LKS Safety Control System Product Manual

Automation for Better Life

Beijing HollySys Intelligent Technologies Co., Ltd.

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LKS Safety Control System

Product Manual

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Address: Di Sheng Middle Road, No.2,
Economic-Technological Development Area, 100176, Beijing, China
Tel: +86 010-5898 1588
Consulting Hotline: 4008-111-999
Fax: +86 010-5898 1558
Web: http://www.hollysys.com
Email: PLC@hollysys.com
Sina weibo: http://weibo.com/hollysysplc

Contents

Chapter 1 About This Book

1.1 Document Update

Version	Date	Description
V1.0	February 02.2018	New
V1.1	March 30.2018	Update Chapter 3.2.3.3 Terminal Matching Resistor Settings
V1.2	November 30.2018	Optimize functions
V1.0	June 14.2019	Update Copyright
V1.1	August 07.2019	Update LK710S
V1.2	January 17, 2020	1. Add LK630S 2.PROFIsafe fault confirmation 3. Add channel filter parameters to LK610S
V1.3	June 05, 2020	1. LK710S updates channel diagnosis information 2. LK710S updates relay type
V1.4	January 25, 2020	Add LK611S, LK410, LK720, LK442
V1.0	Match 09. 2021	Update 2.1.3 IO capacity Update 2.3 Hardware Product List Add description of DV value configuration in Chapter 6.4.1.8 and 6.4.1.9
V1.1	March 11.2022	Update logo
V1..2	July 15. 2022	Update ESD switch specifications of LK611S
V1.3	March 20.2023	Descriptive modification

1.2 Purpose

This Manual mainly introduces the operational principle, major functions, wiring instructions, configuration settings, technical specifications and so on of LKS safety 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

LKS Safety Control System Instruction Manual

Safety FA-AutoThink User Manual

LKS Safety Control System Product Manual

1.6 Terminology

Terminology	Description
Profibus –DP	Standard Bus Protocol, used to high-speed data transfer of the field layer
PROFIsafe	Safety communication protocol, describing the communication between safety peripherals and safety controller
Quality bit	The effectiveness of the channel data is identified by adding several bit quality data to the channel data
System A	Decided by the two position toggle switch in the main control module of this system,system A in redundant system have high priority to compete master during power-on
System B	Decided by the two position toggle switch in the main control module of this system, system B in redundant system have low priority to compete master during power-on
Firmware	A program that is stored in a device in memory FLASH chip, run on embedded platform and can be upgraded by a user through a specific refresh step

1.7 Abbreviations

Abbreviations	Full Name
I/O	Input/Output
AC	Alternating Current
DC	Direct Current
FPGA	Field Programmable Gate Array

Abbreviations	Full Name
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
SD	Secure Digital memory card
PCIe	Peripheral Component Interface express
Modbus TCP	Modbus Transmission Control Protocol

Chapter 2 Overview of Hardware System

LKS is a safety control system developed by HollySys, and meets the requirements of system capability of safety integrity level SIL2 with large capacity, high availability, superior performance, fast response characteristics, can be widely used in rail transportation, petrochemical, fine chemical industry, oil and gas pipeline transmission, hospital safety equipment, rail vehicle maintenance station and enterprise ESD system. Control system are composed of controller and the IO module to complete the functions of data acquisition, logic operation, action output, human-computer interaction and so on, so as to realize the security protection function.

2.1 System Characteristic

2.1.1 High Availability

(1) Dual rack redundant structure, including power redundancy, controller redundancy and network redundancy.

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

2.1.2 Fast Response

(1) The typical time of redundancy switching is 90 ms.

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

(3) The fastest control cycle of loop is 50 ms.

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 900 points.

2.1.4 Easy Maintenance

(1) More than 10,000 logs are recorded by logging tools, including abnormal operations, faults and other information.

(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) Update the system by SD card or Safety FA-AutoThink software.

(5) The system is compatible with general IO modules of LK series.

2.2 Hardware Components and Structures

LKS safety control system adopts the dual backplane redundant structure, install a control unit on the two backplanes respectively as A series and B series. Each control unit consists of the following components:

Figure 1　LKS Control Unit Components

- **1：** LK921S safety 24V power adapter module
- **2：** LK220S safety main control module
- **3：** LK240S safety redundant communication module
- **4：** LK249S Safety Master Station Communication Module
- **5：** LK130 4 slot local backplane module

1. Safety 24V power adapter module

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

2. Safety main control module

Safety main control module LK220S supports single and redundant configuration. Module contains two 10/100 Mbps Ethernet interfaces to connect engineer station and operator station, to download the user program and upgrade controller. And also as a Modbus TCP master/slave station to communicate with other devices. You can upgrade controller via SD card slot in panel. The controller runs in the different mode by changing the position of key switch. In redundancy configuration, two controllers are in master –slave relationship, and the master switches to slave when fault occurs in master controller.

3. Safety redundant communication module

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

4. Safety Master Station Communication Module

LK249S module includes two DB9 communication interface, connected to the expansion backplane LK117 / LK118 by DP cable, establish the communication connection with IO module. LK249S module exchanges data with safety main control module via the bus in backplane.

5. 4 slot local backplane module

It is used to install the LK220S, LK921S, LK240S and LK249S. It supports high-speed local backplane bus for data exchanging between modules.

- LK240S and LK249S can be installed in SLOT0 and SLOT1, and installation slot must be consistent in dual rack.
- LK220S, LK240S, LK249S, LK921S and LK130 need to be installed in the cabinet.
- LK220S, LK240S, LK249S, LK921S and LK130 are designed in pollution degree 2.
- Above modules should be installed inside a metal cabinet, IP rating of the cabinet no less than IP41.

Topological structure schematic diagram of LKS safety control system is shown in Figure 2:

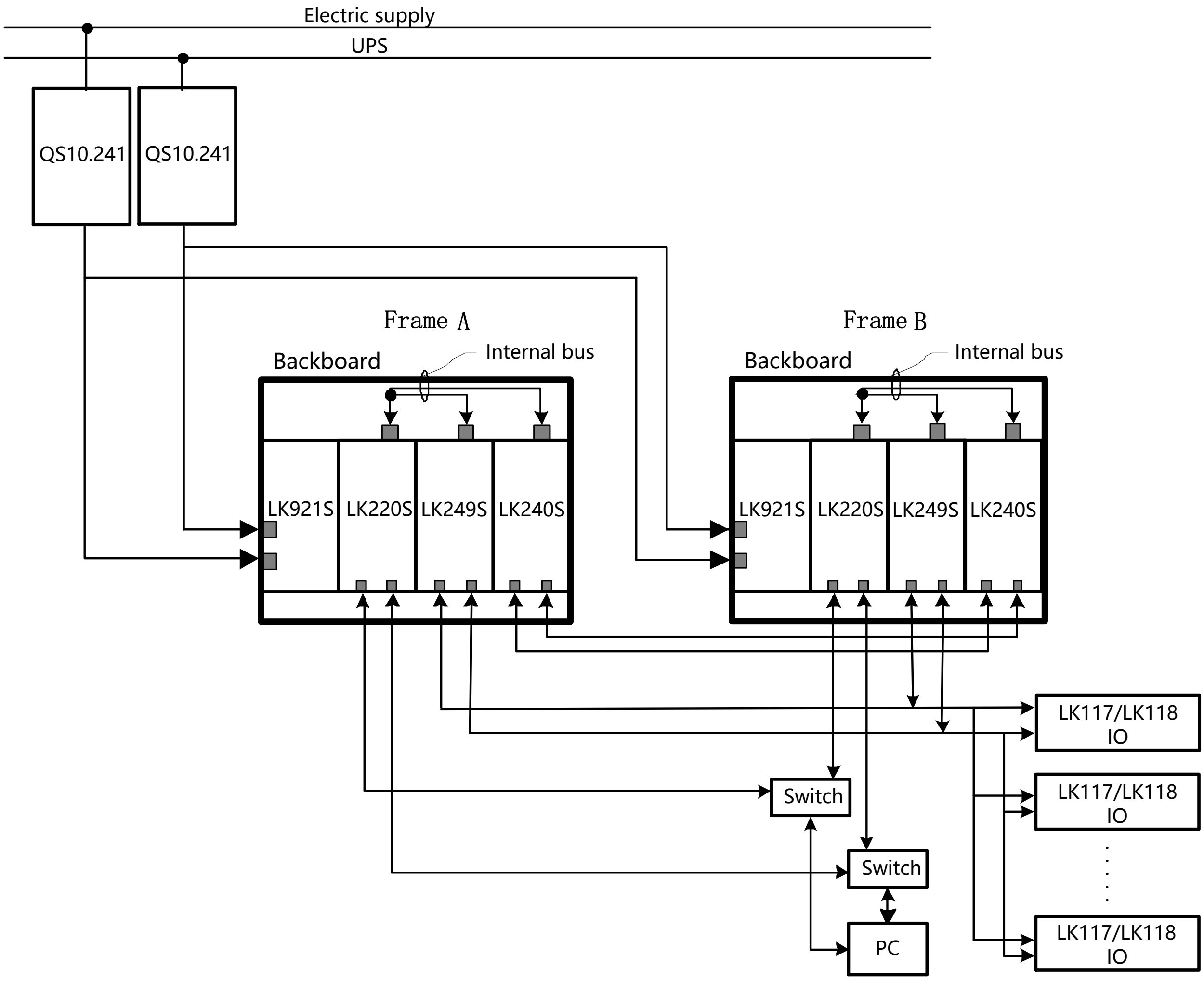


Figure 2 Schematic diagram of LKS safety control system

2.3 Hardware Product List

Hardware products of LKS safety control system mainly include backplanes, power modules, main control module, communication modules, I/O modules and attachments, as shown in Table 1.

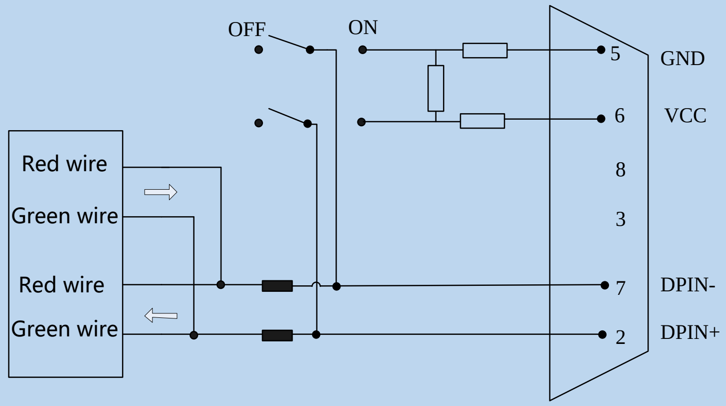
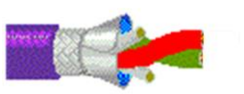
Table 1 LKS System Hardware Product List

Module Type	Model	Specifications	Protection Key
Backplane	LK117	Extended backplane, 11-slot, 385×166×55.5 mm, with DB9 hole receptacles applied to DP interfaces, provided pluggable with I/O terminals	None
	LK118	Extended backplane, 5-slot, 210×166×55.5 mm, with Type-D 9-pin receptacles applied to DP interfaces, provided with pluggable I/O terminals	None
	LK130	4 slot local backplane module, 235×166×44.3 mm	None

Module Type	Model	Specifications	Protection Key
Power supply	LK921S	Safety 24V power adapter module, input voltage: 12~30 VDC, with independently pluggable input terminals	None
	QS10.241	DC power supply, 24VDC output with switch output	None
Main control	LK220S	667 MHz, bit instruction: 0.013ms/K, program memory: 32MB, power-loss retentive memory 512KB, supporting redundancy	None
Communication modules	LK232S	Safety Profibus-DP bus repeater module, with terminal resistance switch	A5
	LK249S	Safety Master Station Communication Module, double DB9 female sockets, supporting hot plug	None
	LK240S	Safety redundant communication module, dual optical fiber communication interface of LC type	None
DI	LK610S	Safety 8 channels digital input module	D0
	LK611S	Safety 8 channels digital input module（with LFD Function）	D0
AI	LK411S	Safety 8 channels analog input module	A1
DO	LK710S	Safety 8 channels digital output module, MOSFET output, capacity 0.5 A, 10~30 VDC	E0
SOE	LK630S	Safety 8 channels digital input module (with SOE function)	D0
Attachment	LKA103	Capacitor power supply box module	None
	LKA104	Profibus-DP bus connector mdule	None
	LKA105	Fiber jumper	None

Table 2　LKS 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, slide switch option ■ To Realize Profibus-DP bus signal transfer

Connecting Cable	Specifications and Purposes
	
	Profibus-DP communication extension cable ■ RS485 STP system ■ 2-core stranded and paired ■ Profibus-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 3 for the power consumption of the modules. The table only represents the LKS system power capacity. The field power capacity of the LKS 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 abnormal power supply 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 3 Power Consumption of Hardware Modules

Module Type	Model	Rated Voltage	Current (max.)	Power consumption
Safety main control module	LK220S	24 VDC	300 mA	7.2 W
DI	LK610S	24 VDC	50 mA	1.2 W
AI	LK411S	24 VDC	100 mA	2.4 W
DO	LK710S	24 VDC	50 mA	1.2 W

Module Type	Model	Rated Voltage	Current (max.)	Power consumption
SOE	LK630S	24 VDC	50 mA	1.2 W
Communication module	LK232S	24 VDC	60 mA	1.44 W
	LK240S	24 VDC	250 mA	6 W
	LK249S	24 VDC	200 mA	4.8 W

2.4.2 Ethernet Connection

LK220S module provides dual-redundancy Ethernet interface, with the standard RJ45 interface and unshielded twisted pair as the transmission medium. X1 interface default as network segment 128, IP address default as 128.0.0.250. X2 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 configure switches independently.

The Ethernet interface (Ethernet) can connect the safety main 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.

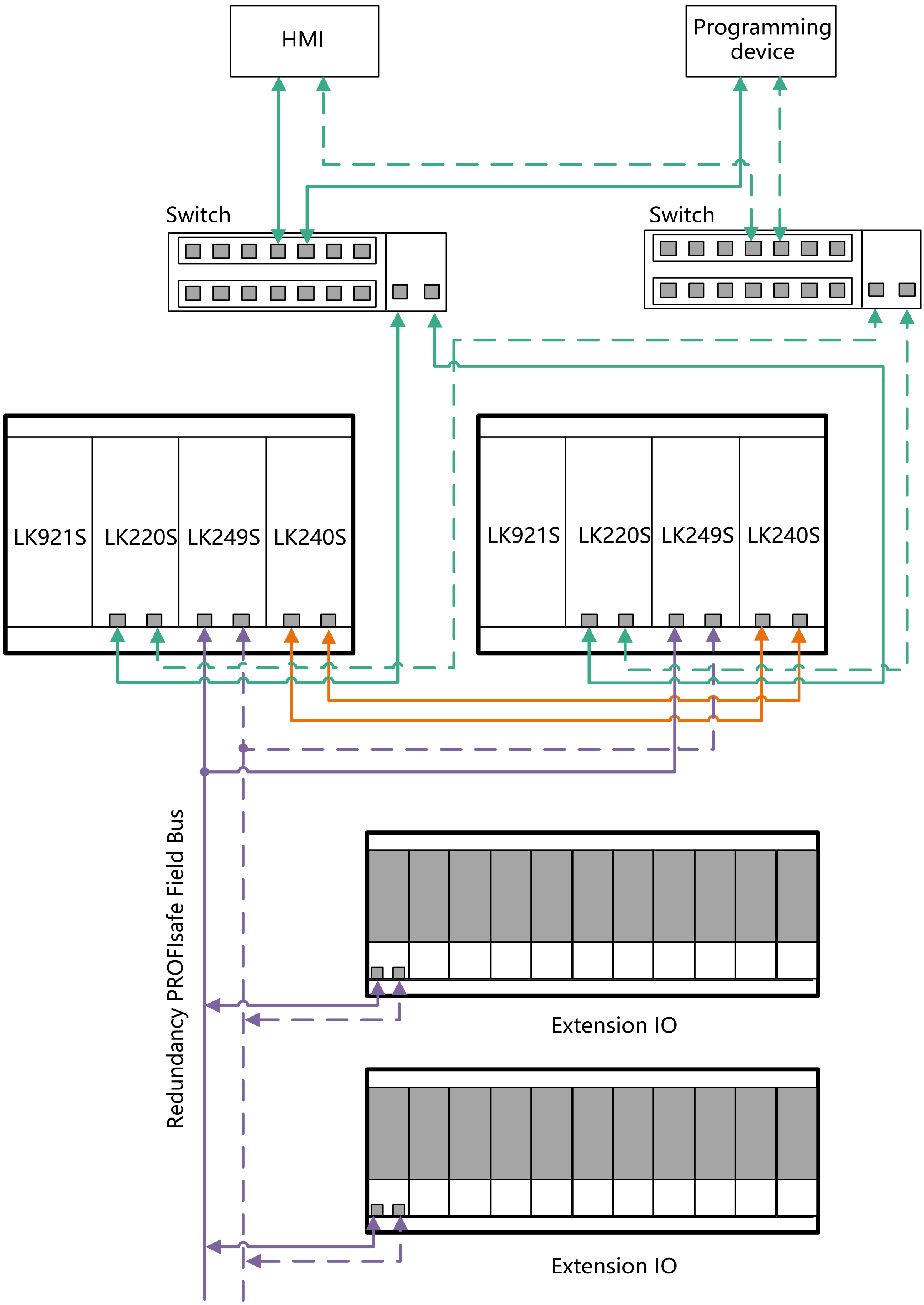


Figure 3　Network Connection of LKS System

Connecting the programming device via the Ethernet, the user can download and upgrade the firmware. It can remote real-time monitor and operate to the controller by connecting the HMI device.

- Internal test environment of LKS safety control system is in the case of using the switch.

2.4.3 PROFIsafe Network Connection and Calculation

As shown in Figure 3, it can cascade multiple extension backplanes to extend system via the redundant PROFIsafe bus interface (DP1, DP2) on LK249S module. It shall adopt LKA104 modules to connect DP interface between backplanes, with the communication rate 187.5 kbps, 500 kbps, 1.5Mbps, 3 Mbps, 6 Mbps optional and shielded twisted pair as transmission medium.

For the I/O extended by PROFIsafe, it shall carefully calculate its node capacity before configuring the LKS safety control 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 PROFIsafe segment, node address from 2 to 125. 1 is fixed to the address of the main 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 PROFIsafe Bus Scanning Period

When configuring the DP slave scale, the entire DP polling cycle should not exceed 150ms. Refer to Table 4 for roughly estimating DP polling cycle in current DP scale (Note: Table 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 4 Polling Cycle for Single Slave Station

Baud rate	**Non-LK239 module requires time (ms)**
187.5kbps	2.2
500kbps and above which	1

2.5 System Specification

Table 5 General Technical Specifications for LKS Safety Control System

Reliability specification	
AC/DC power supply	Voltage: Rated AC100V ~ AC240V (root mean square), tolerance -15% ~ +10% (85VAC ~ 264VAC) Frequency: rated 50Hz or 60Hz, the tolerance -6% ~ +4% (47Hz ~ 63Hz)
Field power supply	24V DC (-15% ~ +20%)
System power supply	24V DC (-15% ~ +20%)
Operating ambient temperature	-40 ℃ ~ +70 ℃, EN60068-2-14, Test Nb

Reliability specification		
Storage ambient temperature	-40 ℃ ~ +70 ℃, EN60068-2-14, Test Na	
Relative humidity	5%～95%, no condensation, EN60068-2-30, Test Db	
Operating altitude	≤2000m	
Storage altitude	≤3000m	
Electrical Safety	Meet the requirement of IEC 61131-2,IEC 61010-1,IEC 61010-2-201. Enclosed, SELV/PELV circuits.	
Isolation withstand voltage (field to the system)	500V AC test 1min., leak current no greater than 5mA	
Overvoltage category	II	
IP protection class	IEC60529 IP20 (preventing the entry of external things of size over 12 mm, non-watertight)	
Pollution degree	2	
Vibration	Sinusoidal vibration (Endurance)	0.5G @ 10 to 150Hz, 3 axis, 20 times per axis, IEC 60068-2-6
	Sinusoidal vibration (Operational)	3.5mm @ 5 to 8.4Hz, 3 axis, 10 times per axis, IEC 60068-2-6
		1G @ 8.4 to 150Hz, 3 axis, 10 times per axis, IEC 60068-2-6
Shock	Half sinusoidal, 15G peak for 11ms, 3 axis, 18 times in total, IEC 60068-2-27	
Impact (Operational)	(0.5±0.04)J, 3 times per spot	
EMC	Radiated Emission	IEC 61131-2, EN 61000-6-4, EN 50121-4
	Conducted Emission	IEC 61131-2, EN 61000-6-4, EN 50121-4
	Electrostatic Discharge	IEC 61000-4-2 Contact discharge ±6 kV, Air discharge ±8 kV.
	Radio-frequency electromagnetic field radiated Immunity	IEC61000-4-3 80MHz~1000MHz, 20V/m 1.4GHz~2.0GHz, 10V/m 2.0GHz~6GHz, 5V/m 80 % AM (1 kHz)
	Power-frequency magnetic field immunity	IEC 61000-4-8 100 A/m (50 Hz)
	Electrical fast transient/Burst	AC power port: 2kV (5/50 ns, 5 kHz and 100 kHz) 4kV (5/50 ns, 5 kHz and 100 kHz)
		Signal port: 2kV (5/50 ns, 5 kHz and 100 kHz) 2kV (5/50 ns, 5 kHz and 100 kHz), DIO with shielded lines.
	Surge	AC power port: 2kV CM, 1kV DM 4kV CM, 2kV DM
		Signal port: 2kV CM

Reliability specification		
	Conducted RF	IEC61000-4-6 20V, 150 kHz to 80 MHz 80%AM(1kHz)
	0Hz~150kHz conducted common-mode voltage	AC power port: 1 V to 10 V increasing with 20 dB/decade (1,5 kHz to 15 kHz). 10 V (15 kHz to 150 kHz)
		Signal port: 1 V to 10 V increasing with 20 dB/decade (1,5 kHz to 15 kHz); 10 V (15 kHz to 150 kHz) 10 V (continuous: DC, 16 2/3 Hz, 50 Hz, 150 Hz) 100 V (short duration 1 s: DC, 16 2/3 Hz, 50 Hz)
	Voltage dips and short interruptions	0 % during 0.5 cycle 0 % during 1 cycle
		40 % during 10 cycles
		70 % during 25 cycles
		0 % during 250 cycles

2.6 Product Storage and Transport

2.6.1 Storage

To hold the performance of the LKS hardware during storage, it should be stored in the storehouse without opening the box, and the equipment should not be placed outdoors. See the following for the optimal storage environment:

1. Storage temperature: -40℃~70℃.
2. Relative humidity: 5%~95% (non-condensing).
3. Storage altitude: no more than 3000m (no less than 70kPa air pressure).
4. Storehouse is not allowed to store all kinds of flammable, explosive, corrosive gas, goods.
5. Storehouse is not allowed to have strong mechanical vibration, shock and strong magnetic field.
6. The packing boxes is not less than 100mm from the ground, and from the wall, heat source, cold source, window or air flow port at least 500mm.

2.6.2 Transport

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

1. Taking protective measures, the packing should not be damaged and affected by rain, snow or liquid.
2. The packing boxes conform with the general regulations on vibration, impact and shock.
3. When handling the packing box, it shall strictly forbid strenuous vibration, collision and falloff.
4. Product weight: refer to Table 6.

Table 6 LKS Hardware Module Weight List

Model	Module Name	Weight

Model	Module Name	Weight
LK117	11 slot extended backplane module	1740 g
LK118	5 slot extended backplane module	880 g
LK130	4 slot local backplane module	940 g
LK220S	Safety main control module	390 g
LK921S	Safety 24V power adapter module	380 g
QS10.241	DC Power Supply	900 g
LK232S	Safety Profibus-DP bus repeater module	170 g
LK240S	Safety redundant communication module	370 g
LK249S	Safety Master Station Communication Module	370 g
LK610S	Safety 8 channels digital input module	200 g
LK411S	Safety 8 channels analog input module	190 g
LK630S	Safety 8 channels digital input module (with SOE function)	200 g
LK710S	Safety 8 channels digital output module	200 g
LKA103	Capacitor power supply box module	20 g
LKA104	Profibus-DP bus connector mdule	30 g
LKA105	Fiber jumper	140 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 backplane after having determined the quantities and configurations of safety main control modules, I/O modules and backplanes.

3.1.1 Space Layout

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

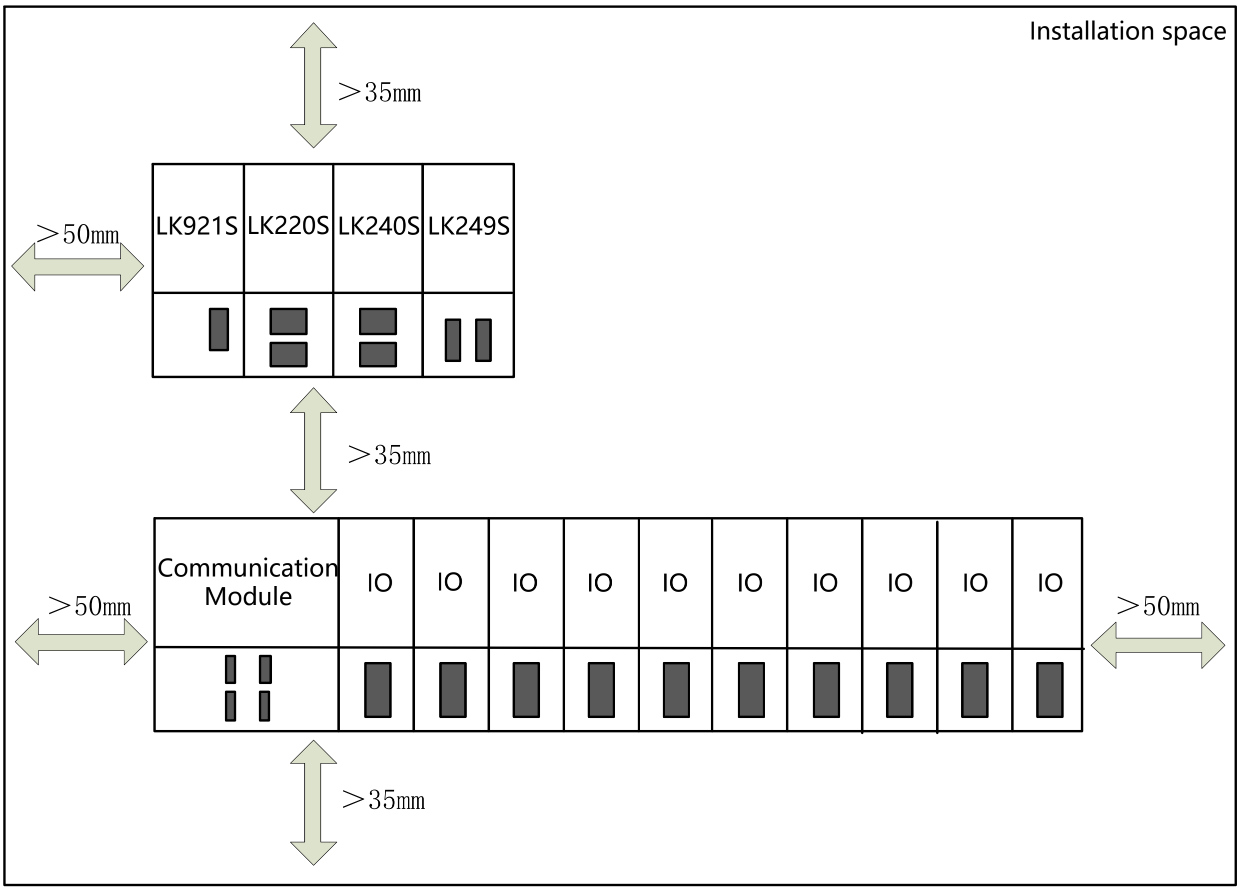


Figure 4 Spatial Layout Requirements Relating to LKS Backplane Installation

3.1.2 Backplane Installation

3.1.2.1 Installation of Local Backplane

The LK130 backplane 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 5 for the hole size (Unit: mm).

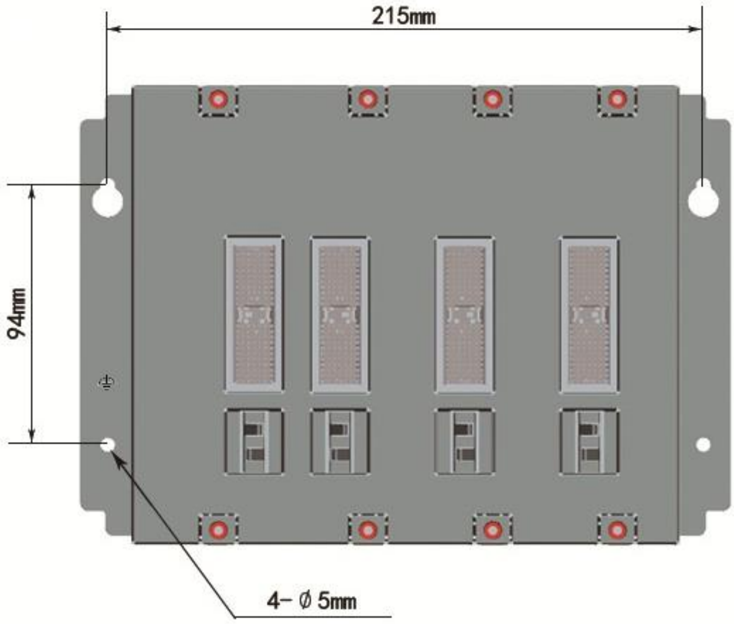


Figure 5 Hole Size on Local Backplane

The LK130 backplane 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 local backplane mounting hole in alignment with the screw, slightly push down to fix the screw into the mounting hole tightly, then fasten the screw.

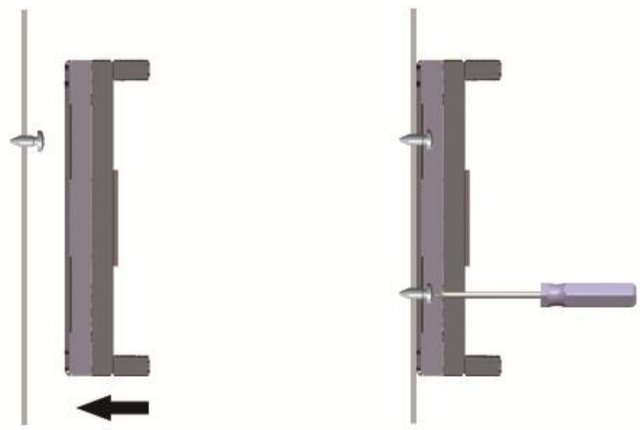


Figure 6 Installation Diagram of Local Backplane

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 LKS safety control system adopts radiation through natural convection. Therefore, some requirements are put forward for the installation mode and the placement space of backplanes, thus ensuring that the PLC equipment is sound in ventilation and radiation.

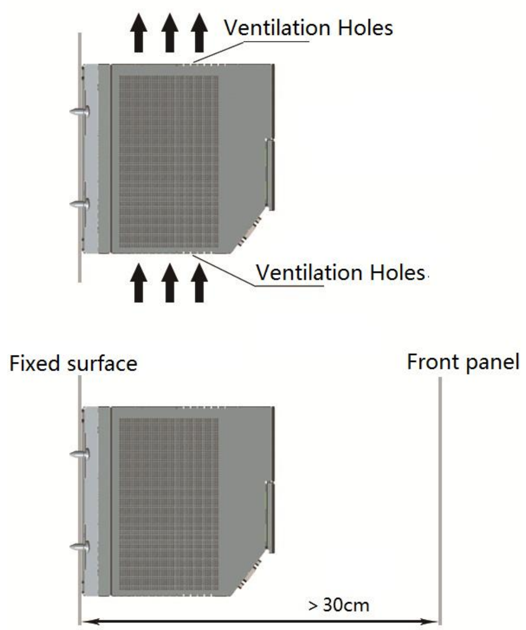


Figure 7 Correct Installation of The backplane

3.1.2.2 Installation of Extension Backplane

The LKS extension backplane 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 8 for the hole size (Unit: mm).

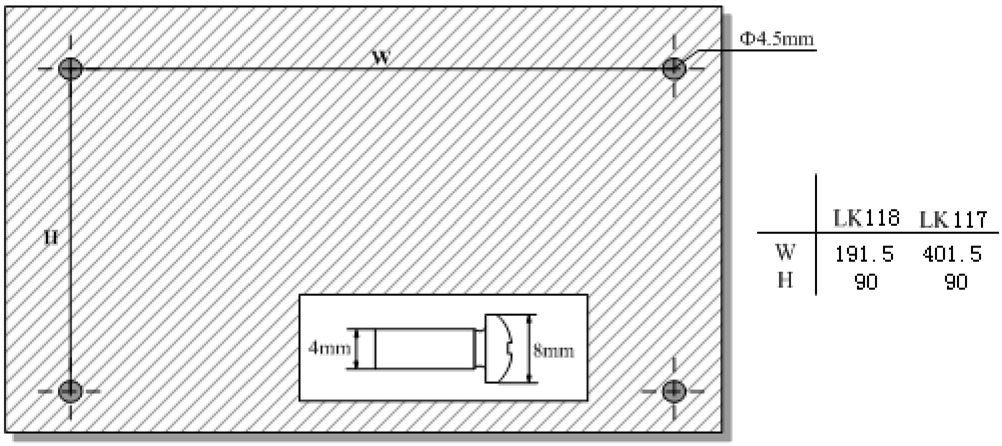


Figure 8   Hole Size on Extension Backplane

The extension backplane 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 backplane mounting hole in alignment with the screw, slightly push down to fix the screw into the mounting hole tightly, then fasten the screw.

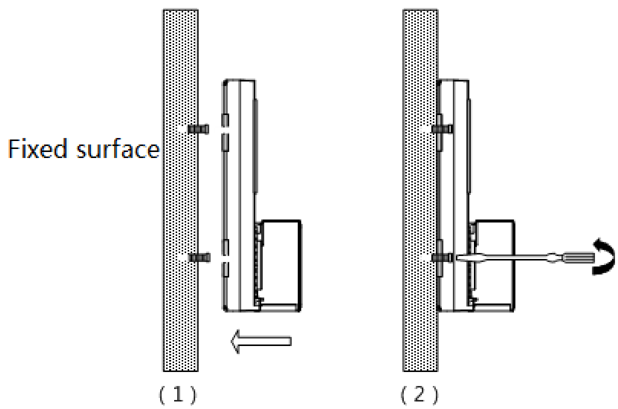


Figure 9   Installation Diagram of Extension Backplane

3.1.3 Protection Key

The I/O wiring is in the extension backplane, 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 LKS Series is located on the module and extension backplane. The code of a protection key for the LKS 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 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 backplane is of a male mold, able to rotate to fit into the plugged module.

LK411S as an example, the protection key code of the module is A1. When installing the module, rotate the protection key for the corresponding slot on the backplane to A1, which corresponds to the protection key position of the module, then plug in LK411S, as shown in Figure 10.

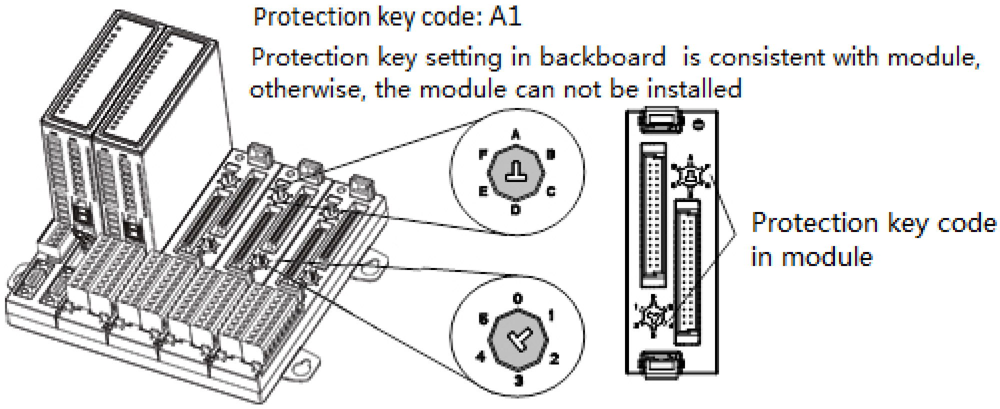


Figure 10 Set Protection Keys for LKS odule

3.1.4 Module Installation and Disassembly

3.1.4.1 Installation and Disassembly of System Module

Installation steps as shown in Figure 11 about LK921S, LK220S, LK249S, LK240S in LK130 backplane.

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 fixing screw at the upper & lower ends.

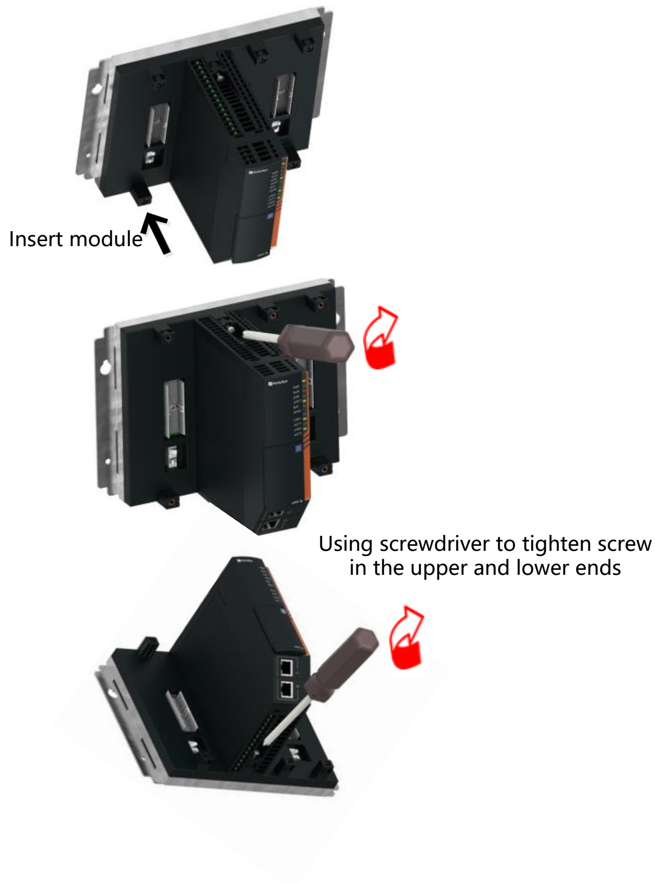


Figure 11 Install Module

- Points for attention
  - ☐ When LK240S module is installed with power on, synchronous optical fiber must has been inserted into the module.
  - ☐ Ensure that the position in backplane of A and B frame is consistent when you install the LK240S and LK249S module.

Disassembly, loosen the screw in top and bottom ends of the module, and then pull out the module level, as shown in Figure 12.

Figure 12　Dismantle Module

3.1.4.2　Installation and Disassembly of IO Module

IO modules are installed on extension backplane. After setting the protection key on the backplane properly, install the module by plugging in it according to Figure 13. After the module is installed and debugged, it can fix each module on the backplane 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).

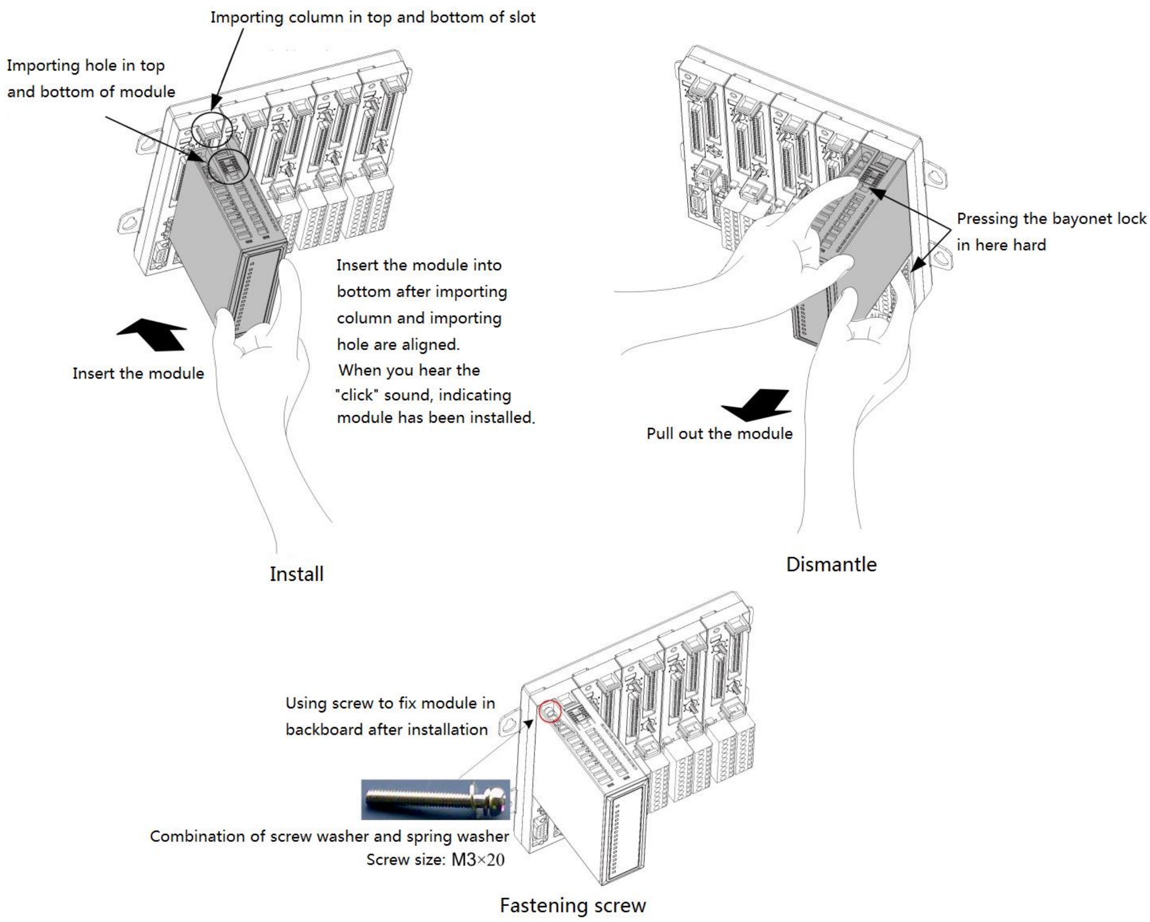


Figure 13 Installation and Disassembly of IO Modules

3.1.5 Installation of QS10.241

1. Dimension

The power module adopts 35mm DIN-rails according to EN 60715 or EN 50022 with a height of 7.5 or 15mm.

The DIN-rail height must be added to the unit depth (117mm) to calculate the total required installation depth, with mounting slot on the back, installation dimensions as shown in Figure 14 and Figure 15.

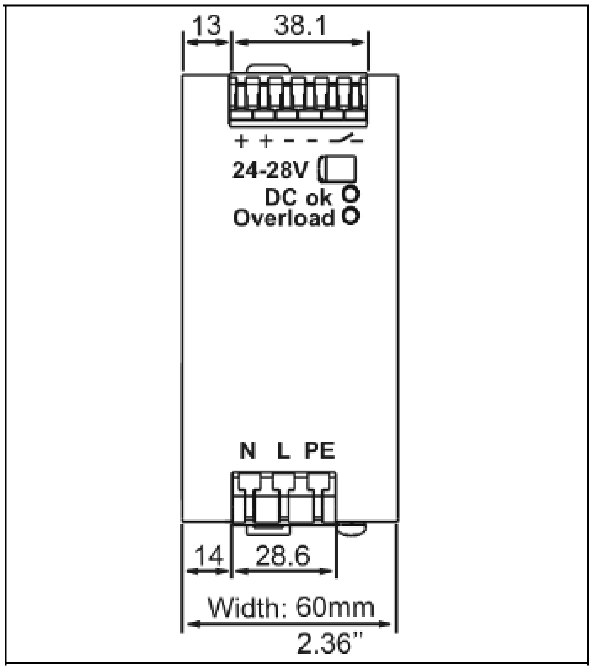


Figure 14 Front View

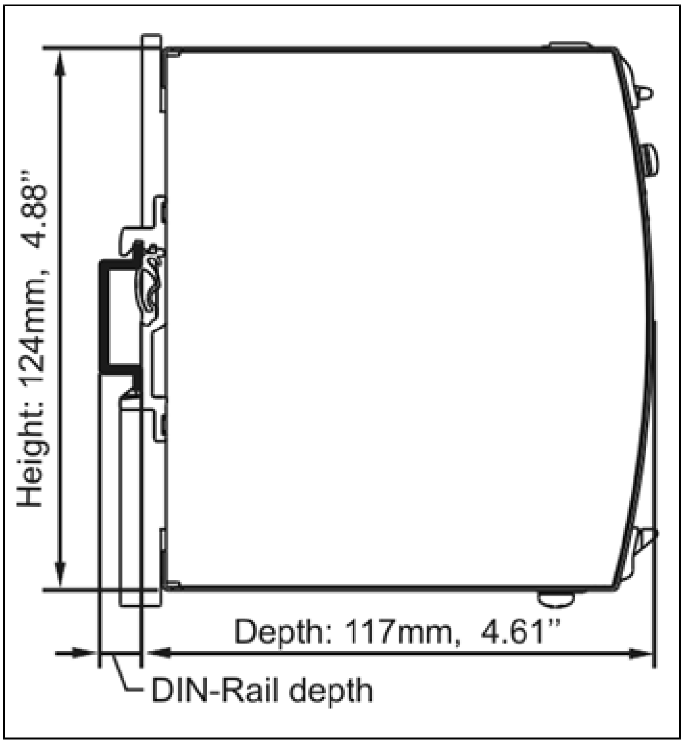


Figure 15 Side View

2. Installation method

■ Wall mounting

You can use follows bracket to mount the power supply onto a flat surface without utilizing a DIN-Rail.

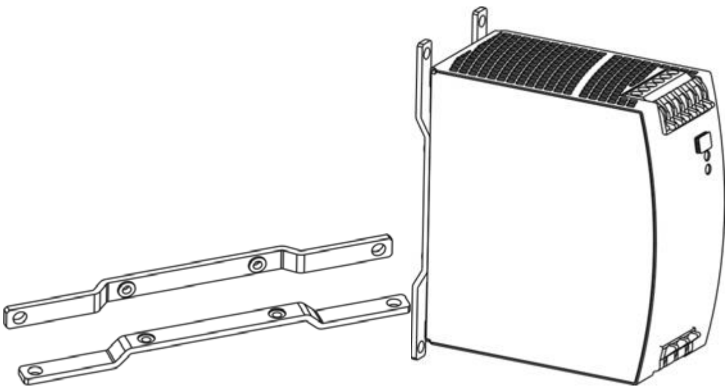
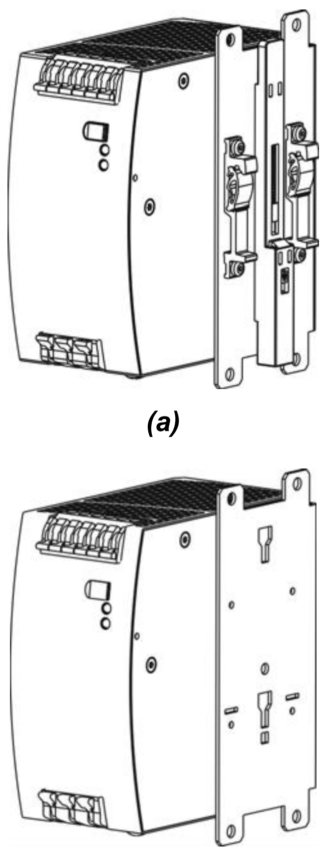


Figure 16　Wall Mounting Bracket

- Side mounting

  You can use follows bracket to mount Dimension units sideways with or without utilizing a DIN-Rail. The two aluminum brackets and the black plastic slider of the unit have to be detached, so that the steel brackets can be mounted.

  For side way DIN-rail mounting, the removed aluminum brackets and the black plastic slider need to be mounted on the steel bracket.



(a)

(b)

Figure 17　Side Mounting without DIN-rail Brackets

- Installation requirements

- ☐ This device may only be installed and put into operation by qualified personnel.
- ☐ This device does not contain serviceable parts. The tripping of an internal fuse is caused by an internal defect.
- ☐ If damage or malfunction should occur during installation or operation, immediately turn power off and send unit to the factory for inspection.
- ☐ Mount the unit on a DIN-rail so that the output terminals are located on the top and the input terminals are located on the bottom of the unit.
- ☐ This device is designed for convection cooling and does not require an external fan. Do not obstruct airflow and do not cover ventilation grid (e.g. cable conduits) by more than 30%!
- ☐ Keep the following installation clearances: 40mm on top, 20mm on the bottom, 5mm on the left and right sides are recommended when the device is loaded permanently with more than 50% of the rated power. Increase this clearance to 15mm in case the adjacent device is a heat source (e.g. another power supply).
- ☐ It is suggested that the circuit breaker is configured in front of the AC/DC power supply, specifications (1~20A recommended) are calculated according to the power consumption of the system and installed near the device.

■ Wire requirements

Wire cross section 0.5-6mm^2(20-10AWG), wire models with insulation requirements such as H05 RR-F,H05 RN-F, H05 VV-F, H05 V2V2-F, H05VVH2-F2. When wire length is less than 2m, wire cross section is at least 0.5mm^2 and wire length is greater than 2m, wire cross section is at least 0.75mm^2.

Avoid dangerous operations cause electric shock, fire, personal injury and death.

- Do not use the power supply without proper grounding (Protective Earth). Use the terminal on the input block for earth connection and not one of the screws on the housing.
- Turn power off before working on the device. Protect against inadvertent re-powering.
- Make sure that the wiring is correct by following all local and national codes.
- Do not modify or repair the unit.
- Do not open the unit as high voltages are present inside.
- Use caution to prevent any foreign objects from entering the housing.
- Do not use in wet locations or in areas where moisture or condensation can be expected.
- Do not touch during power-on, and immediately after power-off. Hot surfaces may cause burns.

3.1.6 Installation of LKA104

LKA104 connector is installed on the extension backplane and LK249S module.

After wiring the DP cable, 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 LK249S module.

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

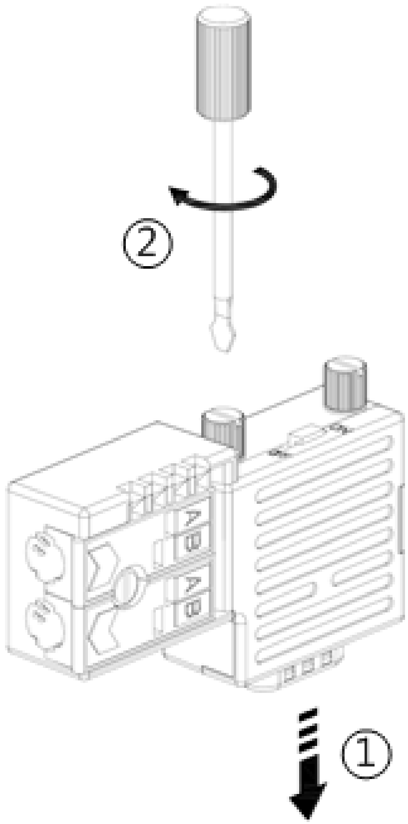


Figure 18　LKA104 Installation Schematic Diagram

3.1.7　Installation of Power Supply Box

Battery slot on the front panel of LK220S module that can be used to install 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 19　Installation Schematic Diagram of Power Supply Box

3.2 System Wiring

3.2.1 Power Wiring

The LK921S has 2 groups input terminals. Three positions are provided in each terminal for 24V+, 24V- and system ground wire. System power wiring is shown in Figure 20.

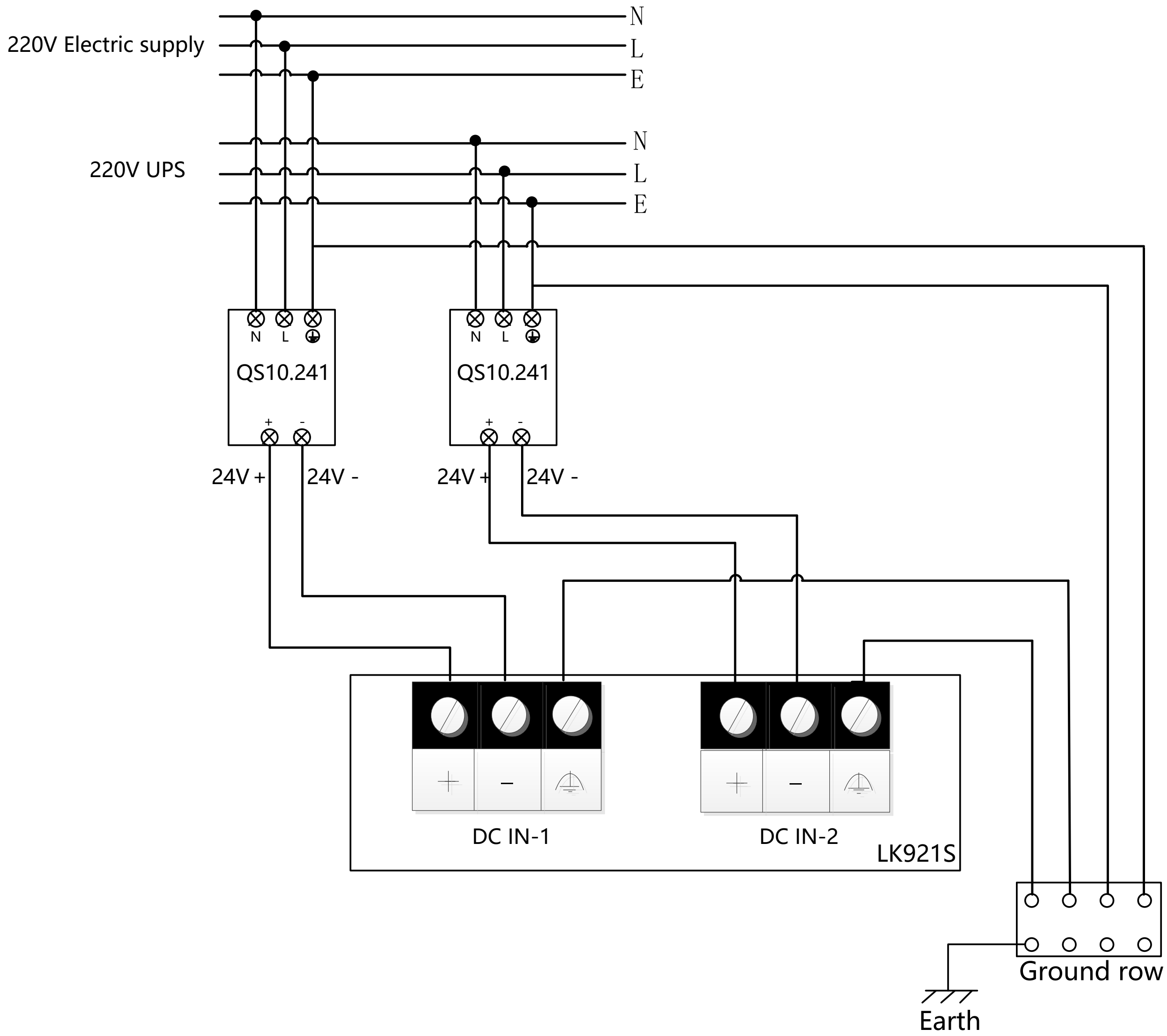


Figure 20　System Power Wiring

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

3.2.2　Redundancy Communication Wiring

The LC plug of LKA105 synchronous optical fiber is inserted into FIBER X1 ports in the LK240S modules which located in master/slave frame, respectively. Another group synchronous optical fiber is inserted into FIBER X2 ports.

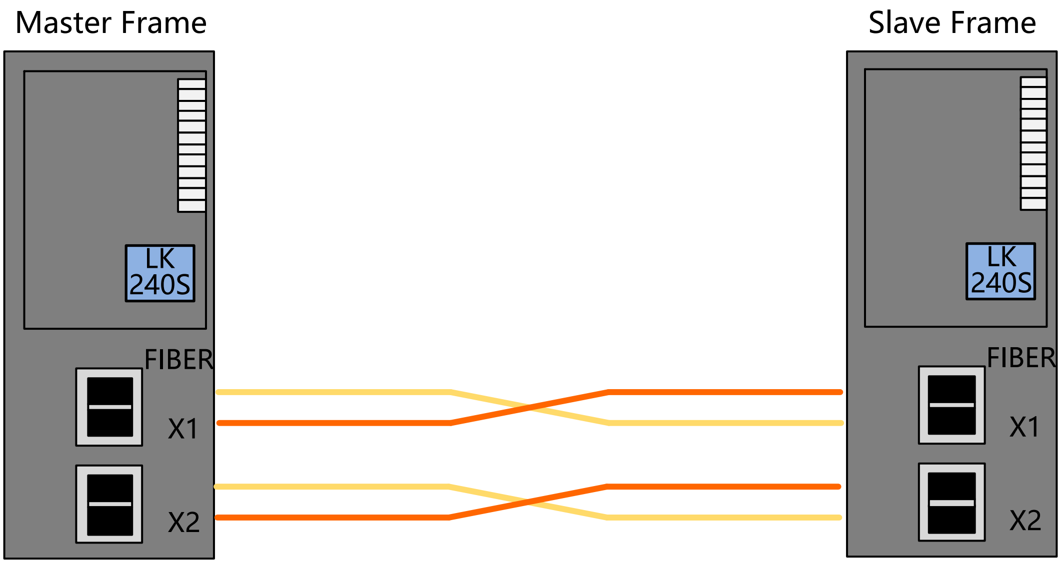


Figure 21 Safety Redundant Communication Module Wiring

3.2.3 PROFIsafe Wiring

3.2.3.1 Cable Requirements

With a view to the network transmission technology of LKS hardware, it shall adopt RS485 twisted-pair cable or synchronous optical fiber. Taking engineering applications (construction difficulty, maintainability and economy efficiency, etc.) and the actual circumstances in the product field application 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 7. 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 7 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 8 when installing the house cable.

Table 8 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 9. For long-distance communication, it can extend the signal transmission distance via the LK232S PROFIsafe 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 9 Max. Cable Length Based on Different Transmission Rates for Twisted-pair Cables (with no repeaters)

Parameters	Units	Value				
Baud rates	kbps	187.5	500	1500	3000	6000
Cable Type A	m	1000	400	200	100	100
Cable Type B	m	600	200	70	Not recommended	Not recommended

3.2.3.3 Terminal Matching Resistor Settings

The terminal matching resistor must be set at both ends of the PROFIsafe. The setting principle is as follows:

- The terminal matching resistor is set at the end of each of the PROFIsafe segment.
- The terminal matching resistor at each end of the PROFIsafe segment can only be set at one place and can't be set repeatedly.

Terminal matching resistor setting precautions:

- Understand the first and end of each segment in order to accurately set the terminal matching resistor.

The start terminal matching resistor is provided by the LKA104, the dialing switch is set to ON, the end terminal matching resistor is provided by the LK232S on the last extension backboard, and the J4 is set to ON. The terminal matching resistor at both ends of the PROFIsafe in extended backboard is provided by LK232S, and J5, J6 are set to ON. As shown in Figure 22.

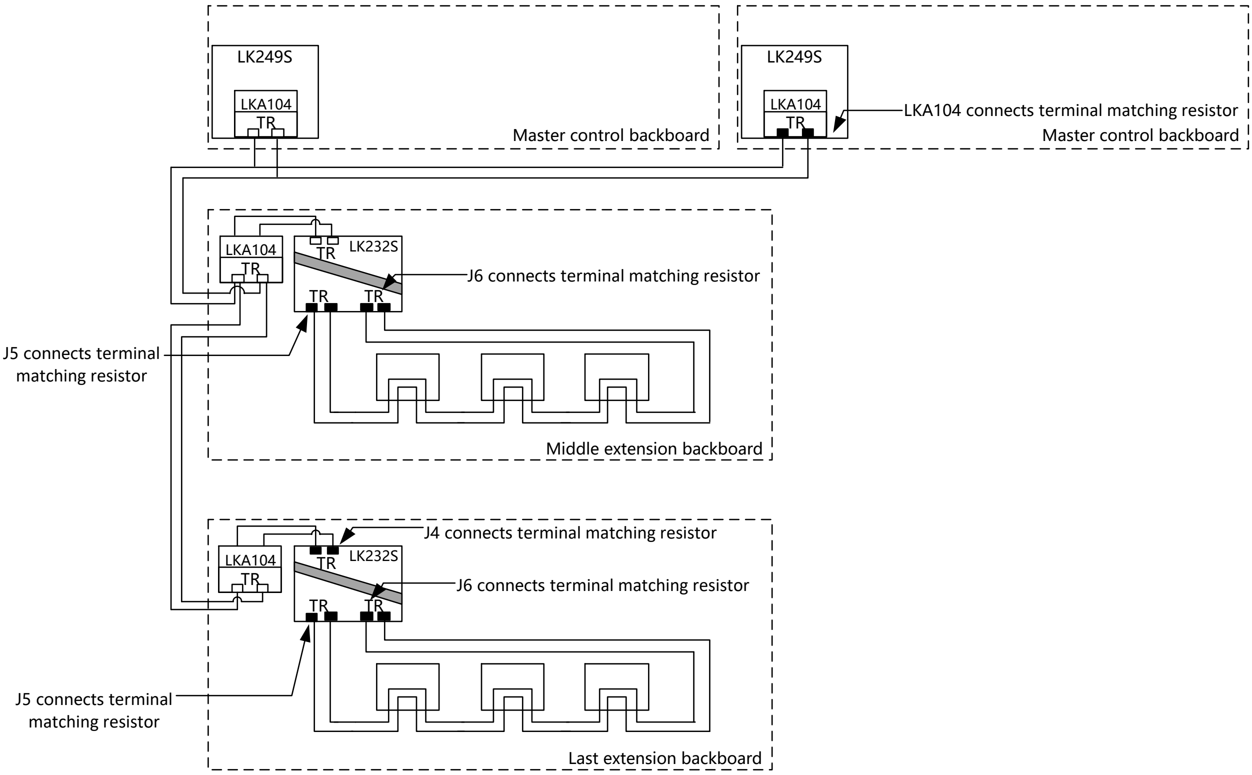


Figure 22　Terminal Matching Resistance Settings

3.2.3.4　LKA104 wiring

The cable processing requirements of the bus connector are shown in Figure 23. The outer diameter of cable is no more than 8 mm. Otherwise it cannot be put into the cable interface of the connector.

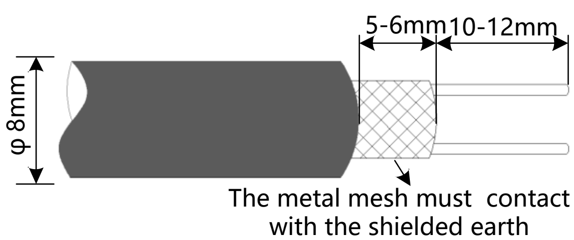


Figure 23　Requirements of DP Cables

Wiring of the bus cable:

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

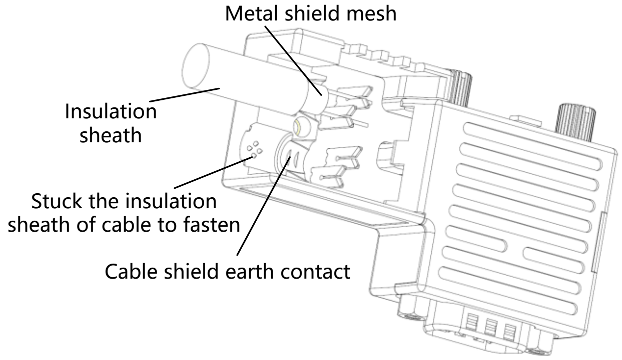
(2) Allow the appropriate length of shielding and core for wiring according to the standard of cable processing.

