DIP Switch Settings for Backboard Cascade Connection

8.4.4 Wiring

Signal definition of LKA104 as follows:

Table 8-2 DP Signal Definition

Cable Identification		Signal Definition
Input wire	Green wire A	DP positive（DPIN+）
	Red wire B	DP negative（DPIN-）
Output wire	Green wire A	DP positive（DPOUT+）
	Red wire B	DP negative（DPOUT-）

See LKA104 wiring in chapter 3.2.3.3 for the cable requirements and wiring steps.

8.4.5 Installation

See chapter 3.1.6 Installation of LKA104.

8.4.6 Technical Specifications

LKA104 PROFIBUS-DP Bus Connector Module		
Connector	D-sub 9 pin	
Cable outer diameter	8mm±0.4mm	
Screw specification	Shell screw	M3, mechanical screw
	DB9 screw	4-40UNC-2A

LKA104　PROFIBUS-DP Bus Connector Module		
	Wiring bracket screw	M3, mechanical tooth free screw
Maximum torque（Nm）	Shell screw	0.5Nm
	DB9 screw	0.4Nm
	Wiring bracket screw	0.22~0.25Nm
Cross-sectional area of core	Rigid wire	0.14~1.5mm2
	Flexible wire	0.14~1mm2
AWG	26~16	
Termination resistance	220Ω	
Module Dimension (W*H*D)	43mm×67mm×16mm	
Protection class	EN60529 IP20	

8.5 LKA105　Optical Fiber

LKA105 is optical fiber which used to connect the redundancy communication module in master/slave frame, optical fiber schematic diagram as shown in Figure 8-17.

Figure 8-17　LKA105 Optical Fiber Diagram

The detailed using refer to 3.2.2 Redundancy Communication Wiring.

Chapter 9 Fault and Treatment

9.1 Fault Mechanism

9.1.1 Serious Failures

1. LK220 fault

■ Ethernet fault

Dual Ethernet fault causes master-slave switching. During this, the ERR indicator on master and slave controller are on, and fault diagnosis information is reported.

2. System fault

■ Backboard communication fault

When the backboard communication between the master control module and the communication module (except the LK240) is broken, it will cause master-slave switching. During this, the ERR indicator on each module are on, and fault diagnosis information is reported.

■ Pull out the module

Any module in master control backboard is pulled out to cause master-slave switching. This moment, master and slave equipment state is error.

If a master control module is pulled out, first, the master and slave equipment state is error state, then initial state.

■ System power off

Power in master frame is off that will cause master-slave switching.

3. LK249 fault

■ DP link fault

This fault is triggered when all polled slave stations have no response to LK249 in master frame. During this, the ERR indicator on LK249 module are on, and fault diagnosis information is reported. The fault will cause master-slave switching.

4. Power fault

■ LK921 fault

The dual power in LK921 are fault that will cause master-slave switching.

■ Power module fault

Both redundancy power modules are fault to cause master-slave switching.

Suggestion:

This fault can be diagnosed through that the switch output terminal DO +, DO- in the power module is connected to DI module.

- Master-slave switching must be carried out in the opposite equipment without serious fault.

9.1.2 General Failures

1. Battery / Capacitance fault

This fault occurs if power in battery/capacitor is low or battery/Capacitor box is not plugged. You need to replace the battery when BAT light in LK220 module is on.

You need to configure function block sysGetBatteryAlarm (Get Battery Alarm) to obtain the alarm information. Function block refer to the manual *HollySys Programmable Logic Controller PLC Instruction Manual* for details.

2. Power fault

It will not cause master-slave switching that the one power in LK921 is fault. This moment, the one power light is off.

3. LK220 fault

■ Ethernet fault

Single Ethernet fault will not cause master-slave switching. This moment, fault diagnosis information is reported.

4. LK249 fault

■ DP link fault

Single DP link fault only reports the diagnosis information, and will not turn off the indicators and master-slave switching.

DP diagnosis information of slave station is not detected.