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

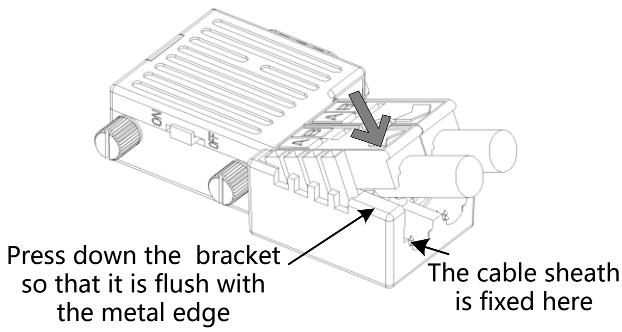
(4) The shield layer and the grounding contact are reliably connected, and the cable sheath is fastened.

(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 24 LKA104 Wiring Schematic Diagram

3.2.4 I/O Cable

The field I/O signals are divided into AI, DI and DO signals. The signal wires need to use shielded wire with metal net, and ensure the reliable shield grounding.

- 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.

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 controller side (system side) for LKS safety control system.

3.2.4.1 I/O Cable Processing

The aperture of backplane 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 25.

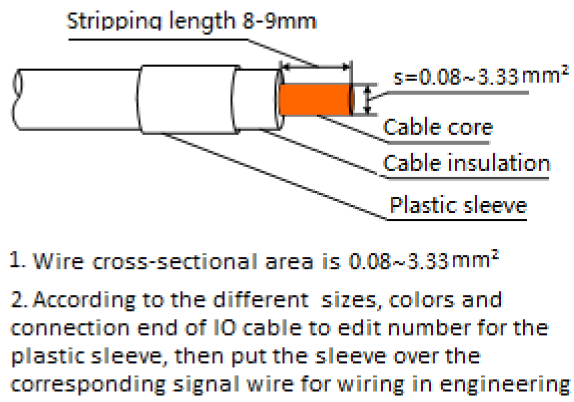


Figure 25 I/O Cable Processing Requirements

3.2.4.2 I/O Wiring

For LK117/LK118 backplane, the terminal is fixed on the backplane, 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 LKS-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.

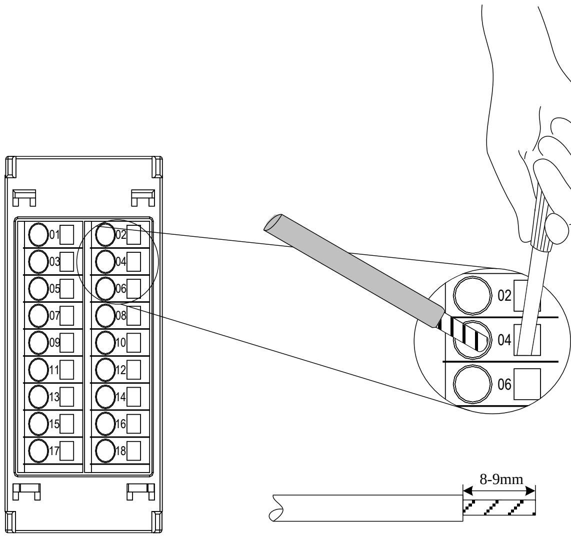


Figure 26 Wiring of I/O Terminals

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 backplane enclosure shall be grounded. The DP cable shielding layer shall be grounded.

The system must be grounded separately. Never to ground the system 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.

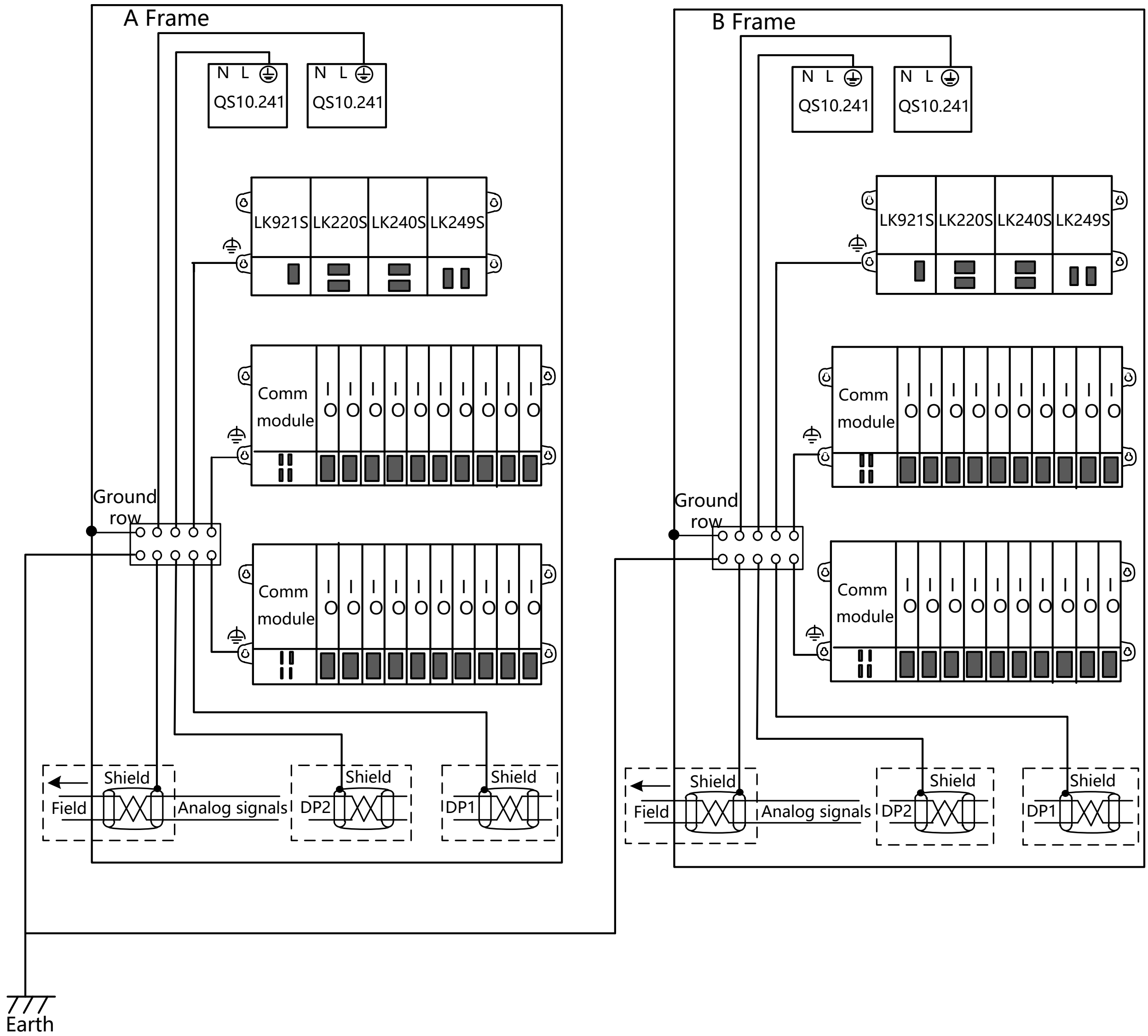


Figure 27   Grounding of LKS safety control system

Chapter 4 System Configuration

After hardware installation and wiring, to realize the input, output and control of controller, it shall configure the LKS safety control system hardware accordingly via the programming software according to the hardware architecture of the actual project, including configuring the I/O module, parameter settings, Modbus communication settings.

Start the Safety FA-AutoThink programming software and create a new project to configure project. including task configuration, creating program, hardware configuration, etc. Refer to the manual *Safety FA-AutoThink V1.0.0_User Manual* for specific configuration. Only hardware-related configuration items are discussed here.

4.1 Hardware Configuration

When a new LKS project is created, A LK220S module is added by default with redundancy configuration. The entire hardware configuration will be completed in LK220S node.

4.2 Configure DP Protocol

4.2.1 Add DP Master Device

You can add LK249S safety master station communication module via [Add Device] in right-click menu of LK220S.

Prompt the Add dialog as shown in Figure 28. Select LK249S to add.

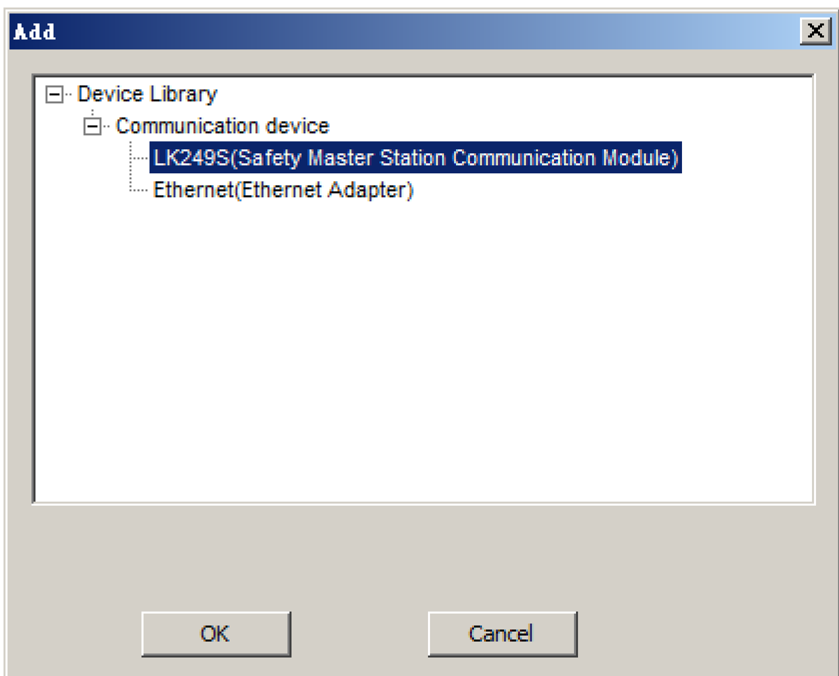


Figure 28   Add LK249S

- LK220S CPU module currently supports up to one safety DP master station communication module and one Ethernet adapter.

You can view device information of module, rename, add protocol and delete module through the right click menu on LK249S.

4.2.2 Add Communication Protocol

LK249S as communication master station of PROFIsafe/Profibus-DP, you need to add master station communication protocol. Select [Add protocol] to add.

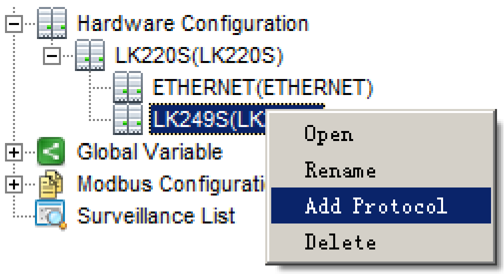


Figure 29　Right click menu on LK249S

The Add dialog is shown in Figure 30.

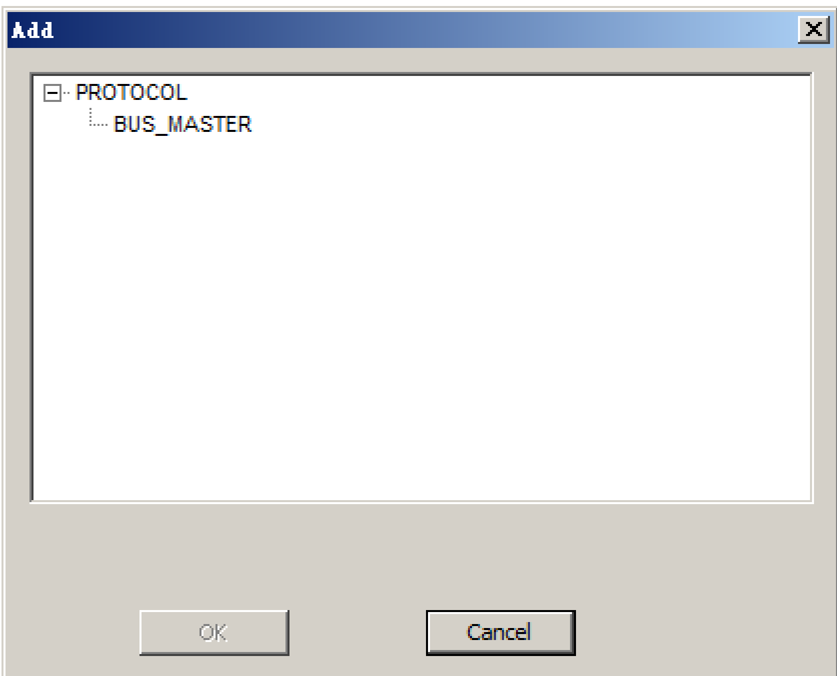


Figure 30　Add BUS_MASTER protocol

- Only support one DP_MASTER protocol under LK249S module.

You can view device information, rename, add devices and delete devices through right-click menu on BUS_MASTER node.

Double-click BUS_MASTER to open the device information window.

BUS_MASTER(BUS_MASTER)

Device Information

Project	Content
Protocol name	BUS_MASTER
Port	COM
Baud rate	500.00
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	600
DP polling cycle	0
Protocol	Profibus-DP/PROFIsafe
Address range of slave station	2~125
Position of master/slave station	Profibus-DP master station/PROFIsafe master stati

Figure 31 BUS_MASTER device information window

Parameter information of communication master station is displayed in the device information window, Port and Baud rate can be set. Port is set as COM1. Choose different baud rate, other bus parameters switch to best value automatically.

4.2.3 Add PROFIsafe/Profibus-DP Slave Station

You can add PROFIsafe safety slave devices and Profibus-DP non-safety slave devices to safety DP master station device.

4.2.3.1 Import Device Description File

The LK249S support the module of other companies as the DP slave station. Before configuration, you need to import the required device description file, and the corresponding devices shall be generated in the device library for the user configuration.

Device description file corresponding to module is as system file, which should not be modified or deleted.

It is must ensure that format and content exported is correct when new device description file is imported.

- Menu bar: Click [Project]-[Import Device Description File].

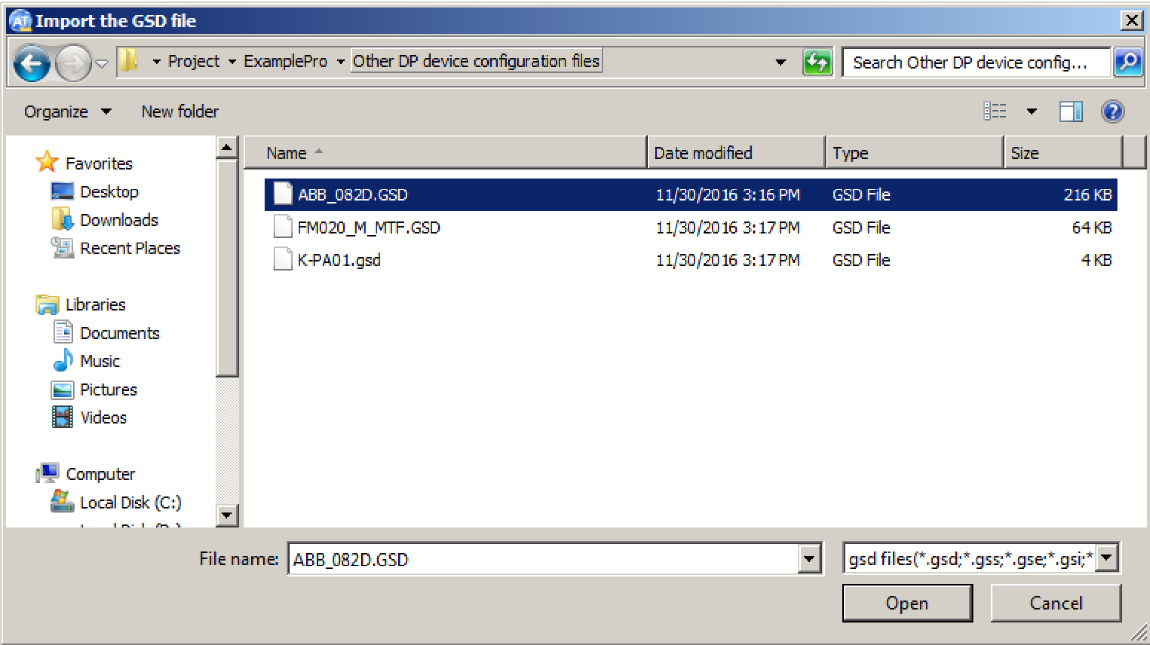


Figure 32 The Dialog of adding configuration file

Choose GSD file and click **Open** to import the device.

4.2.3.2 Add PROFIsafe/Profibus-DP device

Select [Add Device] command to add the slave station.

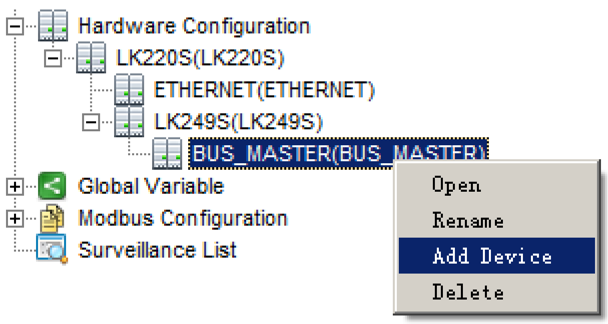


Figure 33 Add devices command

The Add dialog is shown in Figure 34. Profibus-DP as a non-safety protocol and PROFIsafe as a safety protocol, slave modules are selected according to whether the system is a safety system. The default slave station address is displayed in the address box and can be modified.

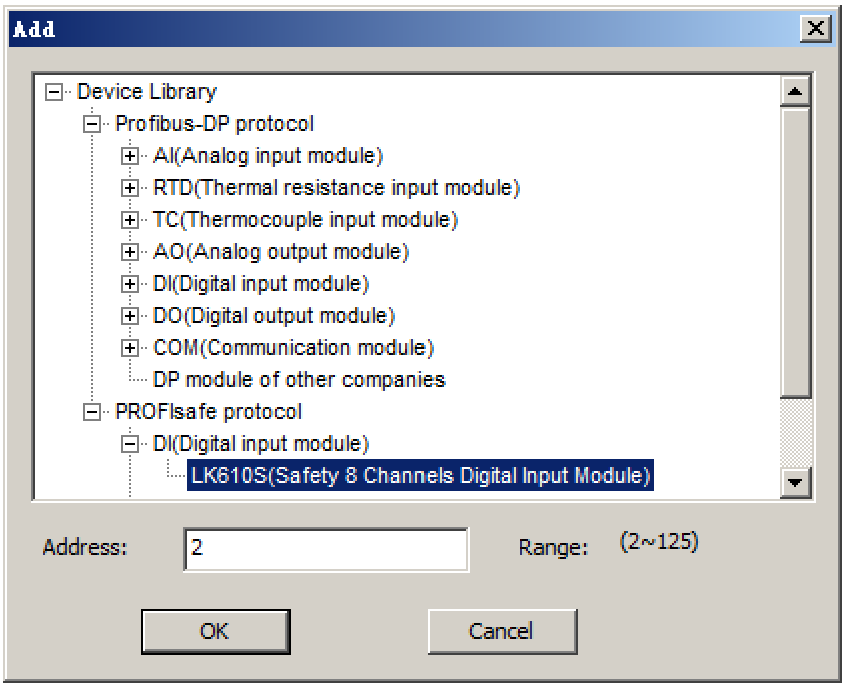
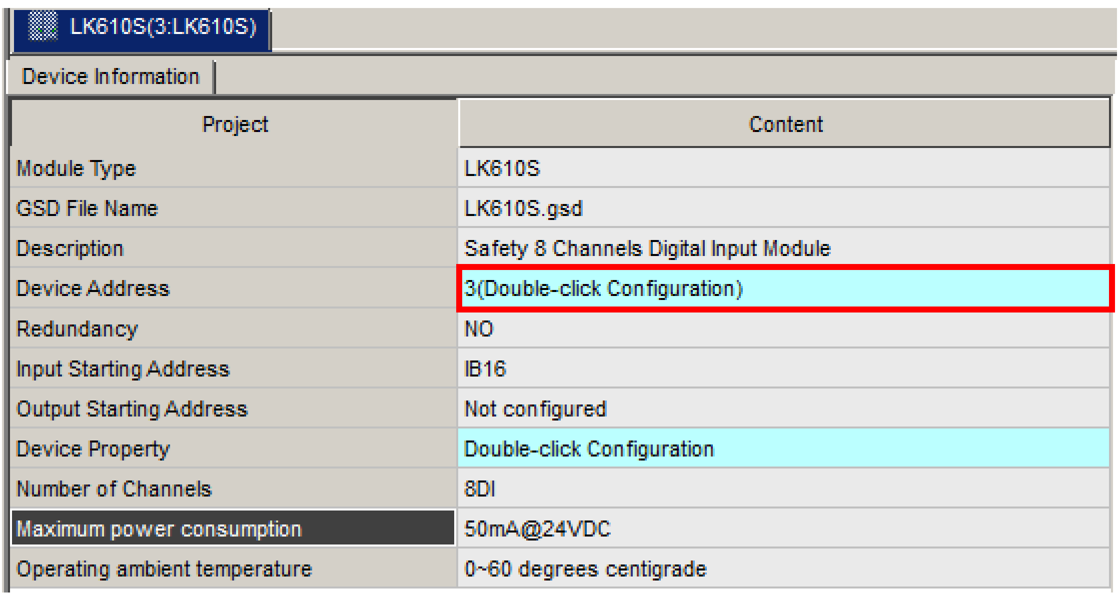


Figure 34　Add slave devices

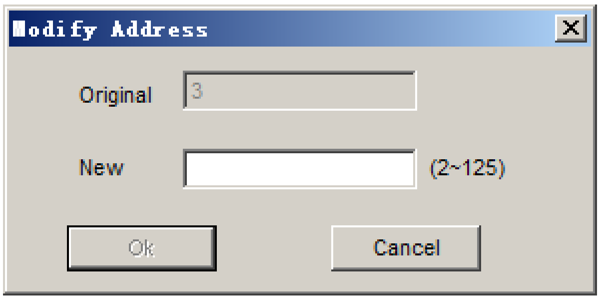
Name of slave module is composed: slave name (slave address: module name). Added serial number is displayed behind the slave name when the same module is added repeatedly. You can modify slave name through [Rename] in right-click menu.

4.2.4　Modify Slave Address

Double-click blue area in Device Address to pop up dialog of Modify Address.



(a)



(b)

Figure 35　Modify address of slave station

Enter the new address, range from 2 to 125. When the address you entered is illegal or reduplicative, The button **OK** is not available.

4.2.5　Configure Slave Station Parameters

Double-click blue area in Device Property (as shown in Figure 35(a)) to open the Module Properties dialog, as shown in Figure 36. The dialog contains [Input / Output selection] tab and [User Parameter].

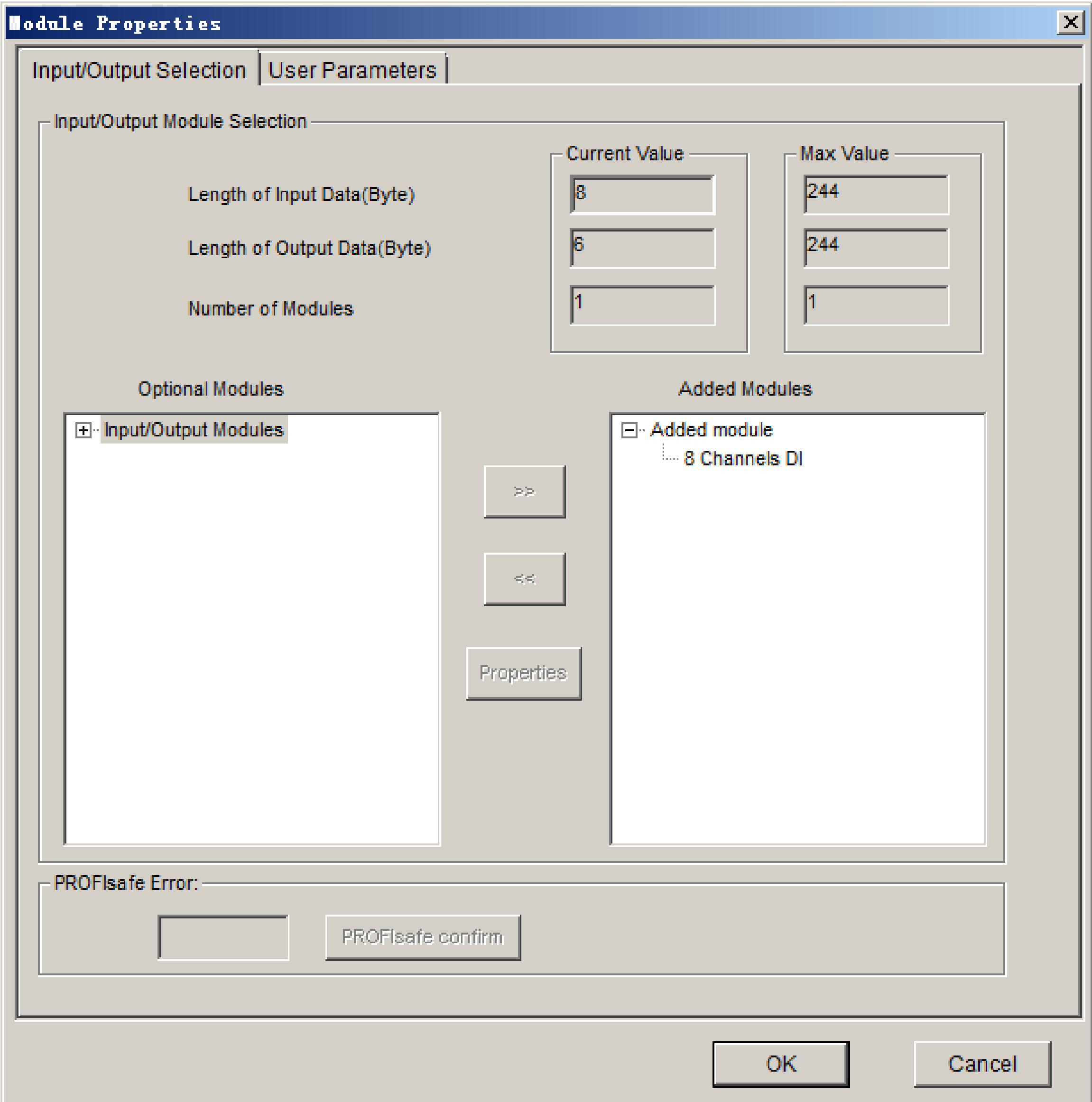


Figure 36　Input / Output selection tab

4.2.5.1　Module Parameter

You can view and configure module parameters through the **Properties** button.

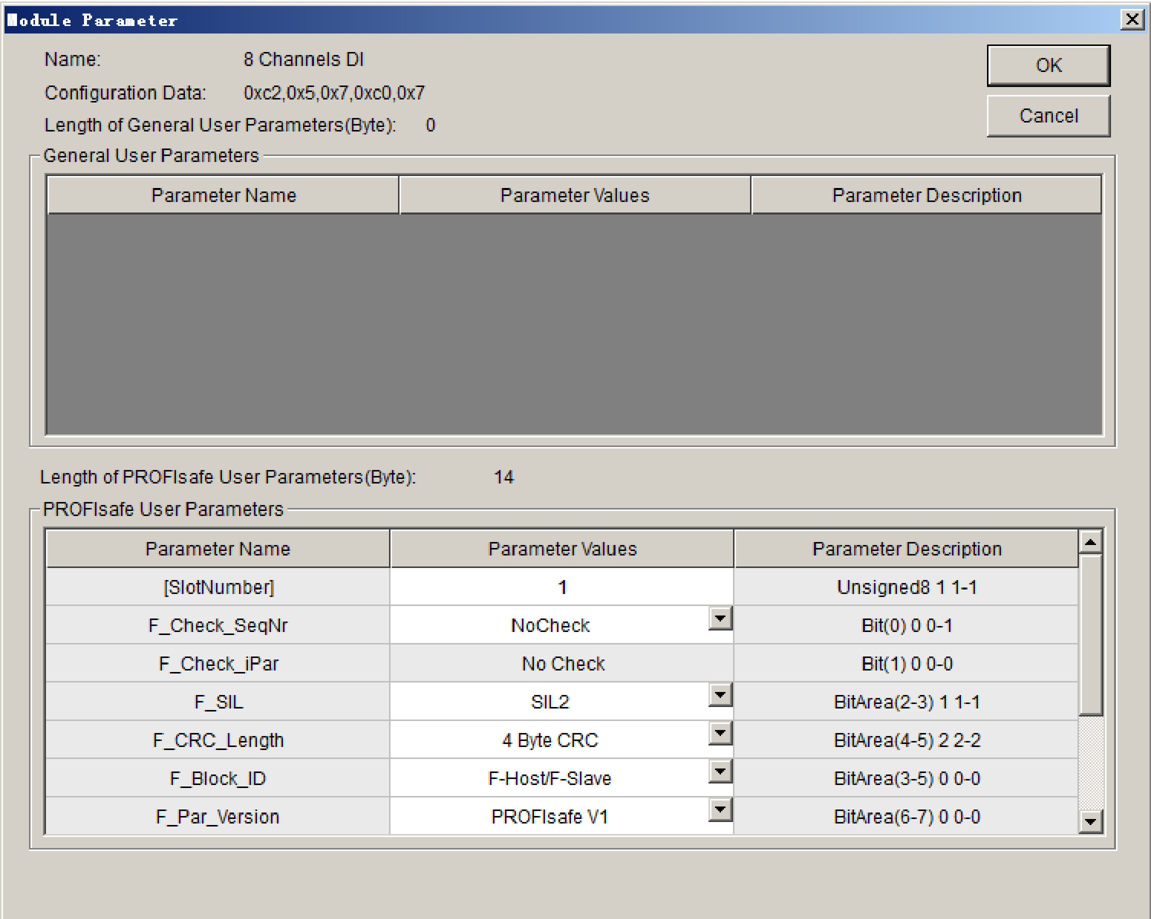


Figure 37　Module parameters

4.2.5.2 User Parameters

User parameters are configured in follows window:

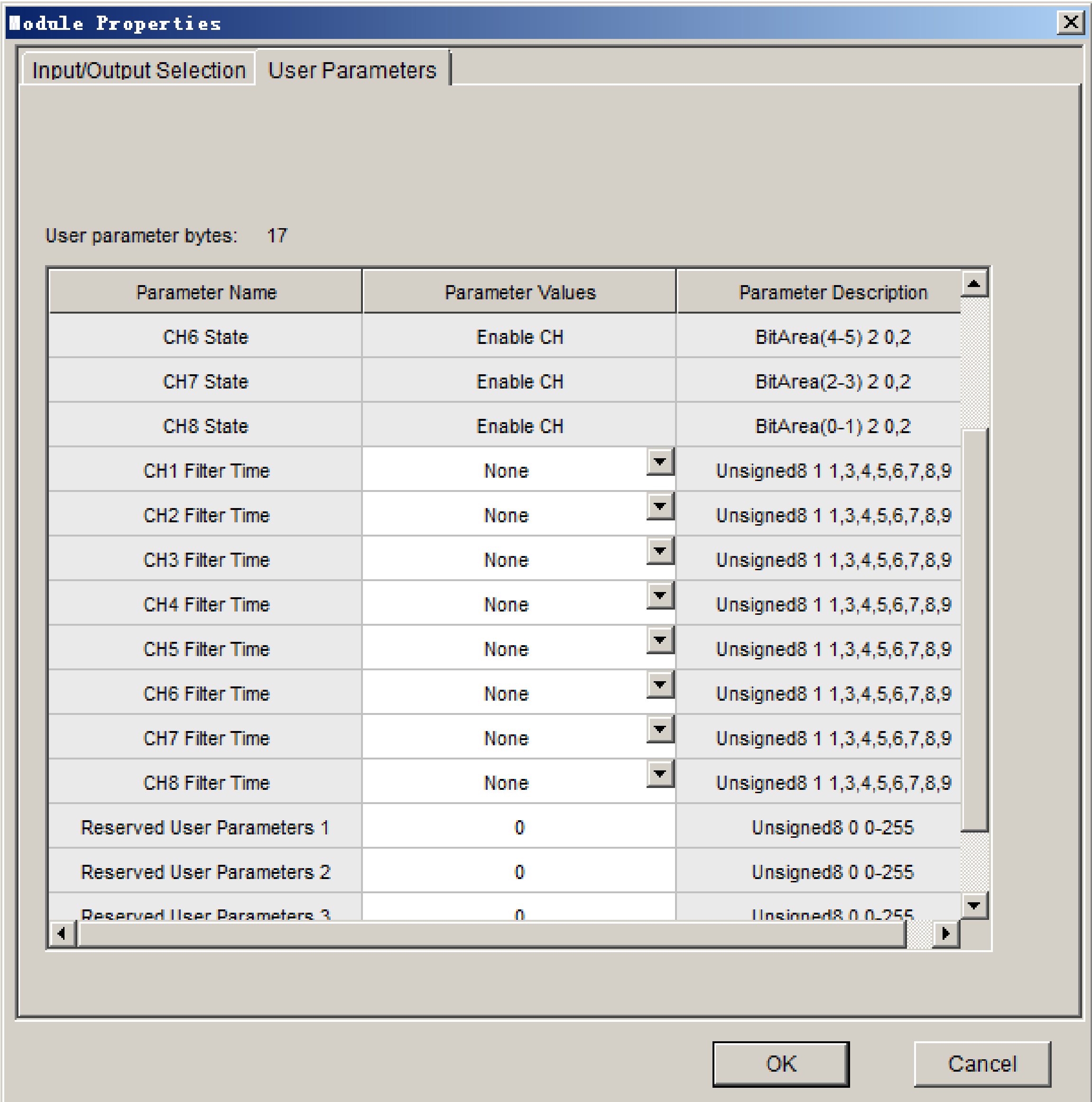


Figure 38 User parameters

- CHn State: Channel enable status. The channel is enabled by checking Channel Enable.

8 Channels DI

Channel Number	Channel Name	Channel Types	Channel Address	Channel Description	Channel Enable	Mode of Safety Value	Safety Value	SOE Enable
1	DPIO_2_1_2_1	BOOL	%IX0.0		☑	Hold On		☐
2	DPIO_2_1_2_2	BOOL	%IX0.1		☑	Hold On		☐
3	DPIO_2_1_2_3	BOOL	%IX0.2		☑	Hold On		☐
4	DPIO_2_1_2_4	BOOL	%IX0.3		☑	Hold On		☐
5	DPIO_2_1_2_5	BOOL	%IX0.4		☑	Hold On		☐
6	DPIO_2_1_2_6	BOOL	%IX0.5		☑	Hold On		☐
7	DPIO_2_1_2_7	BOOL	%IX0.6		☑	Hold On		☐
8	DPIO_2_1_2_8	BOOL	%IX0.7		☑	Hold On		☐
9	Q_DPIO_2_1_2_1	BOOL	%IX1.0					☐
10	Q_DPIO_2_1_2_2	BOOL	%IX1.1					☐
11	Q_DPIO_2_1_2_3	BOOL	%IX1.2					☐
12	Q_DPIO_2_1_2_4	BOOL	%IX1.3					☐
13	Q_DPIO_2_1_2_5	BOOL	%IX1.4					☐
14	Q_DPIO_2_1_2_6	BOOL	%IX1.5					☐
15	Q_DPIO_2_1_2_7	BOOL	%IX1.6					☐
16	Q_DPIO_2_1_2_8	BOOL	%IX1.7					☐

Figure 39 Channel enable

- CHn Filter Time: Channel filter time, None, 20ms, 30 ms, 40 ms, 50 ms, 60 ms, 70 ms, 80 ms, 100ms, 200ms, 300ms, 400ms, 500ms.
- Reserved User Parameters n: Reserved parameters.

4.3 Configure Modbus TCP protocol

4.3.1 Configure Modbus TCP master protocol

When the controller is as a Modbus TCP master station, you need to complete the following configuration.

4.3.1.1 Add the Master Station Protocol

In the [ETHERNET] node's right-click menu, select [Add Protocol] command, dialog is shown in Figure 40. Select MODBUSTCP_MASTER protocol to add.

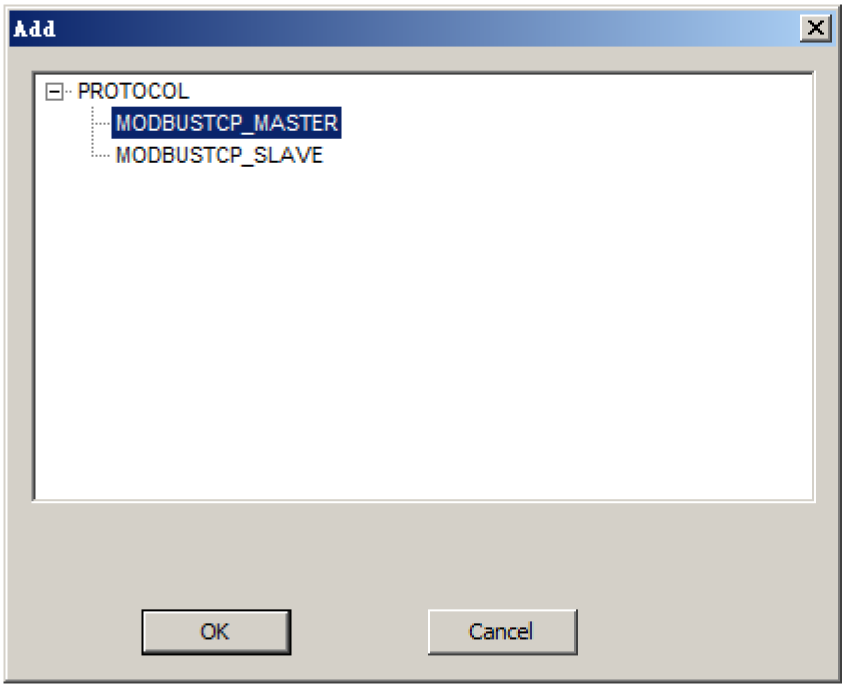


Figure 40 Add Modbus TCP Master Protocol

- Modbus TCP master is a non-safety protocol and is used only in safe project.

4.3.1.2 Configure Modbus TCP Master Station

Double click MODBUSTCP_MASTER node to open master station configuration window.

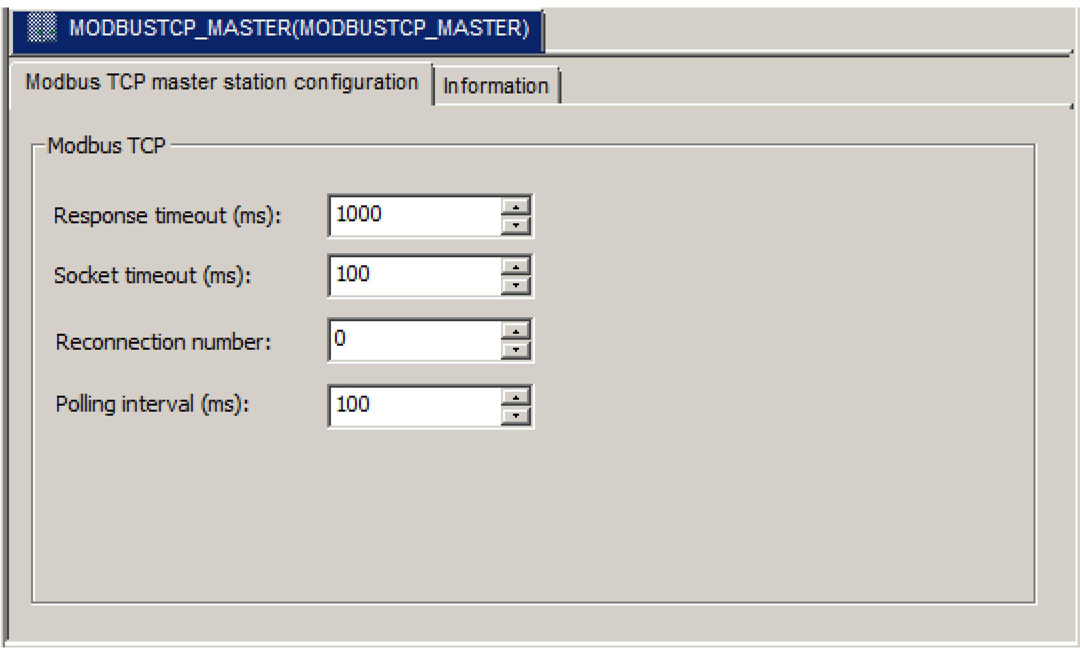


Figure 41 Configuration of Modbus TCP master station

Table 10 Communication configuration parameters of master station

Parameters	Value	Default Value	Description
Response timeout (ms)	10~2,147,483,000	1000	The allowed delay response time after master station sends a request frame
Socket timeout (ms)	10~2,147,483,000	100	TCP/IP connection Socket timeout
Reconnection number	0~10	0	The number of times that the master station re-sends the request after an abnormal response
Polling interval(ms)	100~2,147,483,000	100	The time interval from the moment when the Modbus TCP 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

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).

4.3.1.3 Configure Modbus TCP Slave Station

As master station, controller can configure one or more slave stations for data communication. Select [Add Device] in the right click menu of the MODBUSTCP_MASTER node, and select MODBUSSLAVE_TCP in dialog to add.

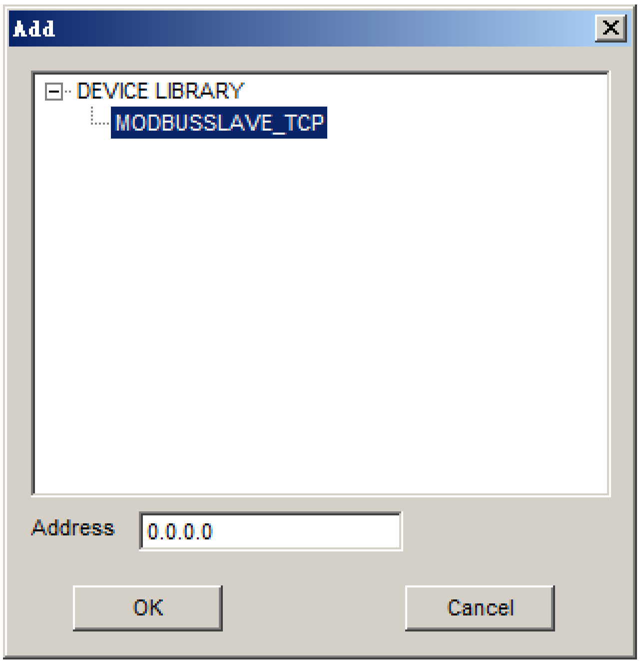


Figure 42 Add Modbus TCP slave station

32 slave stations can be added under the Modbus TCP master station protocol. The added slave station be displayed by default: Slave name (slave address: device name).

■ Modbus TCP slave station configuration

Double click MODBUSSLAVE_TCP node to open slave station configuration window.

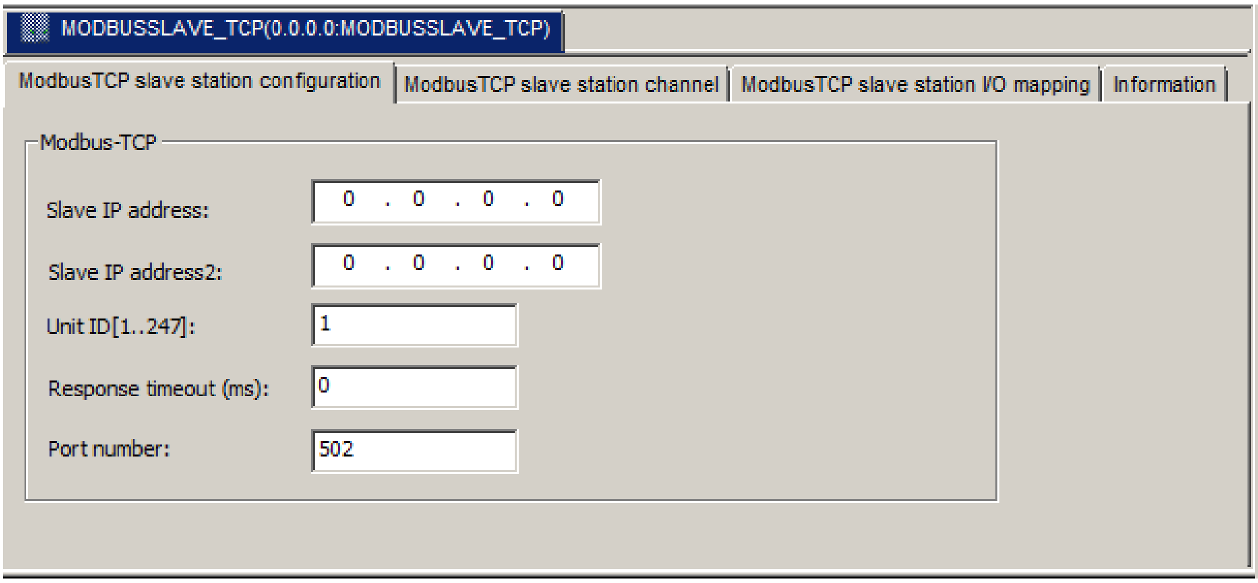


Figure 43 Modbus TCP slave station configuration window

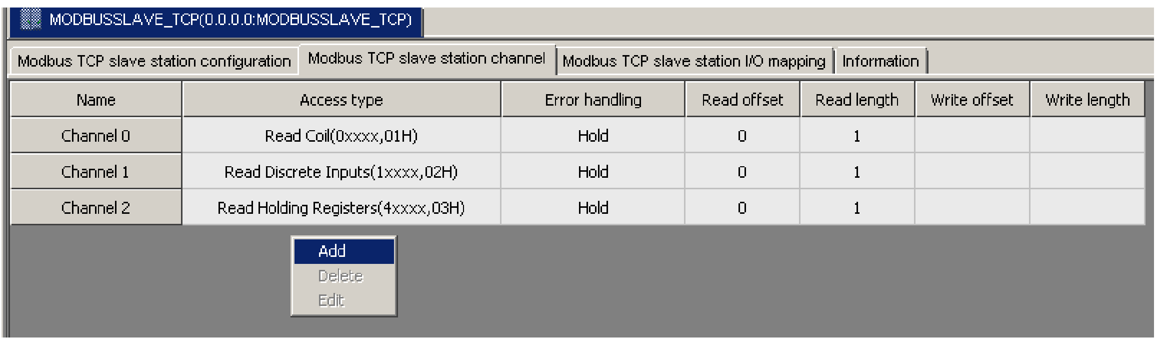
Table 11 Parameters of slave station

Parameters	Value	Default Value	Description

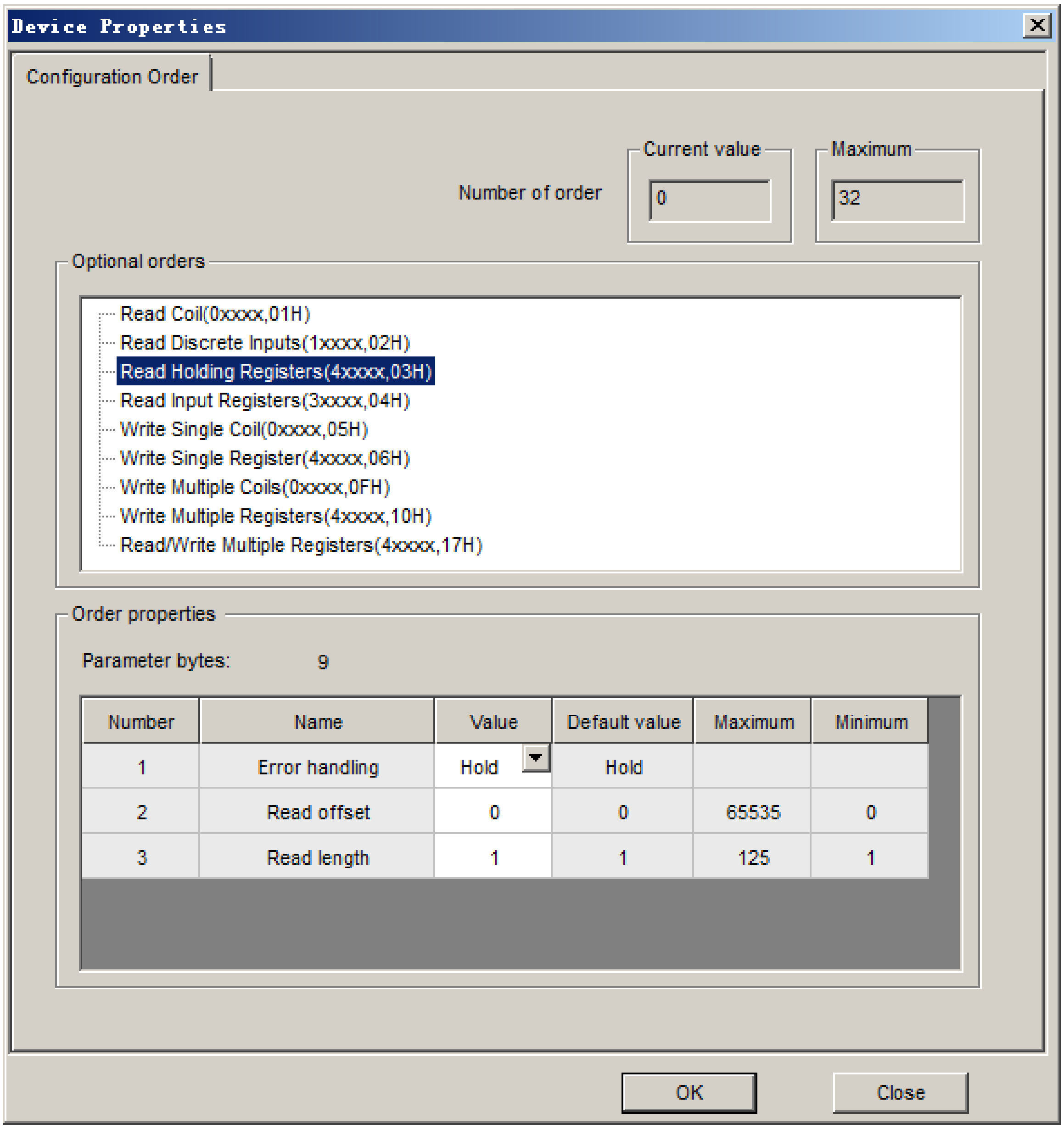
Parameters	Value	Default Value	Description
Slave IP address	Set according to the actual IP address of slave station	0.0.0.0	IP address of the slave station requested by master station The slave station can configue two IP addresses, one for connection and the other for standby
Unit ID	1~247	1	Modbus TCP protocol unit ID
Response timeout (ms)	0~2,147,483,000	0	Default case: the default timeout time of slave is zero. In this case, the response timeout time of the master is adopted. The Response timeout of a slave station can be configured separately. If the parameter is greater than zero, The timeout time is based on the current slave station configuration
Port number	1~65,535	502	The Modbus TCP protocol port

- Configure slave station orders

In the [Modbus TCP slave station channel] tab, you can add orders for the slave station through the [Add] command in the right-click menu, as shown in Figure 44.



(a)



(b)

Figure 44 Add slave station orders

Choose order in the **Optional orders** box, order parameters will be displayed and you can double-click the parameter value item to set.

You can add up to 32 orders.

Table 12 Order parameters

Parameters	Value	Default Value	Description
Error handing	Hold, Clear	Hold	Hold: The current data is held after abnormal response Clear: The current data is cleared after abnormal response Only the read orders can be set

Parameters	Value	Default Value	Description
Read /Write offset	0~65,535	0	Corresponding offset value of start address on the slave
Read /Write length	Different orders correspond to different value range	1	The length value corresponds to the number of corresponding channels of the slave station

- Slave station I/O mapping

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

  - Modbus start address of each instruction = 00001 + read/write offset address.
  - Channel name: The initial value is TCPIO_ device number _ protocol number _ four-bit slave station IP address _ channel number. Channel name supports edit and you can access Modbus variables via channel name.
  - Channel addresses: Channel addresses are automatically allocated by the system and cannot be modified.

MODBUSSLAVE_TCP(0.0.0.0:MODBUSSLAVE_TCP)

Modbus TCP slave station configuration | Modbus TCP slave station channel | Modbus TCP slave station I/O mapping | Information

Channel Number	Modbus Address	Channel Name	Channel Types	Channel Address	Channel Description
Channel 0					
1	000001	TCPIO_1_1_0_0_0_0_1	BOOL	%IX0.0	Read Coil(0xxxx,01H)
2	000002	TCPIO_1_1_0_0_0_0_2_1	BOOL	%IX0.1	Read Coil(0xxxx,01H)
Channel 1					
3	100001	TCPIO_1_1_0_0_0_0_3_1	BOOL	%IX4.0	Read Discrete Inputs(1xxxx,02H)
4	100002	TCPIO_1_1_0_0_0_0_4	BOOL	%IX4.1	Read Discrete Inputs(1xxxx,02H)
5	100003	TCPIO_1_1_0_0_0_0_5	BOOL	%IX4.2	Read Discrete Inputs(1xxxx,02H)
Channel 2					
6	400001	TCPIO_1_1_0_0_0_0_6	WORD	%IW8	Read Holding Registers(4xxxx,03H)
7	400002	TCPIO_1_1_0_0_0_0_7	WORD	%IW10	Read Holding Registers(4xxxx,03H)

Figure 45 Add slave station orders

4.3.1.4 Modbus instruction Diagnosis

When the Modbus master station instruction is configured, after compilation, the diagnosis variables of instructions are generated in the global variable group ModbusOrderDiagVar, as shown in Figure 5.5-68. The parameter of variable group does not support editing. The user can find specific instructions according to the diagnostic information which is displayed in **Variable Description** column.

ModbusOrderDiagVar

No.	Name	Description	Data Type	Initial Value	Area
0001	SYS_OrderDiag_0	No.1 communication device, No.1 protocol, Address is 0...	WORD	0	S Area
0002	SYS_OrderDiag_2	No.1 communication device, No.1 protocol, Address is 0...	WORD	0	S Area
0003	SYS_OrderDiag_4	No.1 communication device, No.1 protocol, Address is 0...	WORD	0	S Area

Figure 46 Modbus Variable Diagnostic Message

In online status, you can through code value of instruction state to diagnose the instruction state.

Table 13 Code Value of Master Instruction State for Modbus TCP

Code value of instruction state	meaning
0	No error
2	Time out
4	Function code is error
16	Unite ID not match(the address of salve station is error)
32	The TCP connection fails
33	The request Message sent fails
34	The confirmation message received fails
64	Data sent is not match with data received
128+1	The function code which is not supported by slave station
128+2	Data address overflow
128+3	Data range overflow
128+4	Slave device has fault
128+6	Slave device is busy
128+15	Other fault of slave station

4.3.2 Configure Modbus TCP Slave Protocol

LK220S only as a Modbus TCP slave station in safe project.

4.3.2.1 Add Slave Station Protocol

Right click the ETHERNET node to select [Add Protocol] command, and protocol dialog is shown in Figure 47. Select protocol MODBUSTCP_SLAVE to add, and slave station can be connected by 32 master stations at the same time.

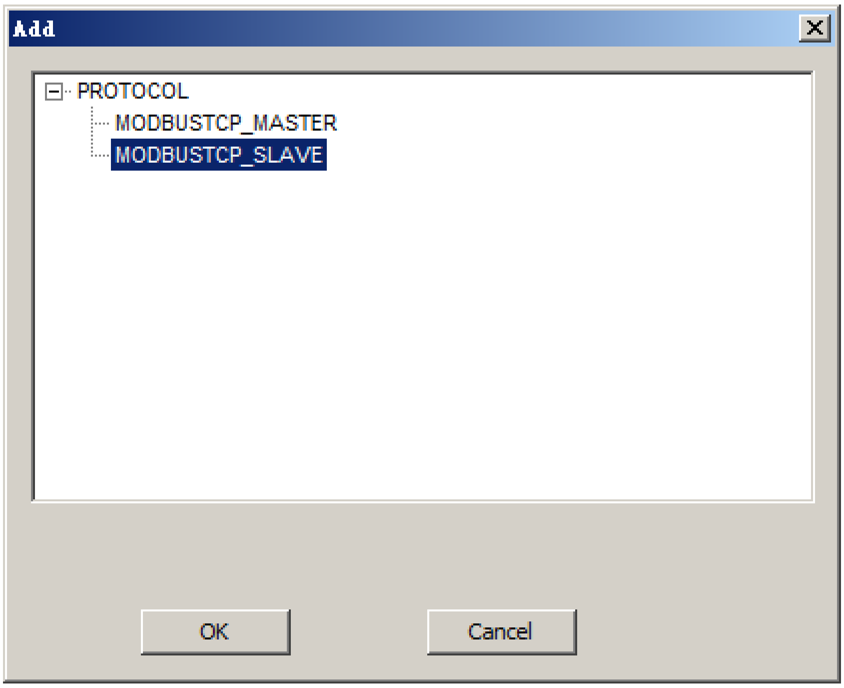


Figure 47 Add slave station protocol

4.3.2.2 Configure Slave Station Parameters

Double click the protocol node to open the slave parameter configuration window.

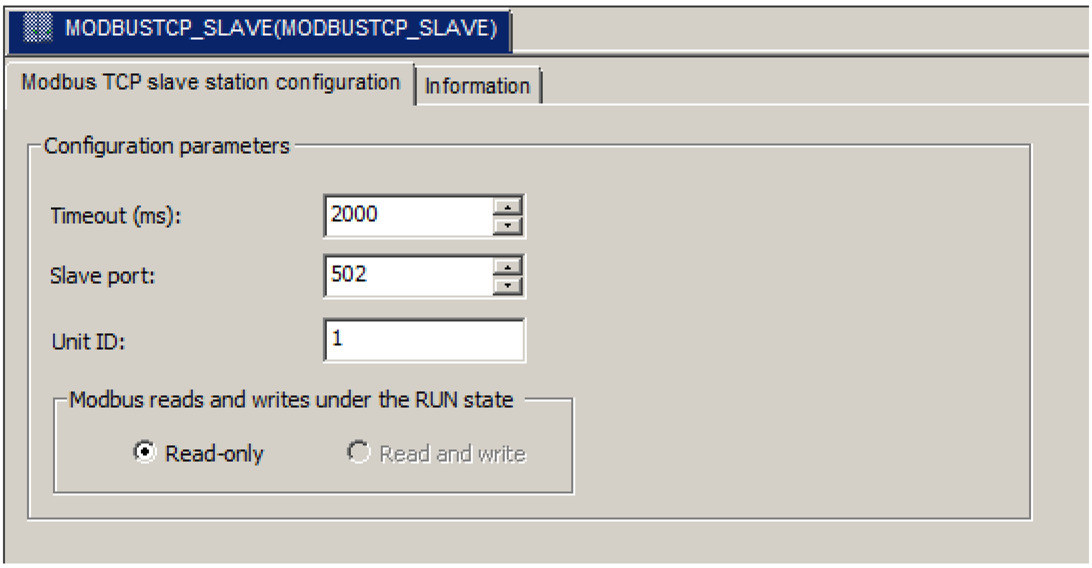


Figure 48 Slave station configuration

Table 14 Configuration parameters

Parameters	Value	Default Value	Description
Timeout (ms)	500~2,147,483,000	2000	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

Parameters	Value	Default Value	Description
			the communication link to the master station.
Slave station port	1~65,535	502	Port number of Modbus TCP protocol
Unit ID	1~247	1	Unit ID of Modbus TCP protocol

- Set Modbus read and write properties in RUN mode
  - Read-only: As a default settings in safety system.
  - Read and write: As non-safety settings, master station can read from slave station and write to slave station.

4.3.2.3 Modbus Variable Configuration

All variables for Modbus communication need to be defined in [Modbus Configuration]. There are four kinds of variable groups: Coil, Input, Input Registers and Holding Registers, as shown in Figure 49, the variable types in each of the above variable group are different.

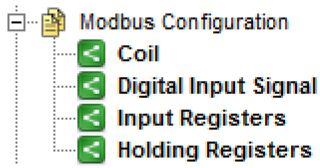


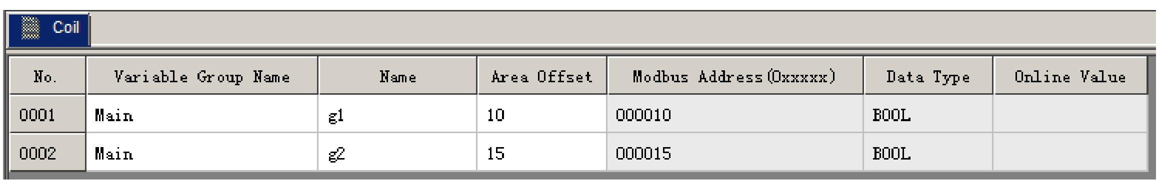
Figure 49 Modbus variable groups

Add variables into the corresponding groups under [Modbus Configuration], the limitations of address and scope are shown in Table 15.

Table 15 Modbus variables definition

Storage Area	Data Type	Access Permission	Area Offset	Modbus Address
Coil	BOOL	Read/Write	1~65535	000001~065535
Digital Input Signal	BOOL	Read-only	1~65535	100001~165535
Input Registers	WORD\DINT\DWORD\REAL	Read-only	1~65535	300001~365535
Holding Registers	WORD\DINT\DWORD\REAL	Read/Write	1~65535	400001~465535

Double-click sub-node below [Modbus Configuration] to open variable group window.


Coil

No.	Variable Group Name	Name	Area Offset	Modbus Address(0xxxxx)	Data Type	Online Value
0001	Main	g1	10	000010	BOOL	
0002	Main	g2	15	000015	BOOL	

Figure 50 Modbus variable group window

Modbus variables are configured in four ways:

(1) Manually add

You can add variables through [Add] command in the right-click menu of variable group window.

(2) Add by command

Variables that are defined in PRG type POU, global variable group and channel are add to the corresponding Modbus variable group by [Send To] command in right click menu.

(3) Copy variables to Modbus variable group

Copy variables from PRG or global variable group to Modbus variable group.

Variable properties in the Modbus variable group are as follows:

■ Variable Group Name: Variable group name sent is shown below.

POU local variables: POU(PRG) name where the variable is located.

Variable in global variable group: Variable group name under the [Global Variable] node.

Channel variables: Shown Physical.

■ Name:

The variables sent show original variable name.

BOOL/WORD pins of function block: Function block name.pin name.

■ Area Offset: Define area offset in variable group according to the slave address and register type set by master station. Master station access Modbus data of slave station through Modbus address and read/write data.

Setting instructions:

□ Offset address length of DWORD, DINT, REAL type variables is 2 words, set the offset address to n + 2, n is an address that has been occupied. For example, REAL variables g1 and g2, set offset address of g1 to 1, then address of g2 is set to 3.

□ The offset address of DWORD, DINT, REAL type variables cannot be set to 65535.