5. LK240 fault

■ Redundancy fiber fault

This fault occurs if dual fiber are broken and fiber are cross connected. During this, the ERR light on LK240 module is on, and fault diagnosis information is reported. The value of Error pin in the function block sysGetRedState outputs error code at the same time.

When the single fiber is broken, the function block sysGetRedState reports the error code and the ERR light on LK240 module is off.

■ A/B switch conflict

It will trigger this fault that LK240 A, B Dail switch is consistent, and the controller is restarted. At this time, the ERR indicator light on LK240 module is on, the two controllers are in a failed state without running.

A/B switch conflict show the different phenomenon in following case.

□ Slave restart

The ERR indicator on LK240 module which in master and slave frame are red.

This moment, the slave equipment state is fault.

Output parameter ExtDiag [0] in diagnosis function block sysGetComModleDiagInfo (Get Diagnosis of Communication Module) is 1.

□ Master and slave restart

The ERR indicator on LK240 module which in master and slave frame are red.

This moment, both the master and slave equipment state are fault.

This moment, the master controller is in failed state, unable to view the function block diagnostic information.

6. Data is out of sync between the master and slave

Stop data redundancy between master and slave frame when IEC running cycle not matches with the size of the engineering data area configured. This moment, slave ERR light is on, while, the Error pin in function block sysGetRedState outputs error code.

9.2 Troubleshooting Way

When error occurs in LK redundancy system, you can troubleshoot faults in three ways:

- Check status indicator on the module.
- See the tool [Controller Operation] in AutoThink.
- See the diagnosis information in AutoThink.

9.2.1 Indicator Lamp

Check the module status indicator to determine the faulty module when error occurs in redundancy system.

If the ERR indicator is red in any module, you can obtain detailed diagnosis information through viewing the diagnosis function block.

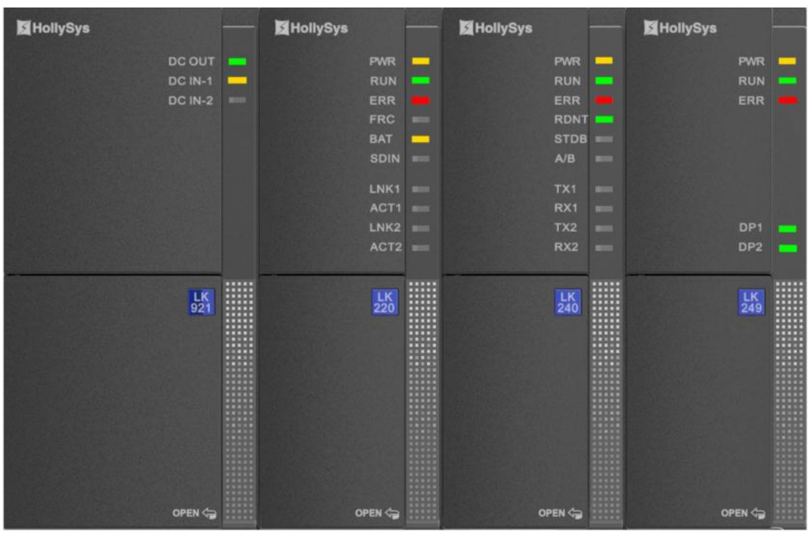


Figure 9-1 Abnormal Indicator Lamp Diagram

Indicator lamp meaning refer to the specific definition of each module indicators.

9.2.2 View Tool Information

- Tool bar: Click [Tool]-[Assistant tool]-[Controller Operation].

Display the related information of master and slave equipment in [Controller information] tab.