■ Modbus Address: Modbus address is composed of register type and area offset .

The register is divided into the following four types:

□ 0: Coil

□ 1: Digital input signal

□ 3: Input register

□ 4: Holding register

(4) Import or export Modbus variables

When you first import the Modbus variable, you need to export the template of Modbus variable from the software.

■ Export

• Menu bar: click [Project] - [Export Modbus Variable].

Figure 51 Template excel

■ Import

You fill in excel with Modbus variables, and import excel to project.

Variable Group Name, Name, Area Index are required to fill. Software will first empty original Modbus variables and import new variables.

- Menu bar: click [Project] - [Import Modbus Variable].

Import results will be displayed in the [Information window].

4.4 System Running

4.4.1 Required Devices

Basic hardware of LKS safety control system: local backplane, extension backplane, power supply module, main control module, communication module, I/O module, connecting cable.

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

4.4.2 Device Wiring

- Field power wiring and signal wiring, see each IO module wiring.
- Backplane power supply
  - Local backplane power supply: provided by LK921S. Positive terminal of 24VDC system power supply is connected to DC IN—1/2+, negative terminal is connected to DC IN—1/2－ in LK921S module.
  - Extended backplane power supply: 24VDC system power supply is connected to power port in backplane, positive terminal is connect to L+ and negative terminal is connected to M.
- Network wiring: two RJ45 network cable, with one end is connected to the network interface of the PC and the other end is connected to the X1 or X2 port in LK220S module.
- Profibus-DP wiring: via the LKA104 to connect the LK249S module in A chassis and B chassis, then connect to the extended backplane LK117/LK118.
- Redundancy communication wiring: two synchronous optical fibers LKA105 are separately connected to the FIBER X1, FIBER X2 in LK240S module in master-slave frame.

Configure redundancy system, the suggested steps as following:

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

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

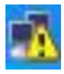
(3) Power -on for other frame and you need to wait for some time until it becomes the slave frame.

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

4.4.3 Network Connection

After completing various configuration, you will program, compile and download the compiled user program to the mian control module and run to achieve the control.

The mian control 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 52.

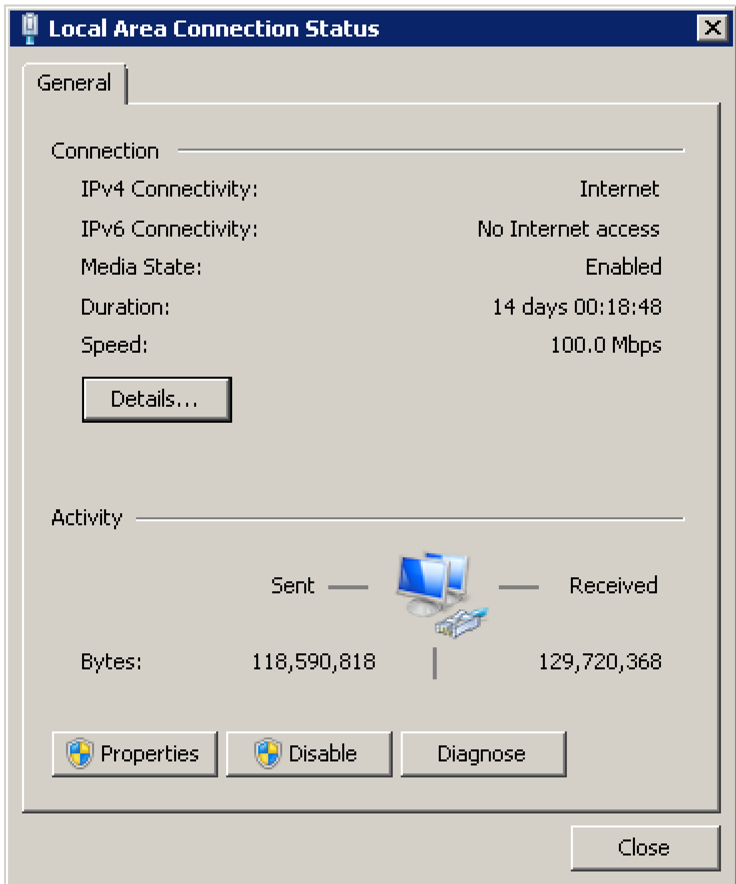


Figure 52 Local Connection Status

Step 2. Click the **Properties** button to pop up the **Local Area Connection properties** window, as shown in Figure 53.

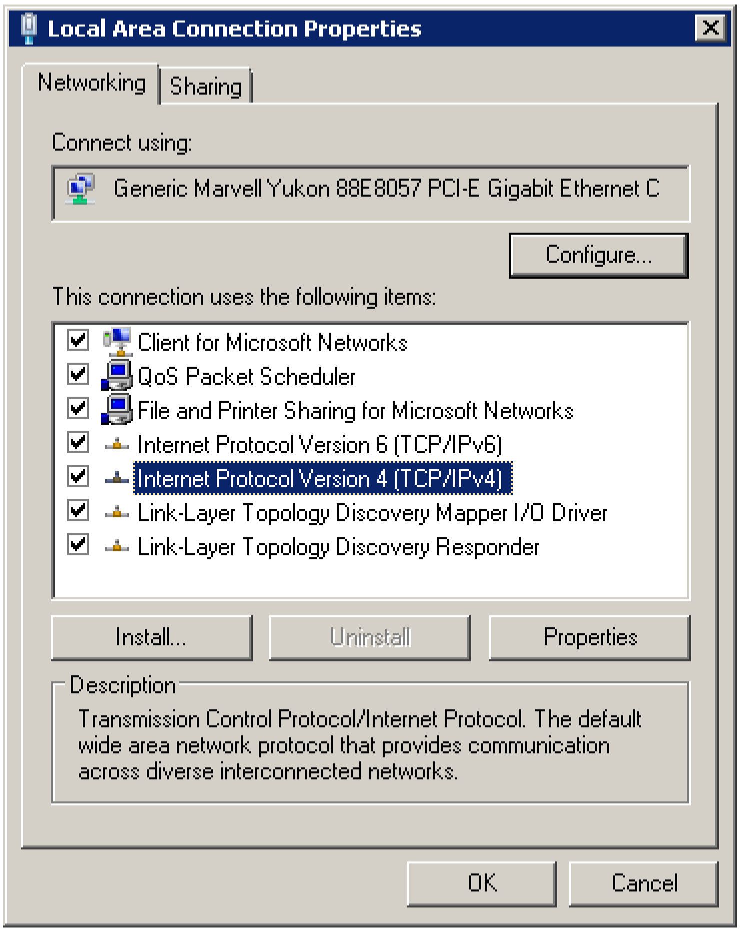


Figure 53　Local Area Connection Properties

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.

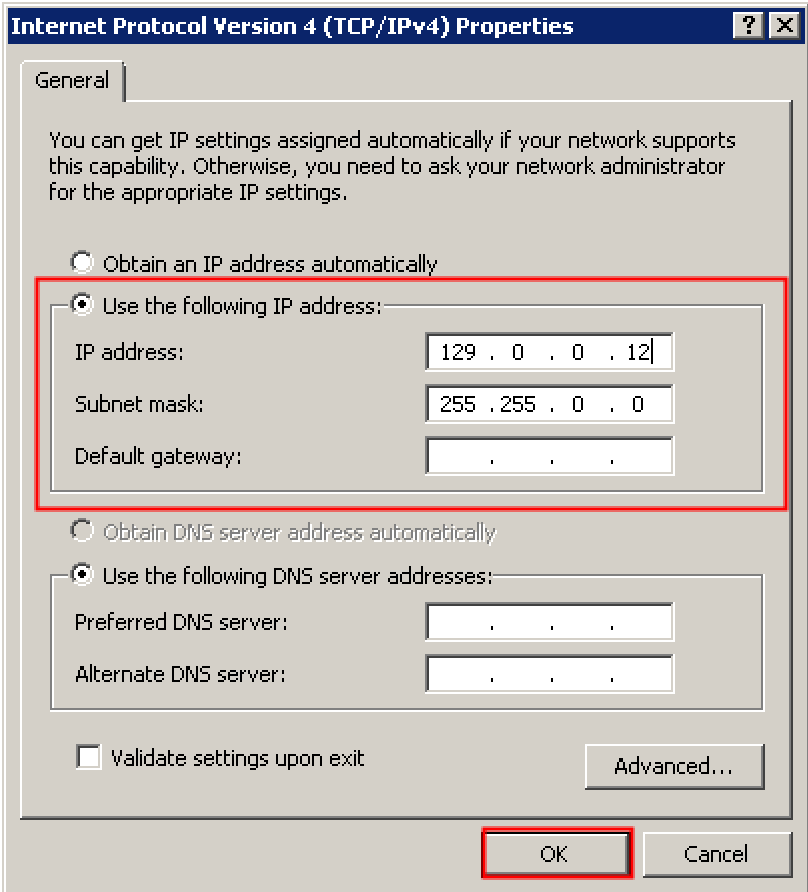
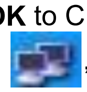


Figure 54   Dialog Box of Internet Protocol (TCP/IP) Properties

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 controller (default IP address of Ethernet 1 is128.0.0 and IP address of Ethernet 2 is 129.0.0). The final digit shall be any number, only of there is no address conflicts with the controller 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 54. 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.

4.4.4 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.

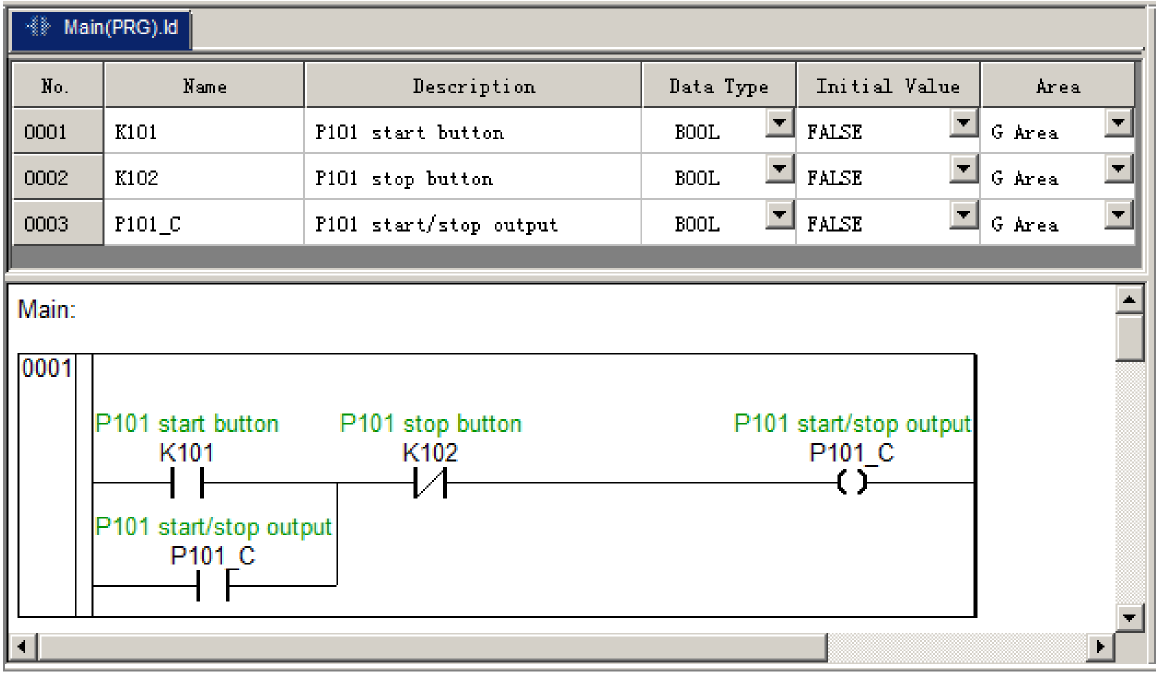


Figure 55 Example for Program Configuration

4.4.5 Download Program

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

Step 1. Select [Online]-[Set Communication] in the menu bar of Safety FA-AutoThink software, as shown in Figure 56.

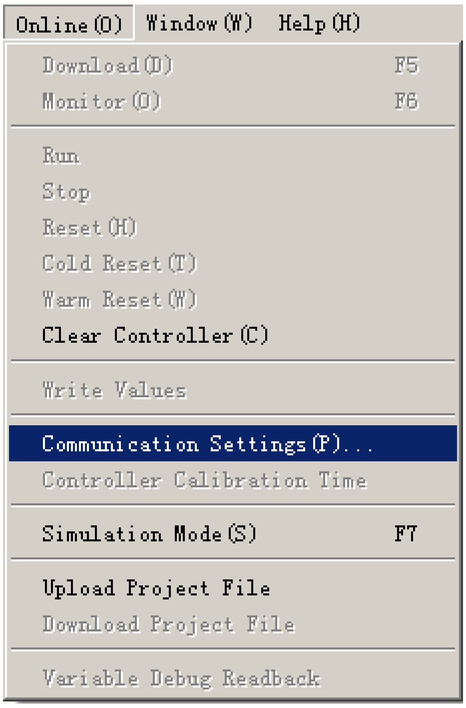


Figure 56 Online Menu

Step 2. Enter the IP address of controller in the **Communication Settings** window, such as 128.0.0.250, as shown in Figure 57.

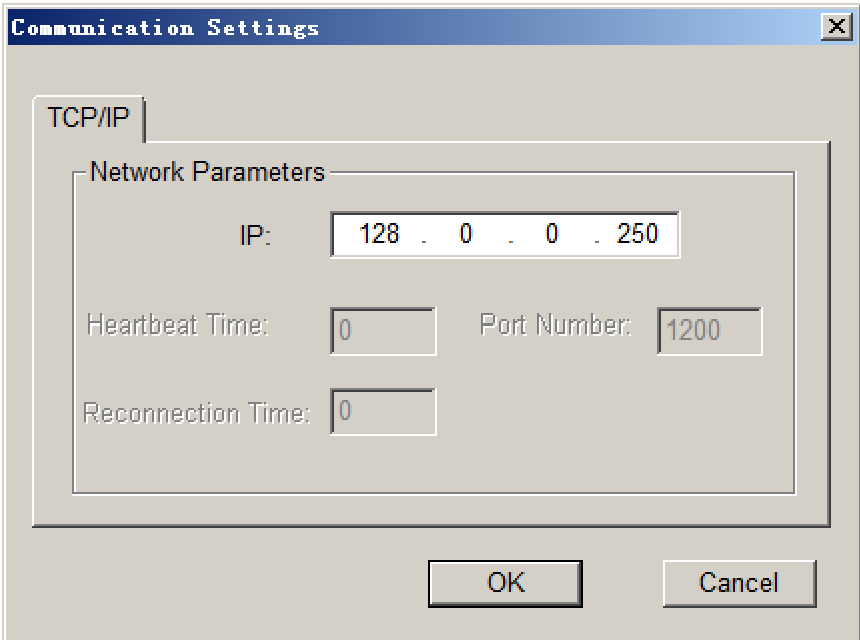


Figure 57 Communication Parameters Settings

Step 3. Set the key switch in the controller panel as **PRG** or **REM**, and Select [Online]-[Download] in the menu bar, as shown in Figure 58.

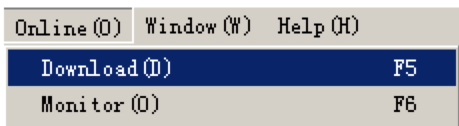


Figure 58 Select the Download Command

4.4.5.2 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 Safety FA-AutoThink when the key switch is in REM position. Turn the key switch on the controller panel to **REM**, select [Online]-[Monitor] to run the user program, as shown in Figure 59. 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 to download, run, stop. 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 controller panel to **RUN**, with the controller 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.

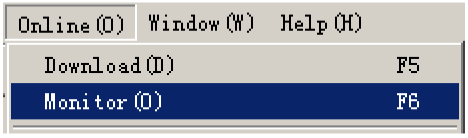


Figure 59   Online Operation

Chapter 5 Master Control Unit

5.1 LK130 4 Slot Local Backplane Module

LK130 has 4 slots to install 24V power adapter module, main control module and communication modules.

Supporting modules:

- 24V power adapter module: LK921S
- Main control module: LK220S
- Communication modules: LK240S, LK249S

5.1.1 Module Composition

See Figure 60 for the external structure of the LK130 module.

Figure 60 LK130 Backplane Schematic Diagram

The backplane slots from left to right are as follows:

1. Power adapter module slot
2. Main control module slot
3. Extension module slot 1

4. Extension module slot 2

Only the corresponding modules can be inserted into the power adapter module slot and the main control module slot. The extension module slots SLOT1 and SLOT2 insert supported communication modules.

The LK130 backplane 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 61 for the internal structure schematic diagram of the LK130 module.

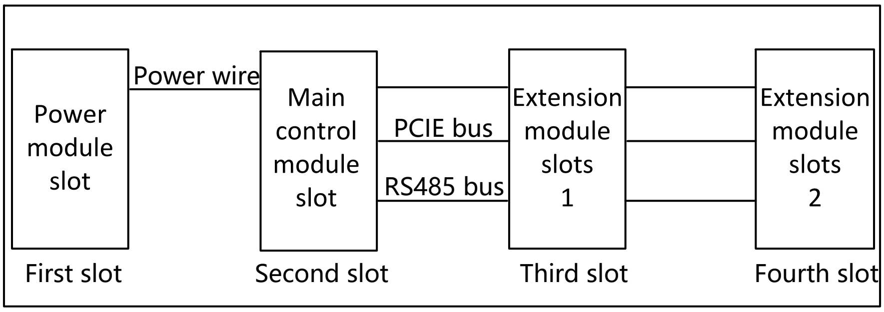


Figure 61 Internal Structure Schematic Diagram of LK130 Module

5.1.2 Installation Dimension

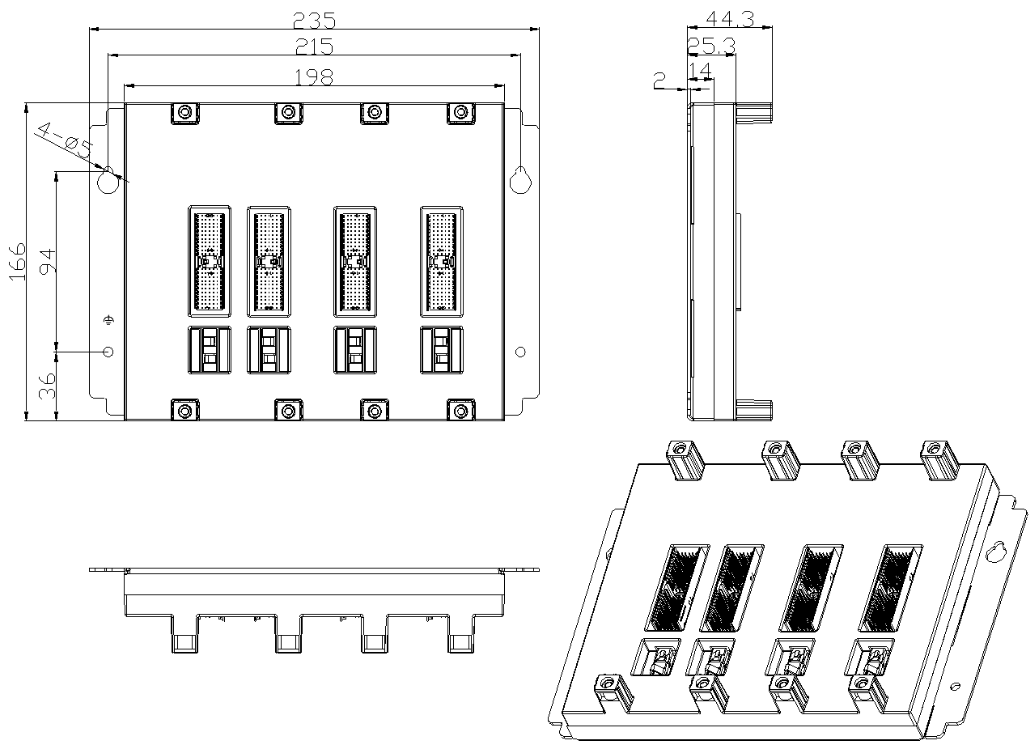


Figure 62 LK130 Backplane Size

5.1.3 Technical Specifications

LK130 4 Slot Local Backplane Module
Interface

LK130 4 Slot Local Backplane Module	
Number of Slots	4
Physical Property	
Installation Mode	Install via a screw hole
Module Dimension (W*H*D)	235 mm *166 mm*44.3 mm

5.2 LK921S Safety 24V Power Adapter Module

LK921S as a redundancy power adapter module of the LKS safety control system. It can convert two 24VDC inputs into a 24VDC output, which is supplied to the main control module and communication module by the LK130 backplane.

5.2.1 Basic Features

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

Figure 63 LK921S Module Schematic Diagram

5.2.2 Operating Principle

The two 24VDC power supplies input by LK921S 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.

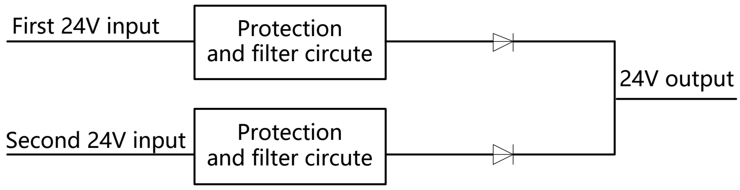


Figure 64 Power Supply Switching Module Block Diagram

5.2.3 Wiring

See Chapter 3.2.1 Power Wiring.

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

5.2.4 Indicators

Table 16 Instructions to LK921S Status Indicators

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

5.2.5 Installation Dimension

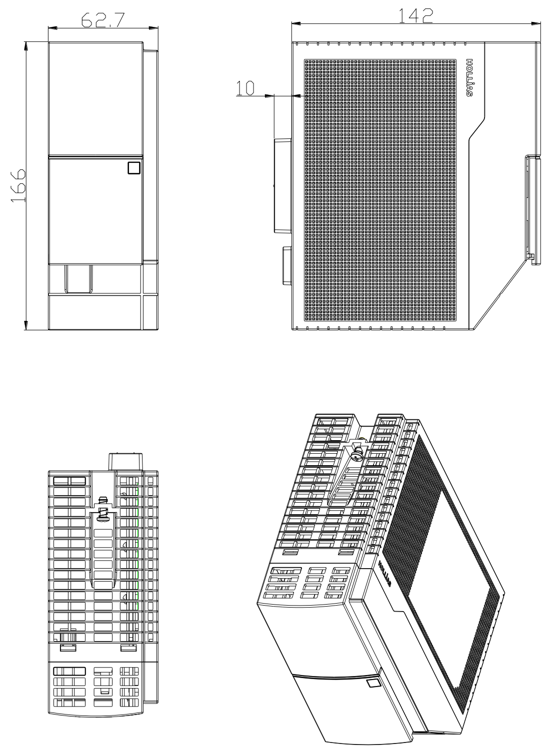


Figure 65 LK921S Dimension Figure

5.2.6 Technical Specifications

LK921S Safety 24V Power Module	
Power Input	
Quantity	2
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 Mode	Backplane slot
Module Dimension (W*H*D)	62.7 mm*166 mm*152 mm±0.5 mm

5.3 LK220S Safety Main Control Module

LK220S as a safety main control module of LKS system is the core for system operation and control, executes data operation andcommunication. The main controller realizes man-machine interaction with the control room via Ethernet, and communicates with LK240S and LK249S via the internal bus.

5.3.1 Basic Features

- Support upgrading via SD card
- Support dual Ethernet ports
- Support Modbus TCP protocol
- Support safety communication protocol (PROFIsafe)
- Support the backplane safety protocol
- Periodic self-check
- Hot swapping
- Support power-off retention
- Support SOE
- Support NTP timing

5.3.2 Appearance

Figure 66 Appearance of LK220S Module

As shown in Figure 66, the controller panel is provided with:

- 10 LED status indicators, indicating the running status of the controller in real time.
- 1 key switch, switching the working mode of the controller (RUN, PRG, REM).
- 1 mounting slot for SD card.
- 1 capacitor box interface.
- 2 Ethernet interfaces.

5.3.2.1 Dimension

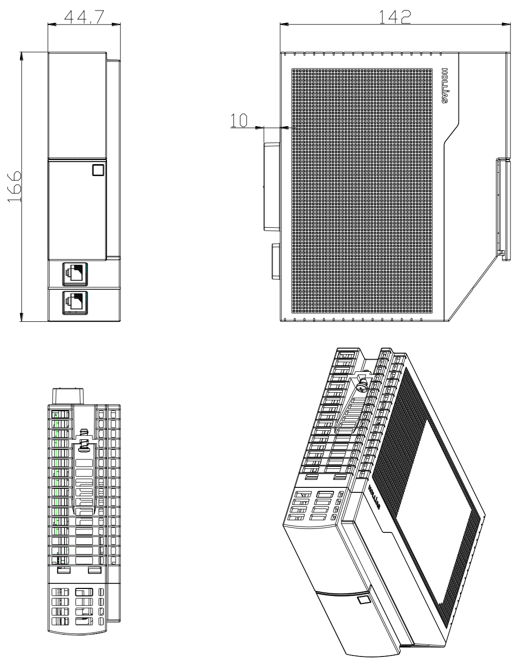


Figure 67 LK220S Module Dimensio

5.3.3 Indicators

Table 17 Instructions to Status Indicators

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	
RUN	Indication of operating pattern	Green	On	Load project but not run.	
			Flashing slowly	User project is running.	
			Off	User project is not loaded.	
ERR	Indication of module failure	Red	On	The module fails.	
			Flashing slowly	The module is in self-checked process.	
			Off	There is no failures	
UPDT	controller operating status indication	Green	Flashing slowly	Being updating the firmware through tool of Safety FA-AutoThink	UPDT and BAT indicators flash slowly together when updating the firmware through tool of Safety FA-AutoThink
			Flashing quickly	Restore factory defaults	

Name	Function	Colour	Status	Description	Combined Indication of Status Indicator
			(one time)		
			Off	No related operation	
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	
			Flashing slowly	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	Flashing slowly	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	
ACT2	Indication of receiving and sending data via Ethernet Interface 2	Yellow	Flashing slowly	Ethernet Interface 2 is receiving and sending data	
			Off	Ethernet Interface 2 is not receiving and sending data	

- Flashing slowly: with a frequency of 1Hz.
- Flashing quickly: with a frequency of 4Hz.

- Communication of LK220S 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.
- During the system is power-on, any modules are not allowed to plug.

5.3.4 Interface Specification

5.3.4.1 Ethernet Interface

The LK220S main control module has two Ethernet interfaces. The Ethernet interface adopts a standard RJ45 receptacle, with a communication rate of 10/100 Mbps, taking twisted pair as the transmission medium. The LK220S main controller is connected to the programming computer via Ethernet to download the user program.

5.3.4.2 SD Card Interface

User can update the controller via the SD card or tool in Safety FA-AutoThinksoftware.

- Update the controller firmware via the SD card:

Step 1. Copy all files from the released CD to SD card.

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

Step 3. Update firmware automatically after a power up.

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 tool in Safety FA-AutoThink software

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

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

Step 2. Open the dialog **Controller operation**, as shown in Figure 68. Firstly, you need to build the connection with the controller. 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.

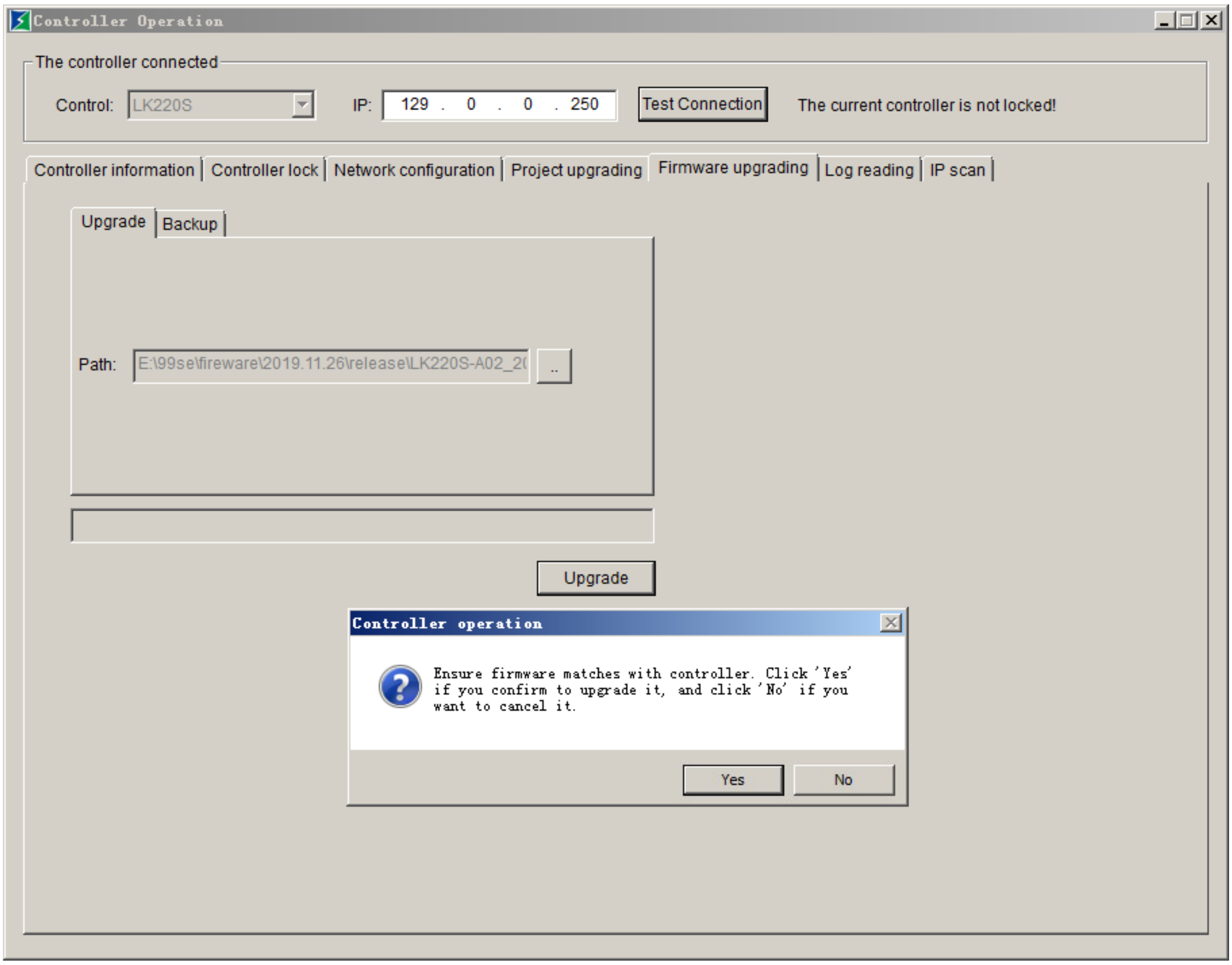


Figure 68 Firmware Upgrading Tools for Safety FA-AutoThink

Step 3. A prompt box as shown in Figure 69 popped up. Click **OK** to start upgrade.

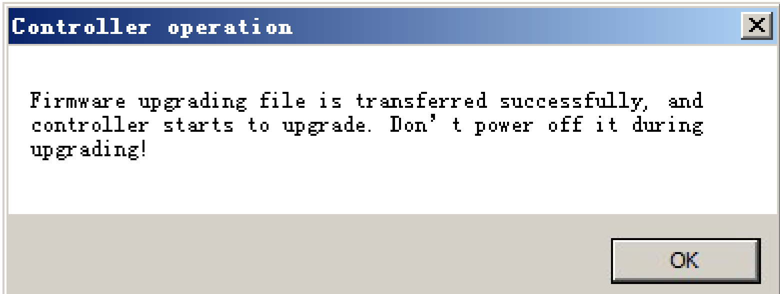


Figure 69 The Prompt box for Transmission of Firmware File

Step 4. Fourth step: UPDT light and BAT light flash slowly together. The ERR light flash slowly after the UPDT 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
  - The key switch is set to PRG or REM mode, and IEC is stopping when you upgrade firmware.
  - It is recommended to disconnect DP connection when updating the firmware via the SD card.

5.3.5 Key Switch

It can set the controller operation modes via the key switch. The LK220S has three working modes: RUN, PRG and REM. It can select the REM mode as the default by make a selection via the key switch. The key switch can be pulled out in RUN, REM, PRG modes. In safety project, when the key switch is switched to the RUN position, all data areas (except S area) are restored to the initial value.

Table 18 Definition of Key Switch

Key Position	Mode Type	Definition
RUN	Running Mode	Controller can execute the user program, but user cannot modify program or operate controller status via Safety FA-AutoThink.
REM (remote)	Remote control Mode	A user can control the program to run and stop, modify the user program and download, reset and write value, etc.
PRG (program)	Program Mode	Controller can stop executing the user program and cannot run the program via the software. It can modify the user program and download, reset and write value, 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.
- Controller module executes I/O scanning and operation.
- The human-machine interface software (that is, HMI) can write variables. The programming softwarecannot write variables.(Modbus TCP slave can write variables through configuration)
- Cannot reset, download and clear.
- Cannot change the operating mode of the controller remotely via the programming software.

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

- Controller 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 controller 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 controller, 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.

- Write variables.
- Reset and clear.
- Program download.
- Change the operating mode of controller remotely via the programming software.

The main controller changes the IEC running status by toggling the key switch, with the IEC running status of the slave controller keeping pace with that of the main controller. For example, when toggling the key switch of the main 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.
- When the system is running normally, please ensure that key switch of the master and slave controller is consistent.

5.3.6 Reset

Reset by key switch: 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 controller can reset the hardware.

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

- Reset: except the power-loss retentive 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-loss retentive data shall be recovered to their starting values.
- Warm reset: all the data stays in the status before resetting.
- Clear controller: it shall clear all data in SD or flash and recover all the variables to their starting values.

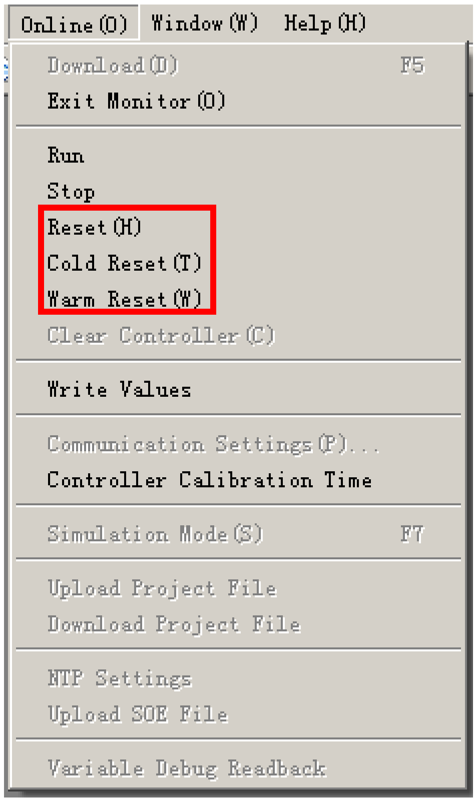


Figure 70　Reset Command of Online Menu

- System running, prohibit resetting master controller !
- In redundancy mode, it is only effective for current frame to reset via key switch. 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, controller can be recovered to factory defaults. The UPDT lamp and the BAT lamp flash together once, the factory defaults are recovered, and restart controller. 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

IO connection must be disconnected when you restore factory defaults.

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

5.3.7 Power-loss Retention

The LK220S module provides power-loss retentive function. The variables defined in the R area have the power-loss retentive property, the LK220S module can provide power-loss retention for the real-time value of the power-loss retentive variables. After restarting the power-failed controller, the retain-type power-loss retentive variables can be recovered to the values before power loss, with other variables recovered to their initial values.

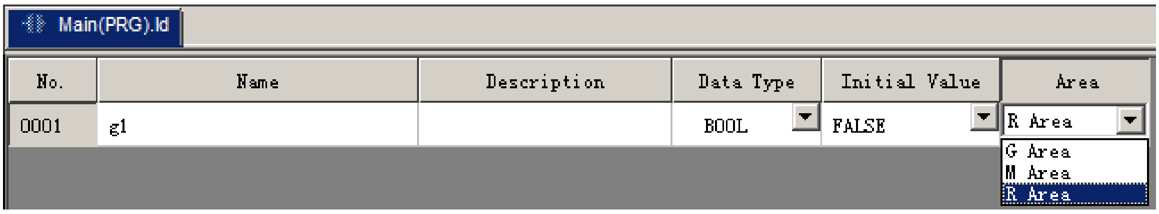


Figure 71　Setting Power Failure Retention

5.3.8 Backup Battery

The front panel of the LK220S module is provided with a backup battery slot. The user can insert the LKA103 capacitor power box. The backup battery can provide power-loss retention for the real-time clock data. Upon the power loss of controller, the real-time clock data can still be kept. The max. power-loss retentive period for capacitor power supply is 7 days.

In case of low battery, BAT indicator shall give an alarm. Check the battery regularly and replace it timely, ensuring that power-loss retention can work well. See the Chapter 7.1.4 Battery Replacement for battery replacement.

LKA103 is not necessary for customers who do not need keep real-time clock data when the system is power-off. LKA103 is a standard product of HollySys, you can only buy it from HollySys.

5.3.9 Modbus Communication Settings

Please see 4.3 Configure Modbus TCP protocol.

5.3.10 Redundancy Data Area

Redundancy data includes data occupied by compiling in G area, M area, I area, Q area and R area. The data area of variables that has been deleted only is released by full compilation.

In a task cycle, the main time includes the run time of project logic, refresh time of controller input and output, and time of redundant data. The amount of redundant data is directly proportional to the time of redundant data, and has no linear relationship with the task cycle.

When the total time above is beyond the task cycles, the controller will run unstable. At this time, the fault indicator of controller is ON. Report the CPU general fault, and stop data redundancy between the master and slave. For this fault, we need to deal with it by one way as follows in time to eliminate the fault.

- Increase the setting value of the IEC task cycle.
- Optimize the configuration logic of the project and reduce its running time.
- Delete the unused input and output points in the project.
- Release the occupied data area by full compilation.

5.3.11 Technical Specifications

LK220S　Safety Main Control Module	
Operating speed	
CPU	667MHz
Execution speed of commands	Typical value 2.5DMIPS/MHz
Memory	

LK220S Safety Main Control Module	
Program memory	32MB (16MB for the system, 16MB for users)
Data memory	512MB, 800Mbps, bit width 32 bits
Power-loss retentive memory (MRAM)	512KB
Extend memory	SD card , max. 32GB
Ethernet	
10/100M	2-channel, dual network ports, supporting Modbus TCP protocol
Real-time clock	
Data format	YY:MM:DD:HH:MM:SS, BCD code
Clock precision	Less than 1 minute/month @25℃
Power-loss retention	Supported
Backplane bus	
Communication speed	2.5Gb/S
Load capacity	1×4-way
Protection grade	
Module protection grade	IP20
Hot swapping	
Hot swapping	Supported
Scale of single system	
I/O capacity	I/O supported by system is not less than 1,000 points
Configuration capacity	
Input variable memory (I)	Max. 128KB
Output variable memory (Q)	Max. 128KB
Common variable memory (G)	Max. 1MB
Parameter variable memory (M)	Max. 1MB
Configured power-loss retentive memory (R)	Max. 64KB
Specified register memory (S)	16KB fixed
Power supply	Provided by backplane
Module power consumption (max.)	300mA @24VDC
Backup battery	Battery/capacitance power supply
Redundancy	
Dual-backplane redundancy	Supported
Starting Time	
Time from power on to the user's project starting	≤60 s
Physical specifications	
Installation Mode	Backplane slot
Module Dimension (W*H*D)	44.7 mm×166 mm×152 mm
Weight	382 g

5.4 LK249S Safety Master Station Communication Module

LK249S is a safety master station communication module of LKS safety control system. 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. The module is connected to the LK130 backplane module via the CPCI high-speed connector.

5.4.1 Basic 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 72 LK249S Module Schematic Diagram

As shown in Figure 72, the LK249S module panel is provided with:

- 5 LED indicators, indicating the running status of the LK249S module in real time.
- 2 DB9 interfaces.

5.4.2.2 Module Size

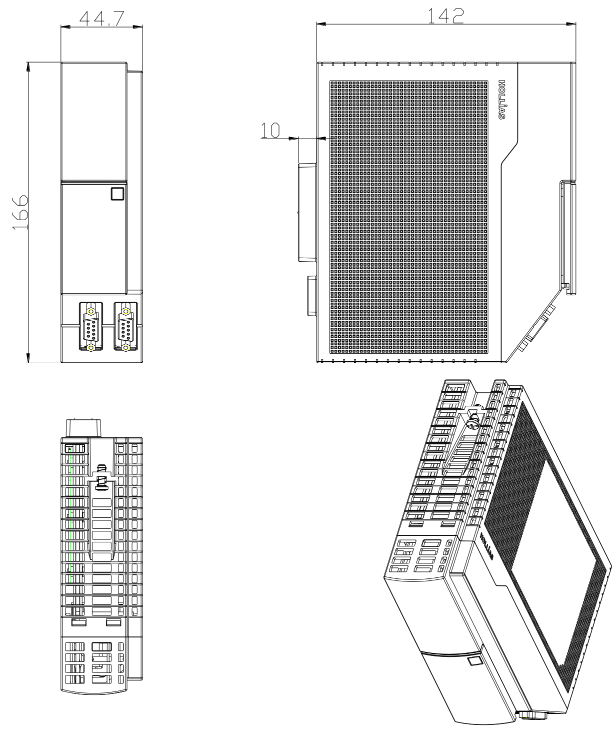


Figure 73 LK249S Module Size

5.4.3 Indicators

Table 19 Instructions to Status Indicators

Name	Function	Colour	Status	Description
PWR	Indication of power supply	Yellow	On	The power supply works regularly.
			Off	The power fails or no power
RUN	Indication of operating pattern	Green	Flashing slowly	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	Flashing quickly	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	Flashing quickly	DP Communication Interface 2 is sending/receiving data
			On/Off	DP Communication Interface 2 does not send/receive data

- Flashing slowly: with a frequency of 1Hz,

- Flashing quickly: with a frequency of 4Hz.

5.4.4 Operating Principle

The DB9 interface of the LK249S 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 MCU for processing.

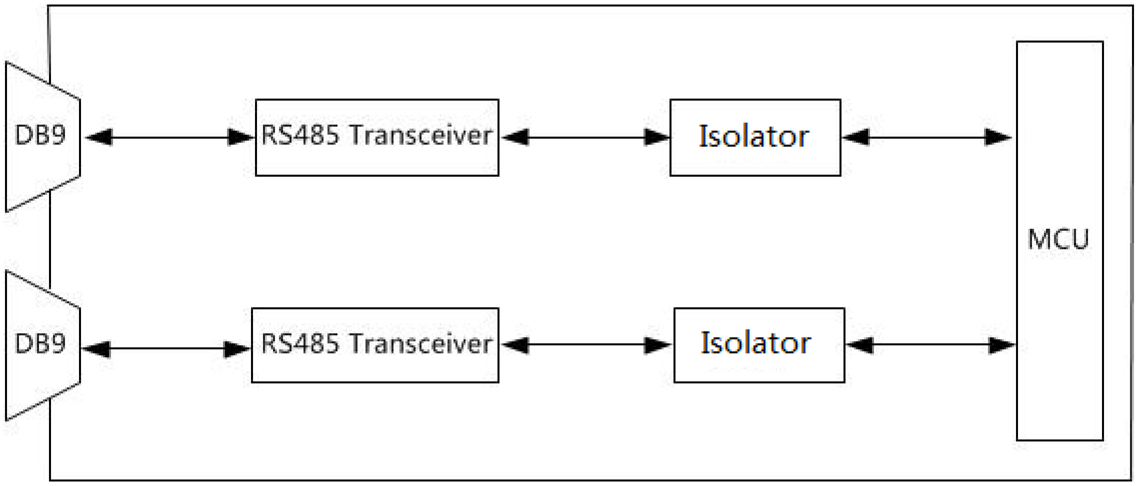


Figure 74 LK249S Internal Schematic Diagram

The DP master station in the master backplane is in operation. The DP master station in the slave backplane 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 LK249S module has two DB9 interfaces with each redundancy.

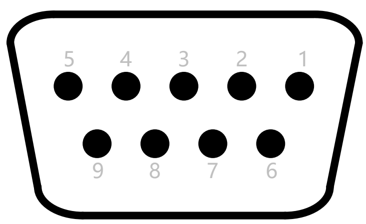


Figure 75 DB9 Interface Schematic Diagram

Table 20 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
7, 8	DP1-	DP signal negative

5.4.6 Diagnosis

LK249S 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 Safety FA-AutoThink software, double click the configured BUS_MASTERBUS_MASTER node under the [Hardware Configuration] node, to open the **Device Information** window, as shown in

Figure 76 to set the Baud rate.

The Baud rate is the communication rate between the controller and the IO device. It can be set as 187.5 kbps, 500 kbps, 1.5 Mbps, 3 Mbps, 6 Mbps.

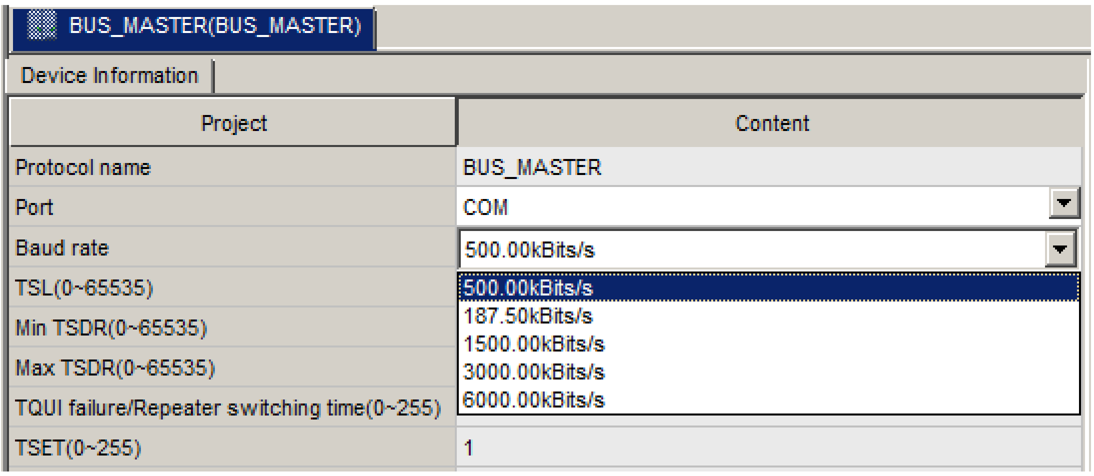


Figure 76 BUS_MASTER Device Information Window

- Attentions in use of baud rate:
  - ☐ When using 3Mbps and 6Mbps baud rate, the length of DP cable between backplanes is recommended to be within 30cm.
  - ☐ When using 3Mbps and 6Mbps baud rate, up to six extended backplanes can be connected.

5.4.8 Technical Specifications

LK249S Safety Master Station Communication Module	
Processor	
CPU platform	ARM
Memory	
SRAM	Off-chip memory, 512KB, bit width 16 bits
DP bus	
Number of channels	2
Physical interface	DB9 female socket

LK249S Safety Master Station Communication Module	
Baud rates	187.5 kbps, 500 kbps, 1.5 Mbps、3Mbps、6Mbps
Backplane bus	
Transmission speed	2.5 Gb/S
Protection grade	
Module protection grade	IP20
Hot swapping	
Hot swapping	Supported
Power supply	Provided by backplane
Module power consumption (max.)	200mA@24V
Dual-network Redundancy	
DP bus redundancy	Supported
Starting time	
Time from power on to initialization done	≤10 s
Physical specifications	
Installation Mode	Backplane slot
Module Dimension (W*H*D)	44.7mm×166mm×152mm
Weight	365 g

5.5 LK240S Safety Redundant Communication Module

LK240S is a safety redundant communication module in LKS safety control 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 safety redundant communication modules by taking synchronous optical fiber as the medium. It is connected to the LK130 backplane module via the bus connector.

5.5.1 Basic Features

- Determine the master/slave status
- Support gigabit synchronous optical fiber communication
- Support two fiber redundant interfaces
- LC interface multimode fiber
- Hot swapping
- Adopt safety communication protocol

5.5.2 Appearance and Size

5.5.2.1 Appearance

Figure 77 LK240S Module Schematic Diagram

As shown in Figure 77, the LK240S module panel is provided with:

- 10 LED indicators, indicating the running status of the LK240S module in real time.
- 1 DIP switch, setting Series A/B of the current controller.
- 2 fiber interfaces

5.5.2.2 Module dimension

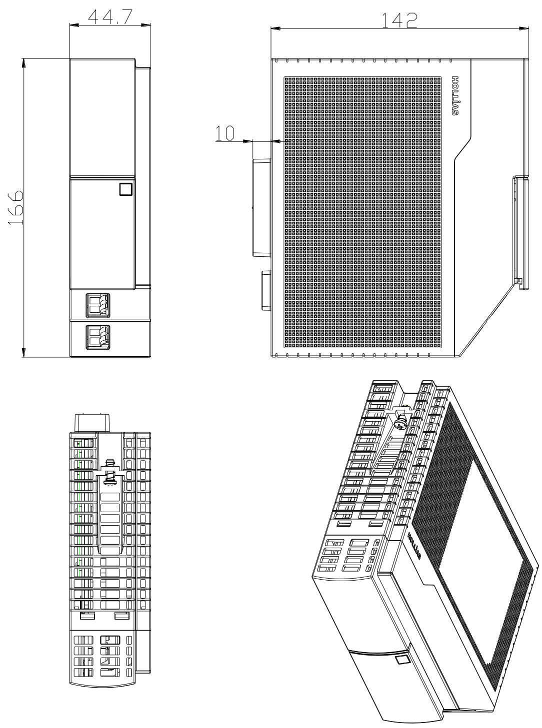


Figure 78 LK240S Module Dimension

5.5.3 Indicators

Table 21 Instructions to Indicators

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.
			Flashing slowly	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.
			Flashing slowly	Redundancy communication work regularly.
STDB	Indication of master-slave status of CPUs	Green	On	The current controller is in standby mode
			Off	The current controller is in running mode
			Flashing slowly	The master-slave status is not determined.

Name	Function	Colour	Status	Description
A/B	Indication of Machine A/B	Green	On	The current controller is A
			Off	The current controller is B
TX1	Indication of data sent via Fiber Interface 1	Green	Flashing quickly	Fiber Interface 1 is sending data
RX1	Indication of data received via Fiber Interface 1	Green	Flashing quickly	Fiber Interface 1 is receiving data
TX2	Indication of data sent via Fiber Interface 2	Green	Flashing slowly	Fiber Interface 2 is sending data
RX2	Indication of data received via Fiber Interface 2	Green	Flashing quickly	Fiber Interface 2 is receiving data

- Flashing slowly: with a frequency of 1Hz.
- Flashing quickly: with a frequency of 4Hz.

5.5.4 Operating Principle

Synchronous optical fiber interface in two safety 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.

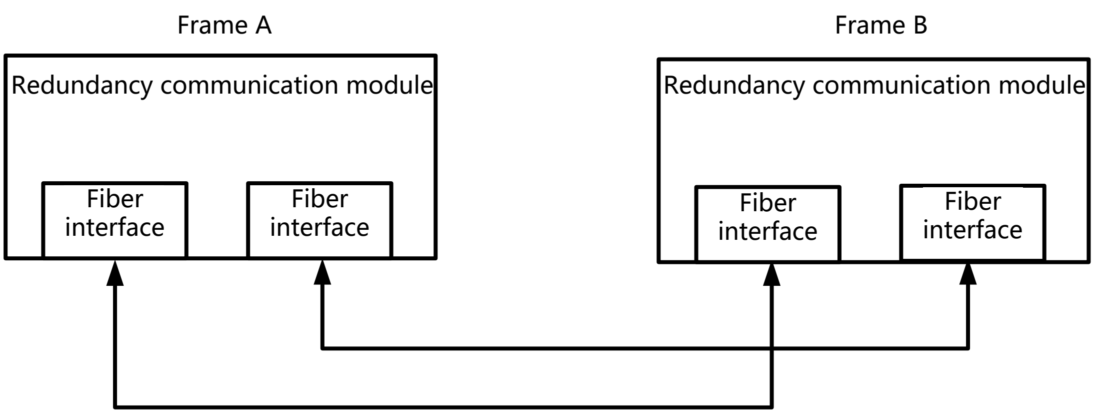


Figure 79 Redundancy Communication Schematic Diagram

5.5.5 Wiring

The LK240S safety redundant communication module has two synchronous optical fiber communication interfaces, both of which are standard LC synchronous optical fiber r interfaces, based on a communication rate of 1Gbps and above. Each synchronous optical fiber interface includes one TX and one RX, which are cross connected to the safety redundant communication module of another frame, with one as the sender and the other as the receiver. Take a group of synchronous optical fiber interface for instance, as shown in Figure 80.

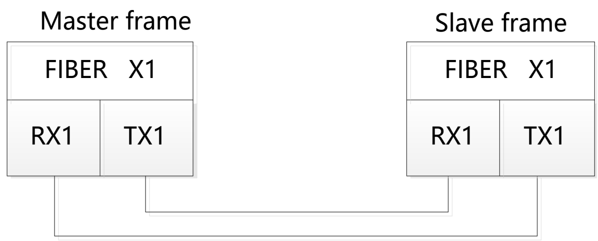


Figure 80 LK240S Synchronous Optical Fiber Connection

Table 22 Definitions of LK240S 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

5.5.6 Set A/B Frame

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

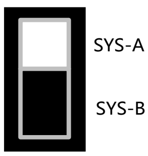


Figure 81 Series A/B DIP Switch Schematic Diagram

- Switch to the SYS-A position, set the current controller as system A.
- Switch to the SYS-B position, set the current controller as system B.

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

5.5.7 Master-slave Determination

When the redundant communication 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 first power-on controller as the master.
- The last running status of the controller. When the last redundancy is regular, then the master-slave status is kept unchanged.
- When a dual-machine project and the last running status are same, then system A is the master.
- The controller involved in a project is the master.

5.5.8 Conditions of Master-slave Switch

When master occurs following cases, if the slave works normally, the master switches to slave.

- Conditions of triggering master-slave switch

- Master frame power off
- Redundancy state fault (master frame)
- Pull out the module in local backplane
- Dual Ethernet fault
- Dual DP link fault
- Call the sysMasterSwitchToSlave (master-slave switchover) command in Safety FA-AutoThink to make a switchover

- Configure SET_RTC function block to set RTC of master controller and RTC of slave controller is synchronized by redundancy communication. Refer to *LKS Safety Control System Instruction Manual* for SET_RTC function block.

5.5.9 Technical Specifications

LK240S Safety Redundant Communication Module	
Processor	
CPU platform	ARM
Synchronous fiber interface	
Number of channels	2
Interface type	LC type
Media redundancy	Supported
Backplane bus	
Communication speed	2.5Gb/S
Protection grade	
Module protection grade	IP20
Hot swapping	Supported
Power supply	Provided by backplane
Module power consumption (max.)	250mA@24V
System performance	
Redundancy performance	The redundant switching time is no more than 130 ms
Starting time	
Time from power on to initialization done	≤10 s
Physical specifications	
Installation Mode	Backplane slot
Module Dimension (W*H*D)	44.7 mm×166 mm×152 mm
Weight	365 g

Chapter 6 IO Unit

6.1 Power Module

- In safety system, QS10.241 power supply is used as AC to DC power supply, and the LK910 or other power modules can also be selected in non-safety system.

6.1.1 QS10.241 DC Power Supply

6.1.1.1 Basic Features

- AC 100-240V Wide-range Input
- Efficiency up to 93.5%
- Output voltage 24~48VDC
- 150% (360W) Peak Load Capability
- Full Power Between -25°C and +60°C
- DC-OK Relay Contact
- Quick-connect Spring-clamp Terminals

The most outstanding features of this dimension QS10 DIN-rail power supply are the high efficiency and the small size, which are achieved by a synchronous rectification and further novel design details.

With short-term peak power capability of 150% and built-in large sized output capacitors, these features help start motors, charge capacitors and absorb reverse energy and often allow a unit of a lower wattage class to be used.

High immunity to transients and power surges as well as low electromagnetic emission makes usage in nearly every environment possible.

The integrated output power manager, a wide range input voltage design and virtually no input inrush current make installation and usage simple. Diagnostics are easy due to the dry DC-ok contact, a green DC-ok LED and red overload LED.

Unique quick-connect spring-clamp terminals allow a safe and fast installation and a large international approval package for a variety of applications makes this unit suitable for nearly every situation.

6.1.1.2 Appearance

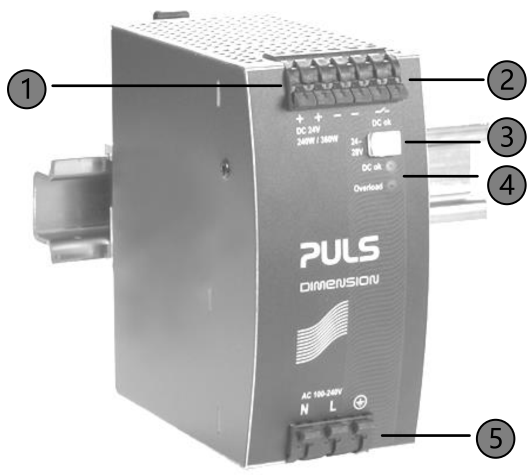


Figure 82 Module Schematic Diagram

Table 23 Interface list

Number	Interface Description
1	2 groups of DC output terminal
2	DC-OK Relay Contact
3	Open the flap to adjust the output voltage. Factory set: 24.1V
4	Indicators
5	AC input terminal

6.1.1.3 Operating principle

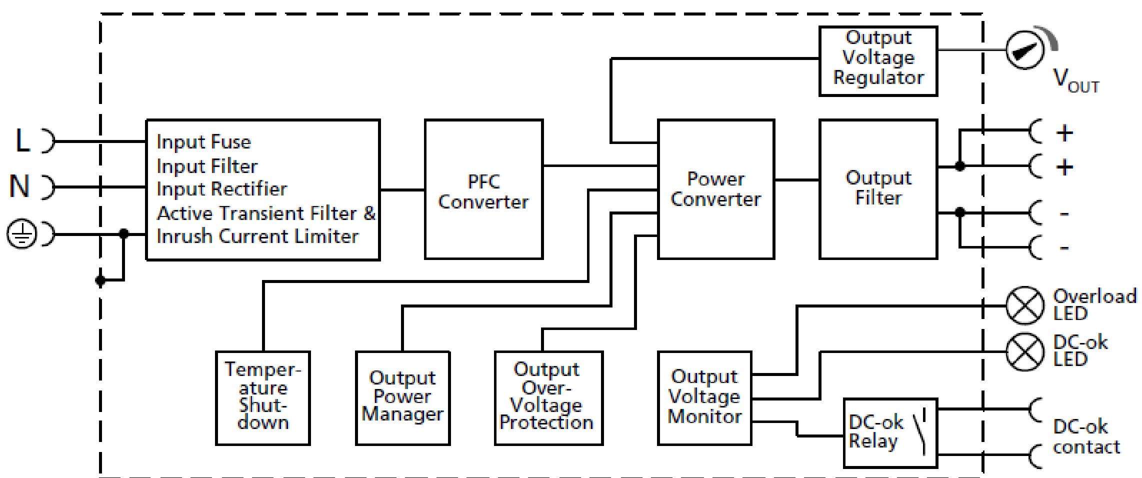


Figure 83 Functional Diagram

6.1.1.4 Indicators

Table 24 Instructions to Indicators

Name	Function	Colour	Description
DC ok	DC-OK LED	Green	On, when the output voltage is >90% of the adjusted output voltage.
Overload	Overload LED	Red	On, when the voltage on the output terminals is <90% of the adjusted output voltage, or in case of a short circuit in the output. Flashing, when the unit has switched off due to over-temperature.

Table 25 Indicators Status in Several Cases

Case	Overload LED	DC-OK LED	DC-OK Contact
Normal mode	OFF	ON	Closed
During BonusPower®	OFF	ON	Closed
Overload (VOUT < 90%)	ON	OFF	Open
Output short circuit	ON	OFF	Open
Temperature Shut-down	Intermitted	OFF	Open
No input power	OFF	OFF	Open

6.1.1.5 Terminals and Wiring

1. Input terminals

Quick-connect spring-clamp terminals are shown in Figure 84.

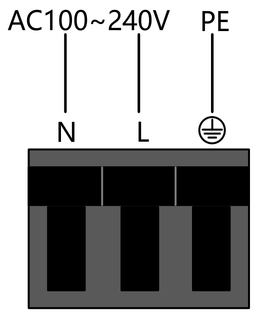


Figure 84 Input Terminals

2. Output terminals

Quick-connect spring-clamp terminals, two pins per pole, as shown in Figure 85.

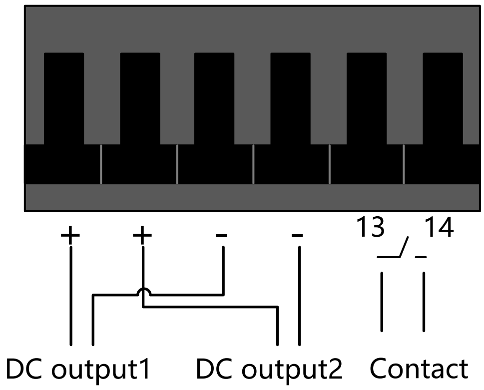


Figure 85 Output Terminals

- Instructions
  - ☐ Use appropriate copper cables that are designed for minimum operating temperatures of:

    60°C for ambient up to 45°C minimum

    75°C for ambient up to 60°C minimum

    90°C for ambient up to 70°C minimum
  - ☐ Follow national installation codes and installation regulations!
  - ☐ Ensure that all strands of a stranded wire enter the terminal connection!
  - ☐ Up to two stranded wires with the same cross section are permitted in one connection point (except PE wire).
  - ☐ Do not use the unit without PE connection.
  - ☐ Unused terminal compartments should be securely tightened.
  - ☐ Ferrules are allowed.