The detailed state information refers to tool in fifth chapter in manual *AutoThink V3.1 User Manual_Project Configuration.*

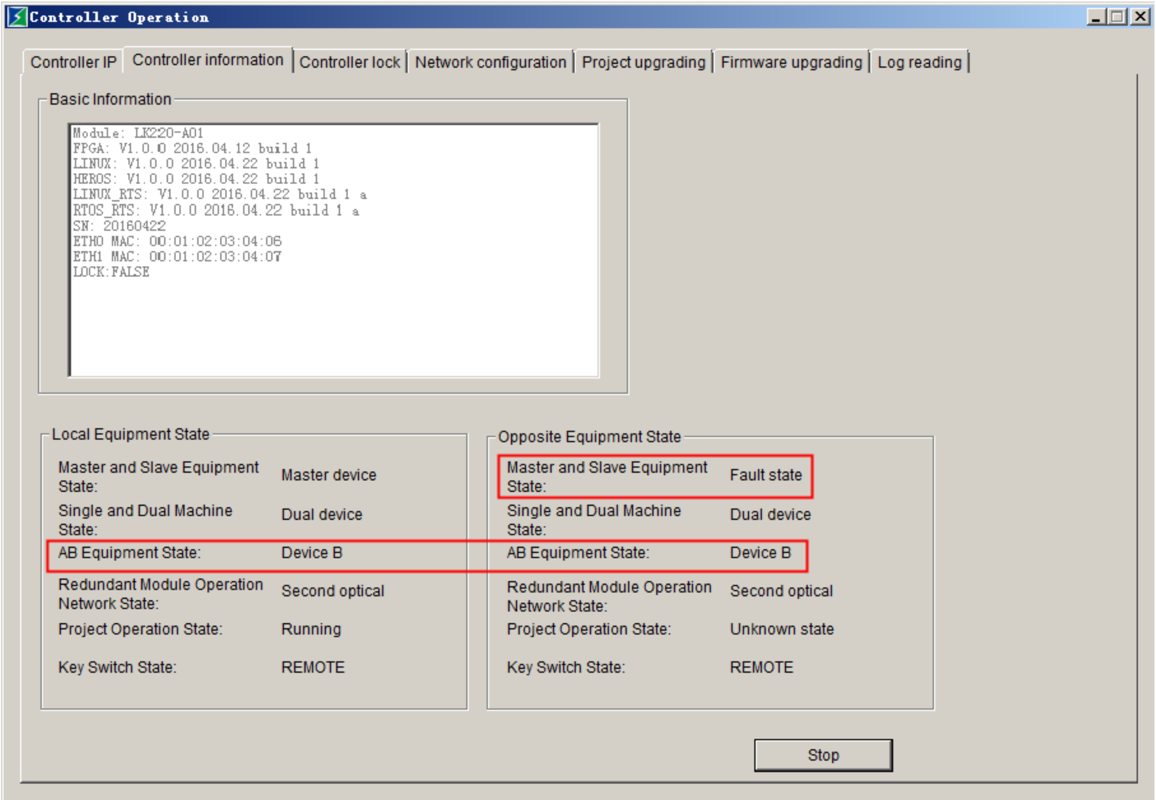


Figure 9-2　Master and Slave State

The system is abnormal when the local or opposite equipment appear the following state.

- Master and slave equipment state: Fault state
- Master and slave equipment state: Error state
- Master and slave equipment state: unqualified host
- Any state appears Unknown state or Unknown

9.2.3　View Diagnosis Information

To determine the detailed fault causes of module by diagnosis information and users need to configure the diagnosis function block of each module in the AutoThink.

LK system diagnostic function blocks are divided into the master control module diagnosis, communication module diagnosis and DP slave extension diagnosis. Detailed diagnostic information sees the manual *HollySys Programmable Logic Controller PLC Instruction Manual*.

Figure 9-3　Configurable Diagnosis Function Block

Function Block	Function
sysGetCPUDiagInfo (Get Diagnosis of CPU)	You can view diagnosis information of master control module .such as ethernet fault information, internal communication link fault information, etc.

Function Block	Function
sysGetComModleDiagInfo (Get Diagnosis of Communication Module)	You can view diagnosis information of communication module LK249, LK240. Such as fiber disconnection, AB switch conflict, DP link disconnection, etc.
sysGetDPSlaveState (Get Diagnosis of DP Slave)	You can view the diagnosis information of IO slave station. Such as line broken, exceed range, exceed limit,etc.
sysGetDPMasterState (Get Current State of DP Master)	You can view running state of DP master station.
sysGetRedState (Get Redundant State of System)	You can view redundant state between master and slave frame.

9.2.4 Example for Troubleshooting

The following example illustrates the troubleshooting procedure when system is abnormal.

Phenomenon: display that the slave equipment is error state.

Step 1. View the tool in AutoThink

Via the tool in AutoThink to view and find that master equipment state is normal and slave equipment state is error state, single and dual state is normal, network state is normal, AB equipment state is normal, key switch state is normal, but project operation state of master equipment is running and project operation state of slave equipment is stopping.

Step 2. Check the indicator lamp

Check if there is an abnormal indicator lamp in cabinet.

In master frame, the lights on each module are normal and RUN light on LK220 is flashing. In slave frame, the ERR light on LK249 is on and RUN light on LK220 is on, the other lights are normal. Therefore, you can determine that LK249 module were broken.

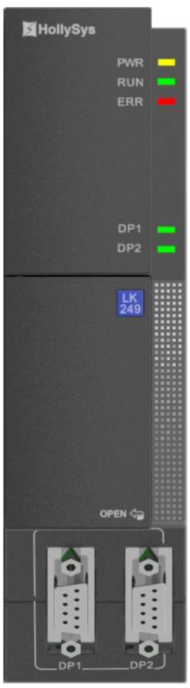
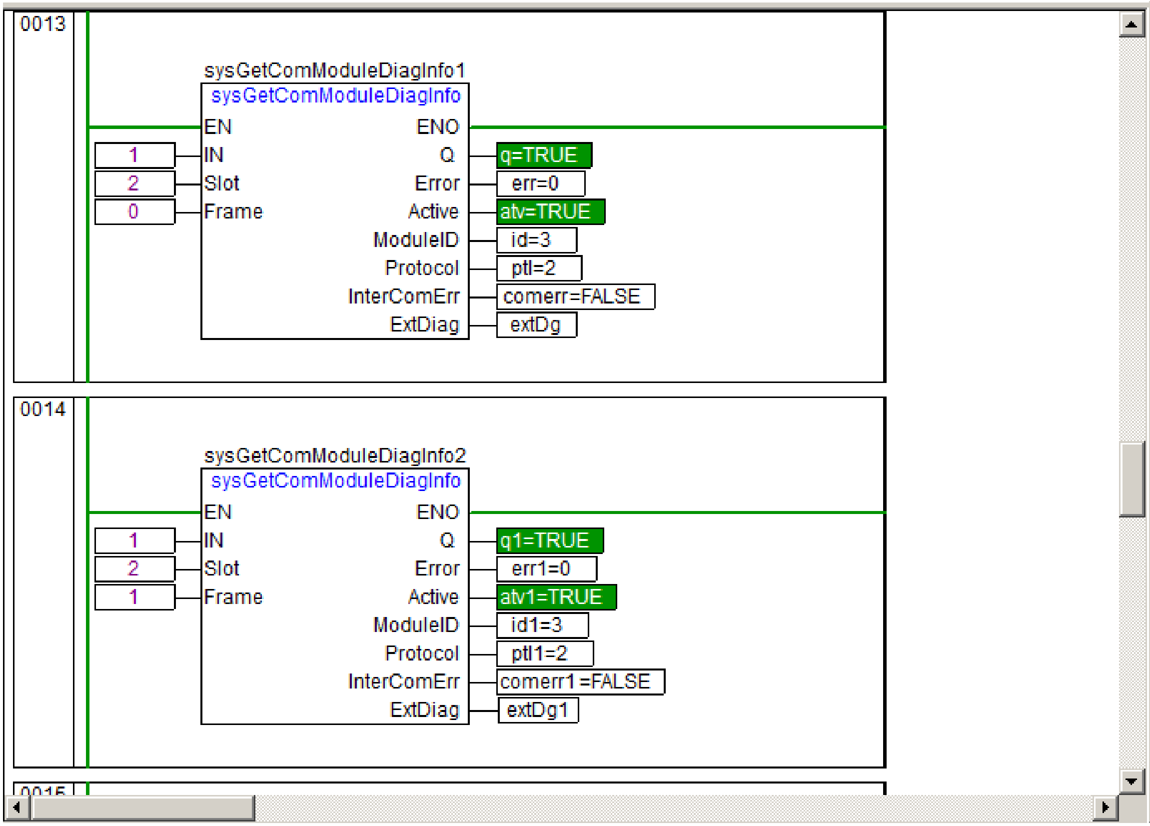