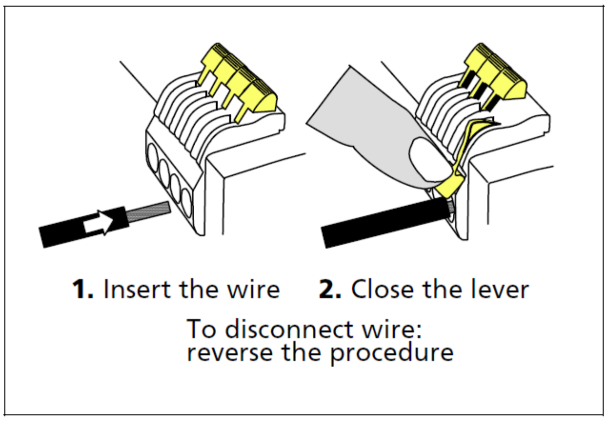


Figure 86 Connecting a Wire

6.1.1.6 Technical Specifications

QS10.241 DC Power Supply	
AC-Input	
AC input	Nom.AC 100~240V,

QS10.241 DC Power Supply	
AC input range	Min. 85-276Vac, continuous operation Min. 60-85Vac, full power for 200ms, no damage between 0 and 85Vac Min. 276-300Vac, < 500ms
Allowed Voltage L or N to earth	Max. 300Vac
Input frequency	50–60Hz ±6%
Turn-on voltage	Typ. 81Vac, steady-state value
Shut-down voltage	Typ. 63Vac, steady-state value Typ. 55Vac, dynamic value
DC-Input	
DC input	Nom.DC 110-150V, -20%/+25%
DC input range	Min.88-187Vdc, continuous operation
DC input current	Typ. 2.37A, 110Vdc, at 24V, 10A
Allowed Voltage L/N to Earth	Max. 375Vdc, IEC 62103
Turn-on voltage	Typ. 80Vac, steady-state value
Shut-down voltage	Typ. 55Vac, steady-state value
Output	
Output voltage	DC 24V
Adjustment range	Min.24 ~ 28V, guaranteed Max.30V, at clockwise end position of potentiometer
Ripple and noise voltage	Max. 50mVpp, 20Hz to 20MHz, 50Ohm
Output current	Nom.10A, continuously available at 24V Nom.9A, continuously available at 28V Nom.15A, short term available BonusPower®, at 24V, for typical 4s Nom.13.5A, short term available BonusPower®, at 28V, for typical 4s
Output power	Nom. 240W / 252W, continuously available at 24V / 28V Nom. 360W / 378W, short term available BonusPower® *, at 24V / 28V
Output ripple	< 50mVpp, 20Hz to 20MHz
Short-circuit current	min. 8A, continuous, load impedance 100mOhm max. 12.5A, continuous, load impedance 100mOhm min.21A , during BonusPower® , load impedance 100mOhm max. 27A, during BonusPower® , load impedance 100mOhm max. 15A, continuous, load impedance <10mOhm
Output capacitance	Typ. 7000μF, included inside the power supply
Physical Property	
Installation Mode	DIN-rail or bracket
Module Dimension (W*H*D)	60mmx124mmx117mm
Weight	900g /1.98lb
Environment	
Operational temperature	-25°C ~ +70°C (-13°F ~ 158°F)
Storage temperature	-40 ~ +85°C (-40°F ~ 185°F)
Humidity	5 ~ 95% r.H.
Over-voltage category	III, IEC 62103, EN 50178, altitudes up to 2000m

QS10.241 DC Power Supply	
	II, altitudes from 2000m to 6000m
Degree of pollution	2, IEC 62103, EN 50178, not conductive

6.2 Extension Backplane

The extension backplane can only install IO module. E.g. LK117 for example, as shown in Figure 87, Slot 1 is the communication module slot. Slots 2~11 are I/O module slot. Each terminal block corresponds to an I/O module, directly connecting to the field signal via an I/O cable.

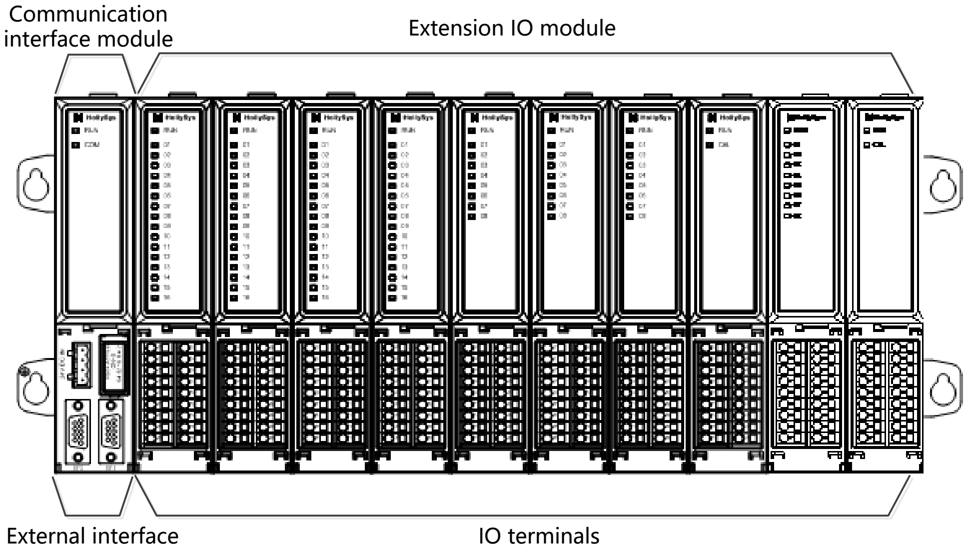


Figure 87 Structure of LK117 Backplane

As shown in Figure 88, the extension backplane supports the redundant DP bus. It provides the DP bus input and output interfaces and connects to the local backplane for extending the I/O points. In case of multiple extension backplane cascade connection, it shall better adopt serial connection, not allowed to connect multiple extension backplanes to a local backplane.

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

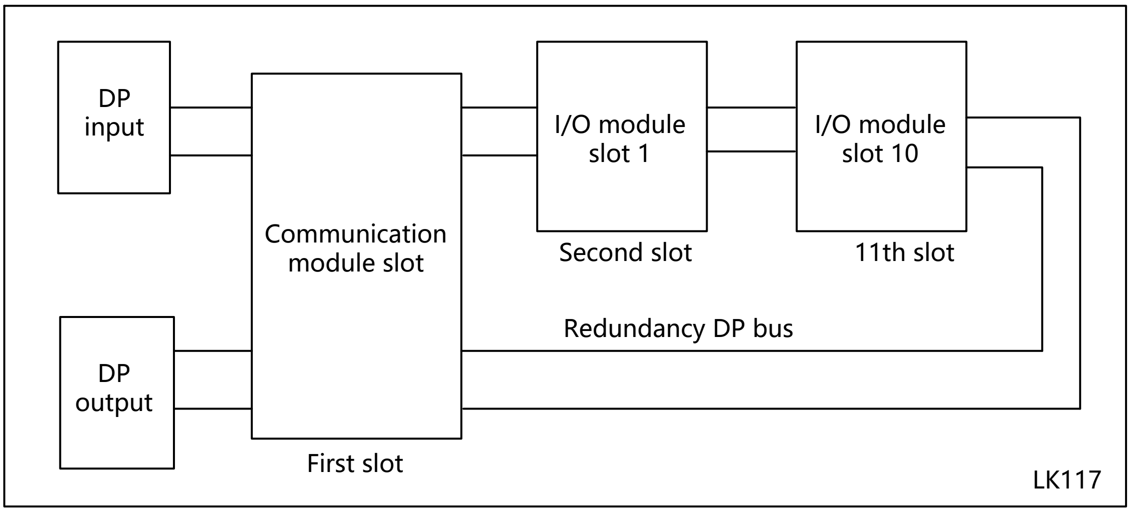


Figure 88　Internal Structure of Extension Backplane

6.2.1　Interface Specification

The extension backplane 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 backplane is led in from the power supply interface of the backplane.

Table 26　Signal Definition of Power Connector on Extension Backplane

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 backplane communicates and exchanges data with the controller on the local backplane via the Profibus-DP bus interface. The DP bus interface is a DB9 hole receptacle.

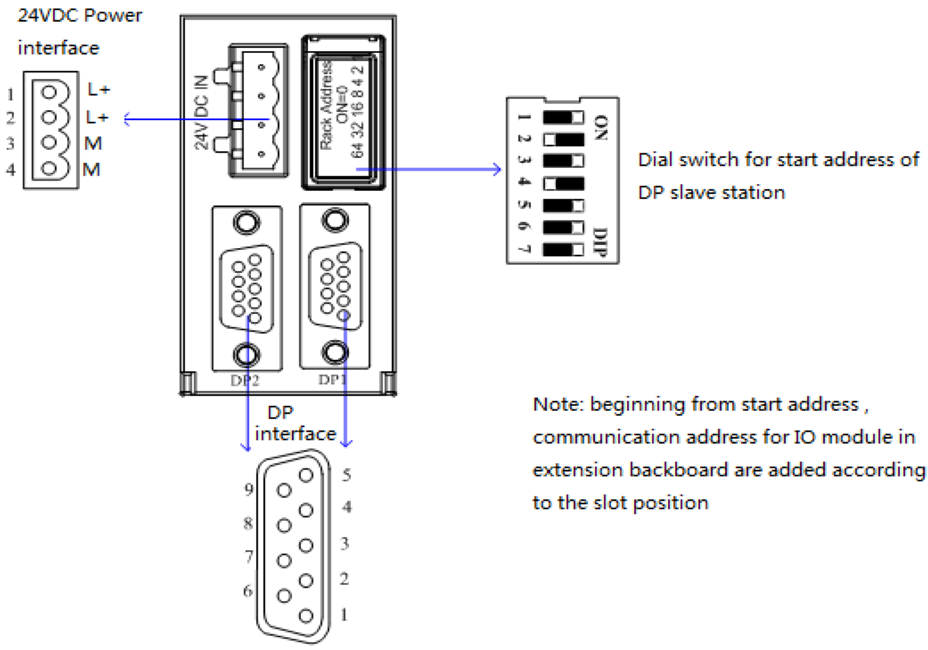


Figure 89　Power and Communication Interfaces of LK117 and LK118 Backplanes

6.2.1.3　Profibus-DP Bus Interface

The DP bus interface realizes the communication between the I/O module on the extended backplane and the controller on the local backplane, 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.

Table 27　Signal Definition of DP Connectors on LK117 Backplane

Pin No.	Signal Name	Meaning
1	Null	Null
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 backplane base address and the backplane 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 backplane. The backplane offset addresses of the 2nd~11th I/O slave station modules are 1~10, as shown in Figure 90.

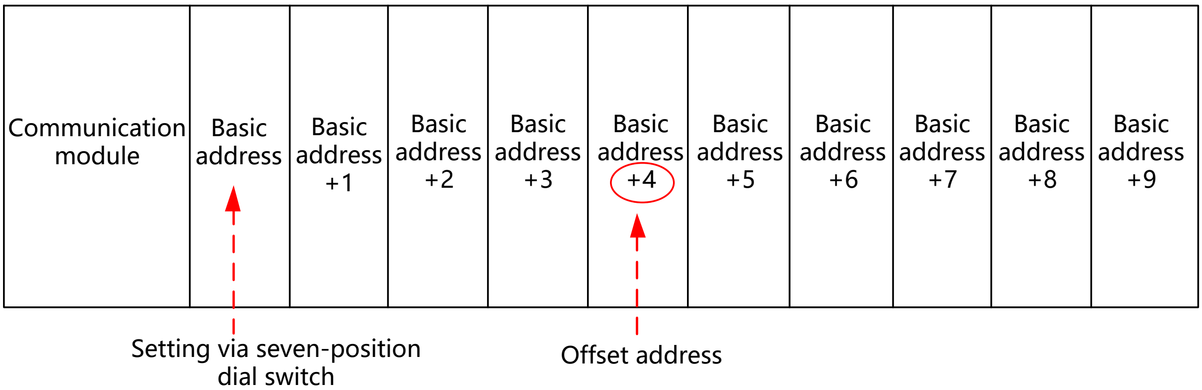


Figure 90　Communication Address Allocation of I/O Module on LK117 Backplane

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 backplane.

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 backplane, and then the communication addresses of the I/O modules on the LK117 backplane are successively: 10, 11, 12, 13... 19.

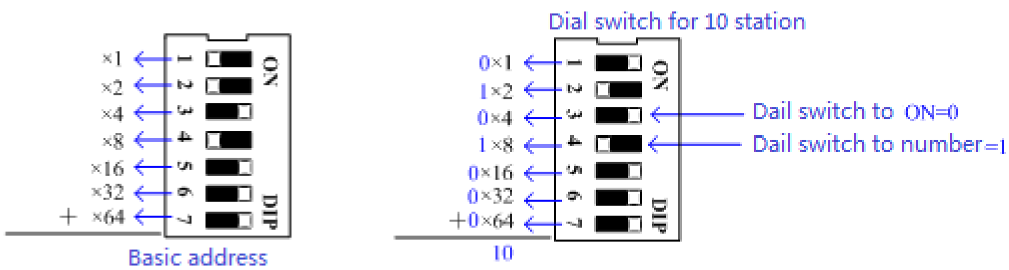


Figure 91　Setup of Backplane Base Address

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

6.2.3　LK117　11 Slot Extended Backplane Module

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 backplane
- 24 VDC system power supply interface, 4-pin receptacle
- Shrapnel terminals, pluggable

6.2.3.2 Installation Dimension

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

All the module widths on the extension backplane are 35 mm. Therefore, for a LK117 backplane, 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 92.

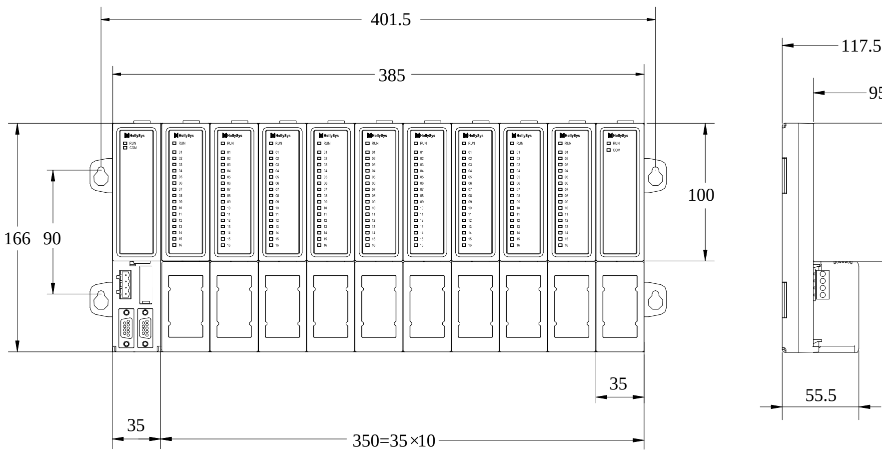


Figure 92　Installation Dimension of LK117 Backplane

6.2.3.3 Technical Specifications

LK117　11 Slot Extended Backplane Module	
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

LK117 11 Slot Extended Backplane Module	
Weight	1740 g

6.2.4 LK118 5 Slot Extended Backplane Module

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 backplane
- Pluggable & Shrapnel I/O terminals

LK118 is a 5 slot extended backplane module, as shown in Figure 93, 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.

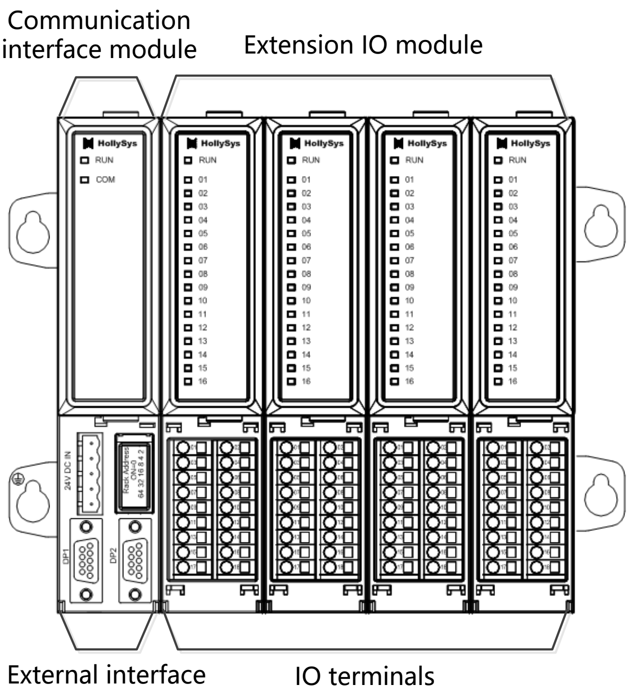


Figure 93 Structure of LK118 Backplane

Refer to Figure 94 for the internal structure of the LK118 extension backplane.

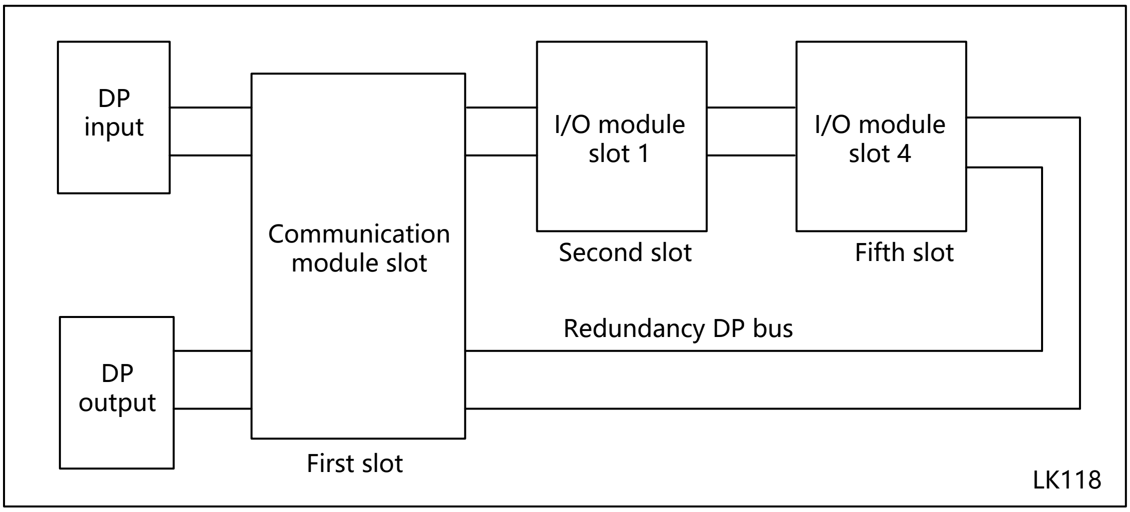


Figure 94 Internal Structure of Extension Backplane

6.2.4.2 Installation Dimension

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

All the module widths on the extension backplane are 35 mm. Therefore, for a LK118 backplane, 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 95.

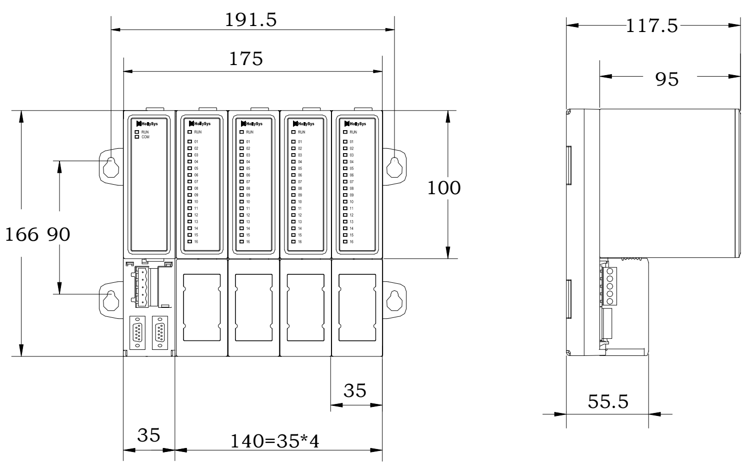


Figure 95 Installation Dimension of LK118 Backplane

6.2.4.3 Technical Specifications

LK118 5 Slot Extended Backplane Module	
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

LK118 5 Slot Extended Backplane Module	
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 LK232S Safety Bus Repeater Module

6.3.1.1 Basic Features

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

6.3.1.2 Operating Principle

LK232S is a safety bus repeater module, installed on the first slot on the left of the extension backplane.

If the transmission distance is too long or load is too high, it can result in weak of transmitted signal on twisted pair. LK232S outputs two DP signals after selecting a normally working one for shaping and amplification from two redundant DP signals, as shown in Figure 96.

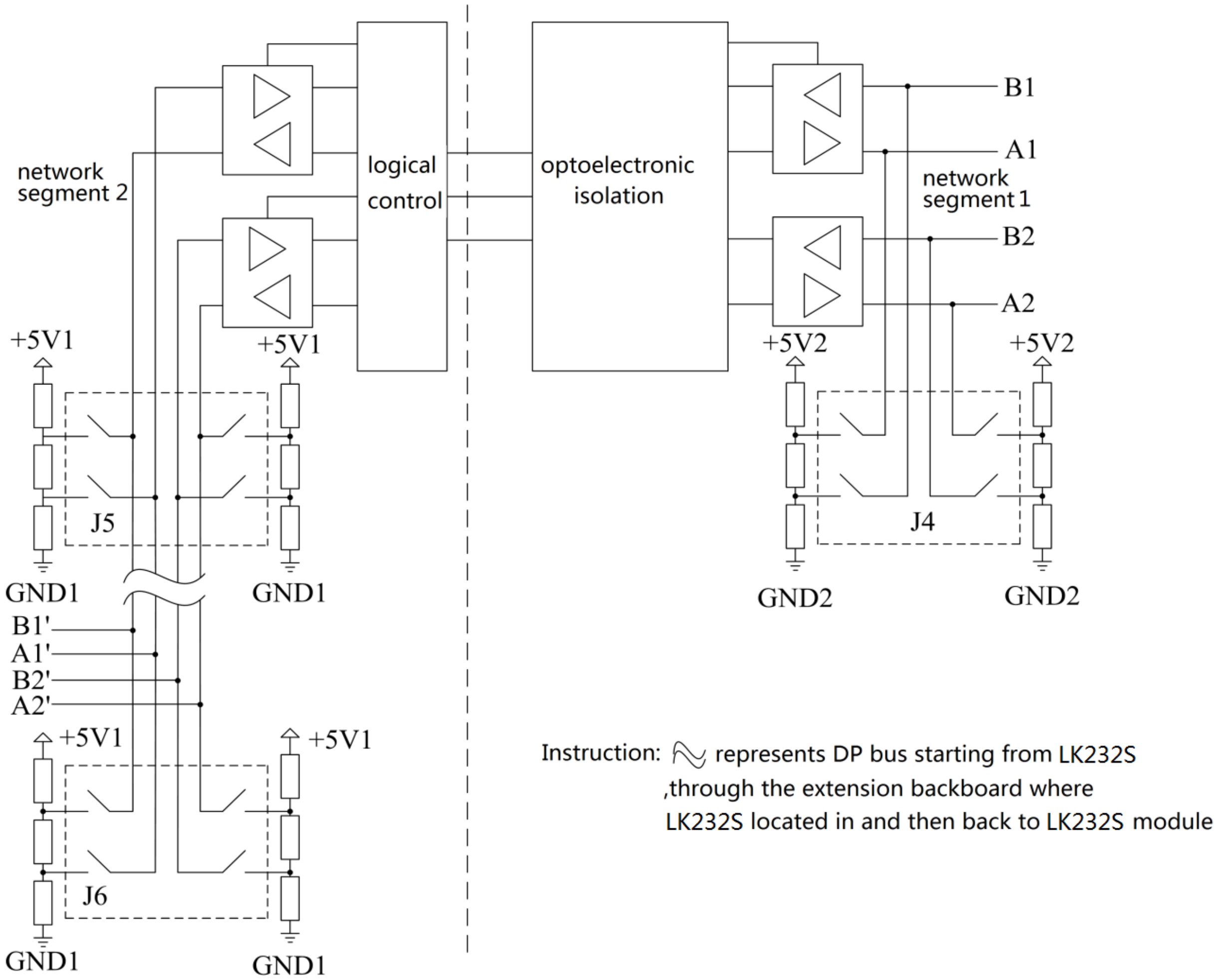


Figure 96　Bus Transition Diagram of LK232S

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

The LK232S module is installed in the far left communication slot of the extension backplane. The protection key is coded as A5.

PROFIsafe bus is extended by LK232S with using LKA104 connector together.

6.3.1.3　Terminal Matching

For the built-in terminal matching DIP switch (J4, J5, J6) of LK232S, as shown in Figure 97. It can set whether to connect the DP bus with source matching resistor network. The factory setting default is that J4 disconnects terminal matching resistor, J5 and J6 connect the terminal matching resistor.

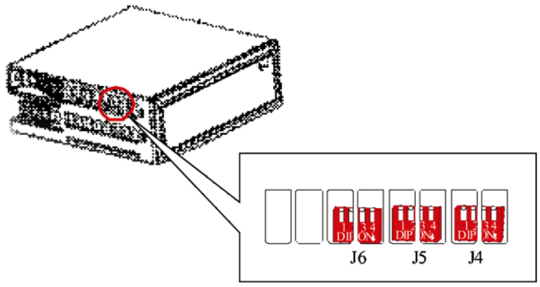


Figure 97 Position of LK232S Terminal Matching DIP switch

The DIP switch is located inside the module, 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 98.

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.

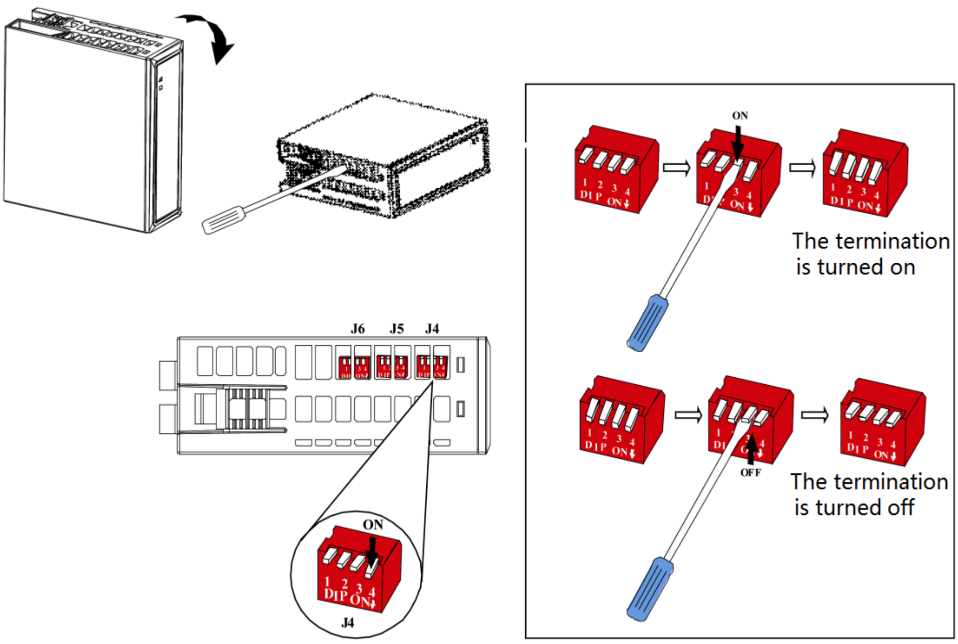


Figure 98 Setting LK232S Terminal Matching DIP Switch

6.3.1.4 Indicators

The definitions for the indicators of the LK232S module are as shown Table 28, the **RUN** indicates the communication link between LK232S and the controller. The **COM** indicates the communication link between LK232S and the extension I/O module.

Table 28 Definitions of LK232S Indicators

Name	Status	Description
RUN (green)	Flash	No data transmission is available to the PROFIsafe bus of segment 1
	On	Data transmission is available to the PROFIsafe bus of segment 1
	Off	The module is not powered up or damaged
COM (yellow)	Flash	Data transmission is available to the PROFIsafe bus of segment 2. The greater the data volume , the higher the flashing frequency
	Off	No data transmission is available to the PROFIsafe bus of segment 2

- 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

LK232S Safety Bus Repeater Module	
Backplane Power Supply	
Operating Voltage	24VDC（-15%~20%）
Power consumption	60 mA max.@24 VDC
Isolation Voltage	
Isolation Voltage between DP and system	To test for 1 minute based on 500 VAC, with a leaking current 5 mA
Communication	
Protocol	PROFIsafe
Dual-network Redundancy	Supported
Communication Rate	187.5 kbps, 500 kbps, 1.5 Mbps、3Mbps、6Mbps
Physical Property	
Installation Mode	Slot Installation
Installation Position	Communication slots of extension backplane
Module Dimension (W*H*D)	35 mm×100 mm×100 mm
Hot swapping	Supported

6.4 IO Module

6.4.1 LK610S Safety 8 Channels Digital Input Module

6.4.1.1 Basic Features

- 8 channel non-polar dry contact inputs
- Field power supply: 20.4 VDC~28.8 VDC

- Support field power loss detection
- Support reverse power supply protection
- Isolation design between field channel and the system
- Periodic self-check
- Support PROFIsafe slave protocol
- Hot swapping

6.4.1.2 Appearance

Figure 99 Appearance of LK610S

6.4.1.3 Principle

The channel of LK610S collects field switch status through Sample circuit 1 and Sample circuit 2. The channel works normally when both the acquisition status are in accordance with the set values. If any sample circuit is abnormal, it will identify the collection value as fault, and ensure the data safety reported to the controller.

Electrical isolation between the LK610S field side and system side, and isolation voltage 500VAC, ensure that the field side failure has no effect on the system side. The field side and the system side need to use different AC/DC power to ensure isolation.

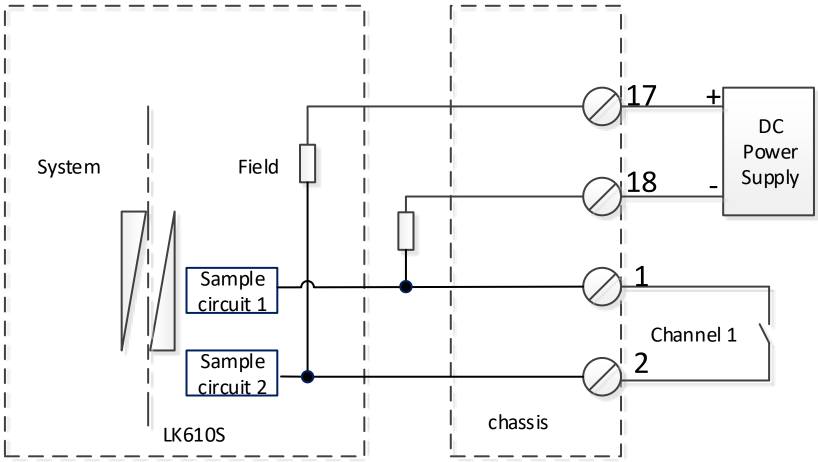


Figure 100　LK610S Channel Interface Circuit Diagram

6.4.1.4　Indicators

Table 29　Definition of LK610S Indicators

Name	Status	Description
RUN indicator (green)	On	The communication is established, and the module works well.
	Flash	The communication is not established or self checking failed.
	Off	No power.
ERR indicator (red)	On	The module has fault.
	Off	No power or module is normal.
1~8 channel indicators (yellow)	On	The channel is connected.
	Off	The channel is disconnected.

Flashing frequency of RUN indicator is 4Hz.

6.4.1.5　Wirings

The LK610S is installed on the expansion backplane, and the channel wiring is carried out on the corresponding backplane terminal. The definition of the terminals is shown in Table 30.

Table 30　Backplane Wiring Terminal

Channel	Corresponding backplane terminals	
Channel 1	01	02
Channel 2	03	04
Channel 3	05	06
Channel 4	07	08
Channel 5	09	10
Channel 6	11	12
Channel 7	13	14

Channel	Corresponding backplane terminals	
Channel 8	15	16

Wiring of 8 channels is in the same way. Take channel 1 as an example, wiring is shown in Figure 101.

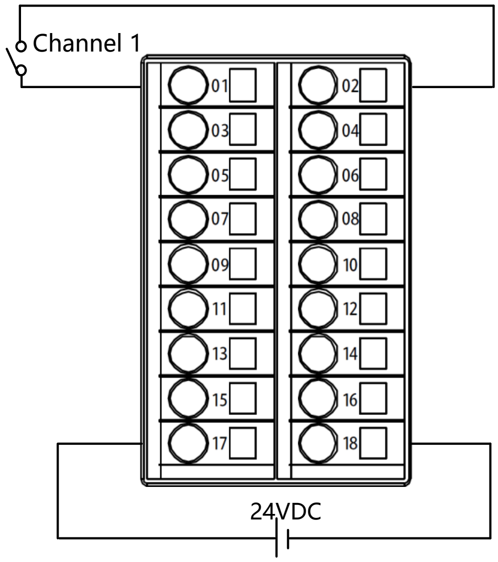


Figure 101 Wiring Diagram

6.4.1.6 Diagnosis

LK610S fault diagnosis includesdevice diagnosisand channel diagnosis. After calling the function block sysGetDPSlaveState (Get Diagnosis of DP Slave), diagnosis data is saved to the output parameters DiagData1~ DiagData54 of function block.

Diagnostic information of LK610S up to 30 bytes, wherein 4 bytes are device-related diagnosis, 2 bytes are identification diagnosis and 24 bytes are channel diagnosis. For 8 channels of LK610S, the diagnosis information of each channel is 3 bytes.

Diagnosis information DiagData1~ DiagData30 of function block sysGetDPSlaveState (Get Diagnosis of DP Slave) is shown in Table 31.

Table 31 Output Parameter DiagData1~ DiagData30

Output parameters	Data type	Parameter description
DiagData1~ DiagData4	BYTE	Device-related diagnosis information See Table 32
DiagData5~ DiagData6	BYTE	Identification diagnosis information DiagData5: 0x42, where 2 represents the diagnostic information length of 2 bytes DiagData6: when diagnosis information is reported, the value is 0x01
DiagData7~ DiagData9	BYTE	Channel 1 diagnosis information See Table 34
DiagData10~ DiagData12	BYTE	Channel 2 diagnosis information
…	BYTE	….
DiagData28~ DiagData30	BYTE	Channel 8 diagnosis information

Table 32 Device-related Diagnosis

Output parameters	Bit	Description
DiagData1	Bit0~ Bit7	=4: 4 bytes diagnostic information length
DiagData2	Bit7	Power fault =0: Normal =1: Failure
	Bit6	MCU fault (heartbeat fault) =0: Normal =1: Failure
	Bit5	MCU self-diagnosis =0: Normal =1: Failure
	Bit0~Bit4	Reserved
DiagData3	Bit7 ~ Bit6	IO_BUS network fault =0: the network is normal =1:DP1 network fault =2:DP2 network fault =3: reserved
	Bit5 ~ Bit3	Reserved
	Bit2	Switch power down 0: No switch power down fault 1: Switch power down fault
	Bit1	Reserved
	Bit0	Channel fault =0: Normal =1: Failure
DiagData4	Bit3~Bit7	Reserved
	Bit2	Program monitoring fault =0: Normal =1: Failure
	Bit1	Module ADC circuit fault =0: Normal =1: Failure
	Bit0	Diagnosis circuit fault of power supply =0: Normal =1: Failure

Table 33 Device-related Fault Response

Fault type	Diagnosis mode	Quality bit	Channel response
Power fault	Power-on diagnostics once and periodic diagnostics	TRUE	The channels turn to the safety side, and use safety value as channel value.
MCU fault	Power-on diagnostics once and periodic diagnostics	TRUE	The channels turn to the safety side, and use safety value as channel value.
MCU self-diagnosis	Power-on diagnostics once and periodic diagnostics	TRUE	The channels turn to the safety side, and use safety value as channel value.

Fault type	Diagnosis mode	Quality bit	Channel response
IO_BUS network fault	Power-on diagnostics once and periodic diagnostics	——	The channels don’t turn to the safety side and report diagnosis information.
Switch power down	Power-on diagnostics once and periodic diagnostics	TRUE	The channels turn to the safety side, and use safety value as channel value.
Channel fault	Power-on diagnostics once and periodic diagnostics	TRUE	The channels turn to the safety side, and use safety value as channel value.
Module ADC circuit fault	Power-on diagnostics once and periodic diagnostics	TRUE	The channels turn to the safety side, and use safety value as channel value.
Diagnosis circuit fault of power supply	Power-on diagnostics once and periodic diagnostics	TRUE	The channels don’t turn to the safety side and report diagnosis information.

Table 34 Channel Diagnosis

Diagnosis Byte						Meaning
Bit		Bit 7	Bit 6	Bit 5	Bit 4 ~ Bit 0	
The first byte	Head	0x80				Decimal online value : 128
The second byte	I/O type/channel	01 (Input)		(Channel)		Failure channel, decimal online value : 64~71, corresponding to the channel 1~8
The third byte	Channel data type/fault type	001 (Bit)			0	Channel fault recovery, decimal online value : 32
					18	Channel acquisition fault, decimal online value : 50

Table 35 Channel Fault Response

Fault type	Diagnosis mode	Quality bit	Channel response
Channel acquisition fault	Power-on diagnostics once and periodic diagnostics	TRUE	The channel turns to the safety side, and use safety value as channel value.

When a communication failure or module failure occurs, the channel turns to the safety side. The possible causes and treatment measures are shown in the following table.

Table 36 Causes and Treatment Measures

Fault type	Causes	Treatment Measures
Module failure	Power fault	Replace module.
	MCU fault	
	MCU self-diagnosis	
	Channel fault	
	Module ADC circuit fault	
	Diagnosis circuit fault of power supply	

Fault type	Causes	Treatment Measures
	Channel acquisition fault	
	Switch power down	Check whether the field power supply is normal.
Communication failure	DP broken	Check whether the DP cable is inserted properly.
	Module without power supply	Check whether the power supply is normal.

For troubleshooting, please refer to 6.4.4.6 Diagnosis.

6.4.1.7 PROFIsafe Fault Status

When the fault is recovered, the system automatically confirms the profisafe fault.

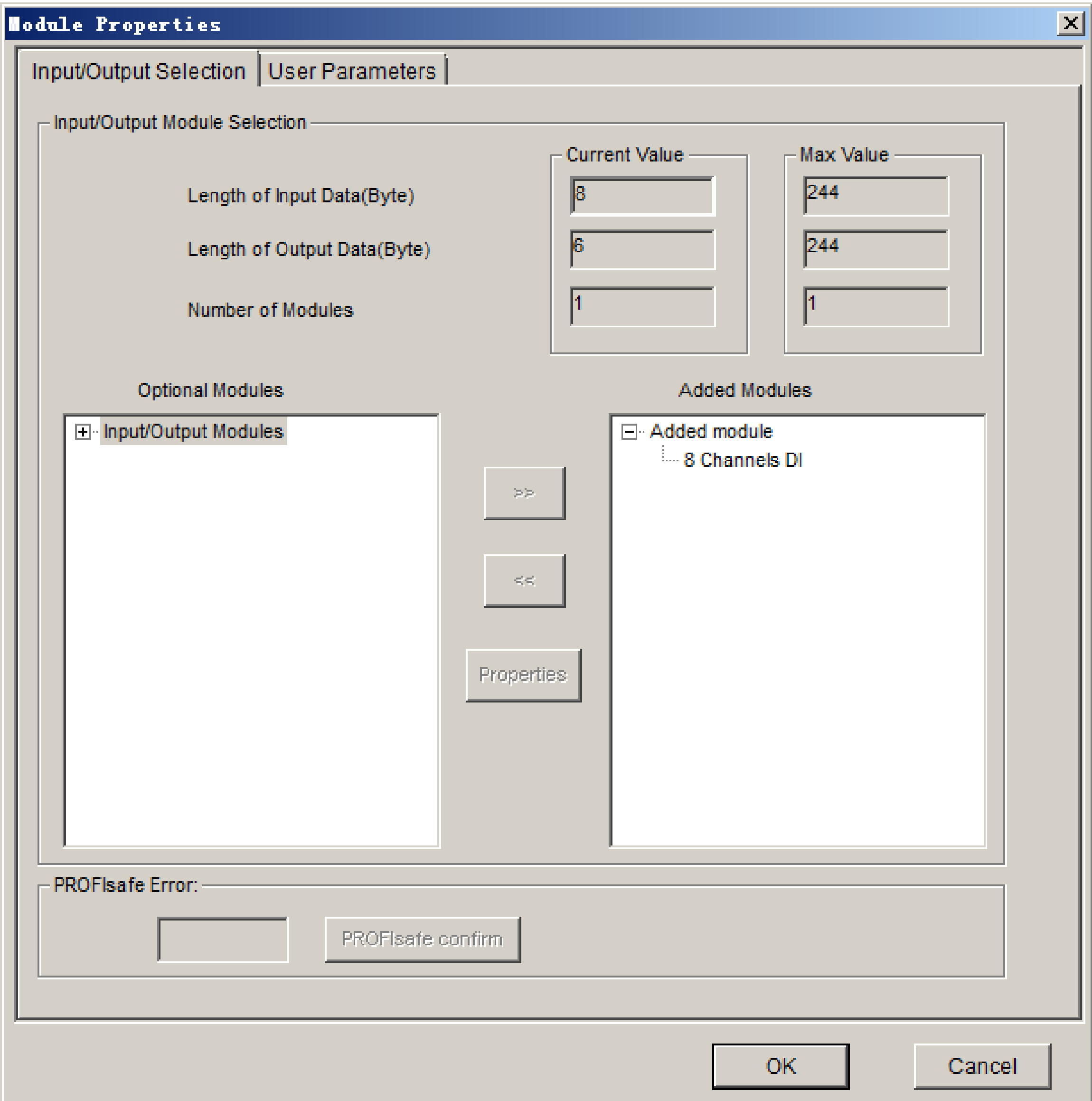


Figure 102 Module Properties

PROFIsafe Error status is displayed at the lower left of the dialog. Error status is shown as TRUE when the PROFIsafe fault occurs, meanwhile, the system is in safety status and the module channel adopts the safety value. When the PROFIsafe fault is recovered, the system automatically confirms the profisafe fault. At this point, Error status turns to FALSE, and the module channel returns to normal logic output.

- View PROFIsafe fault status information

  You can view the status information of the PROFIsafe fault via global variable group DPDevVar_Group, Each slave module has two diagnosis variables, namely, slave station confirmation status and slave station communication status.

  - Slave station confirmation status: 0: there is a PROFIsafe fault. 1: no PROFIsafe fault.
  - Slave station communication status: 1 Byte, communication is normal when value is 1, and vice versa.

DPDevVar_Group

No.	Name	Description	Data Type	Initial Value	Area
0001	SYS_DPConfirm_State_2_1_2	No.2 communication device, No.1 protocol, address is 2, slave confirm st...	WORD	0	S Area
0002	SYS_DPSlaveCom_State_2_1_2	No.2 communication device, No.1 protocol, Address is 2, slave communi...	BYTE	0	G Area
0003	SYS_DPConfirm_State_2_1_3	No.2 communication device, No.1 protocol, address is 3, slave confirm st...	WORD	0	S Area
0004	SYS_DPSlaveCom_State_2_1_3	No.2 communication device, No.1 protocol, Address is 3, slave communi...	BYTE	0	G Area

Figure 103　DPDevVar_Group

PROFIsafe faults that need to be confirmed see LKS Safety Control System Product Manual.

6.4.1.8 Safety Value

Channel provides two modes of safety value. When a channel fault occurs, real-time output value DV of the channel is used to user logic operation. When configuring, please use DV variables in Chapter 6.4.1.9 Channel Value Algorithm.

Mode of Safety Value:

- Hold On: When a channel failure occurs, maintain the last cycle value.
- Set Up: When a channel failure occurs, adopt the preset safety value as channel value.

Module channel information is shown in Figure 104. 1~8 is channel collection value and 9~16 is channel quality bits. You first need to check Channel Enable before setting Mode of Safety Value.

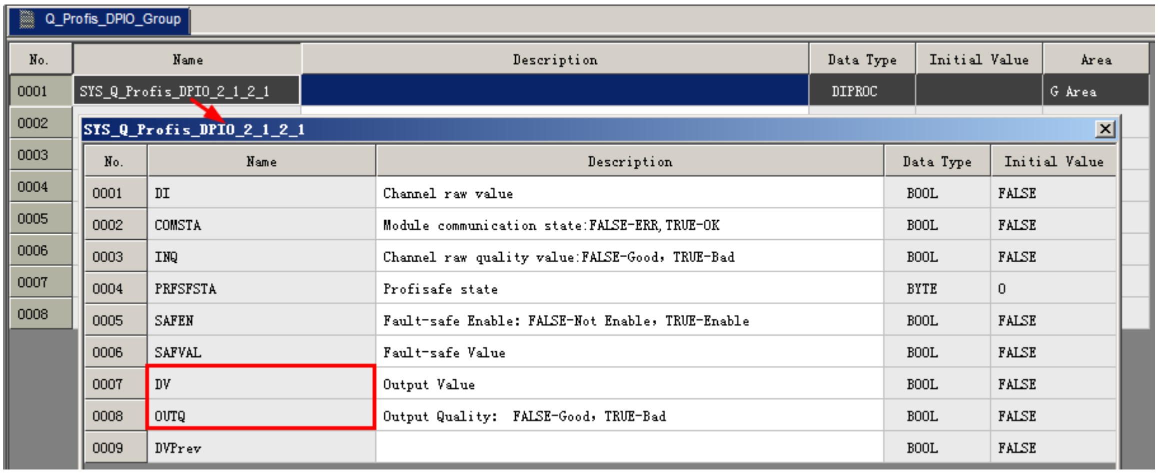
8 Channels DI

Channel Number	Channel Name	Channel Types	Channel Address	Channel Description	Channel Enable	Mode of Safety Value	Safety Value	SOE Enable
1	DPIO_2_1_2_1	BOOL	%IX0.0		☑	Hold On		☐
2	DPIO_2_1_2_2	BOOL	%IX0.1		☑	Hold On		☐
3	DPIO_2_1_2_3	BOOL	%IX0.2		☑	Hold On		☐
4	DPIO_2_1_2_4	BOOL	%IX0.3		☑	Hold On		☐
5	DPIO_2_1_2_5	BOOL	%IX0.4		☑	Hold On		☐
6	DPIO_2_1_2_6	BOOL	%IX0.5		☑	Hold On		☐
7	DPIO_2_1_2_7	BOOL	%IX0.6		☑	Hold On		☐
8	DPIO_2_1_2_8	BOOL	%IX0.7		☑	Hold On		☐
9	Q_DPIO_2_1_2_1	BOOL	%IX1.0					☐
10	Q_DPIO_2_1_2_2	BOOL	%IX1.1					☐
11	Q_DPIO_2_1_2_3	BOOL	%IX1.2					☐
12	Q_DPIO_2_1_2_4	BOOL	%IX1.3					☐
13	Q_DPIO_2_1_2_5	BOOL	%IX1.4					☐
14	Q_DPIO_2_1_2_6	BOOL	%IX1.5					☐
15	Q_DPIO_2_1_2_7	BOOL	%IX1.6					☐
16	Q_DPIO_2_1_2_8	BOOL	%IX1.7					☐

Figure 104　Set Safety Value

6.4.1.9 Channel Value Algorithm

Global variable group Q_ Profis_ DPIO_ Group is used to calculate the channel real-time output value and channel data quality bit, as shown in Figure 105. When configuring program, please use DV variable of corresponding channel with format "Variable name" + ". DV". For example: SYS_Q_Profis_DPIO_2_1_2_1.DV.


Q_Profis_DPIO_Group

No.	Name	Description	Data Type	Initial Value	Area
0001	SYS_Q_Profis_DPIO_2_1_2_1		DIPROC		G Area
0002					
0003					
0004					
0005					
0006					
0007					
0008					

SYS_Q_Profis_DPIO_2_1_2_1

No.	Name	Description	Data Type	Initial Value
0001	DI	Channel raw value	BOOL	FALSE
0002	COMSTA	Module communication state:FALSE-ERR, TRUE-OK	BOOL	FALSE
0003	INQ	Channel raw quality value:FALSE-Good, TRUE-Bad	BOOL	FALSE
0004	PRFSFSTA	Profisafe state	BYTE	0
0005	SAFEN	Fault-safe Enable: FALSE-Not Enable, TRUE-Enable	BOOL	FALSE
0006	SAFVAL	Fault-safe Value	BOOL	FALSE
0007	DV	Output Value	BOOL	FALSE
0008	OUTQ	Output Quality: FALSE-Good, TRUE-Bad	BOOL	FALSE
0009	DVPrev		BOOL	FALSE

Figure 105 Channel Voting Variable Group

DV and OUTQ are logic out values of channel, which are determined by the logic operation of other input variables in the variable group, see Table 37 for variable description.

Table 37 Variable Description

Variable name		Variable type	Description
Input variables	DI/AI	BOOL/WORD	Channel collection value, and votes DV value output It corresponds channel name variable, such as DPIO_2_1_2_1
	COMSTA	BOOL	Slave station communication status , and votes quality bit output True: slave station communication is normal False: slave station communication is abnormal
	INQ	BOOL	Channel quality bit, and votes quality bit output It corresponds channel name variable, such as Q_ DPIO_ 2_ 1_ 2_1 True: bad channel quality False: good channel quality
	PRFSFSTA	WORD	The slave station Profisafe status, and votes the quality bit output 0: Profisafe fault 1: No profisafe fault
	SAFEN	BOOL	It corresponds safety value mode: Hold On / Set Up, and votes DV value output
	SAFVAL	BOOL/WORD	It corresponds security value
Out variables	DV/AV	BOOL/WORD	channel real-time output value
	OUTQ	BOOL	Channel data quality bit
	DVPrev	BOOL/WORD	reserved

Channel data quality bit OUTQ is determined by COMSTA, INQ and PRFSFSTA.

The channel real-time output value DV is determined by OUTQ and the safe value mode.

- When the channel data quality is good, DV outputs the channel collection value.
- When the channel data quality is bad, DV is determined by the safety value mode. When the safe value mode is Hold On, DV outputs the channel collection value of the previous period. When the safe value mode is Set Up, DV outputs the security value.

Table 38 Voting Relationship

DI/AI	COMSTA	INQ	PRFSFSTA	SAFEN	SAFVAL	DV	OUTQ
*	TRUE	FALSE	1	*	*	DI/AI	FALSE
*	TRUE	TRUE	1	Hold On	*	DI/AI of previous cycle value	TRUE
*	TRUE	TRUE	1	Set Up	*	SAFVAL	TRUE
*	FALSE	*	*	Hold On	*	DI/AI of previous cycle value	TRUE
*	FALSE	*	*	Set Up	*	SAFVAL	TRUE
*	TRUE	*	0	Hold On	*	DI/AI of previous cycle value	TRUE
*	TRUE	*	0	Set Up	*	SAFVAL	TRUE

* represents any value.

6.4.1.10 Parameters

1. Module Parameter

Choose the added module in Module Properties dialog and click **Properties** button to open the Module Parameter dialog.

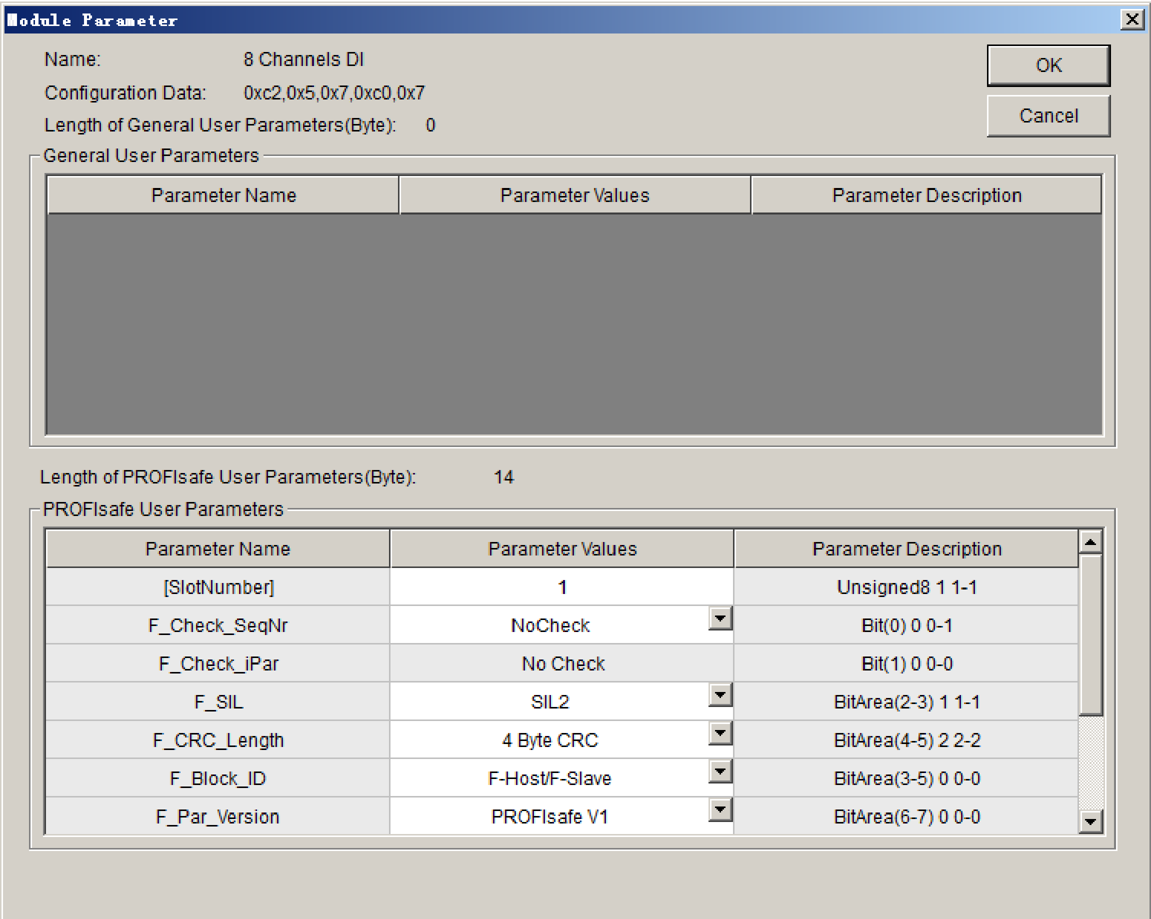


Figure 106 Module Parameter

Table 39 Definition of LK610S User Parameter

Parameter	Meaning	Value
SlotNumber	Module slot number	Default value
F_Check_SeqNr	Whether the message sequence number takes part in the CRC check	You can choose the following two ways Check: The sequence number field in PROFIsafe message takes part in the CRC check Nocheck: The sequence number field in PROFIsafe message does not take part in the CRC check This parameter setting is suitable for both the PROFIsafe master station and the PROFIsafe slave station
F_Check_iPar	Whether the i parameter takes part in the CRC check	Default value
F_SIL	SIL level selection	Default value
F_CRC_Length	Message CRC check and length.	Set as 4 Byte CRC, This parameter setting is suitable for both the PROFIsafe master station and the PROFIsafe slave station
F_Block_ID	Module ID	Default value

Parameter	Meaning	Value
F_Par_Version	F parameter version	Default value
F_Source_Add	F source address	Default value
F_Dest_Add	F destination address	Default value
F_WD_Time	Watchdog time for monitoring PROFIsafe messages	Default value
F_Par_CRC	F device i parameter CRC check sum	Default value

2. User Parameters

The channel filtering parameters are set in the [User Parameters]. In the Safety FA-AutoThink, double-click the LK610S module under the BUS_MASTER and double-click the Device Property to open the Module Properties dialog, as shown in Figure 107.

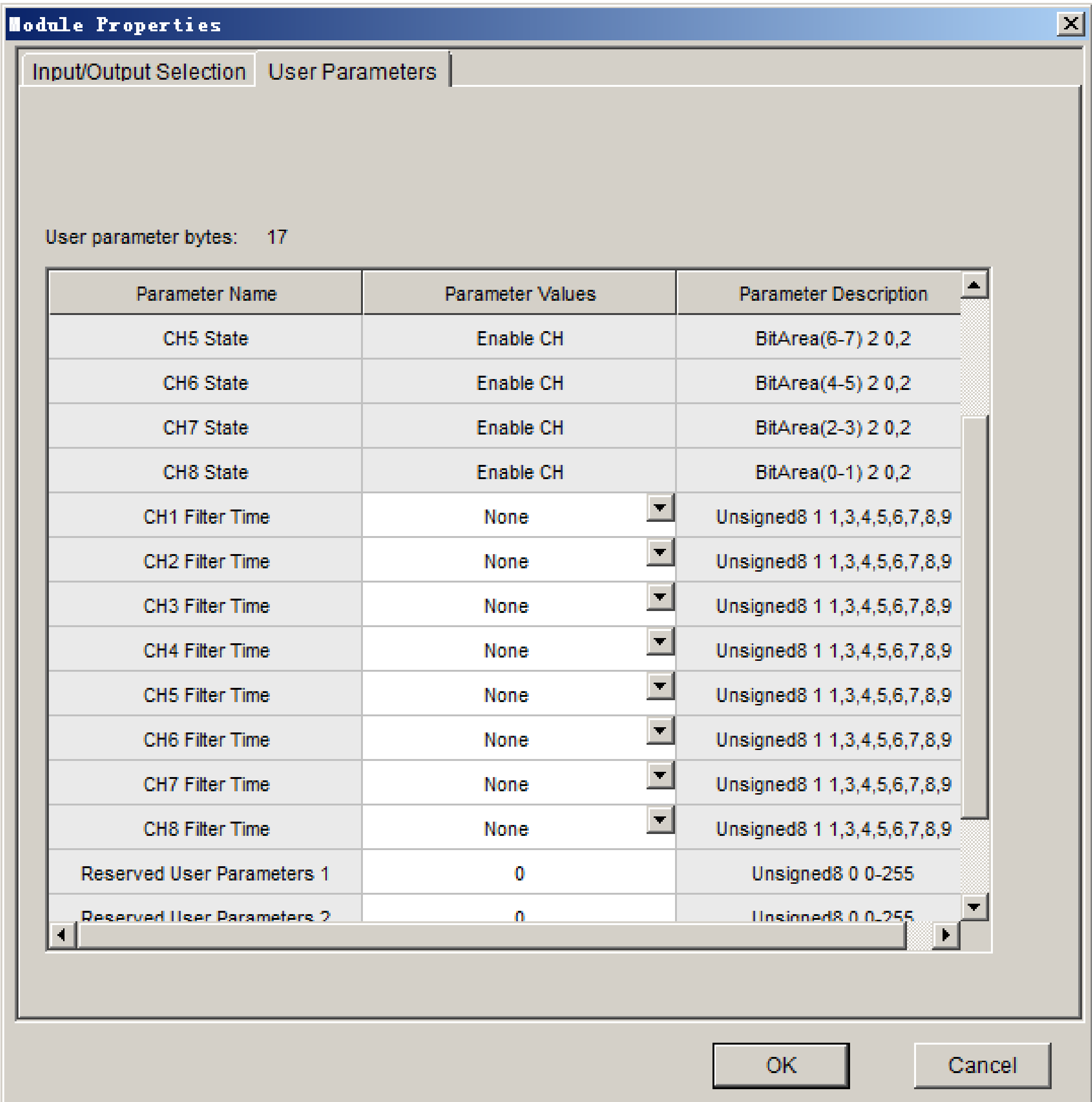


Figure 107 LK610S User Parameter Setting

Table 40 Definition of LK610S User Parameter

Parameter	Description	Value
CH1~8 State	Channel enable status	Enable CH as default value, you can set Enable in Device Information dialog, see 6.4.1.8 Safety Value
CH1~8 Filter Time	Channel filter time	None, 20ms, 30 ms, 40 ms, 50 ms, 60 ms, 70 ms, 80 ms, 100ms, 200 ms, 300 ms, 400 ms, 500 ms
Reserved User Parameters 1~4	Reserved	You not need to set

6.4.1.11 Technical Specifications

LK610S Safety 8 Channels Digital Input Module	
Power supply	
Input voltage	24VDC(-15%~+20%)
Power consumption	Field power: 100mA @24VDC (max.)
	System power: 50mA@24VDC (max.)
Reverse power supply protection	Supported
Over-voltage protection(60VDC)	Supported (hold in safety status)
Hot swapping	Supported
Input channel	
Number of channels	8
Contact type	Non-polar dry contact
Data format uploaded by channel	2 bytes (16 bits), the first byte represents a channel state, the second byte represents a channel quality value, high in front, low follow
ON	R_{on}<1KΩ（@ Voltage query = 20.4V）
OFF	R_{off}>100KΩ（@ Voltage query = 28.8V）
Query voltage	24VDC(-15%~+20%)
Dithering-removing filter time OFF→ON ON→OFF	None, 20ms, 30 ms, 40 ms, 50 ms, 60 ms, 70 ms, 80 ms, 100ms, 200 ms, 300 ms, 400 ms, 500 ms None, 20ms, 30 ms, 40 ms, 50 ms, 60 ms, 70 ms, 80 ms, 100ms, 200 ms, 300 ms, 400 ms, 500 ms
Isolation voltage between field and system	500 VAC@1 min, leaking current: 5 mA
Communication	
Protocol	PROFIsafe
Dual network redundancy	Supported
Communication rate	187.5 kbps, 500 kbps, 1.5 Mbps、3Mbps、6Mbps
Physical specifications	
Installation position	Expansion backplane

LK610S　Safety 8 Channels Digital Input Module	
Module dimension (W*H*D)	35 mm×100 mm×100 mm

6.4.2　LK611S　Safety 8 Channels Digital Input Module（with LFD Function）

6.4.2.1　Basic Features

- 8 channel non-polar dry contact inputs
- Support ESD switches with diagnostic of external circuit
- Field power supply: 20.4 VDC~28.8 VDC
- Support field power loss detection
- Support reverse power supply protection
- Isolation design between field channel and the system
- Periodic self-check
- Support PROFIsafe slave protocol
- Hot swapping

6.4.2.2　Appearance

Figure 108　Appearance of LK611S

6.4.2.3　Principle

The channel of LK611S collects field switch status through Sample circuit 1 and Sample circuit 2. The channel works normally when both the acquisition status is in accordance with the set values. If any sample circuit is abnormal, it will identify the collection value as fault, and ensure the data safety reported to the controller.

The field signal supports ESD switch with diagnostic resistance for external line diagnosis. The module periodically detects the external line fault. When the external line is broken or short circuited, it will identify the collection value as fault, and ensure the data safety reported to the controller.

Electrical isolation between the LK611S field side and system side, and isolation voltage 500VAC, ensure that the field side failure has no effect on the system side. The field side and the system side need to use different AC/DC power to ensure isolation.

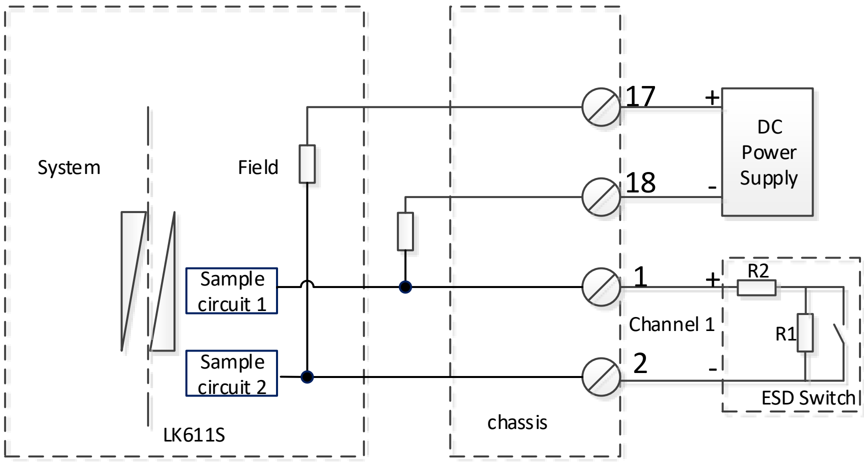


Figure 109 LK611S Channel Interface Circuit Diagram

6.4.2.4 Indicators

Table 41 Definition of LK611S Indicators

Name	Status	Description
RUN indicator (green)	On	The communication is established, and the module works well.
	Flash	The communication is not established or self checking failed.
	Off	No power or module has faults.
ERR indicator (red)	On	The module has fault.
	Off	No power or module is normal.
1~8 channel indicators (yellow)	On	The channel is connected.
	Off	The channel is disconnected.

Flashing frequency of RUN indicator is 4Hz.