Figure 9-4 LK249 Status Indicator

Step 3. View the diagnosis information in AutoThink

Open the AutoThink to view function block sysGetCPUDiagInfo (Get Diagnosis of CPU) of master/slave controller,and master station function block sysGetDPMasterState (Gets DP master card status), diagnosis output values are normal. Function blocks sysGetDPSlaveState corresponding to each slave station are normal, and communication between master controller and slave controller are normal.

View the function block sysGetComModuleDiagInfo (Get Diagnosis of Communication Module), wherein, Error is 0 to indicate that the block executes and feedback actual results. Active is True to indicate that module is operating normally. ModuleID is 3 to indicate that current module is LK249. Protocol is 2 to indicate that current protocol is DP. InterComErr is 0 to indicate that communication between LK220 and LK249 is normal. Online values of the forward two bytes in the array variable ExtDiag are 1 to indicate that dual DP links of LK249 in slave frame are broken.



(a)

exlib_test.extDg1

No.	Variable Name	Address	Variable Description	Variable Type	Online Value	Power Fail Safeguard
0001	extDg1[0]			BYTE	1	FALSE
0002	extDg1[1]			BYTE	1	FALSE
0003	extDg1[2]			BYTE	0	FALSE
0004	extDg1[3]			BYTE	0	FALSE
0005	extDg1[4]			BYTE	0	FALSE
0006	extDg1[5]			BYTE	0	FALSE
0007	extDg1[6]			BYTE	0	FALSE
0008	extDg1[7]			BYTE	0	FALSE
0009	extDg1[8]			BYTE	0	FALSE
0010	extDg1[9]			BYTE	0	FALSE
0011	extDg1[10]			BYTE	0	FALSE
0012	extDg1[11]			BYTE	0	FALSE
0013	extDg1[12]			BYTE	0	FALSE
0014	extDg1[13]			BYTE	0	FALSE
0015	extDg1[14]			BYTE	0	FALSE
0016	extDg1[15]			BYTE	0	FALSE

(b)

Figure 9-5 SysGetComModleDiagInfo Function Block

Step 4. Troubleshooting

(1) Check if the DP cable is plugged well

(2) Check if the DP cable is broken, and replace it

9.3 Fault Phenomenon and Causes

The following are some fault symptoms, possible causes and correction measures.

Table 9-1 Fault Symptoms and Possible Causes

Fault symptoms	Causes	Treatment measures
The ERR light of master control module is on	History state is not run : the IEC of master controller was stopping state, and key switch of slave controller in RUN, then the fault is touched off after slave rise to master controller	Dial switch to PRG position
	History state is not run : when the single controller runs normally, and key switch is in RUN, then you pull out the LK240 and plug it	Dial switch to PRG position