6.4.2.5 Wirings

The LK611S is installed on the expansion backplane, and the channel wiring is carried out on the corresponding backplane terminal. The definition of the terminals is shown in Table 42.

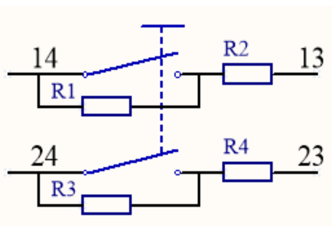
Table 42 Backplane Wiring Terminal

Channel	Corresponding backplane terminals

Channel	Corresponding backplane terminals	
Channel 1	01	02
Channel 2	03	04
Channel 3	05	06
Channel 4	07	08
Channel 5	09	10
Channel 6	11	12
Channel 7	13	14
Channel 8	15	16

The channel can connect dry node signal and ESD switch with external diagnosis function, and the switch specification is shown in Table 43. When ESD switch as input signal, you need to configure Resistance value according to the actural Specifications of ESD switch. Default value of ESD switch: R1=22 KΩ,R2=2 KΩ.

Table 43 Specifications of ESD switch

Specifications of ESD switch					Recommended model
Circuit topology	Resistance value				
	R1	R2	R3	R4	
	10 KΩ	1 KΩ	10 KΩ	1 KΩ	FEA(M)2020-24-11
	22 KΩ	2 KΩ	22 KΩ	2 KΩ	FEA(M)2020-24-12
	27 KΩ	2 KΩ	27 KΩ	2 KΩ	FEA(M)2020-24-13
	13.7 KΩ	1 KΩ	13.7 KΩ	1 KΩ	FEA(M)2020-24-14
	22.1 KΩ	2.05 KΩ	22.1 KΩ	2.05 KΩ	

Wiring of 8 channels is in the same way. Take channel 1 and channel 2 as an example. Channel 1 connects a dry contact signal and channel 2 connects an ESD switch signal. Wiring is shown in Figure 110.

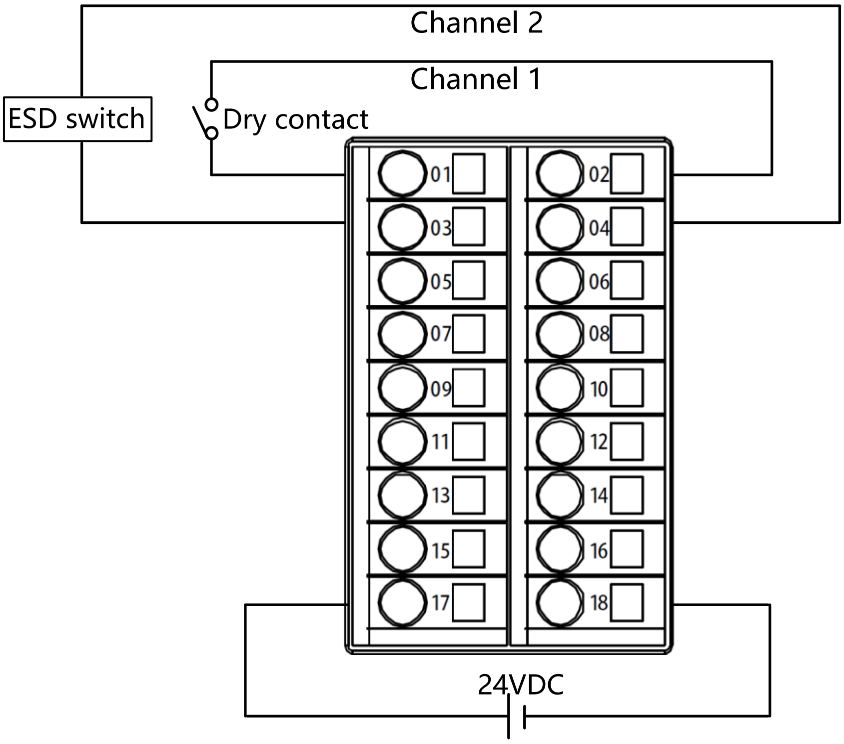


Figure 110 Wiring Diagram

6.4.2.6 Diagnosis

LK611S fault diagnosis includesdevice diagnosisand channel diagnosis. After calling the function block sysGetDPSlaveState (Get Diagnosis of DP Slave), diagnosis data is saved to the output parameters DiagData1~ DiagData54 of function block.

Diagnostic information of LK611S up to 30 bytes, wherein 4 bytes are device-related diagnosis, 2 bytes are identification diagnosis and 24 bytes are channel diagnosis. For 8 channels of LK611S, the diagnosis information of each channel is 3 bytes.

Diagnosis information DiagData1~ DiagData30 of function block sysGetDPSlaveState (Get Diagnosis of DP Slave) is shown in Table 44.

Table 44 Output Parameter DiagData1~ DiagData30

Output parameters	Data type	Parameter description
DiagData1~ DiagData4	BYTE	Device-related diagnosis information See Table 45
DiagData5~ DiagData6	BYTE	Identification diagnosis information DiagData5: 0x42, where 2 represents the diagnostic information length of 2 bytes DiagData6: when diagnosis information is reported, the value is 0x01
DiagData7~ DiagData9	BYTE	Channel 1 diagnosis information See Table 47
DiagData10~ DiagData12	BYTE	Channel 2 diagnosis information
…	BYTE	….
DiagData28~ DiagData30	BYTE	Channel 8 diagnosis information

Table 45 Device-related Diagnosis

Output parameters	Bit	Description
DiagData1	Bit0~ Bit7	=4: 4 bytes diagnostic information length
DiagData2	Bit7	Power fault =0: Normal =1: Failure
	Bit6	MCU fault (heartbeat fault) =0: Normal =1: Failure
	Bit5	MCU self-diagnosis =0: Normal =1: Failure
	Bit0~Bit4	Reserved
DiagData3	Bit7 ~ Bit6	IO_BUS network fault =0: the network is normal =1:DP1 network fault =2:DP2 network fault =3: reserved
	Bit5 ~ Bit3	Reserved
	Bit2	Switch power down 0: No switch power down fault 1: Switch power down fault
	Bit1	Reserved
	Bit0	Channel fault =0: Normal =1: Failure
DiagData4	Bit3~Bit7	Reserved
	Bit2	Program monitoring fault =0: Normal =1: Failure
	Bit1	Module ADC circuit fault =0: Normal =1: Failure
	Bit0	Diagnosis circuit fault of power supply =0: Normal =1: Failure

Table 46 Device-related Fault Response

Fault type	Diagnosis mode	Quality bit	Channel response
Power fault	Power-on diagnostics once and periodic diagnostics	TRUE	The channels turn to the safety side, and use safety value as channel value.
MCU fault	Power-on diagnostics once and periodic diagnostics	TRUE	The channels turn to the safety side, and use safety value as channel value.
MCU self-diagnosis	Power-on diagnostics once and periodic diagnostics	TRUE	The channels turn to the safety side, and use safety value as channel value.

Fault type	Diagnosis mode	Quality bit	Channel response
IO_BUS network fault	Power-on diagnostics once and periodic diagnostics	___	The channels don't turn to the safety side and report diagnosis information.
Switch power down	Power-on diagnostics once and periodic diagnostics	TRUE	The channels turn to the safety side, and use safety value as channel value.
Channel fault	Power-on diagnostics once and periodic diagnostics	TRUE	The channels turn to the safety side, and use safety value as channel value.
Module ADC circuit fault	Power-on diagnostics once and periodic diagnostics	TRUE	The channels turn to the safety side, and use safety value as channel value.
Diagnosis circuit fault of power supply	Power-on diagnostics once and periodic diagnostics	TRUE	The channels don't turn to the safety side and report diagnosis information.

Table 47 Channel Diagnosis

<table>
<tr><th colspan="6">Diagnosis Byte</th><th>Meaning</th></tr>
<tr><td colspan="2">Bit</td><td>Bit 7</td><td>Bit 6</td><td>Bit 5</td><td>Bit 4 ~ Bit 0</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>Failure channel, decimal online value : 64~71, corresponding to the channel 1~8</td></tr>
<tr><td rowspan="5">The third byte</td><td rowspan="5">Channel data type/fault type</td><td colspan="3" rowspan="5">001 (Bit)</td><td>0</td><td>Channel fault recovery, decimal online value : 32</td></tr>
<tr><td>1</td><td>Short circuit, decimal online value :33</td></tr>
<tr><td>6</td><td>Wire break, decimal online value: 38</td></tr>
<tr><td>18</td><td>Channel acquisition fault, decimal online value : 50</td></tr>
<tr><td>24</td><td>Channel ground fault, decimal online value : 56</td></tr>
</table>

Table 48 Channel Fault Response

Fault type	Diagnosis mode	Quality bit	Channel response
Channel acquisition fault	Power-on diagnostics once and periodic diagnostics	TRUE	The channel turns to the safety side, and use safety value as channel value.
Short circuit fault	Periodic diagnostics	TRUE	The channel turns to the safety side, and use safety value as channel value.
Wire break fault	Periodic diagnostics	TRUE	The channel turns to the safety side, and use safety value as channel value.
Channel ground fault	Periodic diagnostics	TRUE	The channel turns to the safety side, and use safety value as channel value.

When a communication failure or module failure occurs, the channel turns to the safety side. The possible causes and treatment measures are shown in the following table.

Table 49 Causes and Treatment Measures

Fault type	Causes	Treatment Measures
Module failure	Power fault	Replace module.
	MCU fault	
	MCU self-diagnosis	
	Channel fault	
	Module ADC circuit fault	
	Diagnosis circuit fault of power supply	
	Channel acquisition fault	
	Switch power down	Check whether the field power supply is normal.
Communication failure	DP broken	Check whether the DP cable is inserted properly.
	Module without power supply	Check whether the power supply is normal.
External line diagnosis	Short circuit fault	Check the external line.
	Wire break fault	Check the external line.
	Channel ground fault	Check whether the external circuit is connected to ground.

For troubleshooting, please refer to 6.4.4.6 Diagnosis.

6.4.2.7 PROFIsafe Fault Status

When the fault is recovered, the system automatically confirms the profisafe fault.

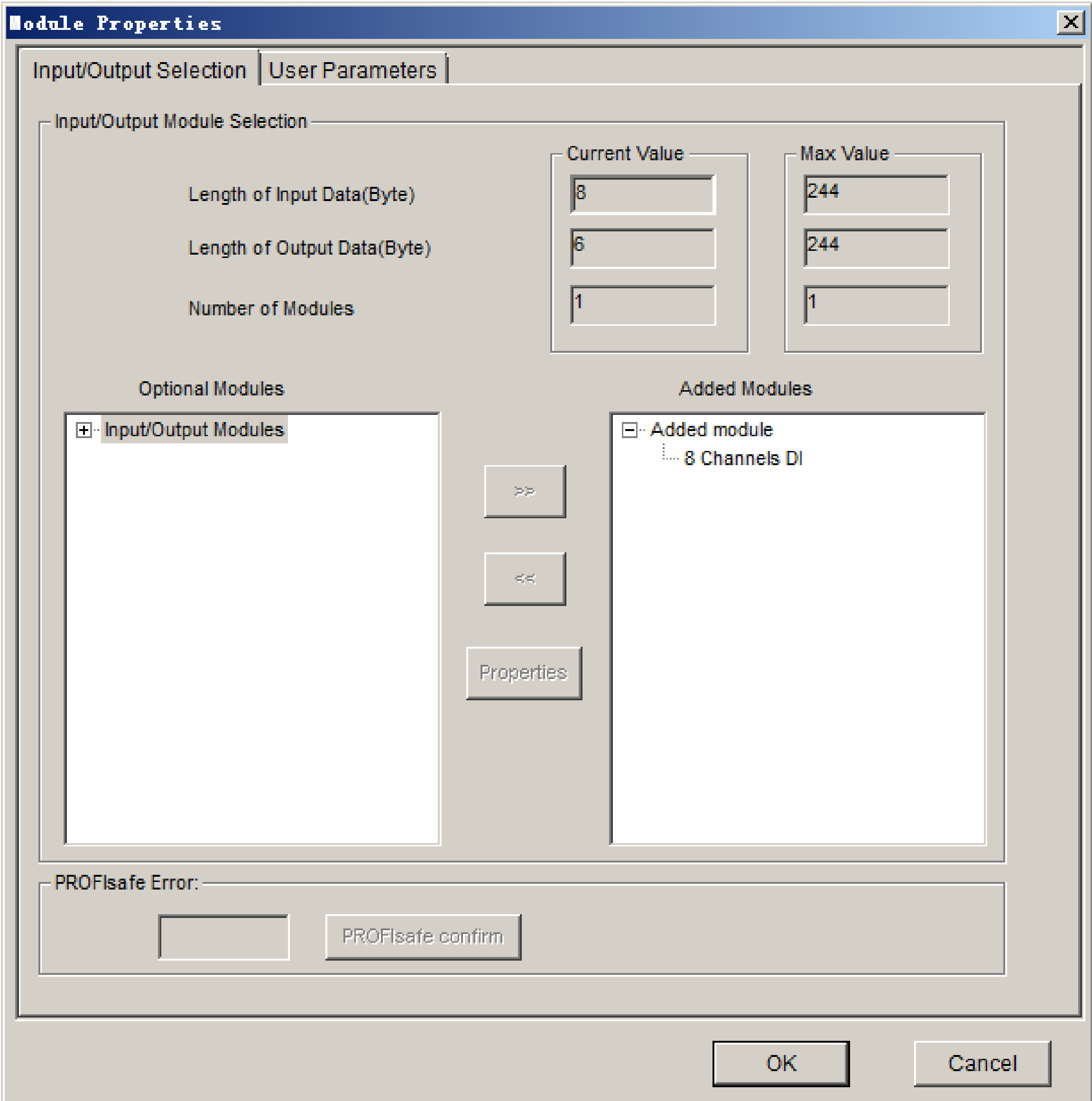


Figure 111　Module Properties

PROFIsafe Error status is displayed at the lower left of the dialog. Error status is shown as TRUE when the PROFIsafe fault occurs, meanwhile, the system is in safety status and the module channel adopts the safety value. When the PROFIsafe fault is recovered, the system automatically confirms the profisafe fault. At this point, Error status turns to FALSE, and the module channel returns to normal logic output.

- View PROFIsafe fault status information

  You can view the status information of the PROFIsafe fault via global variable group DPDevVar_Group, Each slave module has two diagnosis variables, namely, slave station confirmation status and slave station communication status.

  - Slave station confirmation status: 0: there is a PROFIsafe fault. 1: no PROFIsafe fault.
  - Slave station communication status: 1 Byte, communication is normal when value is 1, and vice versa.

DPDevVar_Group

No.	Name	Description	Data Type	Initial Value	Area
0001	SYS_DPConfirm_State_2_1_2	No.2 communication device, No.1 protocol, address is 2, slave confirm st...	WORD	0	S Area
0002	SYS_DPSlaveCom_State_2_1_2	No.2 communication device, No.1 protocol, Address is 2, slave communi...	BYTE	0	G Area
0003	SYS_DPConfirm_State_2_1_3	No.2 communication device, No.1 protocol, address is 3, slave confirm st...	WORD	0	S Area
0004	SYS_DPSlaveCom_State_2_1_3	No.2 communication device, No.1 protocol, Address is 3, slave communi...	BYTE	0	G Area

Figure 112　DPDevVar_Group

PROFIsafe faults that need to be confirmed see LKS Safety Control System Product Manual.

6.4.2.8　Safety Value

Channel provides two modes of safety value. When a channel fault occurs, real-time output value DV of the channel is used to user logic operation. When configuring, please use DV variables in Chapter 6.4.1.9 Channel Value Algorithm.

Mode of Safety Value:

- Hold On: When a channel failure occurs, maintain the last cycle value.
- Set Up: When a channel failure occurs, adopt the preset safety value as channel value.

Module channel information is shown in Figure 113. 1~8 is channel collection value and 9~16 is channel quality bits. You first need to check Channel Enable before setting Mode of Safety Value.

8 Channels DI

Channel Number	Channel Name	Channel Types	Channel Address	Channel Description	Channel Enable	Mode of Safety Value	Safety Value	SOE Enable
1	DPIO_2_1_2_1	BOOL	%IX0.0		☑	Hold On		☐
2	DPIO_2_1_2_2	BOOL	%IX0.1		☑	Hold On		☐
3	DPIO_2_1_2_3	BOOL	%IX0.2		☑	Hold On		☐
4	DPIO_2_1_2_4	BOOL	%IX0.3		☑	Hold On		☐
5	DPIO_2_1_2_5	BOOL	%IX0.4		☑	Hold On		☐
6	DPIO_2_1_2_6	BOOL	%IX0.5		☑	Hold On		☐
7	DPIO_2_1_2_7	BOOL	%IX0.6		☑	Hold On		☐
8	DPIO_2_1_2_8	BOOL	%IX0.7		☑	Hold On		☐
9	Q_DPIO_2_1_2_1	BOOL	%IX1.0					☐
10	Q_DPIO_2_1_2_2	BOOL	%IX1.1					☐
11	Q_DPIO_2_1_2_3	BOOL	%IX1.2					☐
12	Q_DPIO_2_1_2_4	BOOL	%IX1.3					☐
13	Q_DPIO_2_1_2_5	BOOL	%IX1.4					☐
14	Q_DPIO_2_1_2_6	BOOL	%IX1.5					☐
15	Q_DPIO_2_1_2_7	BOOL	%IX1.6					☐
16	Q_DPIO_2_1_2_8	BOOL	%IX1.7					☐

Figure 113　Set Safety Value

6.4.2.9　Parameters

1.　Module Parameter

Choose the added module in Module Properties dialog and click **Properties** button to open the Module Parameter dialog.

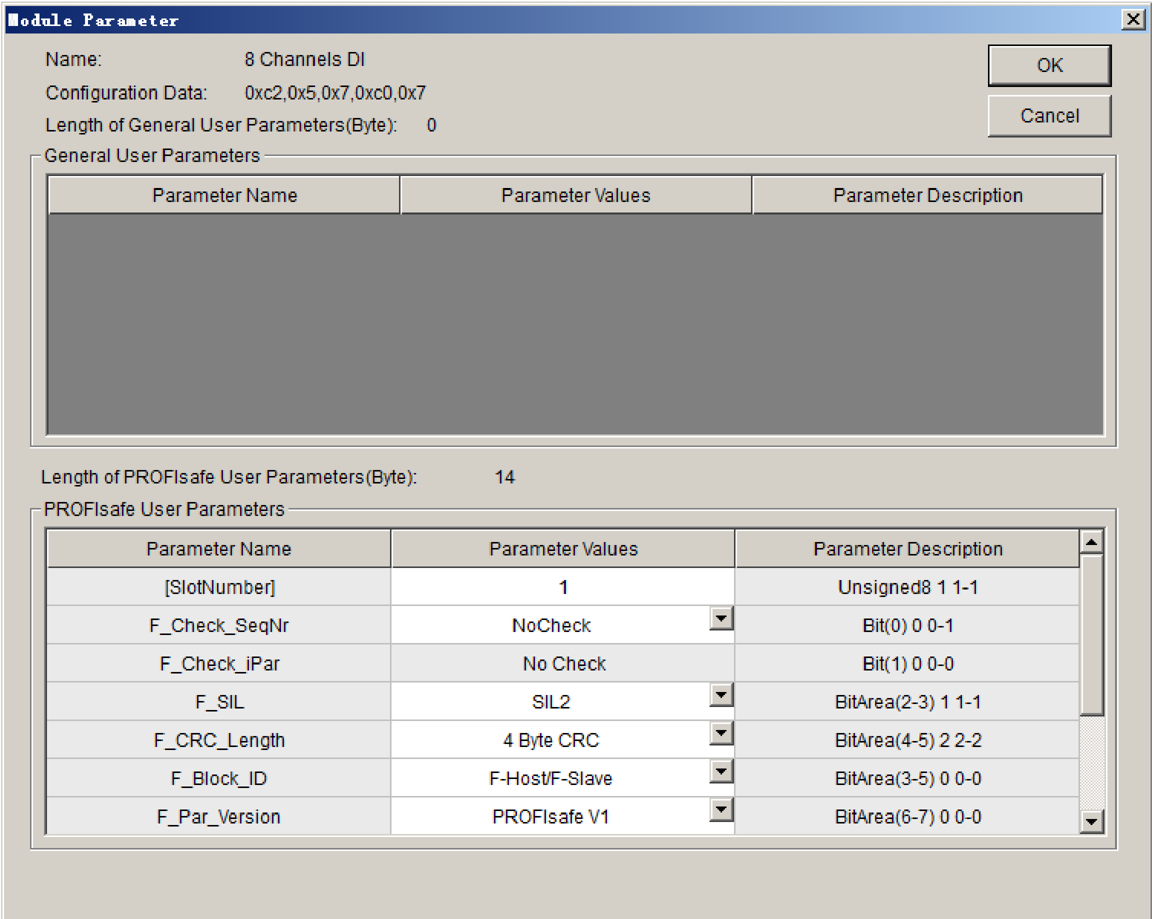


Figure 114　Module Parameter

Table 50　Definition of LK611S User Parameter

Parameter	Meaning	Value
SlotNumber	Module slot number	Default value
F_Check_SeqNr	Whether the message sequence number takes part in the CRC check	You can choose the following two ways Check: The sequence number field in PROFIsafe message takes part in the CRC check Nocheck: The sequence number field in PROFIsafe message does not take part in the CRC check This parameter setting is suitable for both the PROFIsafe master station and the PROFIsafe slave station
F_Check_iPar	Whether the i parameter takes part in the CRC check	Default value
F_SIL	SIL level selection	Default value
F_CRC_Length	Message CRC check and length.	Set as 4 Byte CRC, This parameter setting is suitable for both the PROFIsafe master station and the PROFIsafe slave station
F_Block_ID	Module ID	Default value

Parameter	Meaning	Value
F_Par_Version	F parameter version	Default value
F_Source_Add	F source address	Default value
F_Dest_Add	F destination address	Default value
F_WD_Time	Watchdog time for monitoring PROFIsafe messages	Default value
F_Par_CRC	F device i parameter CRC check sum	Default value

2. User Parameters

The channel filtering parameters are set in the [User Parameters]. In the Safety FA-AutoThink, double-click the LK611S module under the BUS_MASTER and double-click the Device Property to open the Module Properties dialog, as shown in Figure 115.

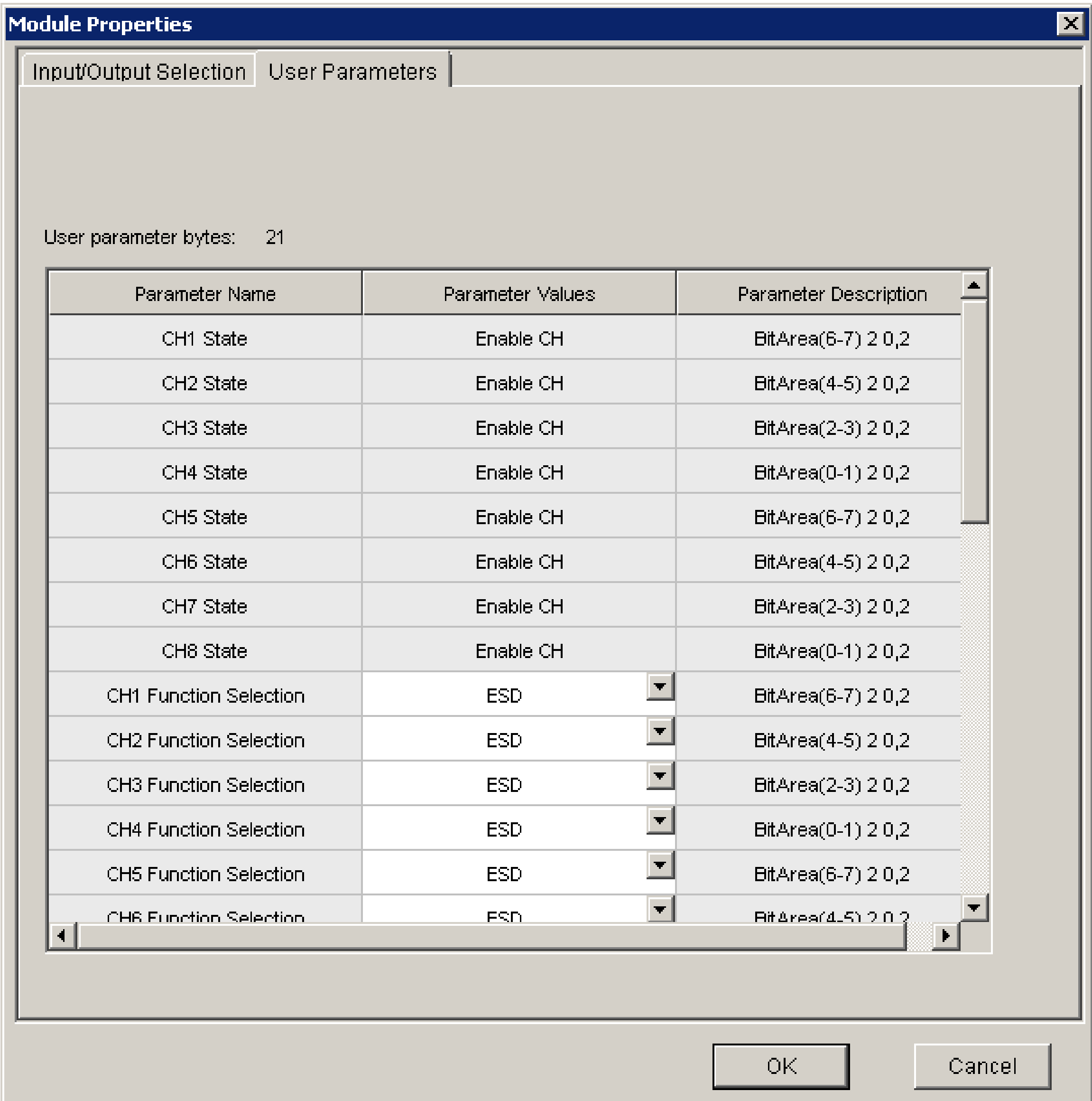


Figure 115 LK611S User Parameter Setting

Table 51 Definition of LK611S User Parameter

Parameter	Description	Value
CH1~8 State	Channel enable status	Enable CH as default value, you can set Enable in Device Information dialog, see 6.4.2.8 Safety Value
CH1~8 Function Selection	Channel function selection	The channel supports dry contact DI ignal and ESD switch signal with diagnostic function. Please configure according to the signal type of channel access
CH1~8 Filter Time	Channel filter time	None, 20ms, 30 ms, 40 ms, 50 ms, 60 ms, 70 ms, 80 ms, 100ms, 200 ms, 300 ms, 400 ms, 500 ms
CH1~8 Line Fault Detection State	Channel external line fault detection status	When the Function Slection parameter is set to ESD, the Line Fault Detection State parameter is allowed to set. When the Function Slection parameter is set to DI, Line Fault Detection State parameter defaults to Disable Enable: Activate the external line detection function of the channel. When the external line is broken or short circuited, the diagnosis information is reported to the controller. At the same time, the channels turn to the safety side, and the preset safety value is used as the channel data to participate in the calculation Disable: Disable the external line detection function of the channel
ESD Resistance1/ESD Resistance2	ESD resistance value	R1=22 KΩ(default value) R2=2 KΩ(default value) When the channel connectes to the ESD switch signal, resistance value needs to be configured here according to the actual resistance of the ESD switch ESD resistance1: R1 resistance of ESD switch ESD resistance2: R2 resistance of ESD switch ESD switch resistance R1=R3, R2=R4. You configure R1 and R2 here, the corresponding R3 and R4 are automatically adapted When configuring, please refer to the ESD switch specifications in Table 43. If the resistance value is decimal, please enter rounded value
Reserved User Parameters 1~2	Reserved	You not need to set

6.4.2.10 Technical Specifications

LK611S Safety 8 Channels Digital Input Module（with LFD Function）	
Power supply	
Input voltage	24VDC(-15%~+20%)
Power consumption	Field power: 100mA @24VDC (max.)
	System power: 50mA@24VDC (max.)
Reverse power supply protection	Supported
Over-voltage protection(60VDC)	Supported (hold in safety status)
Hot swapping	Supported
Input channel	
Number of channels	8

LK611S Safety 8 Channels Digital Input Module（with LFD Function）	
Contact type	Non-polar dry contact
Data format uploaded by channel	2 bytes (16 bits), the first byte represents a channel state, the second byte represents a channel quality value, high in front, low follow
Query voltage	24VDC(-15%~+20%)
ON(without ESD)	Ron<1KΩ（@ Voltage query = 20.4V）
OFF(without ESD)	Roff>100KΩ（@ Voltage query = 28.8V）
ESD switch on	Rload= MIN（R1, R2）
ESD switch off	Rload= R1+R2
Dithering-removing filter time OFF→ON ON→OFF	None, 20ms, 30 ms, 40 ms, 50 ms, 60 ms, 70 ms, 80 ms, 100ms, 200 ms, 300 ms, 400 ms, 500 ms None, 20ms, 30 ms, 40 ms, 50 ms, 60 ms, 70 ms, 80 ms, 100ms, 200 ms, 300 ms, 400 ms, 500 ms
Isolation voltage between field and system	500 VAC@1 min, leaking current: 5 mA
Sett-up time	12ms
Full channel scan time	20ms
Communication	
Protocol	PROFIsafe
Dual network redundancy	Supported
Communication rate	187.5 kbps, 500 kbps, 1.5 Mbps、3Mbps、6Mbps
Physical specifications	
Installation position	Expansion backplane
Module dimension (W*H*D)	35 mm×100 mm×100 mm

6.4.3 LK710S Safety 8 Channels Digital Output Module

6.4.3.1 Basic Features

- 8-channel MOSFET type output
- Support reverse power supply protection
- Output voltage range: 20.4 VDC~28.8 VDC
- Support over-voltage protection(60VDC)
- Isolation between the system and the field
- Hot swapping
- Periodic self-check

- Support PROFIsafe slave protocol
- Output off in safety status

6.4.3.2 Appearance

Figure 116 Appearance of LK710S

6.4.3.3 Principle

The channel of LK710S controls load in field through double MOSFET, when two MOSFET are turned on, the load is energized (relay coil), any MOSFET is turned off, field load (relay coil) is deenergized (loss power as safety).

The module periodically checks the two MOSFET and its control circuit, and when the MOSFET fault is detected, the corresponding safety measures are taken to ensure the channel is in safety status.

Electrical isolation between the LK710S field side and system side, and isolation voltage 500VAC, ensure that the field side failure has no effect on the system side. The field side and the system side need to use different AC/DC power to ensure isolation.

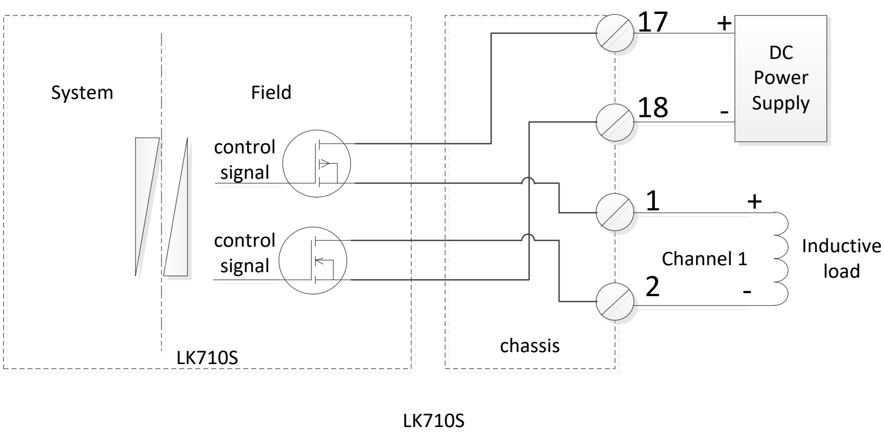


Figure 117 Circuit Diagram of LK710S Channel Interface

6.4.3.4 Indicators

Table 52 Definition of LK710S Indicators

Name	Status	Description
RUN indicator (green)	On	The communication is established, and the module works well.
	Flash	The communication is not established or self checking failed.
	Off	No power or module has faults.
ERR indicator (red)	On	The module has faults.
	Off	No power or module is normal.
1~8 channel indicators (yellow)	On	The channel is connected.
	Off	The channel is disconnected.

Flashing frequency of RUN indicator is 4Hz.

6.4.3.5 Wirings

The LK710S is installed on the expansion backplane, and the channel wiring is carried out on the corresponding backplane terminal. The definition of the terminals is shown in Table 53.

Table 53 Backplane Wiring Terminal

Channel	Corresponding backplane terminals	
	Signal +	Signal -
Channel 1	01	02
Channel 2	03	04
Channel 3	05	06
Channel 4	07	08
Channel 5	09	10
Channel 6	11	12
Channel 7	13	14
Channel 8	15	16

Wiring of 8 channels is in the same way. Take channel 1 as an example, wiring is shown in Figure 118.

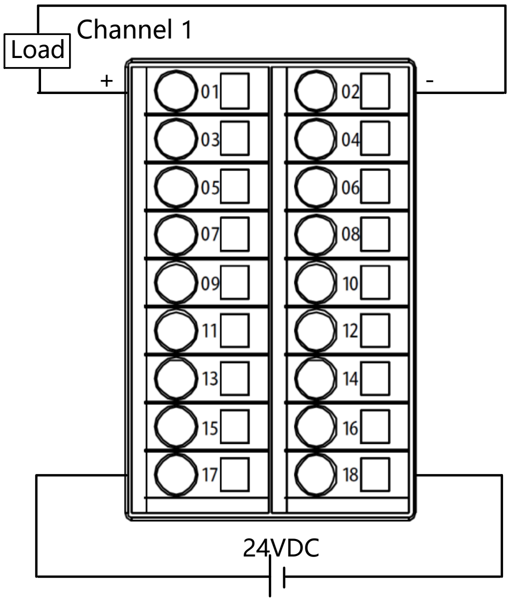


Figure 118 Wiring Diagram

6.4.3.6 Diagnosis

LK710S fault diagnosis includesdevice diagnosisand channel diagnosis. After calling the function block sysGetDPSlaveState (Get Diagnosis of DP Slave), diagnosis data is saved to the output parameters DiagData1~ DiagData54 of function block.

Diagnostic information of LK710S up to 30 bytes, wherein 4 bytes are device-related diagnosis, 2 bytes are identification diagnosis and 24 bytes are channel diagnosis. For 8 channels of LK710S, the diagnosis information of each channel is 3 bytes.

Diagnosis information DiagData1~ DiagData30 of function block sysGetDPSlaveState (Get Diagnosis of DP Slave) is shown in Table 54.

Table 54 Output Parameter DiagData1~ DiagData30

Output parameters	Data type	Parameter description
DiagData1~ DiagData4	BYTE	Device-related diagnosis information See Table 55
DiagData5~ DiagData6	BYTE	Identification diagnosis information DiagData5: 0x42, where 2 represents the diagnostic information length of 2 bytes DiagData6: when diagnosis information is reported, the value is 0x01
DiagData7~ DiagData9	BYTE	Channel 1 diagnosis information See Table 57
DiagData10~ DiagData12	BYTE	Channel 2 diagnosis information
…	BYTE	….
DiagData28~ DiagData30	BYTE	Channel 8 diagnosis information

Table 55 Device-related Diagnosis

Output parameters	Bit	Description
DiagData1	Bit0~ Bit7	=4: 4 bytes diagnostic information

Output parameters	Bit	Description
		length
DiagData2	Bit7	Power fault =0: Normal =1: Failure
	Bit6	MCU fault (heartbeat fault) =0: Normal =1: Failure
	Bit5	MCU self-diagnosis =0: Normal =1: Failure
	Bit0~Bit4	Reserved
DiagData3	Bit7 ~ Bit6	IO_BUS network fault =0: the network is normal =1:DP1 network fault =2:DP2 network fault =3: reserved
	Bit5 ~ Bit3	Reserved
	Bit2	Switch power down 0: No switch power down fault 1: Switch power down fault
	Bit1	Reserved
	Bit0	Channel fault =0: Normal =1: Failure
DiagData4	Bit3~Bit7	Reserved
	Bit2	Program monitoring fault =0: Normal =1: Failure
	Bit1	Module ADC circuit fault =0: Normal =1: Failure
	Bit0	Diagnosis circuit fault of power supply =0: Normal =1: Failure

Table 56   Device-related Fault Response

Fault type	Diagnosis mode	Quality bit	Channel response
Power fault	Power-on diagnostics once and periodic diagnostics	TRUE	The channels turn to the safety side, and use safety value as channel value.
MCU fault	Power-on diagnostics once and periodic diagnostics	TRUE	The channels turn to the safety side, and use safety value as channel value.
MCU self-diagnosis	Power-on diagnostics once and periodic diagnostics	TRUE	The channels turn to the safety side, and use safety value as channel value.
IO_BUS network fault	Power-on diagnostics once and periodic diagnostics	———	The channels don’t turn to the safety side and report diagnosis information.

Fault type	Diagnosis mode	Quality bit	Channel response
Switch power down	Power-on diagnostics once and periodic diagnostics	TRUE	The channels turn to the safety side, and use safety value as channel value.
Channel fault	Power-on diagnostics once and periodic diagnostics	TRUE	The channels turn to the safety side, and use safety value as channel value.
Module ADC circuit fault	Power-on diagnostics once and periodic diagnostics	TRUE	The channels turn to the safety side, and use safety value as channel value.
Diagnosis circuit fault of power supply	Power-on diagnostics once and periodic diagnostics	TRUE	The channels don’t turn to the safety side and report diagnosis information.

Table 57　Channel Diagnosis

Diagnosis Byte						Meaning
Bit		Bit 7	Bit 6	Bit 5	Bit 4 ~ Bit 0	
The first byte	Head	0x80				Decimal online value : 128
The second byte	I/O type/channel	10 (Output)		(Channel)		Failure channel, decimal online value : 128~135, corresponding to the channel 1~8
The third byte	Channel data type/fault type	001 (Bit)			0	Channel fault recovery, decimal online value : 32
					1	Short circuit, decimal online value :33
					6	Wire break, decimal online value: 38
					18	Channel output fault, decimal online value : 50

Table 58　Channel Fault Response

Fault type	Diagnosis mode	Quality bit	Channel response
Channel output fault	Periodic diagnostics, Power-on diagnostics	___	If output value is error, the channel turns to the safety side, and output will shutdown

When a communication failure or module failure occurs, the channel turns to the safety side. The possible causes and treatment measures are shown in the following table.

Table 59　Causes and Treatment Measures

Fault type	Causes	Treatment Measures
Module failure	Power fault	Replace module
	MCU fault	
	MCU self-diagnosis	
	Channel fault	
	Module ADC circuit fault	
	Diagnosis circuit fault of power supply	

Fault type	Causes	Treatment Measures
	Channel output fault	
	Switch power down	Check whether the field power supply is normal.
Communication failure	DP broken	Check whether the DP cable is inserted properly.
	Module without power supply	Check whether the power supply is normal.

For troubleshooting, please refer to 6.4.4.6 Diagnosis.

6.4.3.7 PROFIsafe Fault Status

When the fault is recovered, the system automatically confirms the profisafe fault. See Chapter 6.4.1.7 PROFIsafe Fault Status.

6.4.3.8 Parameters

1. Module Parameter

See Chapter 6.4.1.101Module Parameter.

2. User Parameters

The channel coil resistor is set in the [User Parameters]. In the Safety FA-AutoThink, double-click the LK710S module under the BUS_MASTER and double-click the Device Property to open the Module Properties dialog, as shown in Figure 119.

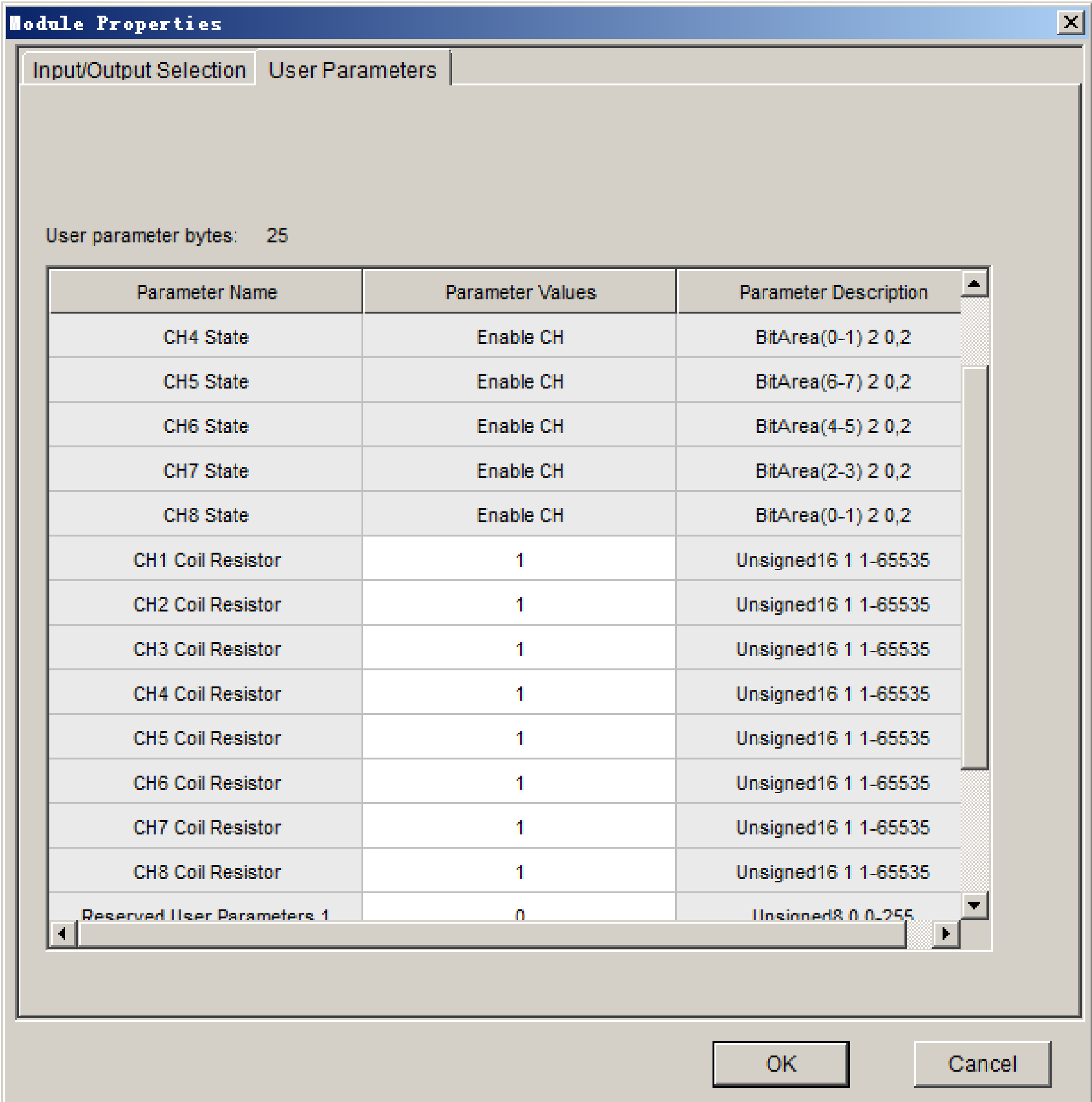


Figure 119 LK710S User Parameter Setting

Table 60 Definition of LK710S User Parameter

Parameter	Description	Value
CH1~8 State	Channel enable status	Enable CH as default value, you can set Enable in Device Information dialog, see 6.4.1.8 Safety Value
CH1~8 Coil Resistor	Channel coil resistor	You not need to set
Reserved User Parameters 1~4	Reserved	You not need to set

6.4.3.9 Technical Specifications

LK710S Safety 8 Channels Digital Output Module	
Power supply	
Input voltage	24VDC(-15%~+20%)
Power consumption	Field power: 100mA @24VDC (max.)
	System power: 50mA@24VDC (max.)
Reverse power supply protection	Supported
Field over-voltage protection(60VDC)	Supported
Output channel	
Number of channels	8 channels
Single channel output drives load capacity	Relay types supported: Omron MY2N-GS. ChenZhu CZSR8401-1A (8.71.5.8401.X003), ChenZhu CZSR8401-1A (TSD-2018-0039), CZSR8401-2A,; Chint NXJ/2Z(D). For the chenzhu safety relayCZSR8001-3A1B.;ChenZhu safety barrier GS8523-EX, GS8523-EX.I, GS5023-EX, the intermediate relay (the type of relay supported) should be used. Relay action time: 10~20ms Relay power: <1.5W
Surge current per point	1 A, for 10 ms, period 2s@60°C
Channel over-current protection	Over-current to single channel and no influence to other channels
Maximum on-state voltage drop	150mVDC@ channel maximum load@8 channel full
Max. Off-status leakage current	0.1 mA each point
Output settling time OFF→ON ON→OFF	0.5 ms (max.) 0.5 ms (max.)
Isolation voltage between field and system	500 VAC@1 min, leaking current: 5 mA
Communication	
Protocol	PROFIsafe
Dual network redundancy	Supported
Communication rate	187.5 kbps, 500 kbps, 1.5 Mbps、3Mbps、6Mbps
Physical specifications	
Hot swapping	Supported
Installation position	Expansion backplane
Installation Mode	Slot installation
Module Dimension (W*H*D)	35 mm×100 mm×100 mm

6.4.4 LK411S Safety 8 Channels Analog Input Module

6.4.4.1 Basic Features

- 8-channel current input

- Support 4-wire instrument and 2-wire instrument with external power supply
- Signal range: 0~20mA /4~20mA
- Short circuit diagnosis
- Wire break diagnosis
- Over-limit diagnosis
- Isolation between field channel and the system
- Periodic self-check
- Support PROFIsafe slave protocol
- Hot swapping

6.4.4.2 Appearance

Figure 120 Appearance of LK411S

6.4.4.3 Principle

LK411S channel collects the field current signal through ADC1 and ADC2. ADC1 is the main sample circuit and ADC2 is the diagnosis sample circuit. The channel works normally when the acquisition error is within the required range. If any sample circuit is abnormal, it will identify the collection value to fault, and ensure the data safety reported to the controller.

Electrical isolation between the LK411S field side and system side, and isolation voltage 500VAC, ensure that the field side failure has no effect on the system side. The system side uses AC/DC power supply, and the power supply in field side use the isolated system power supply.

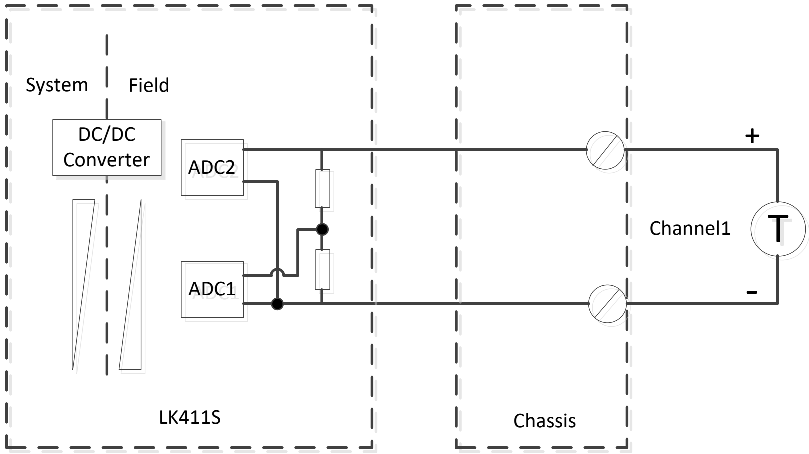


Figure 121 LK411S Channel Interface Circuit Diagram

6.4.4.4 Indicators

Table 61 Definition of LK411S Status Indicators

Name	Status	Description
RUN indicator (green)	On	The communication has been established, and the module works well.
	Flashing quickly	The communication is not established or communication error.
	Off	No power or module has faults.
ERR indicator (red)	On	The module has faults.
	Off	No power or module is normal.
1~8 channel indicators (yellow)	On	Channel signal is normal.
	Flashing slowly	Channel signal exceeds range.
	Flashing quickly	Channel wire failure or channel acquisition failure.
	Off	No power or channel is not enabled.

- Flashing quickly: with a frequency of 4Hz.
- Flashing slowly: with a frequency of 1Hz.

6.4.4.5 Wirings

The output channel of LK411S does not supply power externally, connecting 4-wire instrument and 2-wire instrument with external power supply. When connected to a 2-wire transmitter, 24VDC 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 backplane.

The LK411S module is installed on the extension backplane, and the channel wiring is carried out on the corresponding backplane terminal.

Table 62　Definition of LK411S Backplane Terminals

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

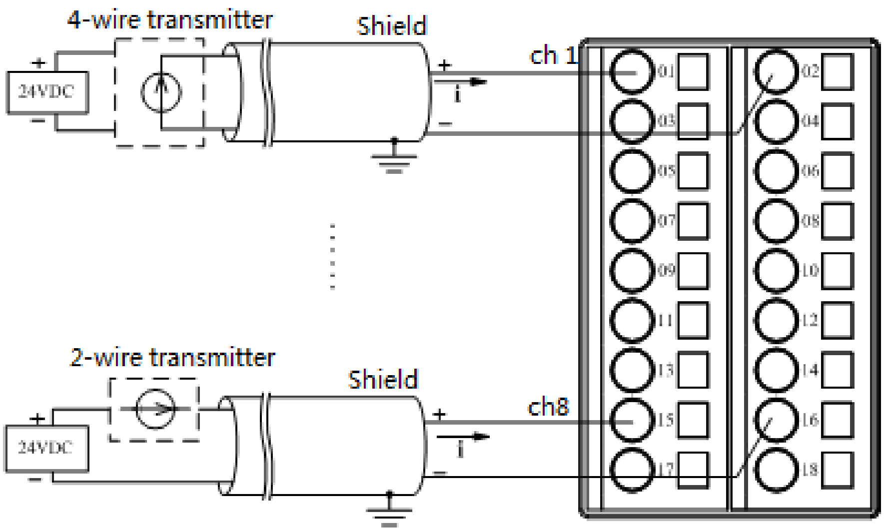


Figure 122　Backplane Terminal Wiring Schematic Diagram

Pay attention to the following during wiring:

- The double-row 18-channel terminals are fixed on the backplane, located below the LK411S module.
- Each AI signal is separately connected to the terminals via two conductors (shielded cable).
- The output channel of LK411S does not supply power externally. When connected to a 2-wire transmitter, 24VDC 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 use the power supply in the backplane.
- Terminals 17 and 18 are not used.

6.4.4.6　Diagnosis

LK411S fault diagnosis includes device diagnosis and channel diagnosis. After calling the function block sysGetDPSlaveState (Get Diagnosis of DP Slave), diagnosis data is saved to the output parameters DiagData1~ DiagData54 of function block.

Diagnostic information of LK411S up to 30 bytes, wherein 4 bytes are device-related diagnosis, 2 bytes are identification diagnosis and 24 bytes are channel diagnosis. For 8 channels of LK411S, the diagnosis information of each channel is 3 bytes.

Diagnosis information DiagData1~ DiagData30 of function block sysGetDPSlaveState (Get Diagnosis of DP Slave) is shown in Table 63.

Table 63 Output Parameter DiagData1~ DiagData30

Output parameters	Data type	Parameter description
DiagData1~ DiagData4	BYTE	Device-related diagnosis information See Table 64
DiagData5~ DiagData6	BYTE	Identification diagnosis information DiagData5: 0x42, where 2 represents the diagnostic information length of 2 bytes DiagData6: when diagnosis information is reported, the value is 0x01
DiagData7~ DiagData9	BYTE	Channel 1 diagnosis information See Table 66
DiagData10~ DiagData12	BYTE	Channel 2 diagnosis information
…	BYTE	….
DiagData28~ DiagData30	BYTE	Channel 8 diagnosis information

Table 64 Device-related Diagnosis

Output parameters	Bit	Description
DiagData1	Bit0~ Bit7	=4: 4 bytes diagnostic information length
DiagData2	Bit7~ Bit6	Reserved
	Bit5	MCU self-diagnosis =0: Normal =1: Failure
	Bit0~Bit4	Reserved
DiagData3	Bit7 ~ Bit6	IO_BUS network fault =0: the network is normal =1:DP1 network fault =2:DP2 network fault =3: reserved
	Bit5 ~ Bit1	Reserved
	Bit0	Channel fault =0: Normal =1: Failure
DiagData4	Bit3~Bit7	Reserved
	Bit2	Program monitoring fault =0: Normal =1: Failure
	Bit1	Module ADC circuit fault =0: Normal =1: Failure
	Bit0	Reserved

Table 65　Device-related Fault Response

Fault type	Diagnosis mode	Quality bit	Channel response
MCU self-diagnosis	Power-on diagnostics once and periodic diagnostics	TRUE	The channels turn to the safety side, and use safety value as channel value.
IO_BUS network fault	Power-on diagnostics once and periodic diagnostics	——	The channels don't turn to the safety side and report diagnosis information.
Channel fault	Power-on diagnostics once and periodic diagnostics	TRUE	The channels turn to the safety side, and use safety value as channel value.
Program monitoring fault	Power-on diagnostics once and periodic diagnostics	TRUE	The channels turn to the safety side, and use safety value as channel value.
Module ADC circuit fault	Power-on diagnostics once and periodic diagnostics	TRUE	The channels turn to the safety side, and use safety value as channel value.

The channel diagnosis information is shown in following table, no wire break diagnosis to 0~20mA range. Short circuit, Wire break, Over upper limit and Over lower limit are reported only when channel diagnosis has been enabled, see 6.4.4.92 User Parameters for settings.

Table 66　Channel Diagnosis

<table>
<tr><th colspan="6">Diagnosis Byte</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>Failure channel, decimal online value : 64~71, corresponding to the channel 1~8</td></tr>
<tr><td rowspan="7">The third byte</td><td rowspan="7">Channel data type/fault type</td><td colspan="3" rowspan="7">101 (Word)</td><td>0</td><td>Channel fault recovery, decimal online value: 160</td></tr>
<tr><td>1</td><td>Short circuit, decimal online value :161</td></tr>
<tr><td>6</td><td>Wire break, decimal online value: 166</td></tr>
<tr><td>7</td><td>Over upper limit, decimal online value : 167</td></tr>
<tr><td>8</td><td>Over lower limit, decimal online value: 168</td></tr>
<tr><td>18</td><td>Channel acquisition fault, decimal online value : 178</td></tr>
<tr><td>Other values</td><td>Reserved</td></tr>
</table>

Example:

Channel diagnosis data 0x80, 0x40, 0xB2 indicates that channel 1 has an acquisition fault. Corresponding online value is 128, 64,178.

Table 67　Failure Signal Range

Range	Max. measurable range	Failure signal range			
		Short circuit	Wire break	Over upper limit	Over lower limit

Range	Max.	Failure signal range			
0~20 mA	0~25 mA	I＞22.5mA	——	25 mA＞I＞upper limit current	0 mA＜I＜lower limit current
4~20 mA	4~24 mA	I＞22.5mA	I＜0.75 mA	24 mA＞I＞upper limit current	4 mA＜I＜lower limit current

Table 68　Channel Fault Response

Fault type	Diagnosis mode	Quality bit	Channel response
Short circuit	Periodic diagnostics	TRUE	The channels turn to the safety side, and use safety value as channel value.
Wire break	Periodic diagnostics	TRUE	The channels turn to the safety side, and use safety value as channel value.
Over upper limit	Periodic diagnostics	TRUE	The channels turn to the safety side, and use safety value as channel value.
Over lower limit	Periodic diagnostics	TRUE	The channels turn to the safety side, and use safety value as channel value.
Channel acquisition fault	Periodic diagnostics	TRUE	The channels turn to the safety side, and use safety value as channel value.

When a communication failure or module failure occurs, the channel turns to the safety side. The possible causes and treatment measures are shown in the following table.

Table 69　Causes and Treatment Measures

Fault type	Causes	Treatment Measures
Module failure	MCU self-diagnosis	Replace module
	Channel fault	
	Program monitoring fault	
	Module ADC circuit fault	
	Short circuit	Check the loop wire
	Wire break	Check the loop wire
	Over upper limit	Check input signal
	Over lower limit	Check input signal
	Channel acquisition fault	1. Check whether the input signal is within the normal range. 2. Re-insert module after the signal is normal. 3. Replace the module when the above operation can not recover the fault.
Communication failure	DP broken	Check whether the DP cable is inserted properly.

Fault type	Causes	Treatment Measures
	Module without power supply	Check whether the power supply is normal.

- Troubleshooting method

(1) View the status of quality bit.

View the OUTQ value of the channel in the global variable group Q_Profis_DPIO_Group. The OUTQ is 1, representing a fault, and the channel uses the safety value as input value. The OUTQ is 0, representing no fault, and the channel adopts the normal acquisition value.

(2) View the diagnosis of the slave station.

View the diagnosis information in sysGetDPSlaveState (Get Diagnosis of DP Slave) function block and troubleshoot the cause. Detailed diagnosis information is shown in Table 64 and Table 66.

(3) Check the status of DP communication.

View the communication status of slave station in global variable group DPDevVar_Group. Please refer to Chapter for detailed status information.

6.4.4.7 PROFIsafe Fault Status

When the fault is recovered, the system automatically confirms the profisafe fault. See Chapter 6.4.1.7 PROFIsafe Fault Status.

6.4.4.8 Safety Value

Channel provides two modes of safety value. When a channel fault occurs, real-time output value DV of the channel is used to user logic operation. When configuring, please use DV variables in Chapter 6.4.1.9 Channel Value Algorithm.

Mode of Safety Value:

- Hold On: When a channel failure occurs, maintain the last cycle value.
- Set Up: When a channel failure occurs, adopt the preset safety value as channel value.

Module channel information is shown in Figure 123. 1~8 is channel collection value and 9~16 is channel quality bits. You first need to check Channel Enable before setting Mode of Safety Value.

The digital code corresponding to the current signal is entered as a safety value. The formula is as follows:

- 0~20mA: I×65535/25
- 4~20mA: (I－4)×65535/20

Channel Number	Channel Name	Channel Types	Channel Address	Channel Description	Channel Enable	Mode of Security Value	Security Value
1	DPIO_2_1_2_1	BOOL	%IX0.0		✓	Hold On	
2	DPIO_2_1_2_2	BOOL	%IX0.1		✓	Hold On	
3	DPIO_2_1_2_3	BOOL	%IX0.2		✓	Hold On	
4	DPIO_2_1_2_4	BOOL	%IX0.3		✓	Hold On	
5	DPIO_2_1_2_5	BOOL	%IX0.4		✓	Hold On	
6	DPIO_2_1_2_6	BOOL	%IX0.5		✓	Hold On	
7	DPIO_2_1_2_7	BOOL	%IX0.6		✓	Hold On	
8	DPIO_2_1_2_8	BOOL	%IX0.7		✓	Hold On	
9	Q_DPIO_2_1_2_1	BOOL	%IX1.0				
10	Q_DPIO_2_1_2_2	BOOL	%IX1.1				
11	Q_DPIO_2_1_2_3	BOOL	%IX1.2				
12	Q_DPIO_2_1_2_4	BOOL	%IX1.3				
13	Q_DPIO_2_1_2_5	BOOL	%IX1.4				
14	Q_DPIO_2_1_2_6	BOOL	%IX1.5				
15	Q_DPIO_2_1_2_7	BOOL	%IX1.6				
16	Q_DPIO_2_1_2_8	BOOL	%IX1.7				

Figure 123 Set Safety Value

6.4.4.9 Parameters

1. Module Parameter

See Chapter 6.4.1.101Module Parameter.

2. User Parameters

Filter mode, Filter time and Diagnosis Enable are set in the [User Parameters]. In the Safety FA-AutoThink, double-click the LK411S module under the BUS_MASTER and double-click the Device Property to open the Module Properties dialog, as shown in Figure 124.

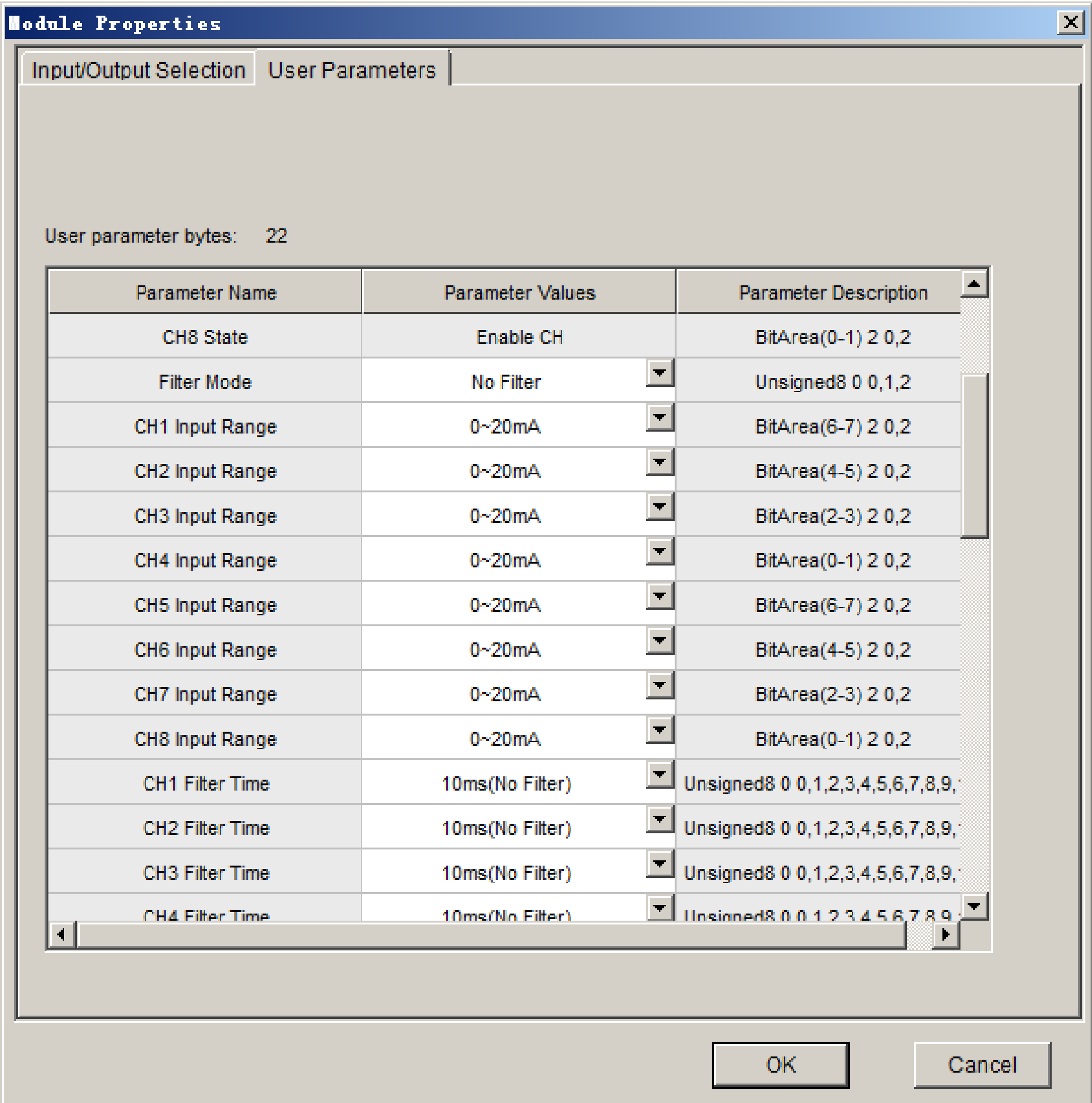


Figure 124 LK411S User Parameter Setting

Table 70 Definition of LK411S User Parameter

Parameter	**Description**	**Value**
CH1~8 State	Channel enable status	Enable CH as default value, you can set Enable in Device Information dialog, see 6.4.1.8 Safety Value
Filter mode	Choose the digital filter mode	No Filter: 10ms, 20ms, 30ms, 40ms, 50ms, 60ms, 80ms, 100ms, 200ms, 300ms, 400ms, 500ms 50Hz/60Hz Filter: 1s, 2s, 3s, 4s, 5s
CH1~8 Input Range	Signal range	0~20mA/4~20mA
CH1~8 Filter Time	Channel filter time	None, 20ms, 30 ms, 40 ms, 50 ms, 60 ms, 70 ms, 80 ms
CH1~8 Line Fault Detection State	Set diagnosis enable for short circuit and wire break	Disable Enable

Parameter	Description	Value
CH1~8 Upper Limit Diag. State	Set diagnosis enable for upper limit alarm	Disable Enable
CH1~8 Lower Limit Diag. State	Set diagnosis enable for u lower limit alarm	Disable Enable
CH1~8 Upper Limit Value	Set upper limit value of alarm	Range :1~65535, the upper limit value must be greater than lower limit value
CH1~8 Lower Limit Value	Set lower limit value of alarm	Range :0~65534

6.4.4.10 Technical Specifications

LK411S Safety 8 channels Analog Input Module	
System Power	
Power Voltage	24VDC (-15%~+20%)
Power consumption	100mA@24 VDC (max.)
Reverse power supply protection	Supported
Field over-voltage protection (60VDC)	Supported
Input channel	
Number of the inputs	8
Signal range	0~20mA /4~20mA
Full scale	0~25mA, corresponding digital code 0~65535 4~24mA, corresponding digital code 0~65535
Short-circuit detection	＞22.5mA, configured
Wire break detection	＜0.75mA, configured in 4~20mA
Over-limit diagnosis	Diagnosis information is reported when input signal is over the upper limit value or lower limit value
Accuracy	0.2%(0.5~20mA, 25℃) 1%(0~0.5mA, 25℃)
Temperature drift	50 ppm/℃
Stability	0.1% F.S.
Input Impedance	≤300Ω
ADC Resolution	16bits
Common Mode Rejection Ratio	≥60dB
Differential Mode Rejection Ratio	≥40dB
Sampling Period	No filter: 10ms, 20ms, 30ms, 40ms, 50ms, 60ms, 80ms, 100ms, 200ms, 300ms, 400ms, 500ms 50Hz/60Hz filter: 1s, 2s, 3s, 4s, 5s
Supported instruments	4-wire instrument and 2-wire instrument with external power supply
Isolation voltage between field and system	500 VAC@1 min, leaking current: 5 mA
Communication	

LK411S　Safety 8 channels Analog Input Module	
Protocol	PROFIsafe
Double-network redundancy	Supported
Communication rate	187.5 kbps, 500 kbps, 1.5 Mbps、3Mbps、6Mbps
Physical specifications	
Hot swapping	Supported
Installation position	Expansion backplane
Installation Mode	Slot installation
Module Dimension (W*H*D)	35 mm×100 mm×100 mm

6.4.5 LK630S　Safety 8 Channels Digital Input Module（with SOE Function）

6.4.5.1 Basic Features

- 8 channel non-polar dry contact inputs
- Field power supply: 20.4 VDC~28.8 VDC
- Support field power loss detection
- Support reverse power supply protection
- Isolation design between field channel and the system
- Periodic self-check
- Record SOE events
- Support PROFIsafe slave protocol
- Hot swapping

6.4.5.2 Appearance

Figure 125 Appearance of LK630S

6.4.5.3 Principle

The channel of LK630S collects field switch status through Sample circuit 1 and Sample circuit 2. The channel works normally when both the acquisition status are in accordance with the set values. If any sample circuit is abnormal, it will identify the collection value as fault, and ensure the data safety reported to the controller.

Electrical isolation between the LK630S field side and system side, and isolation voltage 500VAC, ensure that the field side failure has no effect on the system side. The field side and the system side need to use different AC/DC power to ensure isolation.

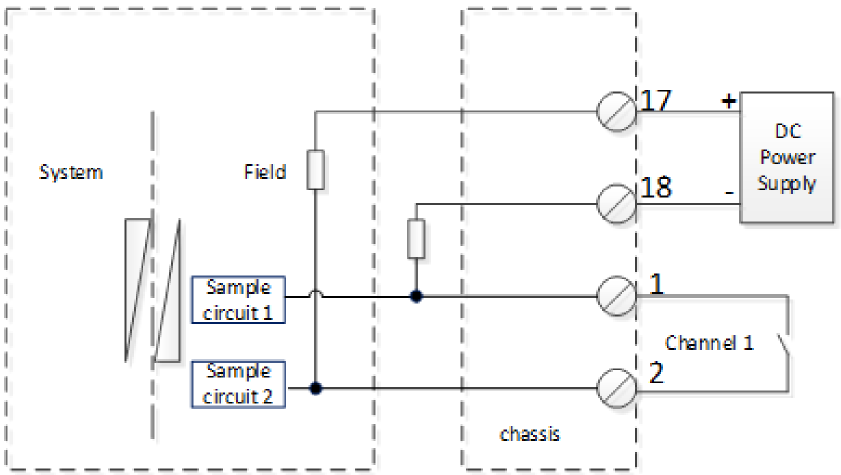


Figure 126　LK630S Channel Interface Circuit Diagram

6.4.5.4　Indicators

Table 71　Definition of LK630S Indicators

Name	Status	Description
RUN indicator (green)	On	The communication is established, and the module works well.
	Flash	The communication is not established or self checking failed.
	Off	No power.
ERR indicator (red)	On	The module has fault.
	Off	No power or module is normal.
1~8 channel indicators (yellow)	On	The channel is connected.
	Off	The channel is disconnected.

Flashing frequency of RUN indicator is 4Hz.

6.4.5.5　Wirings

The LK630S is installed on the expansion backplane, and the channel wiring is carried out on the corresponding backplane terminal. The definition of the terminals is shown in Table 30.

Table 72　Backplane Wiring Terminal

Channel	Corresponding backplane terminals	
Channel 1	01	02
Channel 2	03	04
Channel 3	05	06
Channel 4	07	08
Channel 5	09	10
Channel 6	11	12

Channel	Corresponding backplane terminals	
Channel 7	13	14
Channel 8	15	16

Wiring of 8 channels is in the same way. Take channel 1 as an example, wiring is shown in Figure 101.

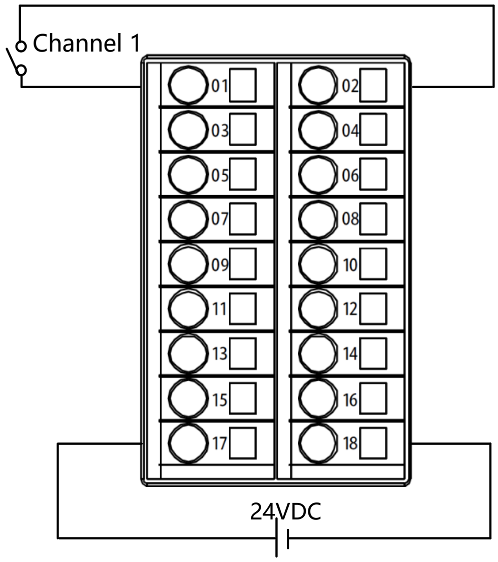


Figure 127 Wiring Diagram

6.4.5.6 Diagnosis

LK630S fault diagnosis includesdevice diagnosisand channel diagnosis. After calling the function block sysGetDPSlaveState (Get Diagnosis of DP Slave), diagnosis data is saved to the output parameters DiagData1~ DiagData54 of function block.

Diagnostic information of LK630S up to 30 bytes, wherein 4 bytes are device-related diagnosis, 2 bytes are identification diagnosis and 24 bytes are channel diagnosis. For 8 channels of LK630S, the diagnosis information of each channel is 3 bytes.

Diagnosis information DiagData1~ DiagData30 of function block sysGetDPSlaveState (Get Diagnosis of DP Slave) is shown in Table 31.

Table 73 Output Parameter DiagData1~ DiagData30

Output parameters	Data type	Parameter description
DiagData1~ DiagData4	BYTE	Device-related diagnosis information See Table 74
DiagData5~ DiagData6	BYTE	Identification diagnosis information DiagData5: 0x42, where 2 represents the diagnostic information length of 2 bytes DiagData6: when diagnosis information is reported, the value is 0x01
DiagData7~ DiagData9	BYTE	Channel 1 diagnosis information See Table 76
DiagData10~ DiagData12	BYTE	Channel 2 diagnosis information
…	BYTE	….
DiagData28~ DiagData30	BYTE	Channel 8 diagnosis information

Table 74　Device-related Diagnosis

Output parameters	Bit	Description
DiagData1	Bit0~ Bit7	=4: 4 bytes diagnostic information length
DiagData2	Bit7	Power fault =0: Normal =1: Failure
	Bit6	MCU fault (heartbeat fault) =0: Normal =1: Failure
	Bit5	MCU self-diagnosis =0: Normal =1: Failure
	Bit0~Bit4	Reserved
DiagData3	Bit7 ~ Bit6	IO_BUS network fault =0: the network is normal =1:DP1 network fault =2:DP2 network fault =3: reserved
	Bit5 ~ Bit3	Reserved
	Bit2	Switch power down 0: No switch power down fault 1: Switch power down fault
	Bit1	Reserved
	Bit0	Channel fault =0: Normal =1: Failure
DiagData4	Bit3~Bit7	Reserved
	Bit2	Program monitoring fault =0: Normal =1: Failure
	Bit1	Module ADC circuit fault =0: Normal =1: Failure
	Bit0	Diagnosis circuit fault of power supply =0: Normal =1: Failure

Table 75　Device-related Fault Response

Fault type	Diagnosis mode	Quality bit	Channel response
Power fault	Power-on diagnostics once and periodic diagnostics	TRUE	The channels turn to the safety side, and use safety value as channel value.
MCU fault	Power-on diagnostics once and periodic diagnostics	TRUE	The channels turn to the safety side, and use safety value as channel value.
MCU self-diagnosis	Power-on diagnostics once and periodic diagnostics	TRUE	The channels turn to the safety side, and use safety value as channel value.

Fault type	Diagnosis mode	Quality bit	Channel response
IO_BUS network fault	Power-on diagnostics once and periodic diagnostics	___	The channels don't turn to the safety side and report diagnosis information.
Switch power down	Power-on diagnostics once and periodic diagnostics	TRUE	The channels turn to the safety side, and use safety value as channel value.
Channel fault	Power-on diagnostics once and periodic diagnostics	TRUE	The channels turn to the safety side, and use safety value as channel value.
Module ADC circuit fault	Power-on diagnostics once and periodic diagnostics	TRUE	The channels turn to the safety side, and use safety value as channel value.
Diagnosis circuit fault of power supply	Power-on diagnostics once and periodic diagnostics	TRUE	The channels don't turn to the safety side and report diagnosis information.

Table 76　Channel Diagnosis

Diagnosis Byte						Meaning
Bit		Bit 7	Bit 6	Bit 5	Bit 4 ~ Bit 0	
The first byte	Head	0x80				Decimal online value : 128
The second byte	I/O type/channel	01 (Input)		(Channel)		Failure channel, decimal online value : 64~71, corresponding to the channel 1~8
The third byte	Channel data type/fault type	001 (Bit)			0	Channel fault recovery, decimal online value : 32
					18	Channel acquisition fault, decimal online value : 50

Table 77　Channel Fault Response

Fault type	Diagnosis mode	Quality bit	Channel response
Channel acquisition fault	Power-on diagnostics once and periodic diagnostics	TRUE	The channel turns to the safety side, and use safety value as channel value.

When a communication failure or module failure occurs, the channel turns to the safety side. The possible causes and treatment measures are shown in the following table.

Table 78　Causes and Treatment Measures

Fault type	Causes	Treatment Measures
Module failure	Power fault	Replace module.
	MCU fault	
	MCU self-diagnosis	
	Channel fault	
	Module ADC circuit fault	
	Diagnosis circuit fault of power supply	

Fault type	Causes	Treatment Measures
	Channel acquisition fault	
	Switch power down	Check whether the field power supply is normal.
Communication failure	DP broken	Check whether the DP cable is inserted properly.
	Module without power supply	Check whether the power supply is normal.

For troubleshooting, please refer to 6.4.4.6 Diagnosis.

6.4.5.7 PROFIsafe Fault Status

When the fault is recovered, the system automatically confirms the profisafe fault. See Chapter 6.4.1.7 PROFIsafe Fault Status.

6.4.5.8 Safety Value

Channel provides two modes of safety value. When a channel fault occurs, real-time output value DV of the channel is used to user logic operation. When configuring, please use DV variables in Chapter 6.4.1.9 Channel Value Algorithm.

Mode of Safety Value:

- Hold On: When a channel failure occurs, maintain the last cycle value.
- Set Up: When a channel failure occurs, adopt the preset security value as channel value.

Module channel information is shown in Figure 104. 1~8 is channel collection value and 9~16 is channel quality bits. You first need to check Channel Enable before setting Mode of Safety Value.

8 Channels DI | New SOE Status

Channel Number	Channel Name	Channel Types	Channel Address	Channel Description	Channel Enable	Mode of Safety Value	Safety Value
1	DPIO_2_1_2_1	BOOL	%IX0.0		☑	Hold On	
2	DPIO_2_1_2_2	BOOL	%IX0.1		☑	Hold On	
3	DPIO_2_1_2_3	BOOL	%IX0.2		☑	Hold On	
4	DPIO_2_1_2_4	BOOL	%IX0.3		☑	Hold On	
5	DPIO_2_1_2_5	BOOL	%IX0.4		☑	Hold On	
6	DPIO_2_1_2_6	BOOL	%IX0.5		☑	Hold On	
7	DPIO_2_1_2_7	BOOL	%IX0.6		☑	Hold On	
8	DPIO_2_1_2_8	BOOL	%IX0.7		☑	Hold On	
9	Q_DPIO_2_1_2_1	BOOL	%IX1.0				
10	Q_DPIO_2_1_2_2	BOOL	%IX1.1				
11	Q_DPIO_2_1_2_3	BOOL	%IX1.2				
12	Q_DPIO_2_1_2_4	BOOL	%IX1.3				
13	Q_DPIO_2_1_2_5	BOOL	%IX1.4				
14	Q_DPIO_2_1_2_6	BOOL	%IX1.5				
15	Q_DPIO_2_1_2_7	BOOL	%IX1.6				
16	Q_DPIO_2_1_2_8	BOOL	%IX1.7				

Figure 128 Set Safety Value

6.4.5.9 Parameters

1. Module Parameter

Choose the added module in Module Properties dialog and click **Properties** button to open the Module Parameter dialog.

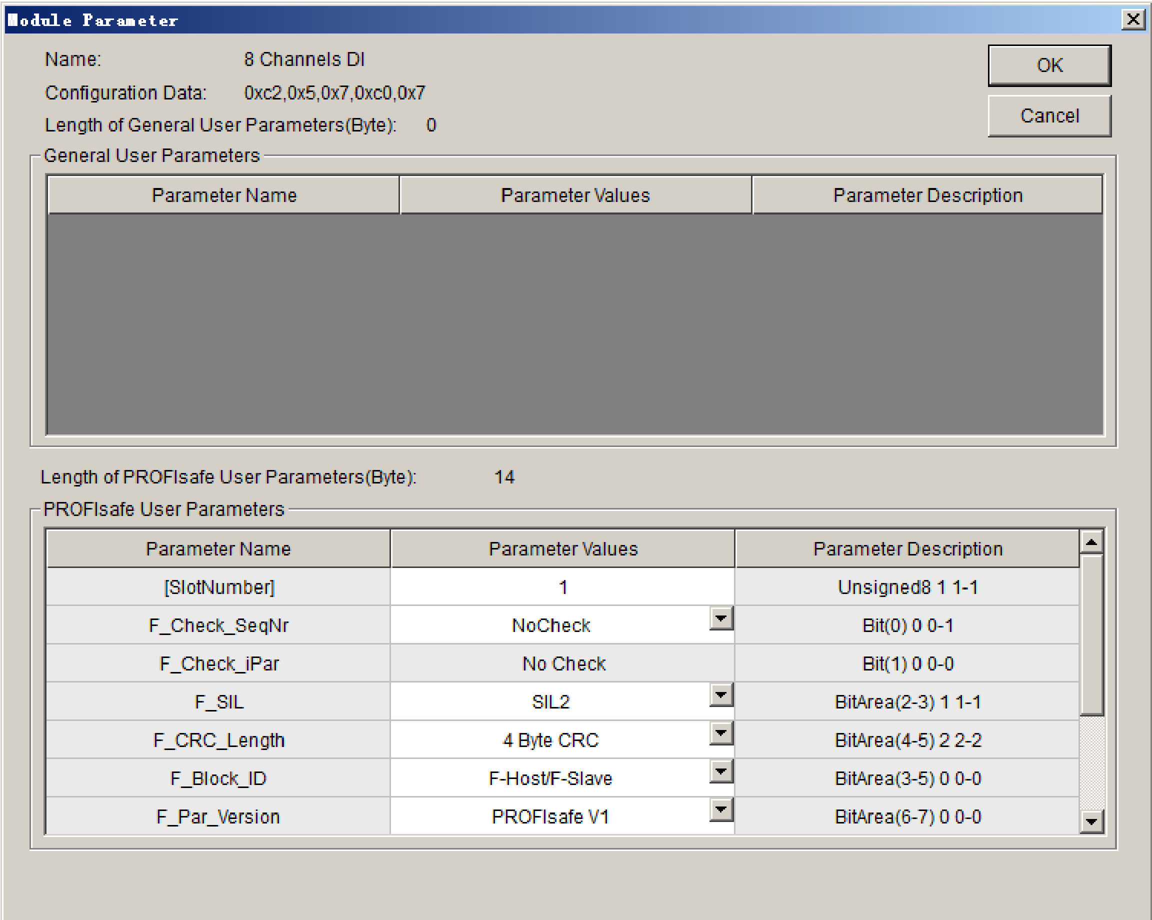


Figure 129 Module Parameter

Table 79 Definition of LK630S User Parameter

Parameter	Meaning	Value
SlotNumber	Module slot number	Default value
F_Check_SeqNr	Whether the message sequence number takes part in the CRC check	You can choose the following two ways Check: The sequence number field in PROFIsafe message takes part in the CRC check Nocheck: The sequence number field in PROFIsafe message does not take part in the CRC check This parameter setting is suitable for both the PROFIsafe master station and the PROFIsafe slave station
F_Check_iPar	Whether the i parameter takes part in the CRC check	Default value
F_SIL	SIL level selection	Default value
F_CRC_Length	Message CRC check and length.	Set as 4 Byte CRC, This parameter setting is suitable for both the PROFIsafe master station and the PROFIsafe slave station
F_Block_ID	Module ID	Default value

Parameter	Meaning	Value
F_Par_Version	F parameter version	Default value
F_Source_Add	F source address	Default value
F_Dest_Add	F destination address	Default value
F_WD_Time	Watchdog time for monitoring PROFIsafe messages	Default value
F_Par_CRC	F device i parameter CRC check sum	Default value

2. User Parameters

The channel filtering parameters are set in the [User Parameters]. In the Safety FA-AutoThink, double-click the LK630S module under the BUS_MASTER and double-click the Device Property to open the Module Properties dialog, as shown in Figure 107.

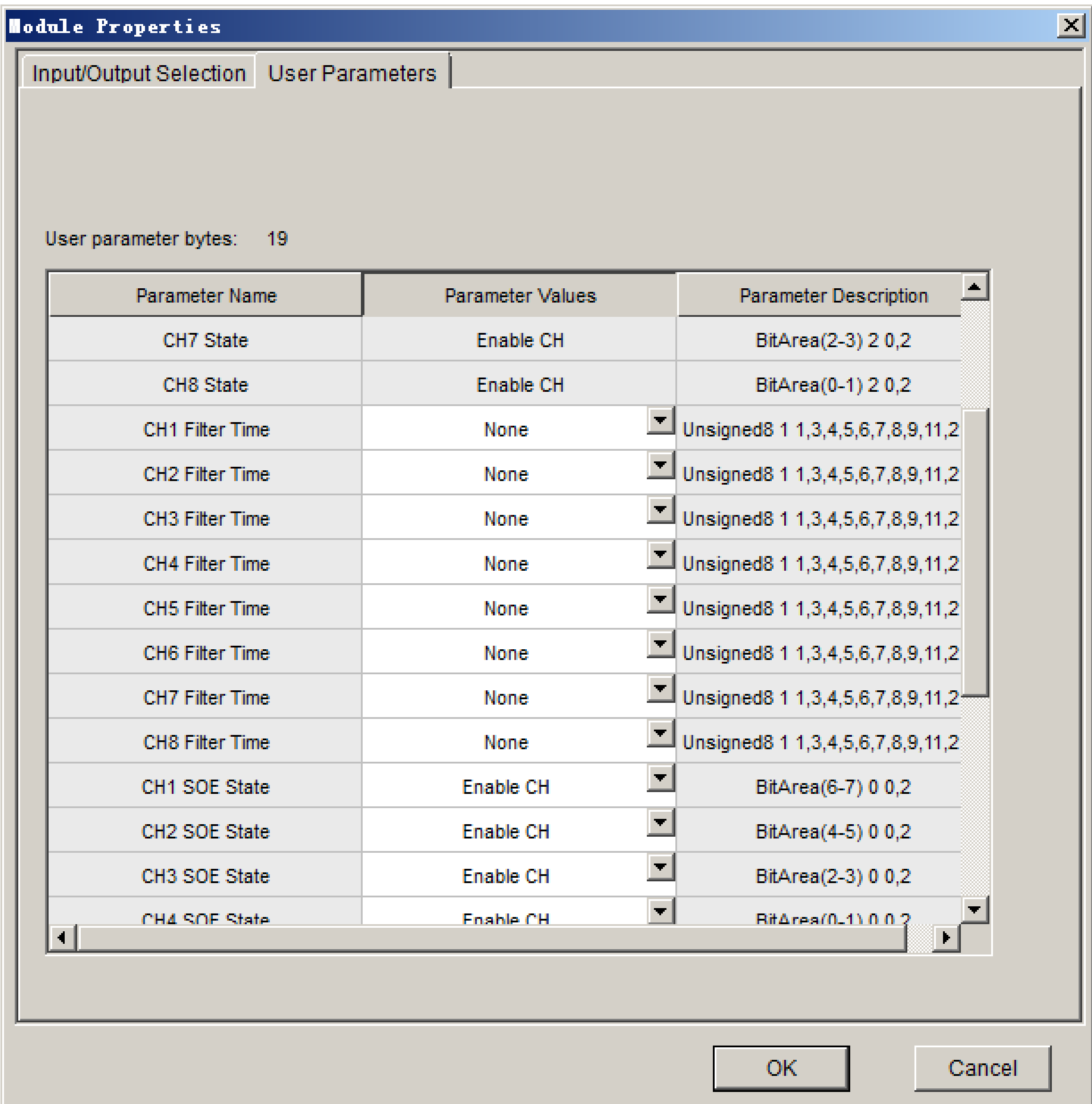


Figure 130 LK630S User Parameter Setting

Table 80 Definition of LK630S User Parameter

Parameter	Description	Value
CH1~8 State	Channel enable status	Enable CH as default value, you can set Enable in Device Information dialog, see 6.4.5.8 Safety Value
CH1~8 Filter Time	Channel filter time	None, 20ms, 30 ms, 40 ms, 50 ms, 60 ms, 70 ms, 80 ms, 100ms, 200 ms, 300 ms, 400 ms, 500 ms
CH1~8 SOE State	Enable SOE function	Enable CH: enable SOE function, the system records event information such as channel value change status, event time, etc Disable CH: disable SOE function View SOE event information, see Chapter “Online Monitor” of Safety FA-AutoThink User Manual
Reserved User Parameters 1~4	Reserved	You not need to set

6.4.5.10 Technical Specifications

LK630S Safety 8 Channels Digital Input Module（with SOE Function）	
Power supply	
Input voltage	24VDC(-15%~+20%)
Power consumption	Field power: 100mA @24VDC (max.)
	System power: 50mA@24VDC (max.)
Reverse power supply protection	Supported
Over-voltage protection(60VDC)	Supported (hold in safety status)
Hot swapping	Supported
Input channel	
Number of channels	8
Contact type	Non-polar dry contact
Data format uploaded by channel	4 bytes(32 bits), each 4 bits represents a channel state, high bits in the front, low bits in the back
ON	R_{on}<1KΩ（@ Voltage query = 20.4V）
OFF	R_{off}>100KΩ（@ Voltage query = 28.8V）
Query voltage	24VDC(-15%~+20%)
Dithering-removing filter time OFF→ON ON→OFF	None, 20ms, 30 ms, 40 ms, 50 ms, 60 ms, 70 ms, 80 ms, 100ms, 200 ms, 300 ms, 400 ms, 500 ms None, 20ms, 30 ms, 40 ms, 50 ms, 60 ms, 70 ms, 80 ms, 100ms, 200 ms, 300 ms, 400 ms, 500 ms
SOE	
Timing method	Between main controller and slave module: timing by Profibus-DP protocol.
Timing period	1min
SOE timing precision	1ms

LK630S　Safety 8 Channels Digital Input Module（with SOE Function）	
SOE event resolution	15ms
SOE event cache	Record the latest 512 events
Isolation voltage between field and system	500 VAC@1 min, leaking current: 5 mA
Communication	
Protocol	PROFIsafe
Dual network redundancy	Supported
Communication rate	187.5 kbps, 500 kbps, 1.5 Mbps、3Mbps、6Mbps
Physical specifications	
Installation position	Expansion backplane
Module dimension (W*H*D)	35 mm×100 mm×100 mm

Chapter 7 Accessory

7.1 LKA103 Capacitor Power Supply Box Module

LKA103 provides the backup battery for RTC of the LK220S module.

When LK220S is powered off, LKA103 supplies power to RTC 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.

7.1.1 Appearance

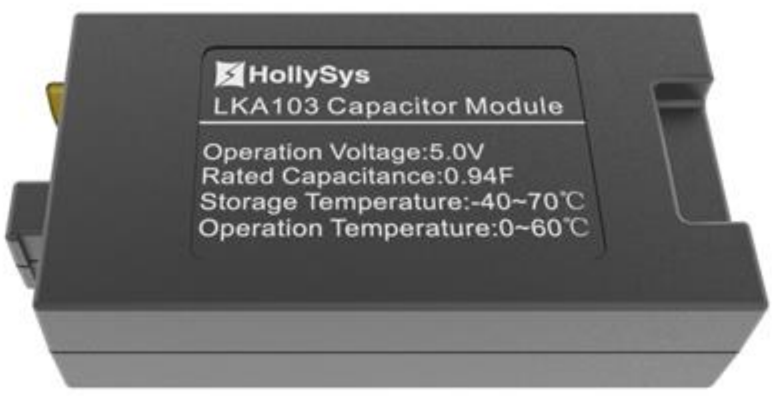


Figure 131 LKA103 Module Schematic Diagram

7.1.2 Installation Dimension

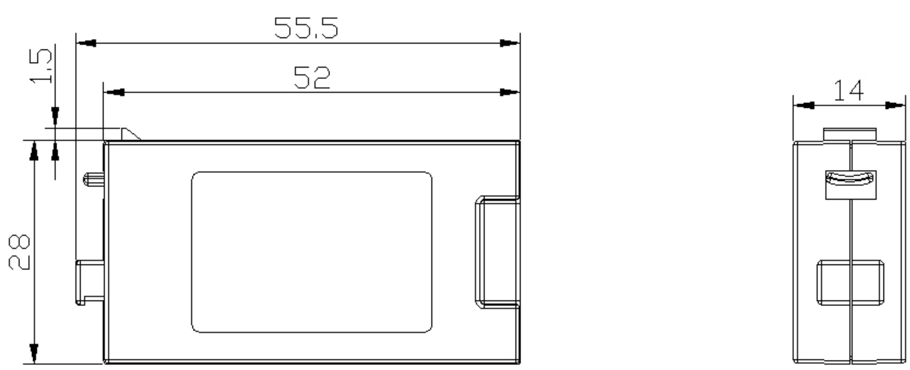


Figure 132 Installation Dimension of LKA103 Module

7.1.3 Installation

See Chapter 3.1.7 Installation of Power Supply Box.

7.1.4 Battery Replacement

When the BAT indicator on the LK220S module panelis is on, 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 LK220S 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 turns off and the battery is replaced.

7.1.5 Technical Specifications

LKA103 Capacitor Power Supply Box Module	
Physical Property	
Installation Mode	Clip
Protection key position	Rear right
Module Dimension (W*H*D)	55.5 mm*28 mm*14 mm

7.2 LKA104 Profibus-DP Bus Connector

LKA104 is a Profibus-DP bus connector. It switches the redundancy DP signal of the previous backplane 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 backplane 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.

7.2.1 Appearance and Size

7.2.1.1 Appearance

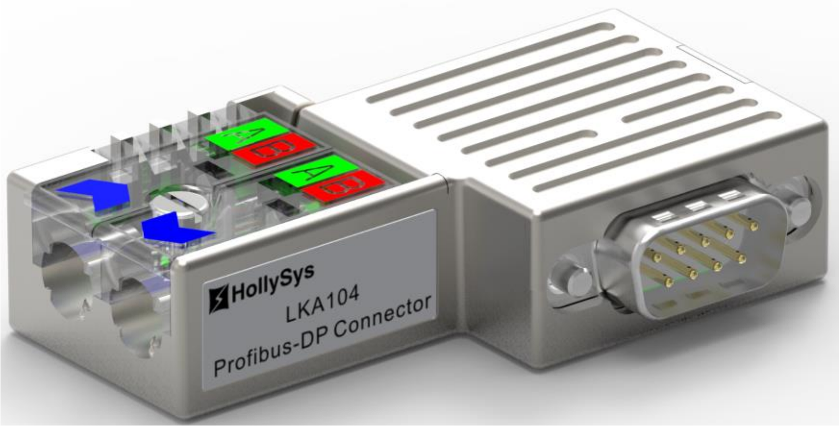


Figure 133 External View of LKA104 Module

7.2.1.2 Module Dimension

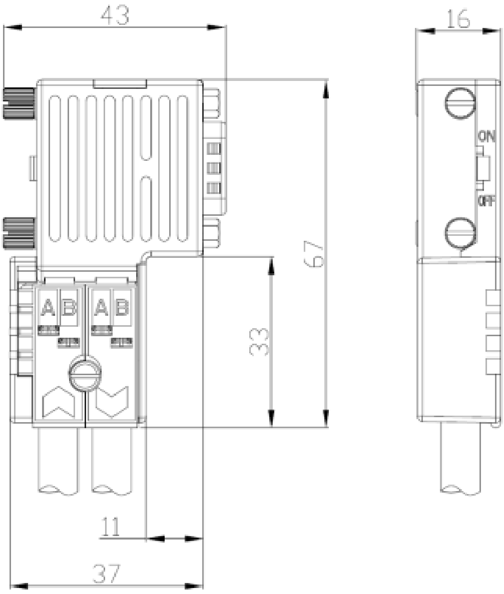


Figure 134 Dimension Figure of LKA104 Module

7.2.2 Operating Principle

The LKA104 bus connector is shown in Figure 135. The DP input signal is input to the backplane via the DPIN pin. In the meantime, the DP signal is connected to the next backplane. You can set whether to connect matched resistors by selecting positions ON, OFF of dial switch.

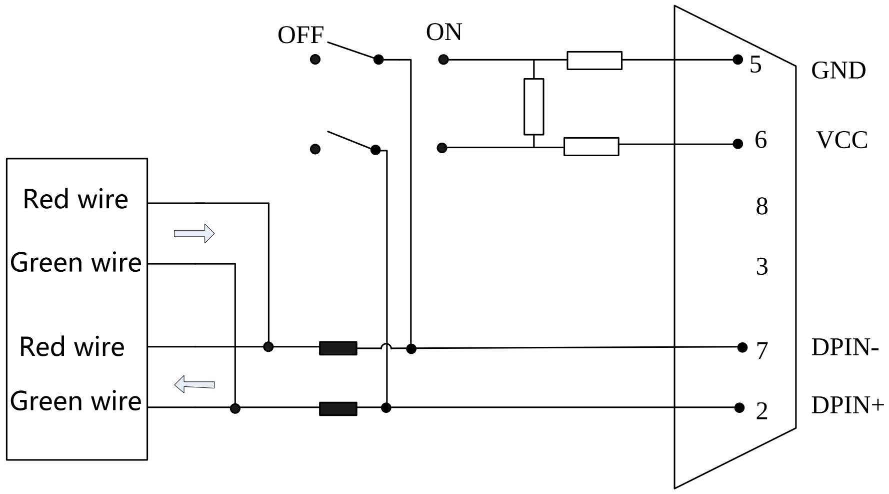


Figure 135　LKA104 Module Schematic Diagram

7.2.3　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. Terminal resistance on extended backplane is set in communication module.

Select the matched resistance on LKA104 by dial switch, which has two positions such as ON, OFF, as shown in Figure 136.

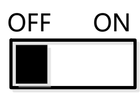


Figure 136　Dial Switch Schematic Diagram

- Switched to ON: connect the matched resistance
- Switched to OFF: disconnect the matched resistance

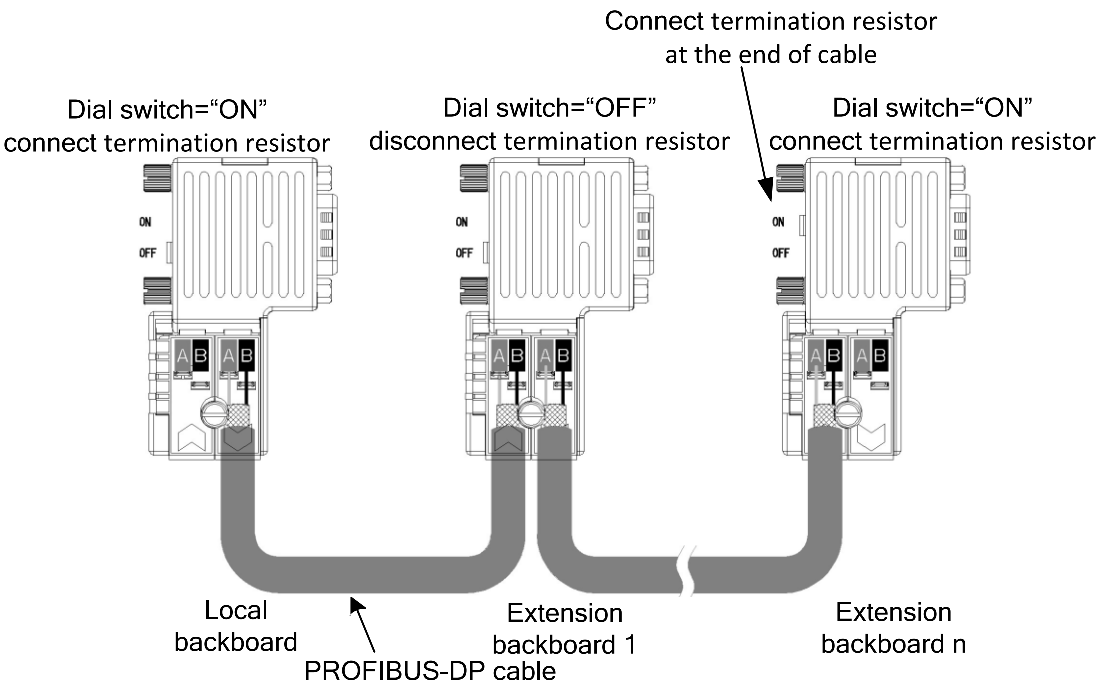


Figure 137 DIP Switch Settings for Backplane Cascade Connection

7.2.4 Wiring

Signal definition of LKA104 as follows:

Table 81 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 Chapter 3.2.3.4 LKA104 wiring for the cable requirements and wiring steps.

7.2.5 Installation

See Chapter 3.1.6 Installation of LKA104.

7.2.6 Technical Specifications

LKA104 Profibus-DP Bus Connector Mdule		
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 Mdule		
	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	

7.3 LKA105 Fiber Jumper

LKA105 is synchronous optical fiber which used to connect the safety redundant communication module in master/slave frame, the length is 5 meters. Synchronous optical fiber schematic diagram is shown in Figure 138.

Figure 138 LKA105 Synchronous Optical Fiber Diagram

The detailed using refers to 3.2.2 Redundancy Communication Wiring.

7.4 LKA106 Fiber Jumper

LKA106 is synchronous optical fiber which used to connect the safety redundant communication module in master/slave frame, the length is 1 meter. Synchronous optical fiber schematic diagram is shown in Figure 138.

Figure 139　LKA106 Synchronous Optical Fiber Diagram

The detailed using refers to 3.2.2 Redundancy Communication Wiring.

HollySys

Chapter 8 Fault and Treatment

8.1 Fault Mechanism

Fault type	Fault	Whether master-slave switch	Indicator	Whether report fault diagnosis	Description
Serious Faults	Pull out the module in local backplane	Yes	——	Yes	
	Master frame power off	Yes	——	No	
	Dual Ethernet fault	Yes	ERR indicator on controller is ON	Yes	Diagnosis information is reported by system diagnosis variable group SysDiagVar
	Redundancy state fault (master frame)	Yes	——	Yes	For 240S is offline under redundant configuration, when LK240S in slave frame is offline, only report diagnosis not to switch master-slave Diagnosis information is reported by system diagnosis variable group SysDiagVar
	Dual DP link fault	Yes	ERR indicator on LK249S is ON	Yes	Diagnosis information is reported by system diagnosis variable group SysDiagVar
	Redundancy timeout fault	No	ERR indicator on slave controller is ON	Yes	The value of Error parameter of function block sysGetRedState outputs error code 130, meanwhile diagnosis information is reported by system diagnosis variable group SysDiagVar
	Master controller conflict fault	No	ERR indicator on slave controller is ON	Yes	Diagnosis information is reported by system diagnosis variable group SysDiagVar
General Faults	Battery fault	No	BAT indicator on controller is ON	No	You need to configure function block sysGetBatteryAlarm (Get Battery Alarm) to obtain the alarm information
	One of input power of LK921S	No	DCIN-n indicator on LK921S is OFF	No	

Fault type	Fault	Whether master-slave switch	Indicator	Whether report fault diagnosis	Description
	fault				
	Single Ethernet fault	No	LINK and ACT indicators on controller are OFF	No	Diagnosis information is reported by system diagnosis variable group SysDiagVar
	Single DP fault	No	DP indicator is ON/OFF	Yes	Both diagnosis function block sysGetComModuleDiagInfo and system diagnosis variable group SysDiagVar report diagnosis information
	DP communication fault (master frame)	No	——	Yes	Diagnosis information is reported by system diagnosis variable group SysDiagVar
	Single optical fiber fault	No	——	Yes	Both diagnosis function block sysGetComModuleDiagInfo and system diagnosis variable group SysDiagVar report diagnosis information
	Double optical fiber fault	No	ERR indicator on LK240S is ON	Yes	The value of Error parameter of function block sysGetRedState outputs error code 128, meanwhile diagnosis information is reported by system diagnosis variable group SysDiagVar
	Optical fiber communication fault	No	ERR indicator on LK240S is ON	Yes	Diagnosis information is reported by system diagnosis variable group SysDiagVar
	A/B switch conflict	No	ERR indicator on LK240S is ON	No	Diagnosis information is reported by system diagnosis variable group SysDiagVar
	History run state fault	No	ERR indicator on controller is ON	Yes	Diagnosis information is reported by system diagnosis variable group SysDiagVar
	Anomal power supply of RTC	No	BAT indicator on controller is ON	Yes	Diagnosis information is reported by system diagnosis variable group SysDiagVar

8.2 Method of Troubleshooting

When error occurs in LKS redundancy system, you can troubleshoot faults in follows ways:

- Check status indicator on the module.
- View system diagnosis SysDiagVar.
- View diagnosis information of function block.

8.2.1 Indicators

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.

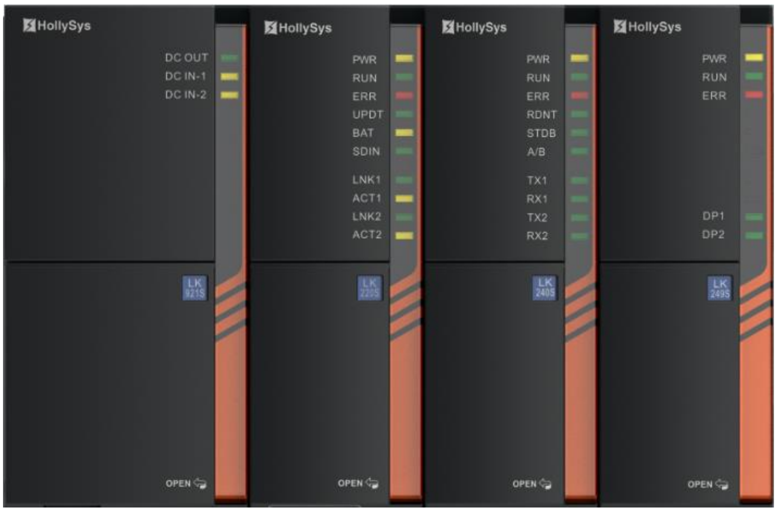


Figure 140 Abnormal Indicator Diagram

Indicator meaning refers to the specific definition of each module indicators.

8.2.2 View System Diagnosis SysDiagVar

You can view controller status and system diagnosis information through the variable group SysDiagVar under the [Global Variable]. Diagnosis information of modules in slave frame are viewed by loading slave controller.

SysDiagVar

No.	Name	Description	Data Type	Initial Value	Area
0001	sys_LocalMSState	Local master/slave state	WORD	0	S Area
0002	sys_LocalRSState	Local single/hot standby state	WORD	0	S Area
0003	sys_LocalABState	Local A/B state	WORD	0	S Area
0004	sys_LocalRedLink	Local RED module operation network state	WORD	0	S Area
0005	sys_LocalTaskState	Local task running state	WORD	0	S Area
0006	sys_LocalKeyState	Local key switch state	WORD	0	S Area
0007	sys_RemoteMSState	Remote master/slave state	WORD	0	S Area
0008	sys_RemoteRSState	Remote single/hot standby state	WORD	0	S Area
0009	sys_RemoteABState	Remote A/B state	WORD	0	S Area
0010	sys_RemoteRedLink	Remote RED module operation network state	WORD	0	S Area
0011	sys_RemoteTaskState	Remote task running state	WORD	0	S Area
0012	sys_RemoteKeyState	Remote key switch state	WORD	0	S Area
0013	sys_TaskFirstRun	First run flag of the task after the download	WORD	0	S Area
0014	sys_ModuleState	Local module exist status	WORD	0	S Area
0015	sys_TaskCycleAbnormal	Task cycle does not match the current project	WORD	0	S Area
0016	sys_CPUModuleFatalErr1	CPU module fatal error 1	WORD	0	S Area
0017	sys_CPUModuleFatalErr2	CPU module fatal error 2	WORD	0	S Area
0018	sys_CPUModuleMinorErr1	CPU module general error 1	WORD	0	S Area
0019	sys_CPUModuleMinorErr2	CPU module general error 2	WORD	0	S Area
0020	sys_REDModuleFatalErr1	RED module fatal error 1	WORD	0	S Area
0021	sys_REDModuleFatalErr2	RED module fatal error 2	WORD	0	S Area
0022	sys_REDModuleMinorErr1	RED module general error 1	WORD	0	S Area
0023	sys_REDModuleMinorErr2	RED module general error 2	WORD	0	S Area
0024	sys_DPModuleFatalErr1	DP module fatal error 1	WORD	0	S Area
0025	sys_DPModuleFatalErr2	DP module fatal error 2	WORD	0	S Area
0026	sys_DPModuleMinorErr1	DP module general error 1	WORD	0	S Area
0027	sys_DPModuleMinorErr2	DP module general error 2	WORD	0	S Area
0028	sys_ReservedDiag	System reserved diagnostic information	ARRAY[0..31] OF WORD		S Area

Figure 141 System diagnosis information

Table 82 Diagnosis information

Variable	Diagnosis value	Description
sys_LocalMSState	Local master/slave state	0: Unknown status 1: Initial status 2: Hardware ready status 3: Hot ready status 4: Single ready status 5: Fault status 6: Error status 7: Engineering redundancy 8: Engineering verification 9: Slave 10: Master 11: Unqualified host 12: Wait to enter the fault status 13: Wait to enter the wrong status
sys_LocalRSState	Local single/hot standby state	0: Unknown status 1: Single 2: Dual
sys_LocalABState	Local A/B state	0: Unknown status 1: A

Variable	Diagnosis value	Description
		2: B
sys_LocalRedLink	Local RED module operation network state	0: Unknown status 1: First optical fiber 2: Second optical fiber
sys_LocalTaskState	Local task running state	The status of each task is represented by 2 bits 0: Unknown status 1: Running 2: Stopped 3: Hang up
sys_LocalKeyState	Local key switch state	0: UNKNOWN 1: RUN 2: REMOTE 3: PRG
sys_RemoteMSState	Remote master/slave state	Same value with local
sys_RemoteRSState	Remote single/hot standby state	Same value with local
sys_RemoteABState	Remote A/B state	Same value with local
sys_RemoteRedLink	Remote RED module operation network state	Same value with local
sys_RemoteTaskState	Remote task running state	Same value with local
sys_RemoteKeyState	Remote key switch state	Same value with local
sys_TaskFirstRun	First run flag of the task after the download	The status of each task is represented by 1 bit 0: Non first run 1: First run
sys_ModuleState	Local module exist status	(Online state of communication module) bit0~bit3: Module ID in slot2 bit4~bit7: Module ID in slot3 bit8~bit11: Module ID in slot4, reserved bit12~bit15: Module ID in slot5, reserved Module ID=0: No module is in slot Module ID=7: LK240S is in online Module ID=8: LK249S is in online
sys_TaskCycleAbnormal	Task cycle does not match the current project	0: The task cycle setting match with the current project 1: The task cycle setting does not match the current configuration project
sys_CPUModuleFatalErr1	CPU module fatal error1	Bit2=1: Double Ethernet fault Bit7=1: Redundancy timeout fault Bit8=1: Redundancy state failure (for 240S is offline under redundant configuration)
sys_CPUModuleFatalErr2	CPU module fatal error2	Reserved

Variable	Diagnosis value	Description
sys_CPUModuleMinorErr1	CPU module general error1	Bit0=1: History run state fault Bit6=1: Anomal power supply of RTC
sys_CPUModuleMinorErr2	CPU module general error2	Reserved
sys_REDModuleFatalErr1	RED module fatal error1	Bit0=1: Self checking fault
sys_REDModuleFatalErr2	RED module fatal error2	Reserved
sys_REDModuleMinorErr1	RED module general error1	Bit0=1: First optical fiber fault Bit1=1: Second optical fiber fault Bit2=1: Double optical fiber fault bit3=1: AB switch conflict Bit5=1: Optical fiber communication fault
sys_REDModuleMinorErr2	RED module general error2	Reserved
sys_DPModuleFatalErr1	DP module fatal error1	Bit0=1: Master controller conflict fault Bit4=1: DP1, DP2 network fault
sys_DPModuleFatalErr2	DP module fatal error2	Reserved
sys_DPModuleMinorErr1	DP module general error1	Bit3=1: DP communication fault Bit4=1: DP1 network fault Bit5=1: DP2 network fault
sys_DPModuleMinorErr2	DP module general error2	Reserved
sys_ReservedDiag	System reserved diagnostic information	Reserved

8.2.3 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 Safety FA-AutoThink.

LKS system diagnostic function blocks are divided into the main control module diagnosis, communication module diagnosis and DP slave extension diagnosis. Detailed diagnostic information sees the *LKS Safety Control System Instruction Manual*.

Table 83 Configurable Diagnosis Function Block

Function Block	Function
sysGetCPUDiagInfo (Get Diagnosis of CPU)	You can view diagnosis information of safety main control module .such as ethernet fault information, internal communication link fault information, etc.
sysGetComModleDiagInfo (Get Diagnosis of Communication Module)	You can view diagnosis information of communication module LK249S, LK240S. Such as fiber disconnection, AB switch conflict, DP link disconnection, etc.

Function Block	Function
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.

8.2.4 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 Safety FA-AutoThink

Via the tool in Safety FA-AutoThink to view and find that master controller state is normal and slave controller state is error state, single and dual state is normal, optical fiber state is normal, AB controller state is normal, key switch state is normal, but project state of master controller is running and project state of slave controller is stopping.

Step 2. Check the indicator

Check if there is an abnormal indicator in cabinet.

In master frame, the indicators on each module are normal and RUN indicator on LK220S is flashing. In slave frame, the ERR indicator on LK249S is on and RUN indicator on LK220S is on, the other indicators are normal. Therefore, you can determine that LK249S module were broken.

Figure 142 LK249S Status Indicator

Step 3. View the diagnosis information in Safety FA-AutoThink

Open the Safety FA-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 main 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 8 to indicate that current module is LK249S. Protocol is 2 to indicate that current protocol is DP. InterComErr is 0 to indicate that communication between LK220S and LK249S is normal. Online values of ExtDiag1 and ExtDiag2 are 1 to indicate that DP1 and DP2 links of LK249S in slave frame are broken.

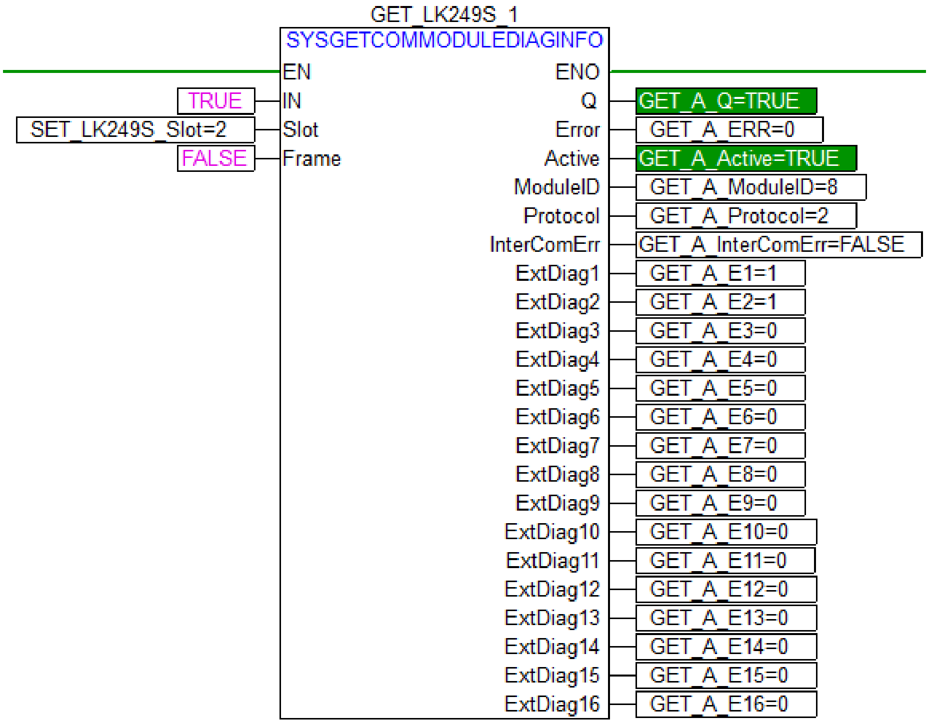


Figure 143 SysGetComModleDiagInfo Function Block

Step 4. Troubleshooting

(1) Check if the DP cable is plugged well

(2) Check if the DP cable is broken, and replace it

8.3 Fault Phenomenon and Causes

The following are some fault symptoms, possible causes and correction measures.

Table 84 Fault Symptoms and Possible Causes

Fault symptoms	Causes	Treatment measures
ERR indicator on master controller is ON	History run state fault: the IEC of main controller was stopping state, and key switch of slave controller in RUN,	1. Check if the dial switch is in PRG 2. Check if the controller is normal main controller

	then the fault is touched off after slave rise to main controller	
	Dual Ethernet disconnection	1. Check if the Ethernet cable is plugged well 2. Check if the Ethernet cable is disconnected
	Anomal power supply of RTC	Restart controller
BAT indicator on controller is ON	Low power	Replace the capacitor box
	The capacitor box is not be plugged in	Check if the capacitor box is plugged well
ERR indicator on slave controller is ON	Redundancy timeout fault: IEC running cycle not matches with the size of the engineering data area configured	1. Increasing task cycle in Safety FA-AutoThink 2. Delete the unused variables to reduce the used data area
	Master controller conflict fault: there has been a master controller in DP link, current controller cannot run as master, switching to slave and reporting diagnosis	Restart controller and ensure optical fiber is connected well
The ERR light of LK240S module is on	A,B switch conflict	Set the A/B dial switch again, and restart controller
	The dual fiber is disconnected	1. Check if the synchronous optical fiber is plugged well 2. Check if the synchronous optical fiber is broken 3. Check if the synchronous optical fiber plug is intact Re-connect the fiber according to the correct way
	Redundancy fiber is cross-connected	Reconnect the synchronous optical fiber in correct way
ERR indicator on LK249S 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
	IO slave station is offline	1． Check if the slave staion is connected well 2． Check if the slave staion is configured correctly
The all modules no power in chassis	QS10.241 power fault	Replace the power module
	Dual input power is broken in LK921S	1. Check if the wiring is connected 2. Check if the cables is broken
The project does not run after power on	History run state fault: the IEC of main controller was stopping state, and key switch of slave controller in RUN, then the fault is touched off after slave rise to main controller	1. Check if the dial switch is in PRG 2. Check if the controller is normal main controller
The controller has been in project redundancy state	Without engineering in main controller	Re-download the project
	Flash space in controller is insufficient	1. Clear the flash and restart controller 2. Contact the factory
The controller is error state	The dual DP link is disconnected	Refer to treatment measures about “ ERR indicator on LK249S is ON”
	Dual Ethernet disconnection	Refer to treatment measures about “ERR indicator on master controller is ON”
	Any module in local backplane is pulled out	Check whether module is plugged well
The controller is fault state	A/B switch conflict	Set the A/B dial switch again, and restart controller
The master controller state is normal, and slave controller state is error state	The dual fiber link is disconnected	Refer to treatment measures about “ ERR indicator on LK240S is ON ”

		This moment, you need to view state information of master equipment or slave equipment separately in Safety FA-AutoThink
The controller is unknown state	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 controller	Controller that project redundancy was not completed last time is unqualified master controller after power on	1. Reset by the key switch 2. Click **Clear** button in Safety FA-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 “ERR indicator on LK249S is ON”
	No main controller in current system	Refer to treatment measures about controller is error state, controller is fault state
Master –slave switching	Dual Ethernet disconnection	Refer to treatment measures about “ERR indicator on master controller is ON”
	The dual DP link is broken	Refer to treatment measures about “ERR indicator on LK249S is ON”
	Power fault	1. Check if the power QS10.241 is normal 2. Check if two-input wire of LK921S is connected well
	Any module is pulled out in backplane	The module is plugged again
RTC time is restored to the default value after power on	The power of the capacitor is low	Refer to treatment measures about “BAT

	No capacitor box is in slot	indicator on controller is ON”
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 “ERR indicator on master controller 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
	Key switch is in RUN status or non-master controller	Dail key switch to “REM” or “PRG”
Unable to establish a Modbus TCP communication connection	Slave controller is connect to Modbus communication	IP address is modified to IP address of main controller

The above faults are common faults. Please contact the manufacturer for other faults.
If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

APPENDIX 1 Non-safety Modules

1.1 LK910 24VDC Power Module

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.

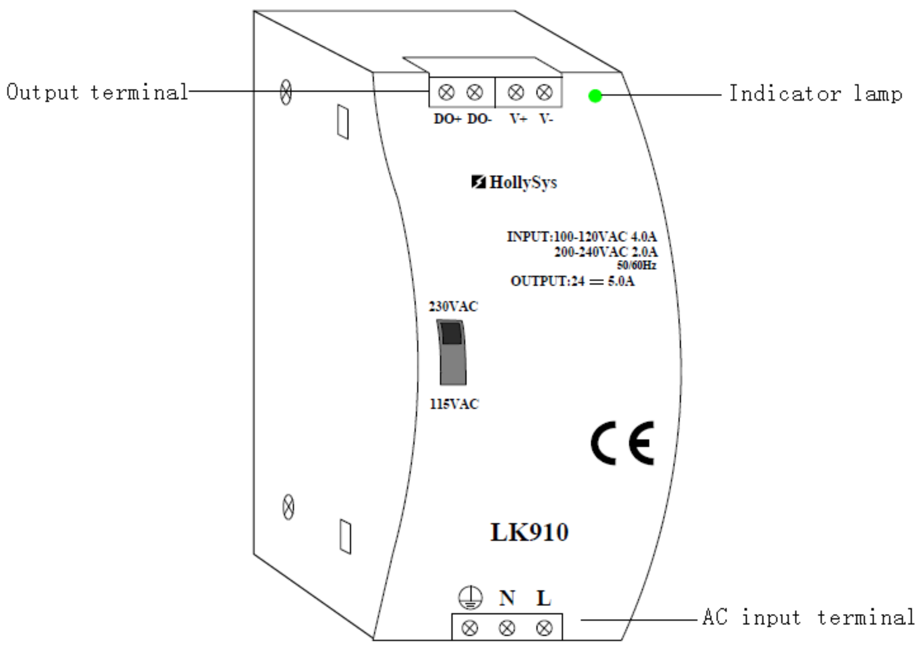


Figure 144 LK910 Wiring Terminals and Indicator

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 indicators is on. The optocoupler is turn off when the output is owed-voltage, while the output lights is off.

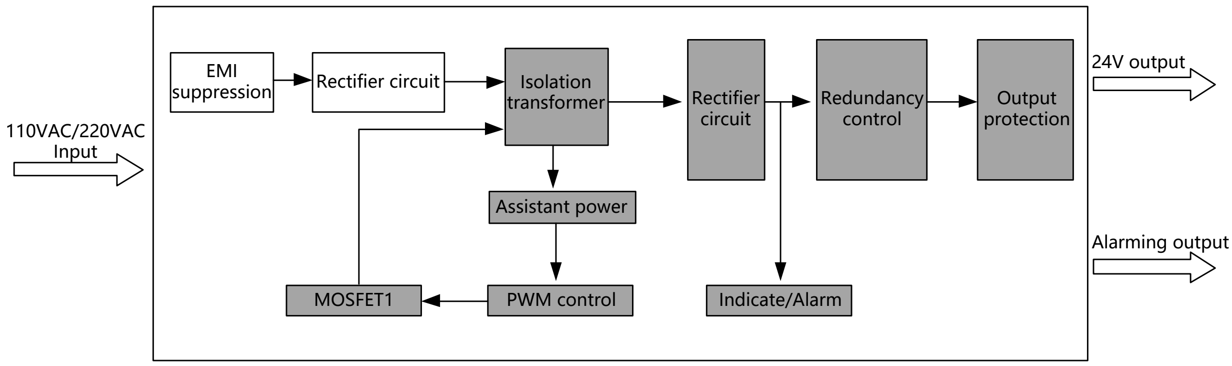


Figure 145 LK910 Schematic Diagram

1.1.3 Instructions for Using

1.1.3.1 Indicators and Terminal

After the module power up, the green LED indicator 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 is shown in Figure 146.

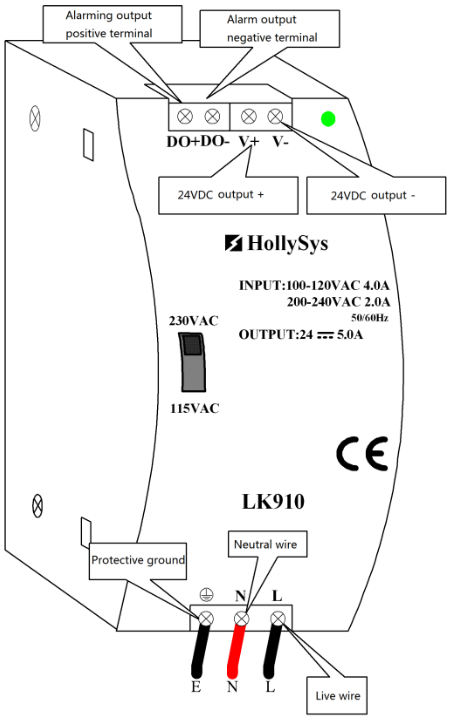


Figure 146   LK910 Wiring Terminals Instruction

1.1.3.2 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 147.

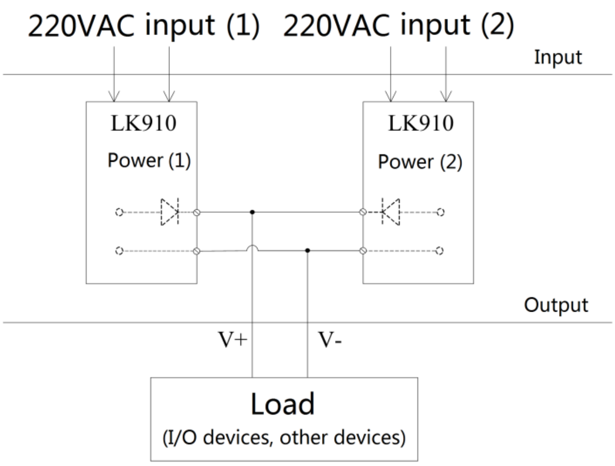


Figure 147   LK910 Power Redundancy Configuration

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 148.

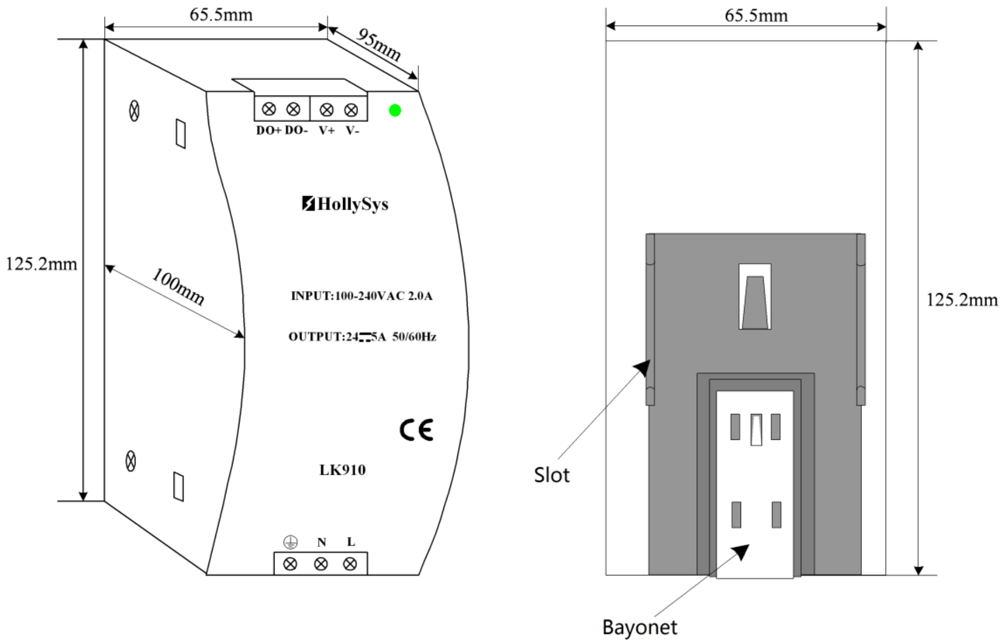


Figure 148 LK910 Appearance Dimension Diagram

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
Output Overvoltage Protection	120%~140% rated voltage
Output Short Circuit Protection	Output short circuit fault protection, power automatically recovery after fault is eliminated

LK910　24VDC Power Module	
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 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 Mode	Standard rail mounting

1.2 LK610　16-channel 24VDC Leaking Type Digital Input Module

1.2.1 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

1.2.2 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 149, 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.