	again, at this time, ERR lights are on	
	Dual Ethernet disconnection	1. Check if the Ethernet cable is plugged well 2. Check if the Ethernet cable is disconnected
	Internal communication link fault in master control module	Replace the module
	Redundancy link is abnormal	Replace the module and check if redundancy link is normal
The BAT light of master control module is on	Low power	Replace the battery / capacitance box
	The battery / capacitance box is not be plugged in	Check if the battery / capacitance box is plugged well
The ERR light of Slave LK220 is on	IEC running cycle not matches with the size of the engineering data area configured	1. Increasing task cycle in AutoThink 2. Delete the unused variables to reduce the used data area
The ERR light of LK240 module is on	A、B dial switch conflict	Set the A/B dial switch again
	The dual fiber link is disconnected	1. Check if the fiber is plugged well 2. Check if the fiber is broken 3. Check if the optical fiber plug is intact Re-connect the fiber according to the correct way
	Redundancy fiber is cross-connected	Reconnect the fiber in correct way
	Internal communication link fault in redundancy module	Replace the module
The ERR light of LK249 module is on	The dual DP link is disconnected	1. Check if the DP cable is plugged well 2. Check if LKA104 Incoming wire, the outgoing wire is well connected 3. Check if the slave address dail switch is correct

		4. Check if the DP cable is broken, and replace it
	Internal communication link fault in LK249 module	Replace the module
The all modules no power in chassis	LK910 power fault	Replace the power module
	Fuse fault	Replace the fuse in power module
	Dual input power is broken in LK921	1. Check if the wiring is connected 2. Check if the cables is broken
The engineering does not run after power up	History without running fault: the IEC of master controller was stopping state, and key switch of slave controller in RUN, then the fault is touched off after slave rise to master controller.	The key switch dial to PRG position
The controller has been in engineering redundancy state	Without engineering in master controller	Re-download the project
	Flash space in controller is insufficient	Clear the flash or contact the factory The power must be turned off to restart after clearing the flash
The controller is error state in tool	The dual DP link is disconnected	Refer to treatment measures about “The ERR lights of master control module is on”
	Dual Ethernet disconnection	Refer to treatment measures about “The ERR lights of LK249 module is on ”
	Backboard communication fault between the master control module and the communication module	Replace the module
	Any module in master control backboard is pulled out	Check whether module is plugged well
The controller is fault state in tool	A/B switch conflict	Set the A/B dial switch again

The master equipment state is normal, and slave equipment state is fault state	The dual fiber link is disconnected	Refer to treatment measures about "The ERR lights of LK240 module is on" This moment, you need to view state information of master equipment or slave equipment separately in AutoThink
The controller is unknown state in tool	Redundancy fiber communication is disconnected	1. Check if the fiber is plugged well 2. Check if the fiber is broken and replace
The controller is unqualified master equipment in tool	Controller that redundancy was not completed last time is unqualified master equipment after power up	1. Reset by the key switch 2. Click **Clear** button in AutoThink assistant tool-[Controller Operation] –[Controller information] tab 3. Restart
DP slave station is offline	Configuration in software not match with hardware configuration	View if the slave station address configured is consistent with the actual hardware address
	DP link fault	Refer to treatment measures about "The ERR lights of LK249 module is on"
	No master controller in current system	Refer to treatment measures about controller is error state, controller is fault state
	Communication switching module fault	Replace the module
Master –slave switching	Dual Ethernet disconnection	Refer to treatment measures about "The ERR lights of master control module is on"
	The dual DP link is broken	Refer to treatment measures about "The ERR lights of LK249 module is on "
	Power fault	1. Check if the power fuse in LK910 is normal 2. Check if two-input wire of LK921 is

		connected well
	Any module is pulled out in backboard	The module is plugged again
	Redundancy LK910 module fault	Replace the power module
	Backboard communication fault	Replace the module
RTC time is restored to the default value after power up	The power of the battery / capacitance box is low	Refer to treatment measures about "The BAT lights of master control module is on"
	The battery / capacitance box is not be plugged in	
Unable to establish an Ethernet communication connection	Without restarting after setting IP address	Restart the controller to make IP settings effective
	Ethernet link fault	Refer to treatment measures about "The ERR lights of master control module is on"
Unable to download the controller	Ethernet communication connection fault	Refer to treatment measures about "Unable to establish a Ethernet communication connection"
	Assistant tool is running	Exit from the assistant tool
Unable to establish a MODBUSTCP communication connection	Slave controller is connect to MODBUS communication	IP address is modified to IP address of master controller

If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

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