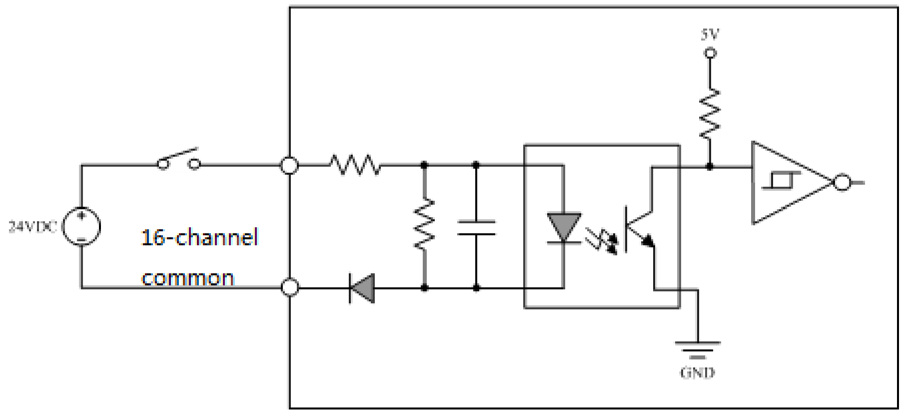


Figure 149 LK610 Channel Interface Circuit Diagram

1.2.3 Indicators

Table 85 Definition of LK610 Indicators

Name	Status	Description
RUN indicator (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 (yellow)	On	The channel is connected.
	Off	The channel is disconnected.

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

- Immediately after being powered on, the green indicator flashes to wait for the initialized data, with a flashing frequency of 4 times/second.
- Upon the completion of initialization, the green indicator 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 indicator keeps flashing. Check whether the communication parameters (slave station address, etc.) are set correctly.
- When the communication is normal, the green indicator is normally on. When the communication is disconnected, the green indicator flashes. When the communication is established again, the green indicator is turned on again.

1.2.4 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 backplane.

LK610 is installed on the extension backplane.

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 150.

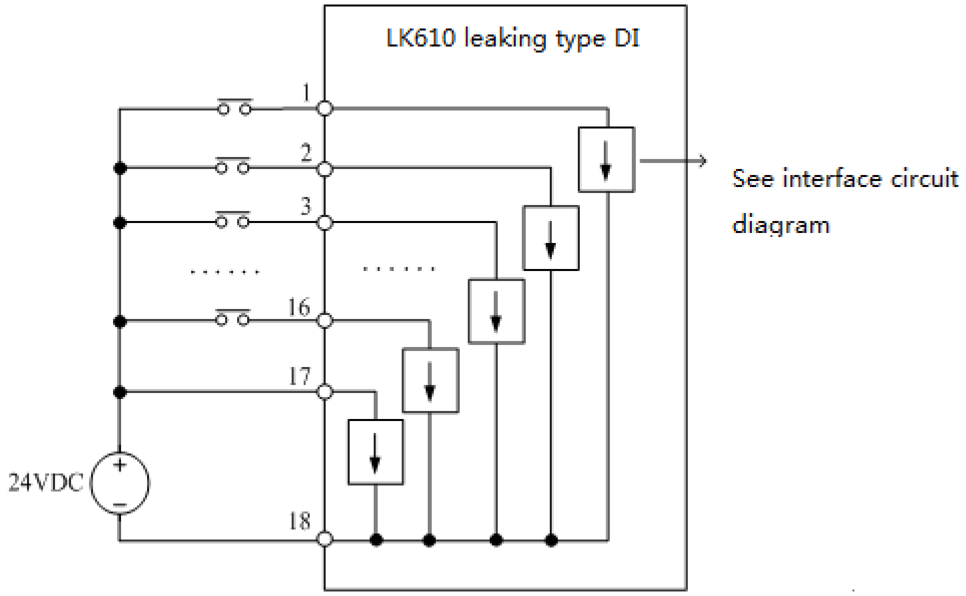


Figure 150　LK610 16-channel DI Interface Block Diagram

LK610 goes through the corresponding terminal connections under the mounting groove of the backplane, as shown in Figure 151. 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 backplane). 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 busbar or a conversion terminal.

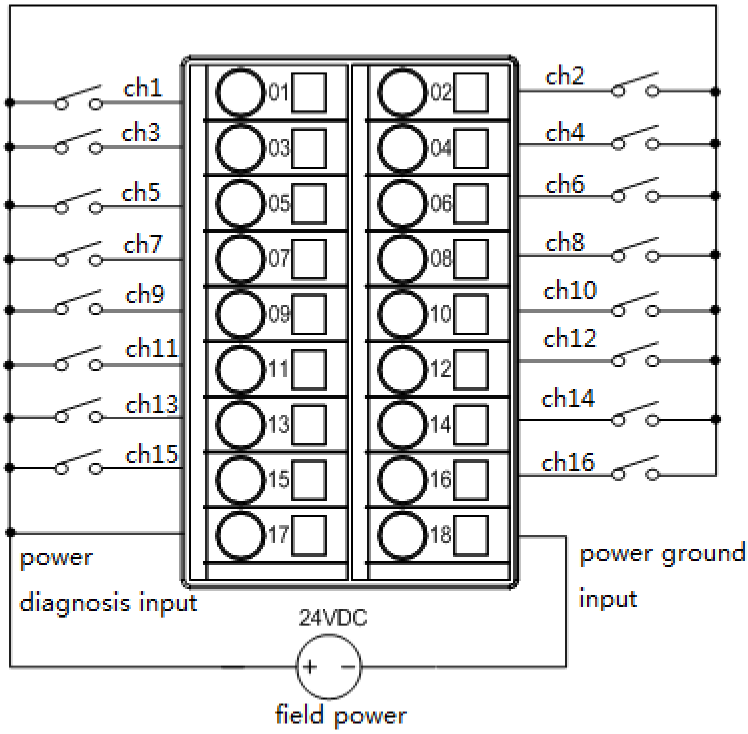


Figure 151 Corresponding Backplane Terminal Wiring Diagram

1.2.5 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 152, 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 controller.

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.

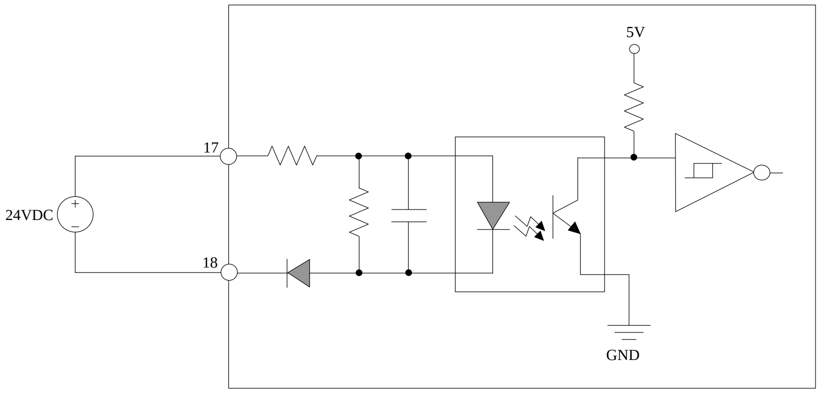


Figure 152 Electrical Schematic Diagram of LK610 Field Power Loss Detection

- 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 controller 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 controller upon the arrival of the next scanning period.
- LK610 only reports the diagnosis data once separately when a failure occurs and the fault recovered.

Device diagnosis byte

0	0	0	0	0	Bit2	0	0

=1， Field power off
=0， Power-off recovery

Figure 153 Diagnosis Byte of LK610

Field power loss detection is device diagnosis, refer to Figure 153 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 DiagData1~ DiagData2 in the function block, as shown in Table 86.

Table 86 Specifications for LK610 Diagnosis Message

Device diagnosis	Value	Meaning
DiagData 1: DiagData 2:	0x02: 0x04	Field power loss
	0x02: 0x00	The failure is recovered or there is no diagnosis data

1.2.6 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.

1.2.7 Parameters

The [User parameter] is used to set the operation mode of the module. The controller 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 BUS_MASTER node to open the dialog of **Device Properties** in Safety FA-AutoThink, as shown in Figure 154, there are 2 bytes in LK610 user parameter.

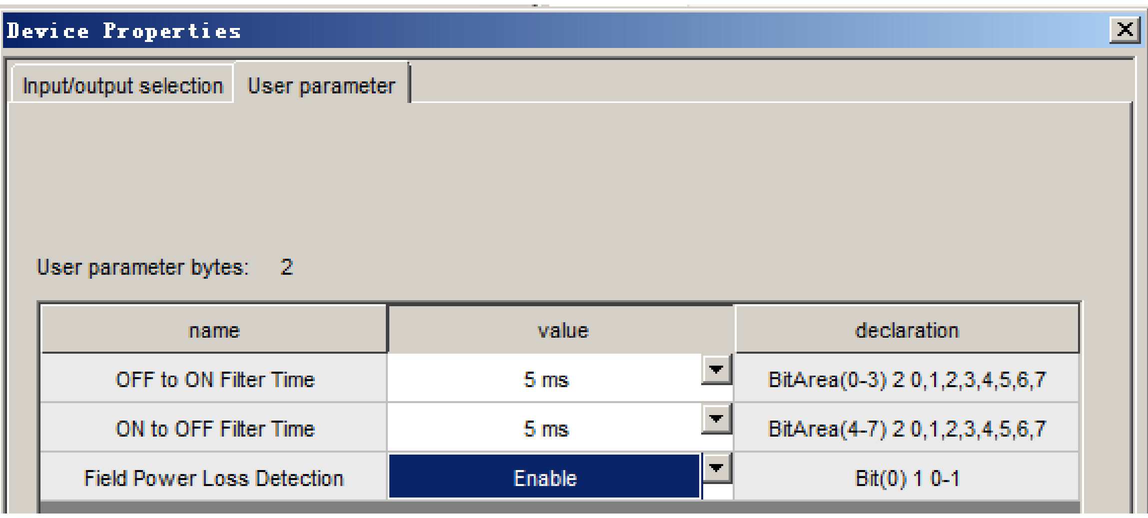


Figure 154 LK610 User Parameter Setting

Table 87 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)

1.2.8 Technical Specifications

LK610 16-channel 24 VDC 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

LK610 16-channel 24 VDC Leaking Type Digital Input Module		
Contact Type		Dry contact, leaking type input
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 swapping		Supported
Physical Property		
Protection Key		D0
Installation Position		Extension backplane
Module Dimension (W*H*D)		35 mm×100 mm×100 mm
Enclosure Protection Rating		IEC60529 IP20
Weight		180g

1.3 LK710 16-channel 10~30VDC Source Type Digital Output Module

1.3.1 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

1.3.2 Operating Principle

As shown in Figure 155, 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 controller 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.

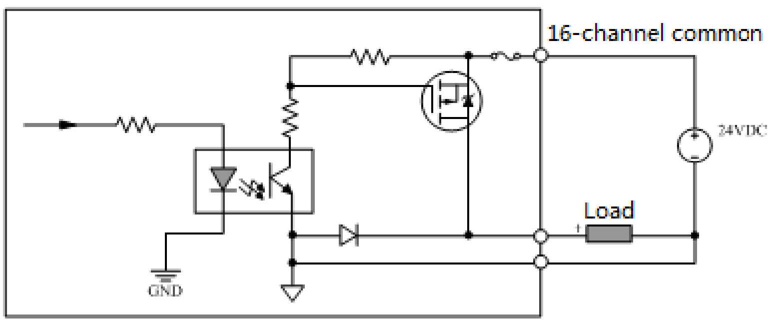


Figure 155 Circuit Diagram of LK710 Channel Interface

1.3.3 Indicators

Table 88 Definition of LK710 Indicators

Name	Status	Description
RUN indicator (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 (yellow)	On	The channel is turned on
	Off	The channel is disconnected

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

- Immediately after being powered on, the green indicator flashes to wait for the initialized data, with a flashing frequency of 4 times/second.
- Upon the completion of initialization, the green indicator 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 indicator keeps flashing. Check whether the communication parameters are set correctly.
- When the communication is normal, the green indicator is normally on. When the communication is disconnected, the green indicator 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 indicator is turned on again. The module automatically exits from the fault mode.

1.3.4 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 backplane.

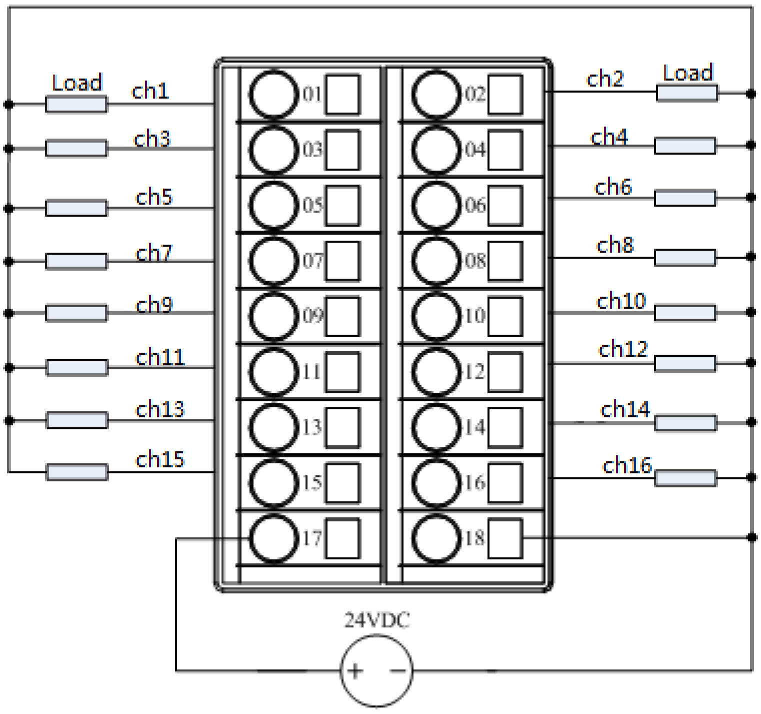


Figure 156 Wiring Diagram of Backplane Terminals Corresponding to LK710

Refer to Figure 156 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 backplane.
- 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 busbar or a conversion terminal.

1.3.5 Functions

1.3.5.1 Output Enable

After the output module is powered on, if the output instruction given from the controller 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 controller 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 controller 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.

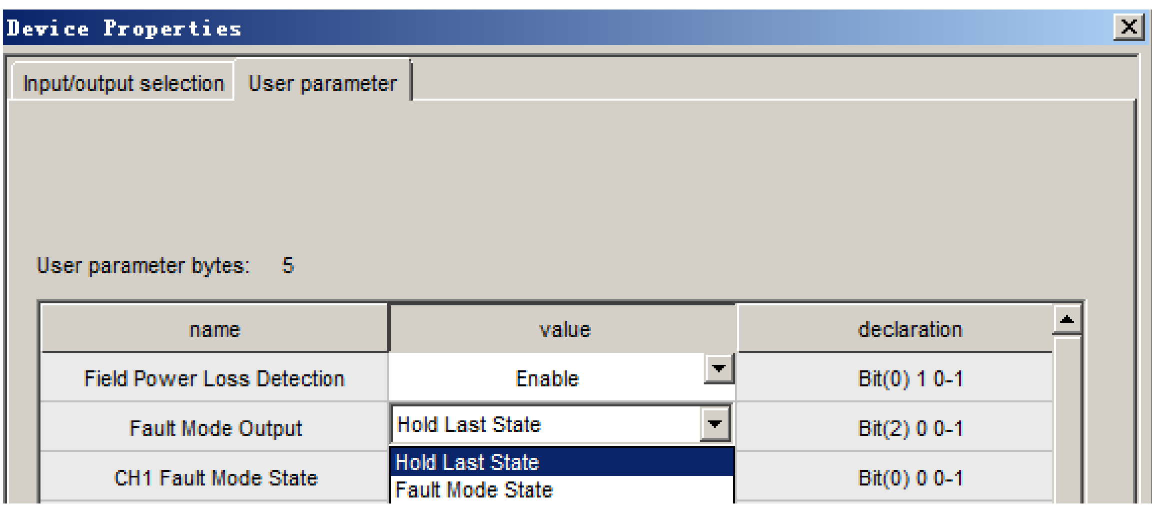
After the output is enabled, the module enters the plug module or is powered up again upon power failure. The module returns to the initial status, with the output disabled. After receiving the output instruction of the controller, the output is re-enabled.

1.3.5.2 Communication Fault

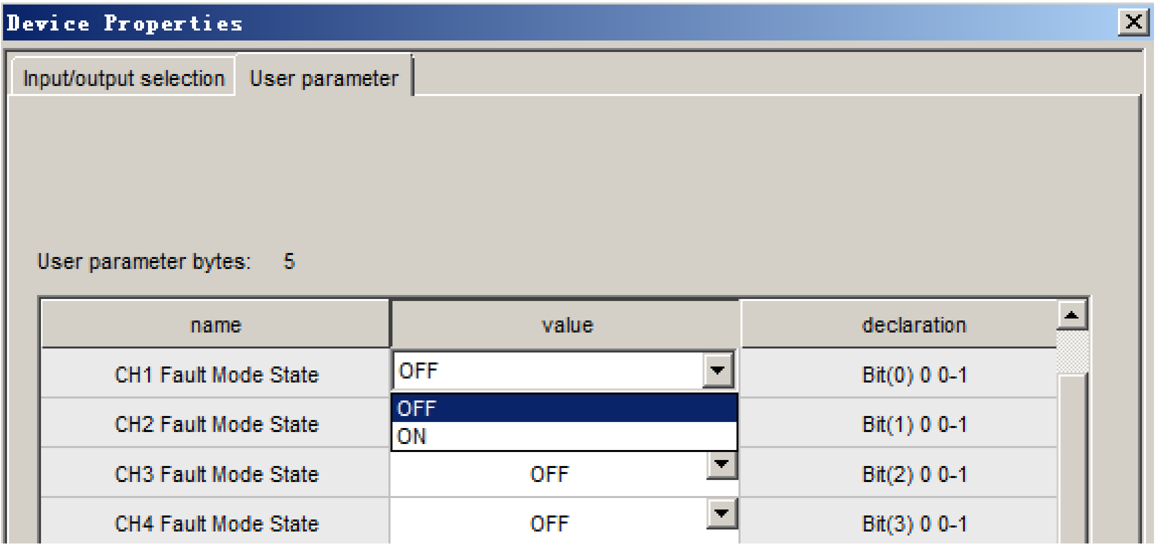
In case of a communication fault, the communication between the module and the controller is disconnected, with RUN indicator flashing. In case of a communication fault, the module status can be divided into the following cases:

- After the module is powered on, it cannot communicate with the controller. 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 157 Output Setting of LK710 Fault Mode

1.3.5.3 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.

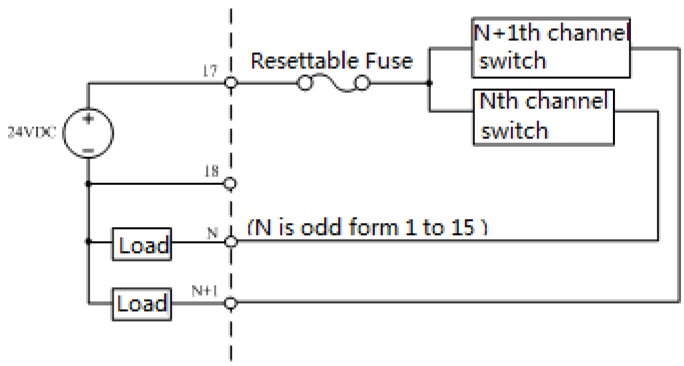


Figure 158 Electrical Schematic Diagram of LK710 Channel over Current Protection

1.3.6 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.

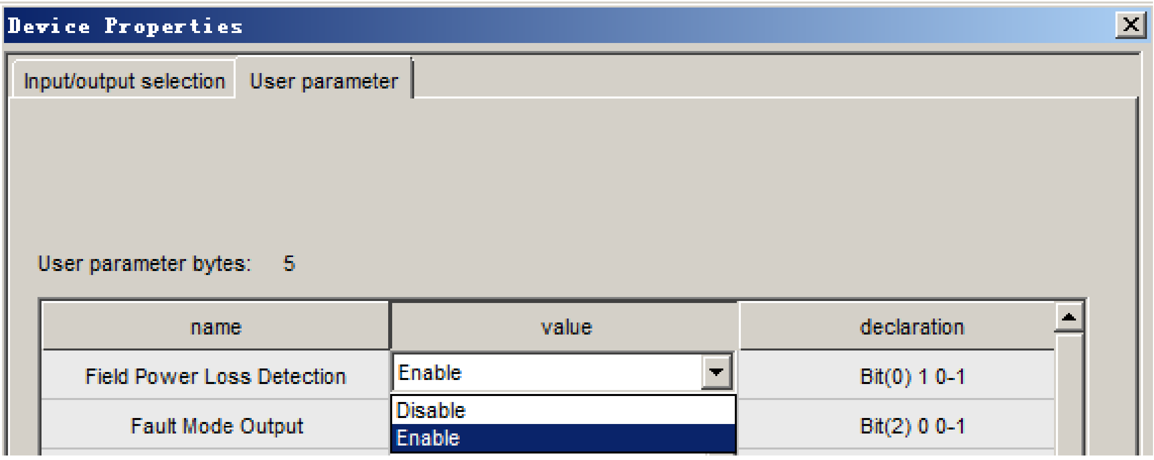


Figure 159 Setting of the LK710 Field Power Loss Detection

As shown in Figure 160, 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 controller.

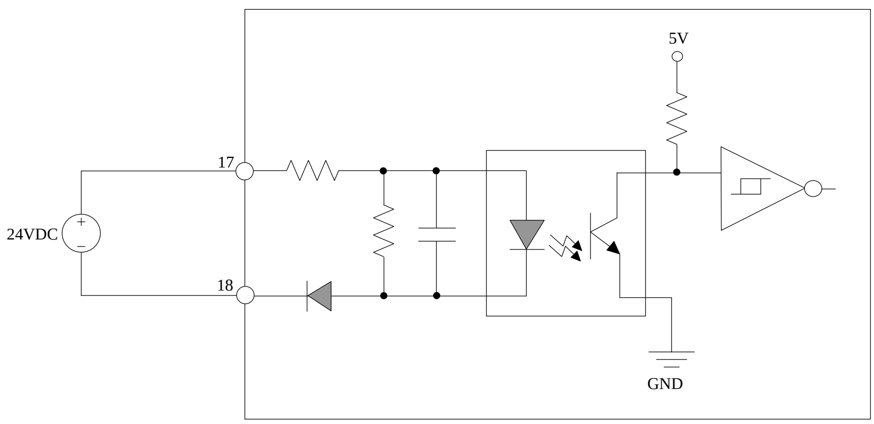


Figure 160 Electrical Schematic Diagram of LK710 Field Power Loss Detection

- 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 controller 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 controller upon the arrival of the next scanning period.
- LK710 only reports the diagnosis data once separately when a failure occurs and the fault recovered.

Device diagnosis byte

0	0	0	0	0	Bit2	0	0

=1, Field power off
=0, Power-off recovery

Figure 161 Diagnosis Byte of LK710

Field power loss detection is device diagnosis, refer to Figure 161 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 DiagData1~ DiagData2 in the function block, as shown in Table 89.

Table 89 Specifications for LK710 Diagnosis Message

Device diagnosis	Value	Meaning
DiagData 1: DiagData 2	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)

1.3.7 Parameters

The [User parameter] is used to set the operation mode of the module. The controller 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 90 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

1.3.8 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 controller 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 91.

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

Table 91 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

1.3.9 Technical Specifications

LK710 16-channel 10~30VDC Source Type Digital Output Module	
System Power	
Operating Voltage	24VDC（-15%~20%）
Backplane 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 swapping	Supported
Physical Property	

LK710 16-channel 10~30VDC Source Type Digital Output Module	
Protection Key	E0
Installation	Extension backplane
Module Dimension (W*H*D)	35 mm×100 mm×100 mm
Enclosure Protection Rating	IEC60529 IP20
Weight	200 g

1.4 LK720 10~265VAC/5~125VDC 8-way Normally Open Relay Output Module

1.4.1 Basic Features

- 8 channels of relay outputs, non source open contact
- DC voltage range: 5~125VDC
- AC voltage range: 10~256VAC@47~63Hz
- Support Profibus-DP slave station protocol
- Fault mode safety Output
- Output readback diagnosis
- Inter-channel isolation
- System-to-field Isolation
- Supports hot swap

1.4.2 Operation Principles

The controller writes the output data into the memory of LK720 through Profibus-DP bus. These data control the drive circuit closing or opening the relay contact to drive the load in the output circuit.

As shown in figure, the relay is in a constantly open status.

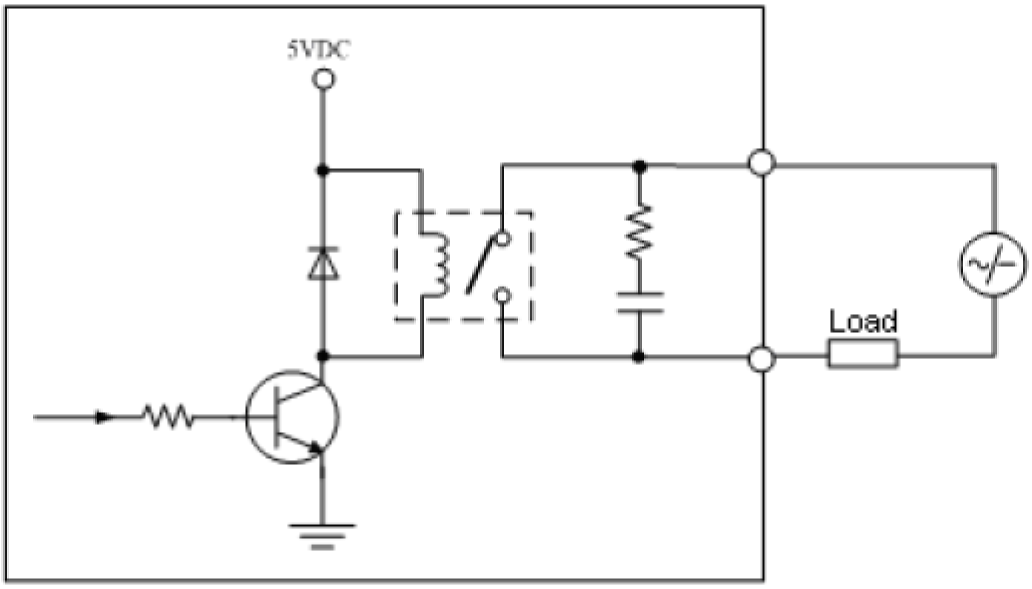


Figure 162 LK720 Channel Interface Circuit

1.4.3 Indicators

Table 92 Definition of LK720 Indicators

Name	Status	Description
RUN indicator (green)	On	The communication is established, the module works well
	Flash	Communication is not established or communication error
	Off	The module is not powered on
01~08 channel indicators (yellow)	On	The channel is conducted
	Off	The channel is disconnected

Specifications of RUN green light are as follows:

- After the power is on, the module waits for initialization data while the green light flashes with a frequency of 4 times per second.
- After the initialization is completed, the green light is constantly on to indicate the module in normal operation; if any error occurs in the initialization, then the communication is not established and the green light keeps flashing. Then, communication parameter settings shall be checked.
- In normal communications, green light is constantly on; when communication breaks, green light flashes while the module automatically enters fault mode; when communication is re-established, the green light is constantly on again and the module automatically exits fault mode.

1.4.4 Wirings

LK720 output contact points are dry contacts; hence it requires field power supply to drive optical coupler output. The field power supply can be a 5~125VDC power or a 10~265VAC power, which is selected according to different types of the load.

LK720 module is installed on LK series backplanes. LK720 module is wired through the correspondence terminals under the local backplane installation slot. The relationship between each channel and terminal is shown in figure. The 8 channel outputs can share a field power supply when there is no isolation between channels. They can also connect to separate field power supplies when the channels are isolated from each other.

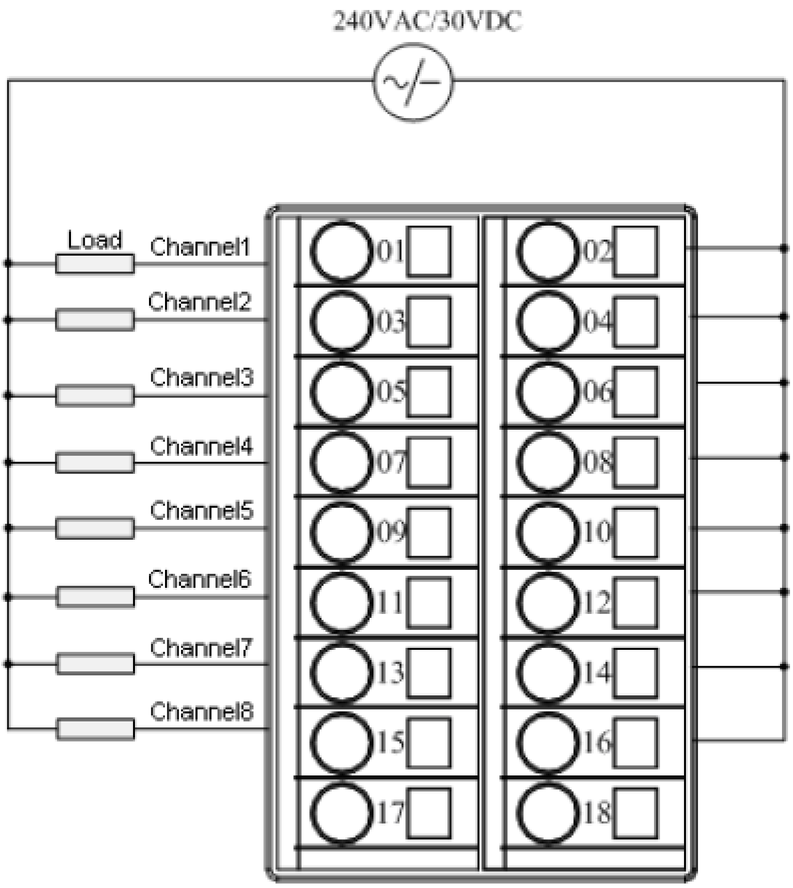


Figure 163　Wiring of LK720 Backplane Terminals with Single Power Supply

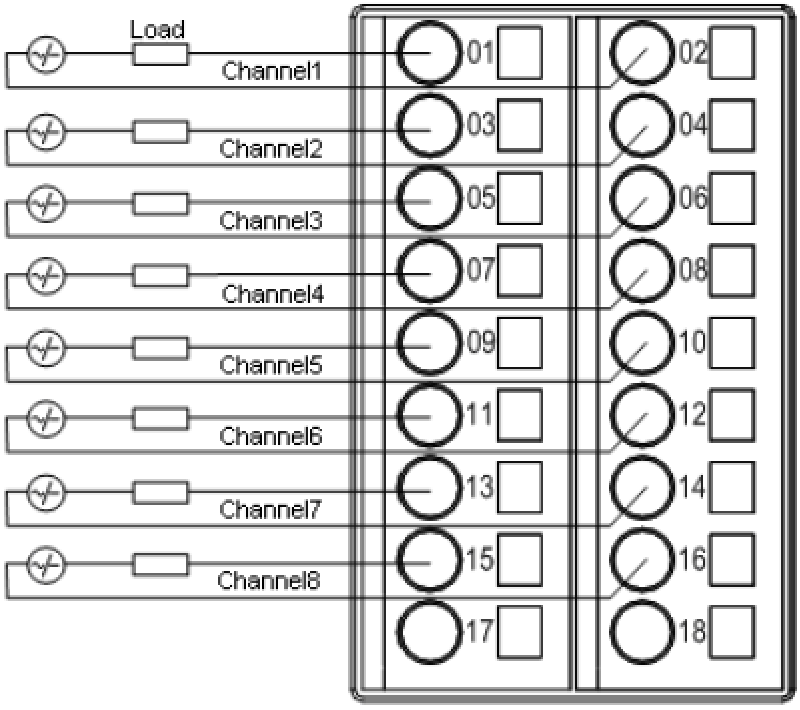


Figure 164　Wiring of LK720 Backplane Terminals with Multiple Power Supply

In the wiring, the following shall be noted:

- The field power supply can use both DC power and AC power.
- Signals of each channel are connected to the wiring terminals through 2 cables without distinguish between positive and negative.
- When module employs single power supply, there is no isolation between channels; when module employs multiple power supplies, there is isolation between channels using different power supplies.
- A single terminal shall not be connected to many wires; therefore multiple-point connection can be established through bus bar or transferring terminal board.
- Terminal 17 and 18 shall not be connected in the wiring.

1.4.5 Functions

1.4.5.1 Output Enable

Please see 1.3.5.1 Output Enable.

1.4.5.2 Communication Failure

Please see 1.3.5.2 Communication Fault.

1.4.6 Parameters

User parameters are used to configure the module's operating mode. They are written into the controller during the download of user program and will not be read in every scanning circle. Each parameter has a default value that can be changed according to requirements of the project. User parameters do not support online modification; therefore they can only be effective after the full download.

LK720 user parameter has 3 bytes (Byte0~Byte2):

Table 93 LK720 User Parameters

Parameter Name	Meaning	Value
Fault Mode Output	Fault mode output setting	0: Output Hold (default) 1: Output the failure mode settings
CH1 Fault Mode State~CH8 Fault Mode State	Fault mode settings for Channels 1~8	0: OFF (default) 1: ON

1.4.7 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 controller module to the slave station in each scanning period, which can be modified online when running the user program.

LK720 contains 8 channels BOOL output data and 8 channels BOOL input data. Channels 1 ~8 as output data control the close and open of channels. Channel 9~16 as the input data feed back current state of channel.The channel read-back data returns the channel output status to the controller module for programming.

1.4.8 Technical Specifications

LK720 10~265VAC/5~125VDC 8-way Normally Open Relay Output Module		
System Power Supply		
Power Supply Voltage	24VDC(-15%~+20%)	
Power consumption	140mA max.@24VDC	
Output Channel		
Number of Channels	8 channels	
Signal Type	Non source open contact	
Valid load voltage range	10~265VAC@47~63Hz/5~125VDC	
Load voltage range (load control)	Resistance load	
	5~30VDC@2A	
	48VDC@0.5A	
	100VDC@0.2A	
	125VAC@2A	
	240VAC@2A	
Rated output current (stable status)	Resistance load	Inductive load
	2A@5~30VDC	2A@5~30VDC
	0.5A@48VDC	0.5A@48VDC
	0.2A@100VDC	0.2A@100VDC
	2A@125VAC	2A@125VAC
	2A@240VAC	2A@240VAC

LK720　10~265VAC/5~125VDC 8-way Normally Open Relay Output Module		
Rated power (stable status)	Resistance load	Inductive load
	125VAC,250W max.	125VAC,250W max.
	240VAC,480W max.	240VAC,480W max.
	30VDC,60W max.	30VDC,60W max.
	48VDC,24W max.	48VDC,24W max.
	100VDC,20W max.	100VDC,20W max.
Minimum load current	10mA/point	
Maximum OFF-state Current Leak	1.5mA	
Initial contact resistance	30mΩ	
Maximum connection frequency at rated load	6 times / minute	
Minimum connection frequency at rated load	1200 times / minute	
Bounce time	1ms	
Operating time	5ms	
Release time	1ms	
Relay contact life span Resistance load Inductive load	 200, 000 times 30, 000 times	
Maximum Output Delay Time OFF→ON ON→OFF	 10ms 10ms	
Configurable fault mode output state of each point	Hold Last State (default); ON of OFF	
Isolation Voltage Field to System Channel to channel	 1000VAC@1min, Current Leak 5mA 1000VAC@1min, Current Leak 5mA	
Failure Diagnosis and Hot Swap		
Field Power Loss Detection	Field power loss: device diagnosis byte 0x04 Power loss recovered: diagnosis byte 0x00	
Hot Swap	Supported	
Communication Bus		
Protocol	Profibus-DP	
Baud Rate	1.5Mbps, 500Kbps, 187.5Kbps，93.75Kbps, 45.45Kbps, 31.25Kbps, 19.2Kbps, 9.6Kbps adaptive	
Media	Communication bus is connected to the backplane through euro connector, hot redundant communication media	
Physical Features		
Mechanic Keys to Prevent Incorrect Insertion	D3	
Installation	Expansion backplane	
Dimension	Width × Height × Depth = 35mm×100mm×100mm	

LK720 10~265VAC/5~125VDC 8-way Normally Open Relay Output Module	
Casing Protection Level	IEC60529 IP20
Weight	210g
Environmental Adaptability	
Operating Temperature	-20℃~70℃
Operating Humidity	5%~95%, with no condensation
Storage Temperature	-40℃~80℃
Storage Humidity	5%~95%, with no condensation

1.5 LK410 8-Channel Voltage Type Analog Input Module

1.5.1 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

1.5.2 Operating Principle

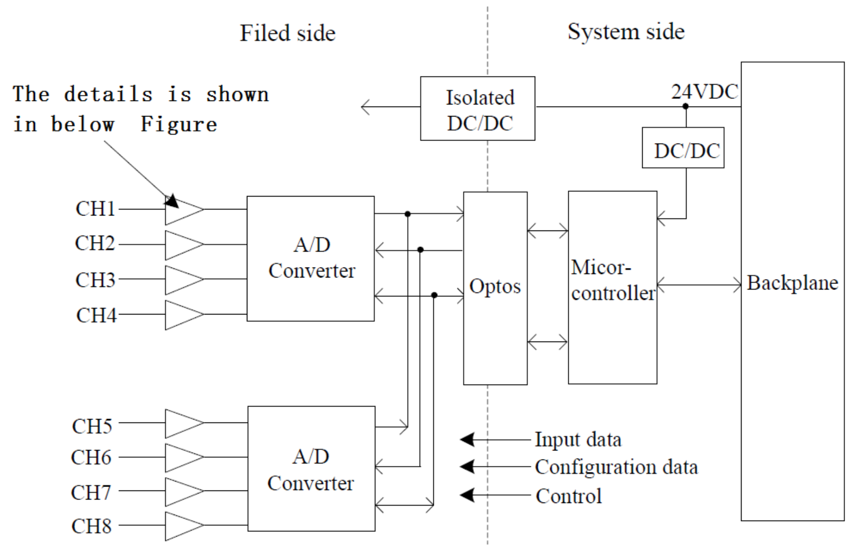


Figure 165 LK410 Input Circuit Block Diagram

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

As shown in Figure 166, 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.

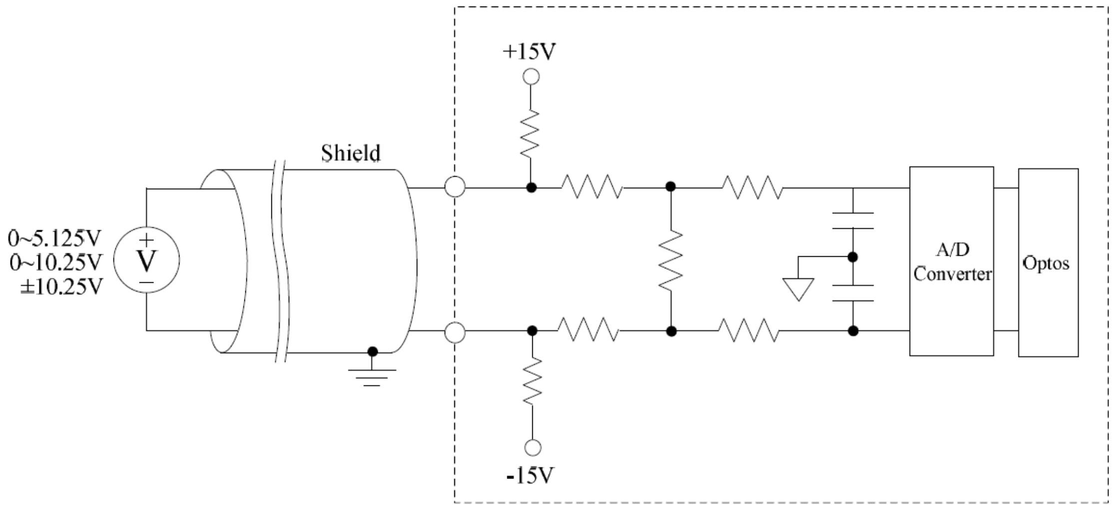


Figure 166 LK410 Input Simplified Circuit

1.5.3 Indicators

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 94 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 95 Definition of LK410 Indicators in Running Mode

Run mode	**RUN light**	**CAL light**	**Description**
	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 96 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

1.5.4 Wirings

The LK410 module is mounted on the expansion backplane.

Table 97 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

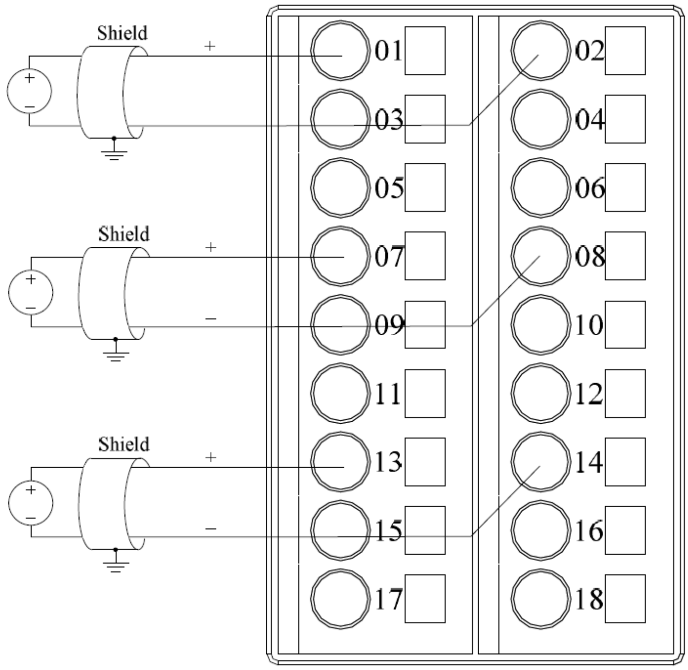


Figure 167 Backboard Terminal Wiring Schematic Diagram

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.

1.5.5 Functions

8.3.1.1 Measured Data Output Format

As shown in Table 98, 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 98 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 Control System 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 168.

CH1 Input Range	0~10.25V	Unsigned8 16 16,
CH1 Upper Limit Exceeded Alarm	Enable	Bit(0) 0 0,
CH1 Lower Limit Exceeded Alarm	Enable	Bit(0) 0 0,
CH1 Upper Limit Value	63936	Unsigned16 32767
CH1 Lower Limit Value	31968	Unsigned16 0 0-

Figure 168 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 169.

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 169 Example of Parameter Setting of Over-limit Alarm with Selected Range

1.5.6 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), diagnosis data is saved to the output parameters DiagData1~ DiagData28 of 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.

Diagnosis information DiagData1~ DiagData28 of function block sysGetDPSlaveState (Get Diagnosis of DP Slave) is shown in Table 112.

Table 99 Output parameter DiagData1~ DiagData28

Output parameter	Data type	Description
DiagData1~ DiagData2	BYTE	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.
DiagData3~ DiagData4	BYTE	Identification diagnosis information The 2-byte identification diagnosis information is 0x42, 0x01 when diagnosis information is reported.
DiagData5~ DiagData7	BYTE	Channel 1 diagnosis information, see Table 100 for channel. diagnosis information
DiagData8~ DiagData10	BYTE	Channel 2 diagnosis information
…	BYTE	…
DiagData26~ DiagData28	BYTE	Channel 8 diagnosis information

Table 100 Specifications for LK410 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>The third byte</td><td>Channel data type/fault type</td><td colspan="3">101 (Word)</td><td>2</td><td>Under range, Decimal online value is 162</td></tr>
</table>

Diagnosis Information				Meaning
			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.

1.5.6.1 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 101 Definition of LK410 Over Range

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

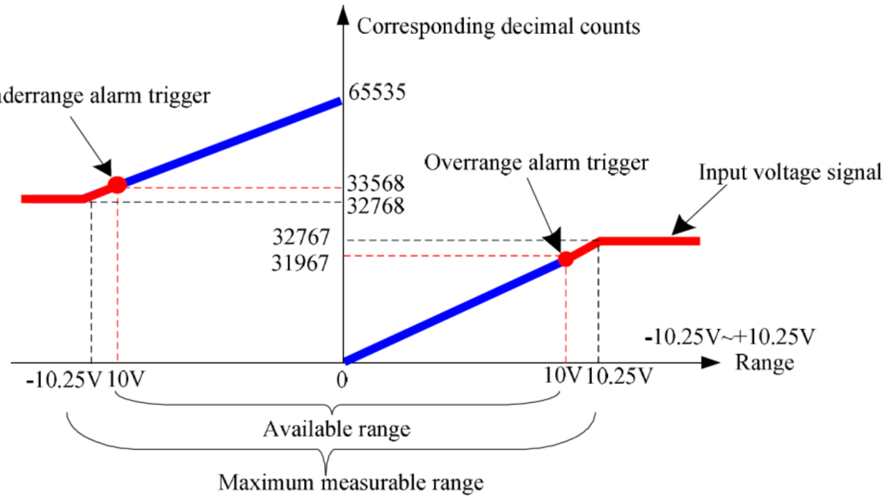


Figure 170 LK410 Over Range Alarm Diagram

As the selected range is different, the diagnostic processing of the modules is different when over range occurred, as shown in Table 102. When the signal is recovered to the normal range, the channel diagnosis byte reports 0xA0.

Table 102 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

1.5.6.2 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 103, the alarm upper limit voltage must be greater than the lower limit voltage; otherwise the LK410 module cannot correctly report the diagnostic information.

Table 103 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 104:

Table 104 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.

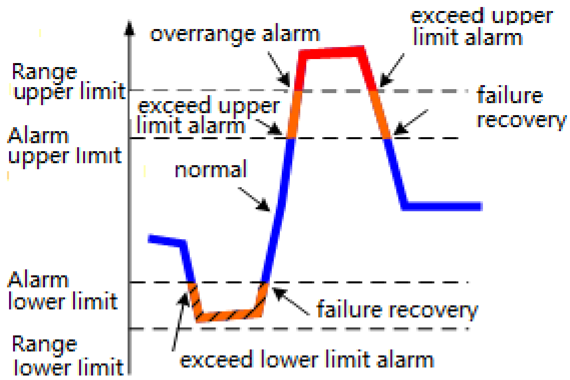


Figure 171 LK410 Over-limit Alarm Diagram

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.

1.5.6.3 Line Broken Detection

The LK410 module has a line broken detection function.

As shown in Figure 172, 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.

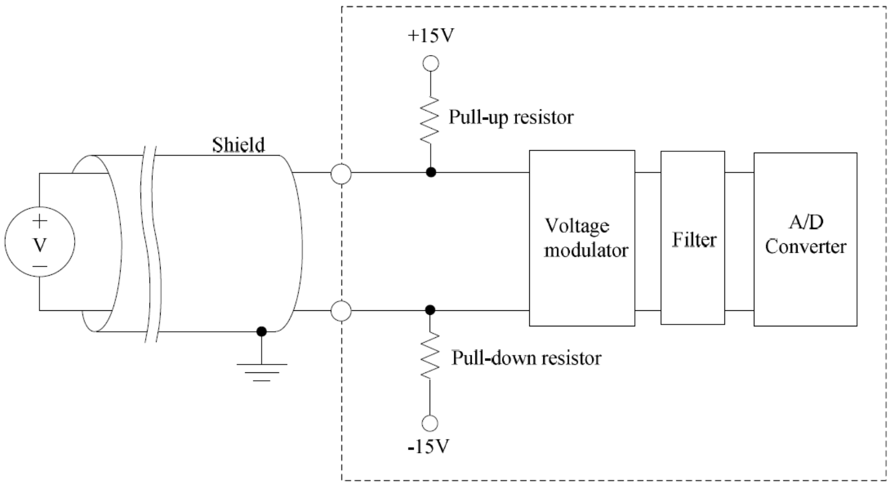


Figure 172 LK410 Line Broken detection schematic diagram

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

1.5.7 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 105 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 8.3.1.1 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	

1.5.8 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

1.6 LK411 8-channel Current Type Analog Input Module

1.6.1 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

1.6.2 Operating Principle

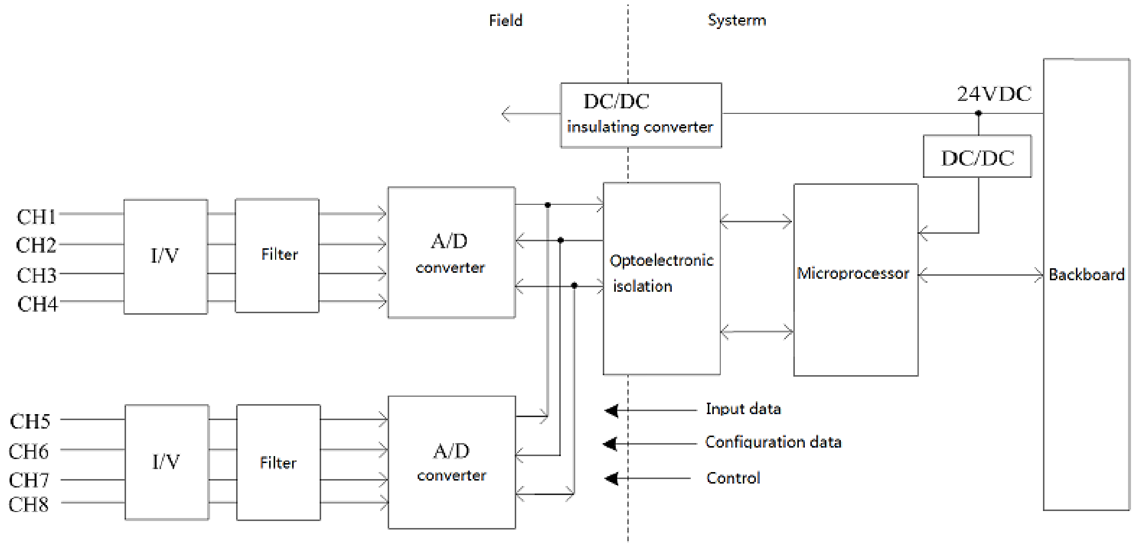


Figure 173 Internal Structure Block Diagram of LK411

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 174, 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 controller via the DP bus.

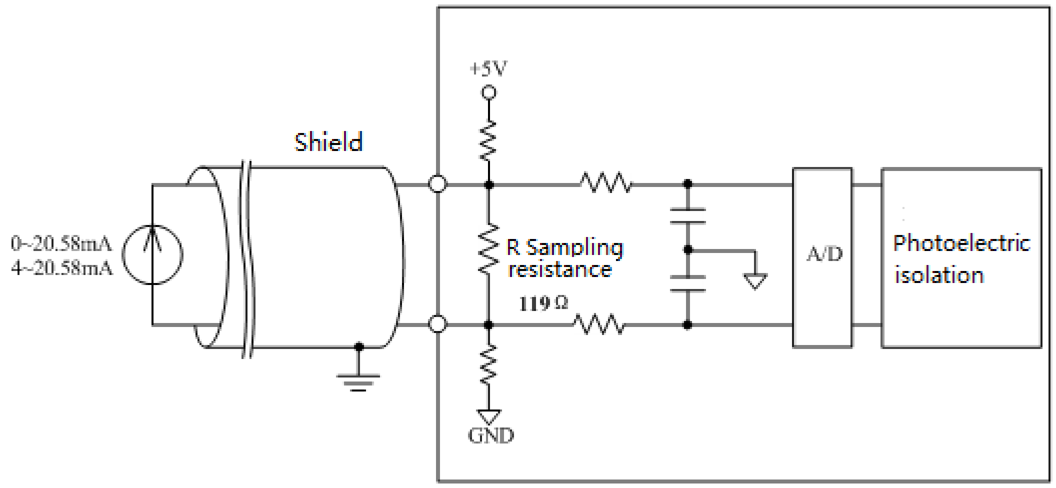


Figure 174 LK411 Channel Interface Circuit Diagram

1.6.3 Indicators

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

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

Table 106 Definition of LK411 Status Indicators

Name	Status	Description
RUN indicator (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 (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 indicator flashing based on a frequency of 4 times/second.
  - Upon the completion of initialization, the green indicator 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 indicator 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 indicator is normally on. When the communication is disconnected, the green indicator flashes. When the communication is established again, the green indicator is turned normally on again.
  - The yellow indicator is normally off when the module is in the running mode.

Table 107 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 indicator flashing based on a frequency of 4 times/second.
  - Upon the completion of initialization, the green indicator is turned normally on. In case of any error in the initialized data, the green indicator 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 indicator

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 indicator then flashes again.

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

Table 108　Definition of LK411 Indicators in Calibration Mode

	RUN Lamp	CAL Indicator	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

1.6.4　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 backplane.

The LK411 module is installed on the extension backplane.

Table 109　Definition of LK411 Backplane Terminals

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

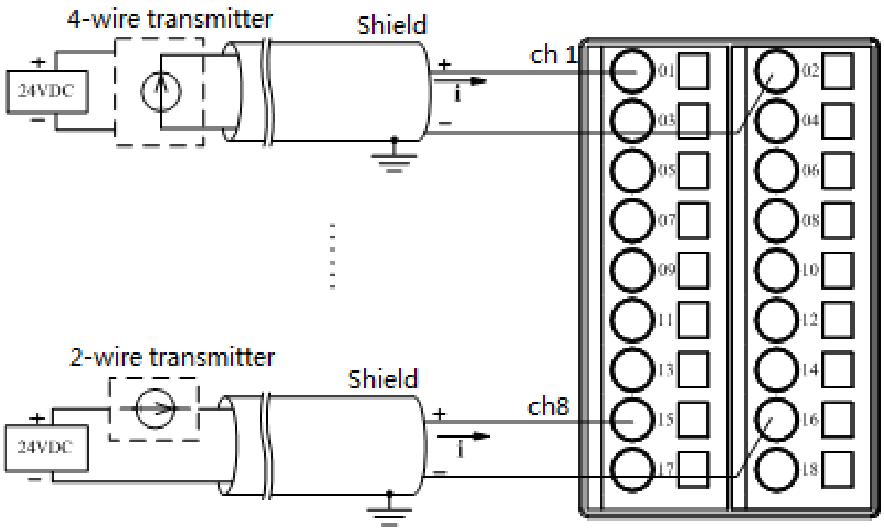


Figure 175 Backplane Terminal Wiring Schematic Diagram

Pay attention to the following during wiring:

- The two-row 18-channel terminals are fixed on the backplane, 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 backplane.
- Terminals 17 and 18 are not used, with wiring forbidden.

1.6.5 Functions

1.6.5.1 Measured Data Output Format

As shown in Table 110, 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) codes.

Table 110 Corresponding Relationship between LK411 Input Current and Digital Code

Max. Measurable Range	Corresponding Decimal Code Value
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 Safety FA-AutoThink, it can convert the 2-byte measured data into the engineering data. Refer to the *LKS Safety Control System 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 111, the current signal is converted to a decimal digital code to fill in.

Table 111　Data Conversion Formula of LK411 Module

Max. Measurable Range	Formula of Corresponding Code Values
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 176 for the relevant user parameter settings.

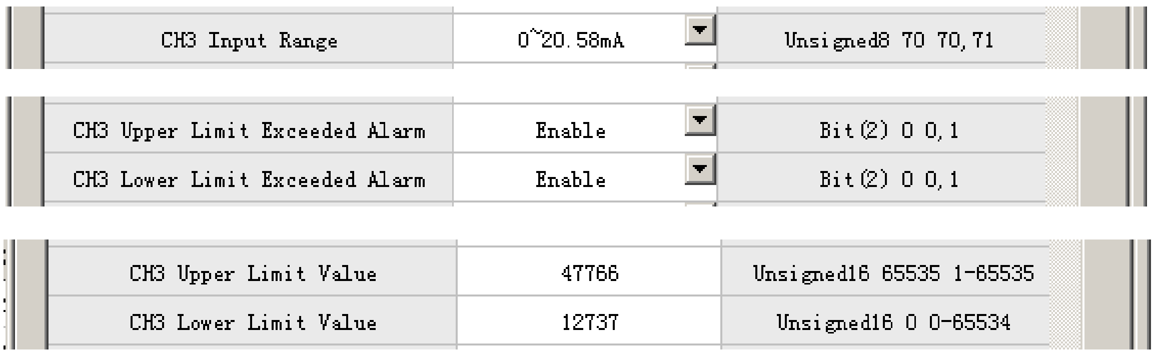


Figure 176　Examples of Over-limit Alarm Parameter Settings Based on Selected Range

1.6.6　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), diagnosis data is saved to the output parameters DiagData1~ DiagData28 of 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.

Diagnosis information DiagData1~ DiagData28 of function block sysGetDPSlaveState (Get Diagnosis of DP Slave) is shown in Table 112.

Table 112　Output parameter DiagData1~ DiagData28

Output parameter	Data type	Description
DiagData1~ DiagData2	BYTE	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.
DiagData3~ DiagData4	BYTE	Identification diagnosis information The 2-byte identification diagnosis information is 0x42, 0x01 when diagnosis information is reported.
DiagData5~ DiagData7	BYTE	Channel 1 diagnosis information, see Table 113 for channel.

Output parameter	Data type	Description
		diagnosis information
DiagData8~ DiagData10	BYTE	Channel 2 diagnosis information
…	BYTE	…
DiagData26~ DiagData28	BYTE	Channel 8 diagnosis information

Table 113　Specifications for LK411 Channel 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. 1~8 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.

1.6.6.1 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 scale code value 0xFFFF. If less than the Min. measured current, the measured channel data reports the code value 0x0000.

Table 114 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.

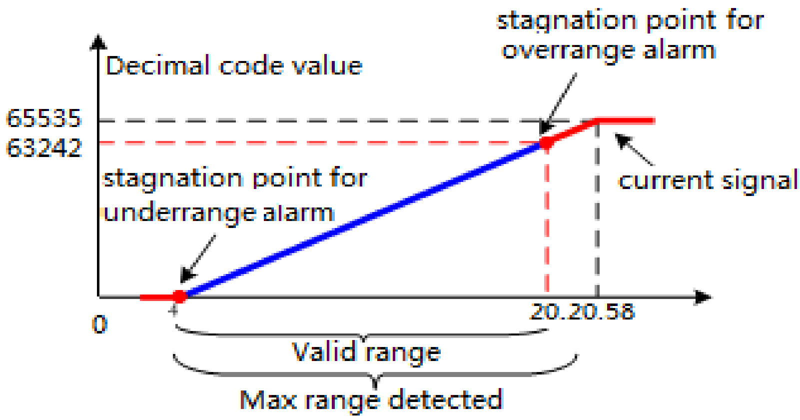


Figure 177 LK411 Over Range Alarm Schematic Diagram

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 115. When the signal is recovered to the normal range, the channel diagnosis byte then reports 0xA0.

Table 115 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

Max. Measurable Range	Effective Range	Type of Over Range	Handling of Over Range
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

1.6.6.2 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 value for current must be more than the lower limit value for current. Otherwise, the LK411 module cannot report the diagnosis message properly.

If over-limit is enabled and occurs in synchronism with the over range, the LK411 module then reports the over range.

Table 116 Range of LK411 Over-limit Alarm Values

Range	Alarm Signal
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

The alarm value in the configuration is the digital code value corresponding to the measured signal in the selected range, expressed in a two-byte decimal code (0~65,535). Range of upper limit value values: 1~65,535, defaulted to 65,535, range of lower limit value values: 0~65,534, defaulted to 0. Refer to Section 1.6.5.1 Measured Data Output Format for the specific calculation methods.

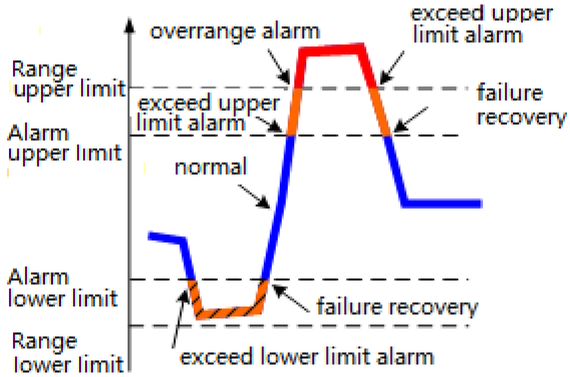


Figure 178 LK411 Over-Limit Alarm Schematic Diagram

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.

1.6.6.3 Line Broken Detection

The LK411 module is capable of line broken detection.

As shown in Figure 179, 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 controller. 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.

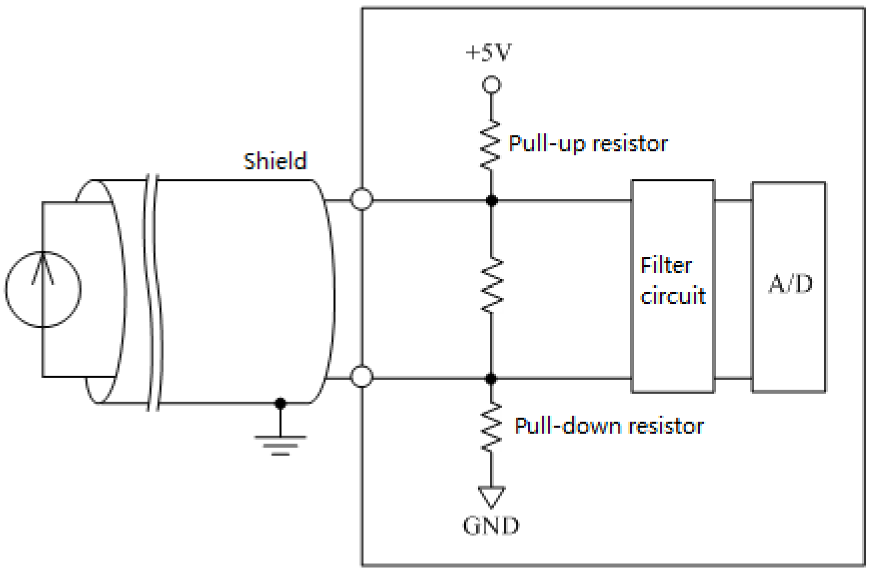


Figure 179　LK411 Line Broken Detection Schematic Diagram

1.6.7 Parameters

The user parameter is used to set the operation mode of the module. The controller 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 117 LK411 User Parameters

<table>
<tr><th>Parameter Name</th><th>Meaning</th><th>Value</th></tr>
<tr><td>Filter Mode</td><td>Parameter for selecting a digital filtering mode</td><td>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</td></tr>
<tr><td>Sample Rate</td><td>To select the sampling rate</td><td>0: Fast, fastest sampling rate
1: Normal (default, drift suppression enabled, but with the internal sampling time doubled)</td></tr>
<tr><td>CH1 Input Range</td><td>To select the range of Channel 1</td><td rowspan="8">70=0~20.58 mA (default)
71=4~20.58 mA</td></tr>
<tr><td>CH2 Input Range</td><td>To select the range of Channel 2</td></tr>
<tr><td>CH3 Input Range</td><td>To select the range of Channel 3</td></tr>
<tr><td>CH4 Input Range</td><td>To select the range of Channel 4</td></tr>
<tr><td>CH5 Input Range</td><td>To select the range of Channel 5</td></tr>
<tr><td>CH6 Input Range</td><td>To select the range of Channel 6</td></tr>
<tr><td>CH7 Input Range</td><td>To select the range of Channel 7</td></tr>
<tr><td>CH8 Input Range</td><td>To select the range of Channel 8</td></tr>
<tr><td>CH1 Digital Filter</td><td>To select software filtering of Channel 1</td><td rowspan="6">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</td></tr>
<tr><td>CH2 Digital Filter</td><td>To select software filtering of Channel 2</td></tr>
<tr><td>CH3 Digital Filter</td><td>To select software filtering of Channel 3</td></tr>
<tr><td>CH4 Digital Filter</td><td>To select software filtering of Channel 4</td></tr>
<tr><td>CH5 Digital Filter</td><td>To select software filtering of Channel 5</td></tr>
<tr><td>CH6 Digital Filter</td><td>To select software filtering of Channel 6</td></tr>
</table>

Parameter Name	Meaning	Value
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	
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 1.6.5.1 Measured Data Output Format for the calculation method
CH1 Lower Limit Value	To set Upper Limit Value of Channel 1	
CH2 Upper Limit	To set Upper Limit Value of	

Parameter Name	Meaning	Value
Value	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 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	
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	

Parameter Name	Meaning	Value
CH8 Line Break Alarm	To enable Line Break Alarm of Channel 8	

1.6.8 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	
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 swapping	Supported	
Physical Property		
Protection Key	A1	
Installation Position	Extension backplane	
Module Dimension (W*H*D)	35 mm×100 mm×100 mm	
Enclosure Protection Rating	IEC60529 IP20	
Weight	190 g	

1.7 LK412　6-channel Isolation Analog Input Module

1.7.1　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

1.7.2　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 controller via the DP bus. The voltage signal is converted into a digital signal via voltage conversion, filtering and A/D, uploaded to the controller via the DP bus.

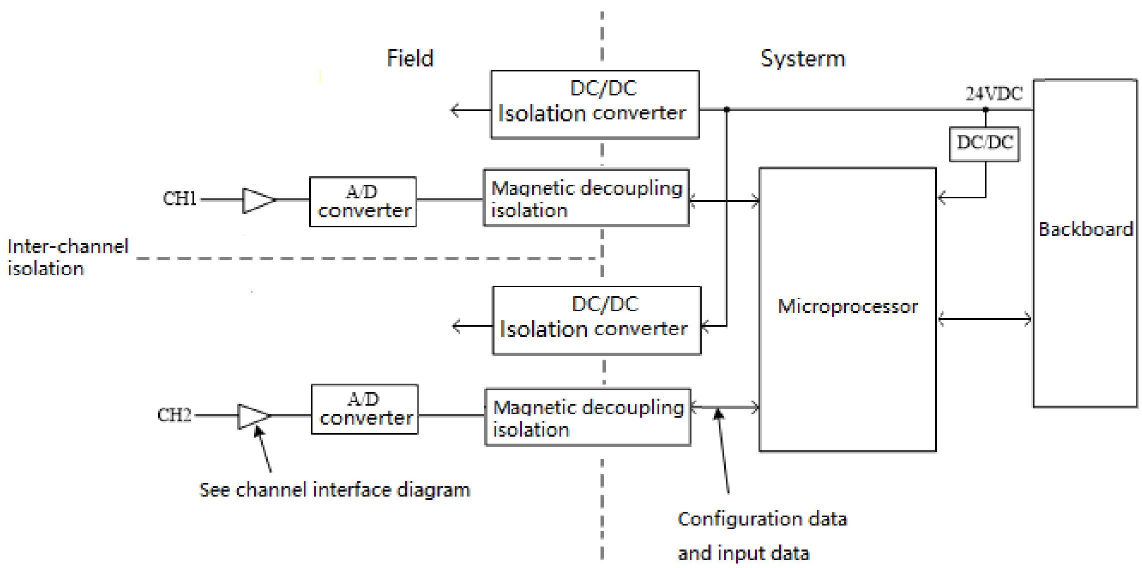


Figure 180　Internal Structure Block Diagram of LK412

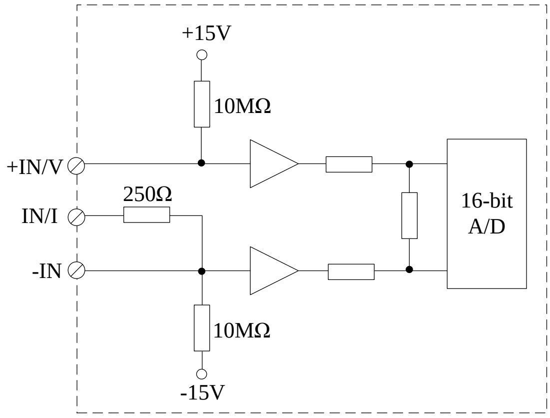


Figure 181 Channel Interface Circuit of LK412 Module

1.7.3 Indicators

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

The LK412 module supports field calibration. The meanings of the indicator are different when in the running mode and the calibration mode.

Table 118 Definition of LK412 Indicators

Name	Status	Description
RUN indicator (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 (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 indicator flashing based on a frequency of 4 times/second.
  - Upon the completion of initialization, the green indicator 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 indicator keeps flashing. Check whether the DP is connected properly and the communication parameters are set properly.
  - When the module works well, the green indicator is normally on. When the communication is disconnected, the green indicator flashes. When the communication is established again, the green indicator is turned normally on again.
  - The yellow indicator is normally off when the module is in the running mode.

Table 119 Definition of LK412 Indicators in Running Mode

	RUN Indicator	CAL Indicator	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 indicator flashing based on a frequency of 4 times/second.
  - Upon the completion of initialization, the green indicator is turned normally on. In case of any error in the initialized data, the green indicator 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 indicator 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 indicator then flashes again.
  - During calibration and detection, the green indicator is normally no. When the communication is disconnected, the green indicator flashes. When the communication is established again, the green indicator is turned normally on again.
  - When the communication is not established or disconnected, the yellow indicator then goes out.

Table 120 Definition of LK412 Indicators in Calibration Mode

	RUN Indicator	CAL Indicator	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

1.7.4 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 backplane.

The LK412 module is installed on the extension backplane.

Table 121 Definition of LK412 Backplane 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

Channel	Terminal No.		
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 backplane, 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.

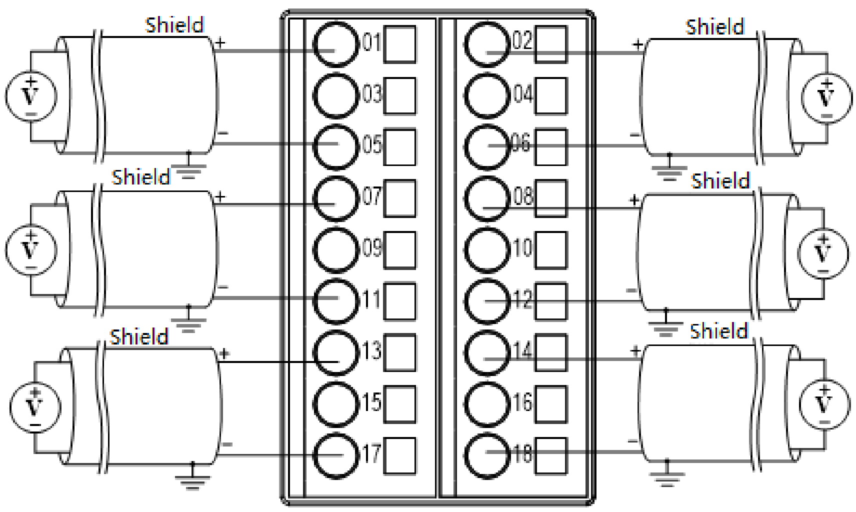


Figure 182   LK412 Voltage Channel Terminal Wiring Diagram

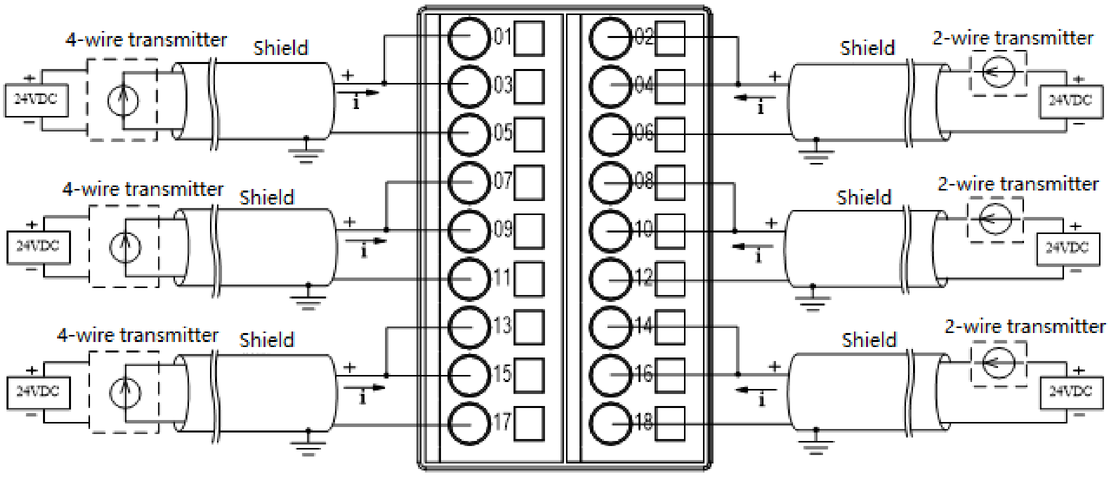


Figure 183 LK412 Current Channel Terminal Wiring Diagram

1.7.5 Functions

1.7.5.1 Measured Data Output Format

As shown in Table 122, 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) codes. Notably, the voltage range (-10.25~+10.25 V) has two segments, including the positive voltage (0~10.25 V) corresponding to the decimal code value (0~32,767) and the negative voltage (-10.25 V~0) corresponding to the decimal code value (32,768~65,535).

Table 122 Corresponding Relationship between LK412 Input Signal and Digital Code

Max. Measurable Range		Corresponding Decimal Code Value
-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 Safety FA-AutoThink, it can convert the 2-byte measured data into the engineering data. Refer to the *LKS Safety Control System 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 123, 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 123 Data Conversion Formula of LK412 Module

Max. Measurable Range		Formula of Corresponding Code Values
-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 184 for the relevant [User parameter] settings.

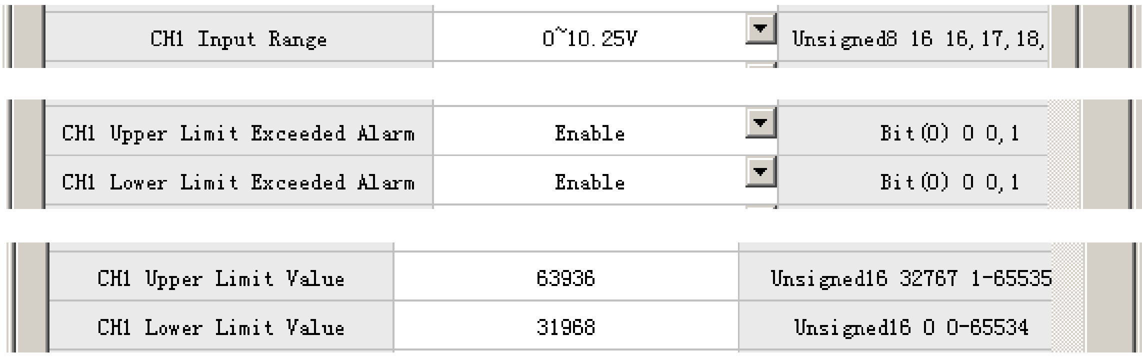


Figure 184 Examples of Over-limit Alarm Parameter Settings Based on Selected Range

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 185 for the relevant user parameter settings.

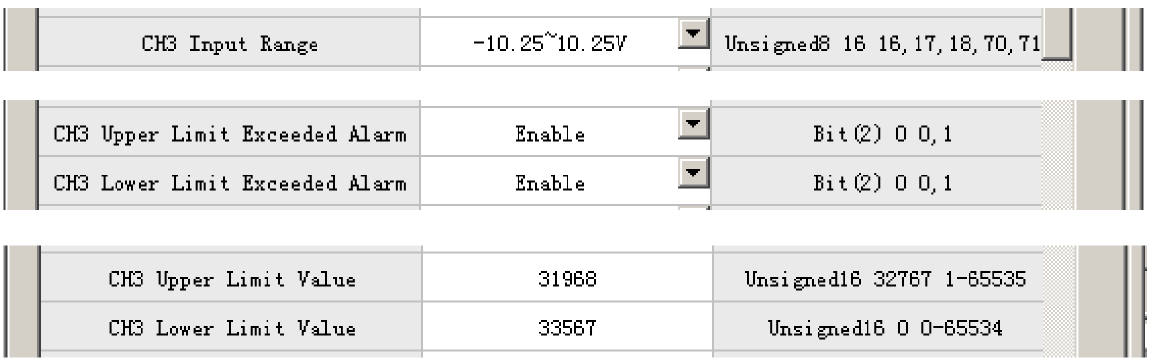


Figure 185 Examples of Over-limit Alarm Parameter Settings Based on Selected Range

1.7.6 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), diagnosis data is saved to the output parameters DiagData1~ DiagData22 of 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 DiagData1~ DiagData22 of function block sysGetDPSlaveState (Get Diagnosis of DP Slave) is shown in Table 124.

Table 124　Output parameter DiagData1~ DiagData22

Output parameter	Data type	Description
DiagData1~ DiagData2	BYTE	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.
DiagData3~ DiagData4	BYTE	Identification diagnosis information The 2-byte identification diagnosis information is 0x42, 0x01 when diagnosis information is reported.
DiagData5~ DiagData7	BYTE	Channel 1 diagnosis information, see Table 125 for channel . diagnosis information
DiagData8~ DiagData10	BYTE	Channel 2 diagnosis information
…	BYTE	…
DiagData20~ DiagData22	BYTE	Channel 6 diagnosis information

Table 125　Specifications for LK412 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. 1~6
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" colspan="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 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 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.

1.7.6.1 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 126 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

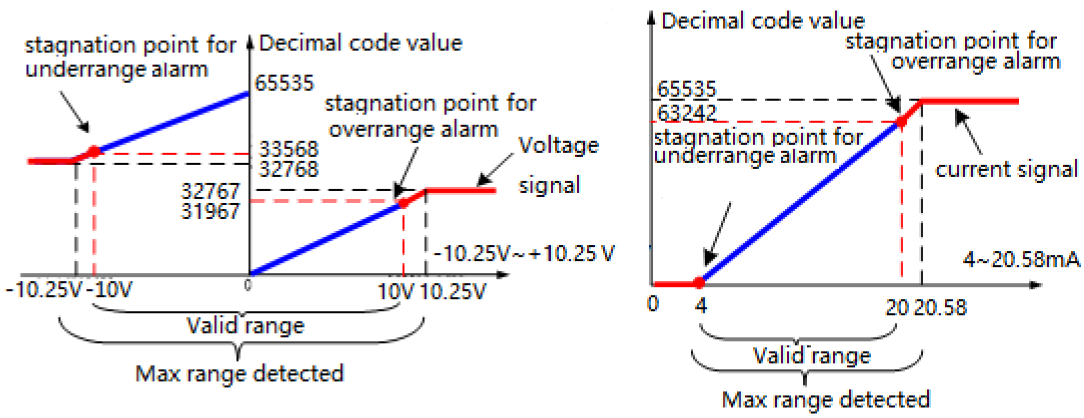


Figure 186 LK412 Over Range Alarm Schematic Diagram

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 127. When the signal is recovered to the normal range, the channel diagnosis byte then reports 0xA0.

Table 127 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 -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

Max. Measurable Range	Range	Type of Over Range	Handling of Over Range
			> 5.125V, the measured channel data reports 65,535
		Under Range	The channel diagnosis byte reports 0xA2 The measured channel data reports 0

1.7.6.2 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 is enabled and occurs in synchronism with the over range, the LK412 module then reports the over range.

Table 128 Range of LK412 Over-limit Alarm Values

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 value corresponding to the measured signal in the selected range, expressed in a two-byte decimal code (0~65,535). Range of upper limit value values: 1~65,535, defaulted to 32,767, range of lower limit value values: 0~65,534, defaulted to 0. The formula of the code value corresponding to the electrical signal is shown in Table 129.

Table 129 Calculation of LK412 Alarm Limit Code

Input Signal		Upper Limit Value Code (Decimal)	Lower Limit Value 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 V	-10.25~0 V	65,535+(Lower Limit voltage × 32,767/ 10.25)	65,535+(Lower Limit 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

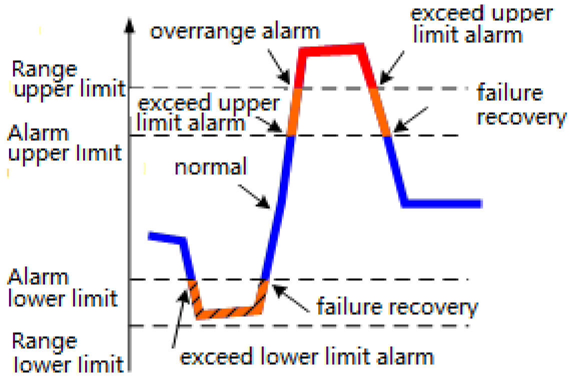


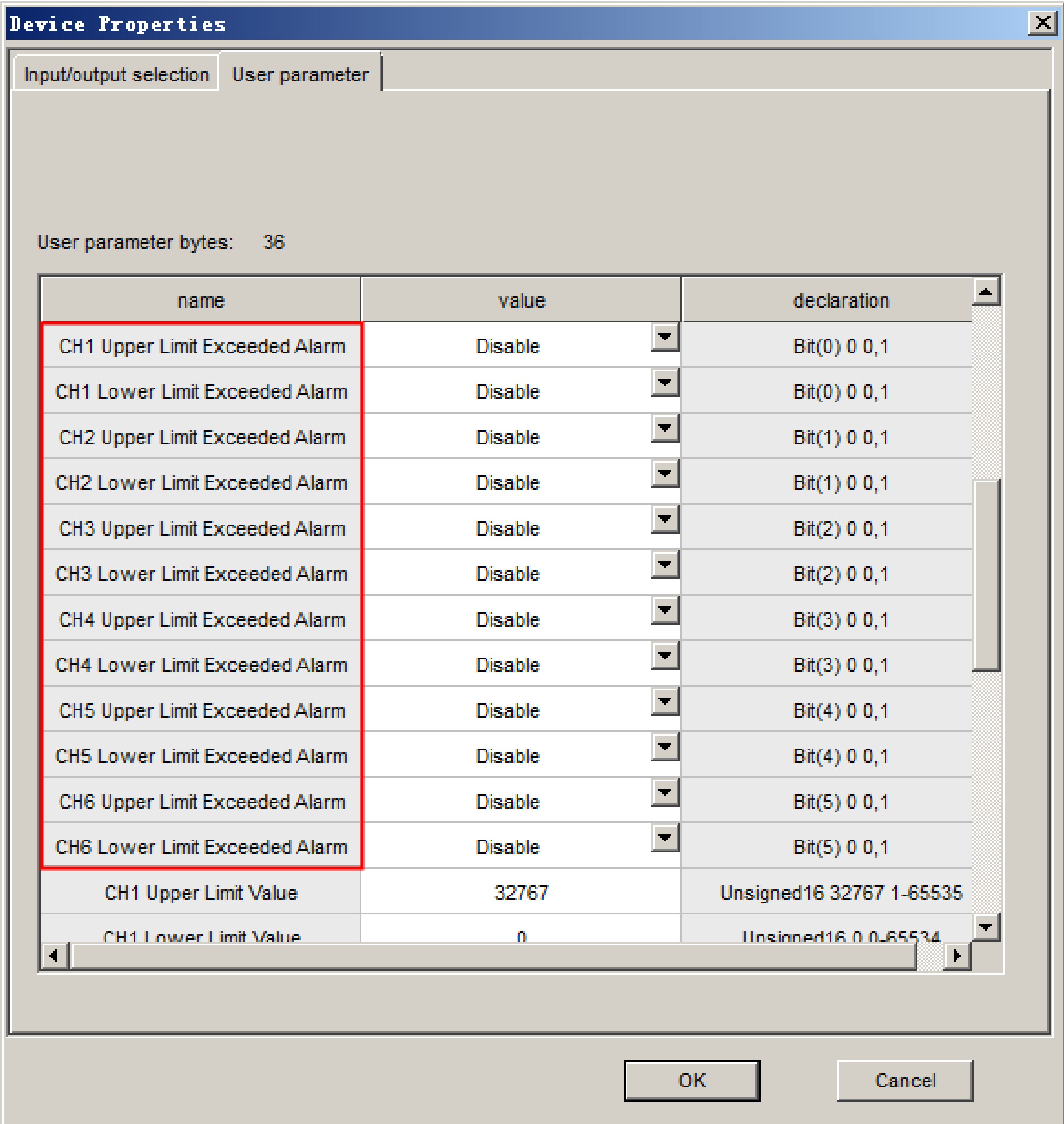
Figure 187   LK412 Over-limit Alarm Diagnosis

When certain input channel signal over-limits:

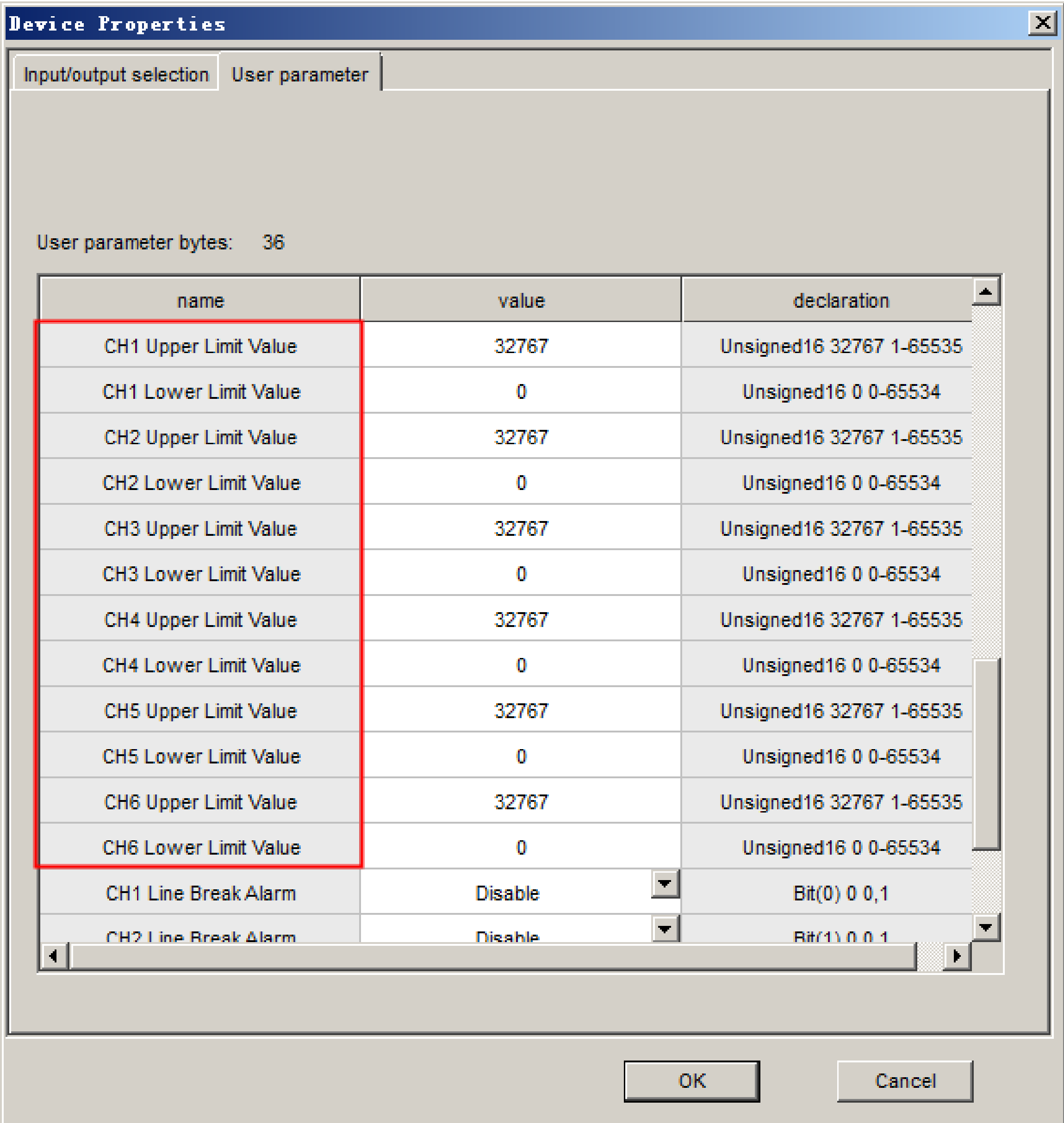
- If going beyond the upper limit, the channel diagnosis byte then reports 0xA7.
- If going beyond the lower limit, the channel diagnosis byte then reports 0xA8.
- The measured channel data reports the code value corresponding to the current signal.
- If the signal is recovered to the normal range, the 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 188 LK412 Over-limit Alarm Parameters

1.7.6.3 Line Broken Detection

The LK412 module is capable of line broken detection.

As shown in Figure 189, 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 controller. 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 130 for the diagnosis and handling of various signal types. After the line broken is recovered, the channel diagnosis byte reports 0xA0.

Table 130 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)

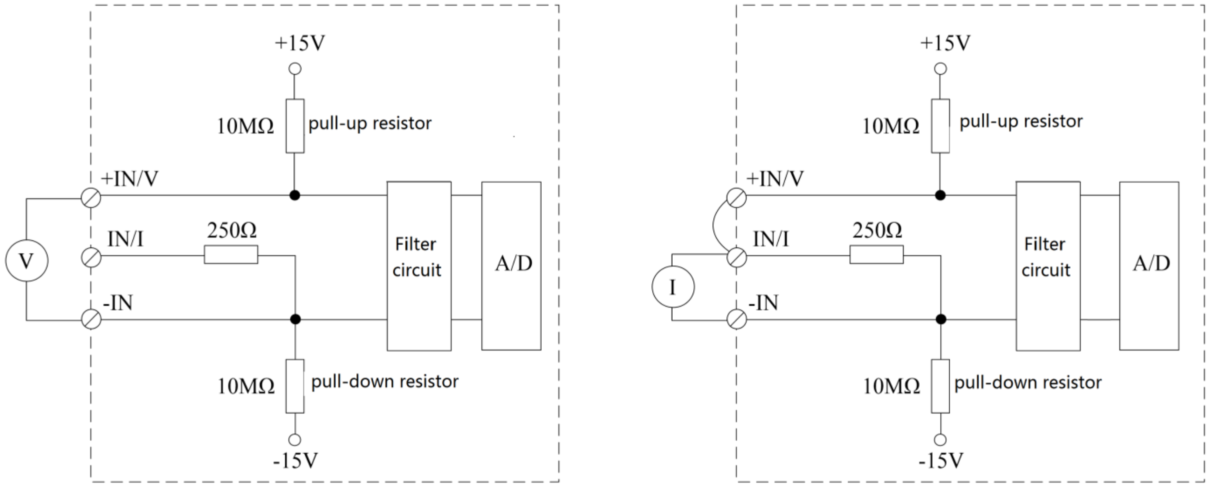


Figure 189 LK412 Channel Line Broken Detection Circuit Diagram

1.7.7 Parameters

The user parameter is used to set the operation mode of the module. The controller 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 131 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 1.7.5.1 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.

1.7.8 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		＞100 dB			
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 swapping		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 backplane			
Module Dimension (W*H*D)		35 mm×100 mm×100 mm			
Enclosure Protection Rating		IEC60529 IP20			
Weight		190 g			

1.8 LK430 6-channel Thermal Resistance Analog Input Module

1.8.1 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

1.8.2 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.

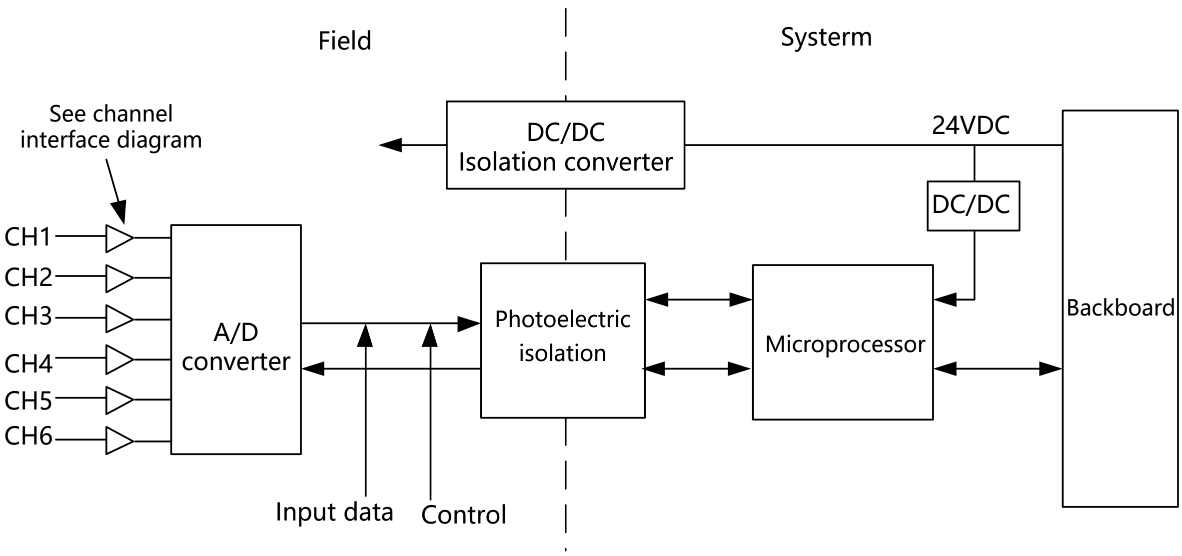


Figure 190 Internal Structure Block Diagram of LK430

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 191 for the interface circuit.

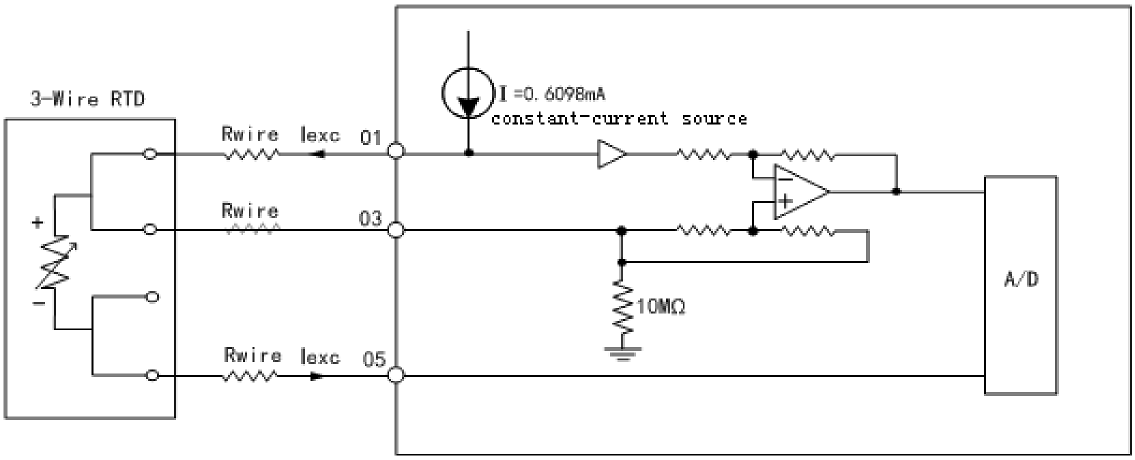


Figure 191 LK430 Channel Interface Circuit Diagram (Taking Channel 1 for Example)

1.8.3 Indicators

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

Table 132 Definition of LK430 Status Indicators

Name	Status	Description
RUN indicator (green)	On	The communication is established
	Flash	The communication is not established or incorrect.
	Off	The module is not powered on.
CAL calibration indicator (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 indicator flashing based on a frequency of 4 times/second.
  - Upon the completion of initialization, the green indicator 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 indicator 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 indicator is normally on. When the communication is disconnected, the green indicator flashes. When the communication is established again, the green indicator is turned normally on again.
  - The yellow indicator is normally off when the module is in the running mode.

Table 133 Definition of LK430 Indicators in Running Mode

	RUN Indicator	CAL Indicator	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 indicator flashing based on a frequency of 4 times/second.
  - Upon the completion of initialization, the green indicator is turned normally on. In case of any error in the initialized data, the green indicator 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 indicator 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 indicator then flashes again.
  - During calibration and detection, the green indicator is normally no. When the communication is disconnected, the green indicator flashes. When the communication is established again, the green indicator is turned normally on again.
  - When the communication is not established or disconnected, the yellow indicator then goes out.

Table 134 Definition of LK430 Indicators in Calibration Mode

	RUN Indicator	CAL Indicator	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

1.8.4 Wirings

The LK430 module is installed on the extension backplane.

Table 135 Definition of LK430 Backplane Terminals

Channel No.	Sequence of Terminals		
1	01	03	05
2	02	04	06
3	07	09	11
4	08	10	12
5	13	15	17
6	14	16	18

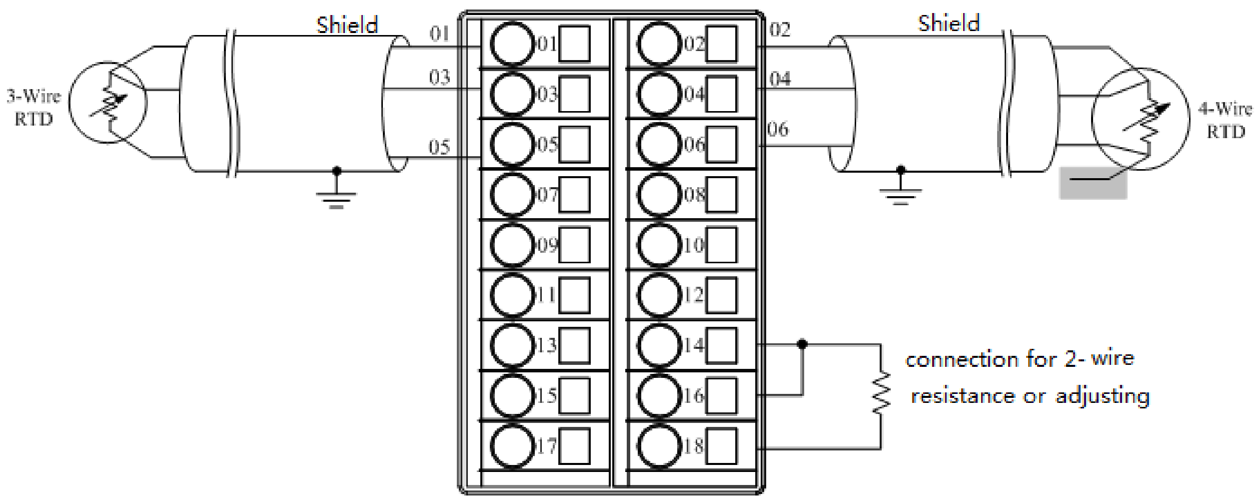


Figure 192 LK430 Backplane Terminal Wiring Diagram

Pay attention to the following during wiring:

- The two-row 18-channel terminals are fixed on the backplane, 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.

1.8.5 Functions

1.8.5.1 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 value code or the output temperature value 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 Code/65,535)× Full Scale Resistance Value +Min. Measurable Resistance Value in Range, notably, the full scale 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 scale resistance value=121.75-1=120.75.

- Output temperature value for configuration selection:

  Temperature Value (℃/℉)=(Temperature 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 Safety FA-AutoThink.

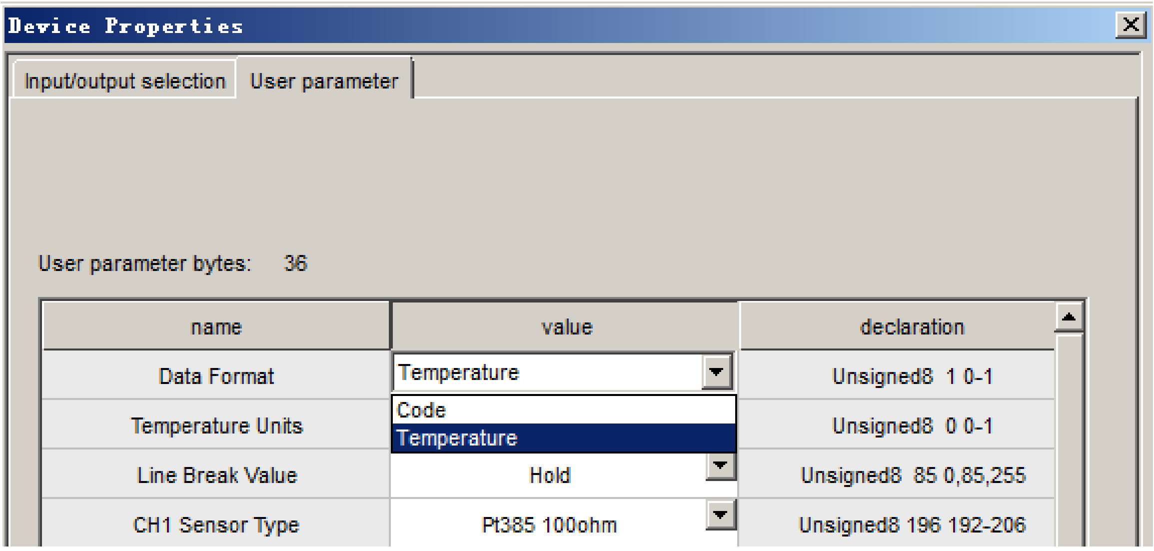


Figure 193 LK430 Output Data Format Selection

1.8.5.2 Measurement Range

Refer to Table 136 for various standard LK430-supported thermal resistances and their measurement ranges.

Table 136 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
Platnium385 500 Ω	-200℃~870℃	92.6005~1981.56	203	
Platnium3916 500 Ω	-200℃~630℃	84.98~1638.72	204	
Platnium385 1000	-200℃~870℃	185.201~3963.11	205	8~4020

Type of Thermal Resistance	Thermal Resistance Temperature Measurement Range (℃)	Corresponding Resistance Value Range of Thermal Resistance (Ω)	Range Code	Max. Measurable Resistance Range (Ω)
Ω				
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.

1.8.6 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), diagnosis data is saved to the output parameters DiagData1~ DiagData22 of function block.

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 DiagData1~ DiagData22 of function block sysGetDPSlaveState (Get Diagnosis of DP Slave) is shown in Table 137.

Table 137 Output parameter DiagData1~ DiagData22

Output parameter	Data type	Description
DiagData1~ DiagData2	BYTE	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.
DiagData3~ DiagData4	BYTE	Identification diagnosis information The 2-byte identification diagnosis information is 0x42, 0x01 when diagnosis information is reported.
DiagData5~ DiagData7	BYTE	Channel 1 diagnosis information, see Table 138 for channel . diagnosis information
DiagData8~ DiagData10	BYTE	Channel 2 diagnosis information

Output parameter	Data type	Description
…	BYTE	…
DiagData20~ DiagData22	BYTE	Channel 6 diagnosis information

Table 138　Specifications for LK430 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)			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, 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.

1.8.6.1 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 136, 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 codes of upper and lower limits given below:

- Upper Limit Value Digital Code=Upper Limit Value　Temperature Value×10+10000
- Lower Limit Value 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.

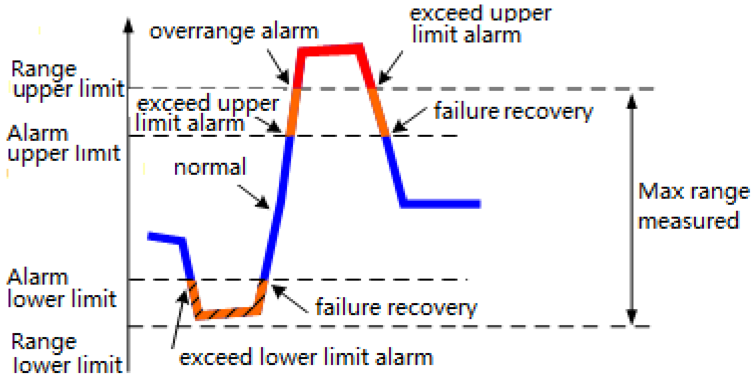


Figure 194 LK430 Over-limit Alarm Schematic Diagram

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 139. When the signal is recovered to the normal range, the channel diagnosis area then reports 0xA0.

Table 139 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 value digital code ＞Upper Range Limit, the measured channel data reports the max. measurable temperature value digital 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 value digital code ＜Lower Range Limit, the measured channel data reports the Min. measurable temperature value digital 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 value 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 value digital code ＜ Lower Range Limit, the measured channel data reports 0x0000

1.8.6.2 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 controller.

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 140.

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 140 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 digital code value in the range When an line broken occurs to Terminal 5, the measured channel data reports the Max. temperature digital code value in the range
	0xFFFF	
	Hold (default)	The measured channel data hold the normal data prior to the line broken

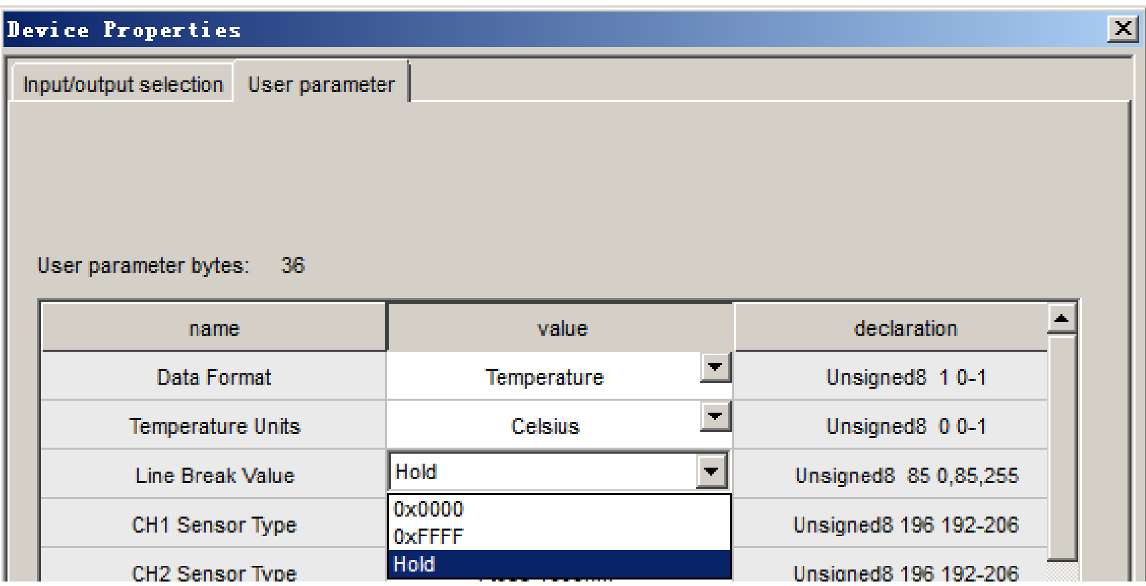


Figure 195 LK430 Line Broken Detection Settings

1.8.7 Parameters

The user parameter length of the LK430 module is up to 36 bytes.

Table 141 Table of LK430 User Parameters

Parameter Name	Meaning	Value	Default
Data Format	To select the 6-channel	0=Code, to report the resistance	1

Parameter Name	Meaning	Value	Default
	measured channel data output format of the module	code value 1=Temperature, to report the temperature code value	
Temperature Units	To select the temperature scale for the measured temperature of the module	0=Celsius, Celsius temperature scale 1=Fahrenheit, Fahrenheit scale	0
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 1.8.6.2 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

Parameter Name	Meaning	Value	Default
CH1 Upper 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 1.8.6.1 Over-limit Alarm for setting and calculating the alarm limits	Lower Limit Value: 8000 Upper Limit Value: 18700
CH1 Lower Limit Value			
CH2 Upper Limit Value			
CH2 Lower Limit Value			
CH3 Upper Limit Value			
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.

1.8.8 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

LK430 6-channel Thermal Resistance Type Analog Input Module			
Thermal Resistance Type and Temperature Measurement Accuracy	Thermal Resistance Type Code	Temperature Measurement Range	Absolute Error
	Copper427: 10 Ω	-200℃~260℃	1.4℃
	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 scale		
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 scale 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 swapping	Supported		
Physical Property			
Protection Key	A2		
Installation	Extension backplane		

LK430　6-channel Thermal Resistance Type Analog Input Module	
Module Dimension (W*H*D)	35 mm×100 mm×100 mm
Enclosure Protection Rating	IEC60529 IP20
Weight	180 g

1.9 LK441　8-channel Thermocouple (with cold junction compensation) Analog Input Module

1.9.1 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

1.9.2 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 controller via the Profibus-DP bus.

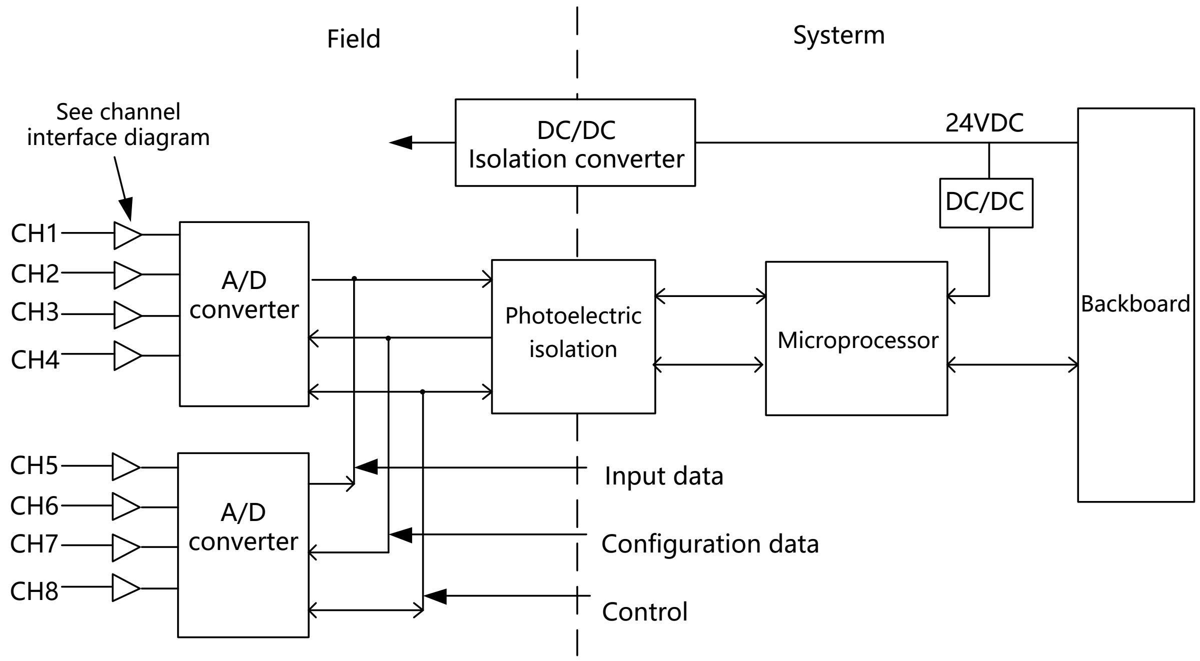


Figure 196 Internal Structure Block Diagram of LK441

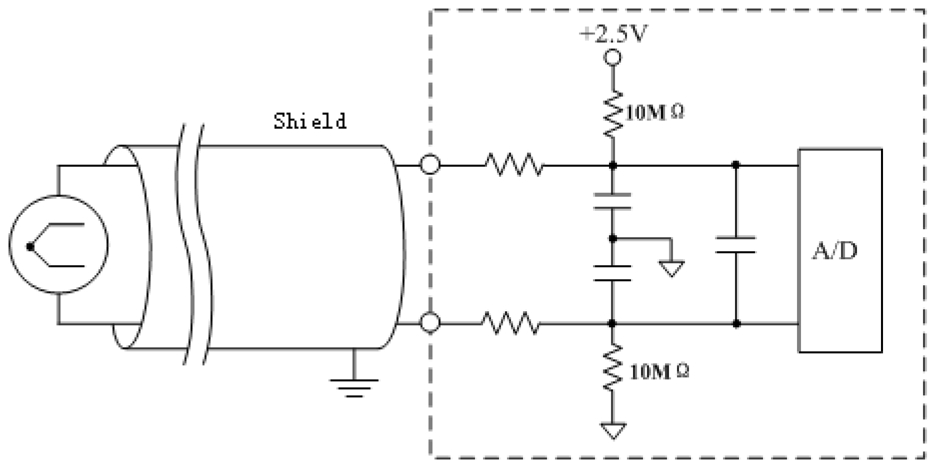


Figure 197 LK441 Channel Interface Circuit Diagram

1.9.3 Indicators

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

The LK441 module supports field calibration. The meanings of the indicator are different when in the running mode and the calibration mode.

Table 142 Definition of LK441 Status Indicators

Name	Status	Description
RUN indicator	On	The communication is established, and the module

Name	Status	Description
(green)		works well
	Flash	The communication is not established or incorrect
	Off	The module is not powered on
CAL calibration indicator (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 indicator flashing based on a frequency of 4 times/second.
  - Upon the completion of initialization, the green indicator 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 indicator keeps flashing. Check whether the DP is connected properly and the communication parameters are set properly.
  - When the module works well, the green indicator is normally on. When the communication is disconnected, the green indicator flashes. When the communication is established again, the green indicator is turned normally on again.
  - The yellow indicator is normally off when the module is in the running mode.

Table 143　Definition of LK441 Indicators in Running Mode

Name	Status	Description
RUN indicator (green)	On	The communication is established
	Flash	The communication is not established or incorrect
	Off	The module is not powered on
CAL calibration indicator (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 indicator flashing based on a frequency of 4 times/second.
  - Upon the completion of initialization, the green indicator is turned normally on. In case of any error in the initialized data, the green indicator 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 indicator

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 indicator then flashes again.

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

Table 144 Definition of LK441 Indicators in Calibration Mode

	RUN Indicator	CAL Indicator	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

1.9.4 Wirings

The LK441 module is installed on the extension backplane.

Table 145 Definition of LK441 Backplane 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

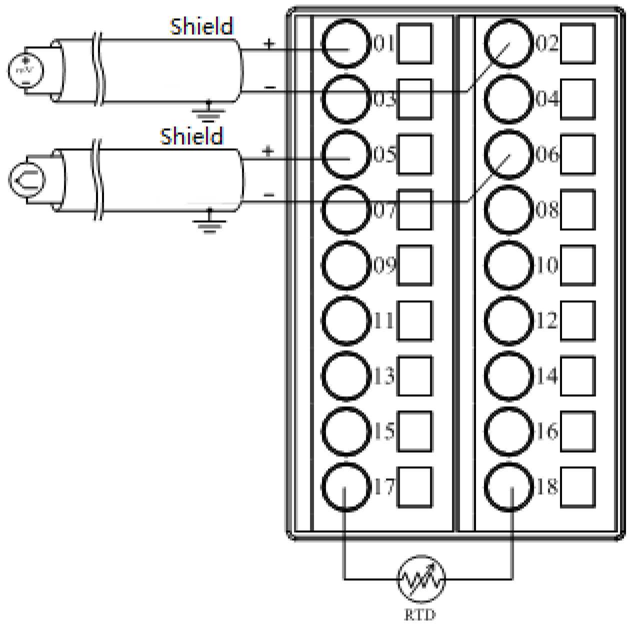


Figure 198 LK441 Backplane Terminal Wiring Diagram

Pay attention to the following during wiring:

- The two-row 18-channel terminals are fixed on the backplane, 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.

1.9.5 Functions

1.9.5.1 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 Safety FA-AutoThink, it can convert the 2-byte millivolt digital 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.

1.9.5.2 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 controller representing a temperature value (that is, to report the temperature digital code).

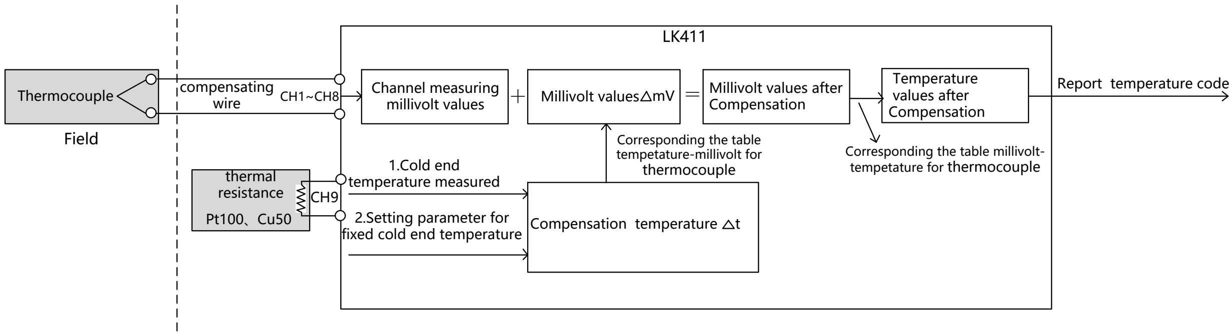


Figure 199　LK441 Cold-conjunction Temperature Compensation Block Diagram

- 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 controller. The specific compensation algorithm is completed automatically in LK441. The controller 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 controller. The specific compensation algorithm is completed automatically in LK441. The controller 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.

1.9.6 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), diagnosis data is saved to the output parameters DiagData1~ DiagData31 of 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 DiagData1~ DiagData31 of function block sysGetDPSlaveState (Get Diagnosis of DP Slave) is shown in Table 146.

Table 146 Output parameter DiagData1~ DiagData31

Output parameter	Data type	Description
DiagData1~ DiagData2	BYTE	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.
DiagData3~ DiagData4	BYTE	Identification diagnosis information The 2-byte identification diagnosis information is 0x42, 0x01 when diagnosis information is reported.
DiagData5~ DiagData7	BYTE	Channel 1 diagnosis information, see Table 147 for channel . diagnosis information
DiagData8~ DiagData10	BYTE	Channel 2 diagnosis information
…	BYTE	…
DiagData29~ DiagData31	BYTE	Channel 9 diagnosis information

Table 147 Specifications for LK441 Channel 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. 1~8 Decimal online value 64~72
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, 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.

1.9.6.1 Optional Alarms

The alarms that are provided by each range for the LK441 module are different, as shown in Table 148.

Table 148 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.

1.9.6.2 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 1.9.6.1 Optional Alarms.

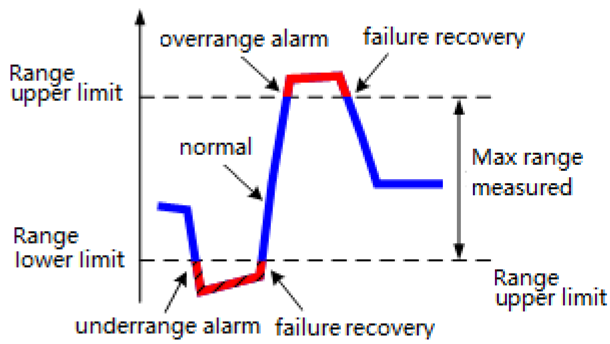


Figure 200 LK441 Over Range Alarm Schematic Diagram

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 149. 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 149 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 digital 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 digital 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

1.9.6.3 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 safety 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 value digital code (when millivolt is selected for the range). Refer to Table 150 for the conversion formula.

Table 150 Calculation of LK441 Alarm Limit Value Digital code

Range Type	Upper Limit Value (Decimal)	Lower Limit Value (Decimal)

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.

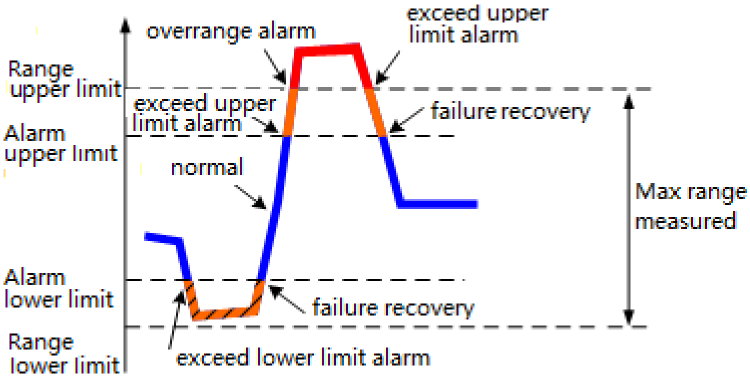


Figure 201 LK441 Over-limit Alarm Schematic Diagram

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 151. 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 151 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 code
	Lower limit exceeded	1. The channel diagnosis area reports the fault value 0xA8 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.

1.9.6.4 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 1.9.6.1 Optional Alarms. For a millivolt signal range, the LK441 module does not support line broken detection.

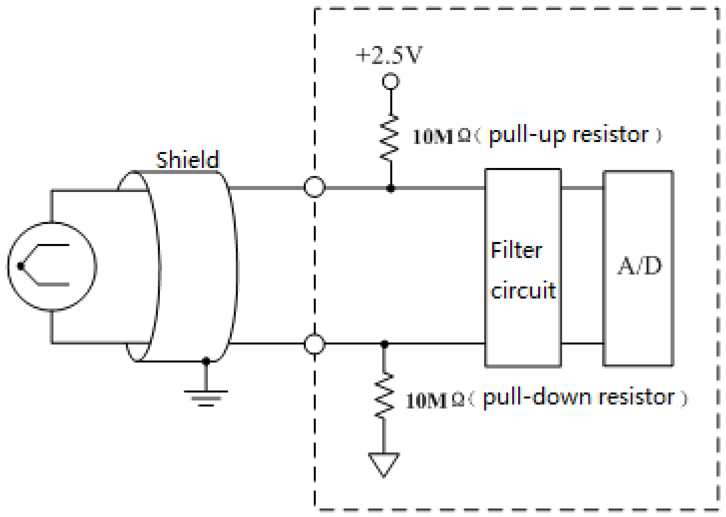


Figure 202 LK441 Line Broken Detection Schematic Diagram

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 value 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.

1.9.7 Parameters

The user parameter is used to set the operation mode of the module. The controller 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 152 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	
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	

[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.

[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.

Parameter Name	Meaning	Value
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	
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	

[3] The software filtering of each channel does not interfere with each other and can be different modes separately.

Parameter Name	Meaning	Value
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	
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	

Parameter Name	Meaning	Value
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	

1.9.8 Technical Specifications

LK441 8-channel Thermocouple (with cold junction compensation) 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)
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	

<table>
<tr><th colspan="3">LK441　8-channel Thermocouple (with cold junction compensation) Analog Input Module</th></tr>
<tr><td>Common Mode Rejection Ratio</td><td colspan="2">100 dB</td></tr>
<tr><td>Input Impedance</td><td colspan="2">10 MΩ min.</td></tr>
<tr><td>Sampling Period (Full-channel Scanning Time)</td><td colspan="2">85 ms, 420 ms, 490 ms, 1500 ms, optional for configuration</td></tr>
<tr><td>Setting Time for full-scall 1％</td><td colspan="2">1 s max., in the ±1% error range of the full-scall</td></tr>
<tr><td>Channel Bandwidth</td><td colspan="2">15 Hz</td></tr>
<tr><td>Voltage Calibration Accuracy</td><td colspan="2"><0.04% F.S.@ 25℃</td></tr>
<tr><td>Calibration Period</td><td colspan="2">12 months</td></tr>
<tr><td>Isolation Voltage between Field and System</td><td colspan="2">500 VAC@1 min, leaking current: 5 mA</td></tr>
<tr><td colspan="3">Uploaded Data Format (0~65,535)</td></tr>
<tr><td>Millivolt Range</td><td colspan="2">65,535×(Millivolt Voltage+12)/Range</td></tr>
<tr><td>Thermocouple range</td><td colspan="2">Acquisition temperature ×10+10000</td></tr>
<tr><td colspan="3">Cold-conjunction Compensation Channel</td></tr>
<tr><td>Implementation Method</td><td colspan="2">To acquire the cold junction temperature of thermal resistance (RTD)</td></tr>
<tr><td>Type of Thermal Resistance</td><td colspan="2">Chinese_Cu 50 ohm, Pt385 100 ohm, Pt3916 100 ohm</td></tr>
<tr><td rowspan="3">Temperature Value Accuracy in Working Range (0~60°C)</td><td>Chinese_Cu 50 ohm</td><td>The absolute deviation is ± 0.3℃</td></tr>
<tr><td>Pt385 100 ohm</td><td>The absolute deviation is ± 0.3℃</td></tr>
<tr><td>Pt3916 100 ohm</td><td>The absolute deviation is ± 0.3℃</td></tr>
<tr><td>Line broken detection</td><td colspan="2">RTD line broken alarm</td></tr>
<tr><td colspan="3">Failure Diagnosis and Hot Plug</td></tr>
<tr><td>Over range alarm[4]</td><td colspan="2">When the signal exceeds the upper/lower limit of the range, the diagnosis byte then reports 0xA3/0xA2</td></tr>
<tr><td>Over-limit alarm</td><td colspan="2">When the signal exceeds Upper Limit Value/Lower Limit Value that is set in the configuration, the diagnosis byte then reports 0xA7/0xA8</td></tr>
<tr><td>Line broken detection[5]</td><td colspan="2">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</td></tr>
<tr><td>Line broken Detection of Cold Junction Compensation Thermal Resistance</td><td colspan="2">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</td></tr>
<tr><td>Hot swapping</td><td colspan="2">Supported</td></tr>
<tr><td colspan="3">Physical Property</td></tr>
<tr><td>Protection Key</td><td colspan="2">B1</td></tr>
<tr><td>Installation Position</td><td colspan="2">Extension backplane</td></tr>
<tr><td>Module Dimension (W*H*D)</td><td colspan="2">35 mm×100 mm×100 mm</td></tr>
</table>

[4]Refer to the Chapter 1.9.6.1 Optional Alarms for the range supporting Over Range Alarm.

[5]Refer to the Chapter 1.9.6.1 Optional Alarms for the range supporting Line Break Alarm.

LK441 8-channel Thermocouple (with cold junction compensation) Analog Input Module	
Enclosure Protection Rating	IEC60529 IP20
Weight	180 g

1.10 LK442 6-channel Thermocouple Analog Input Module

1.10.1 Basic Features

- 6-channel thermocouple or millivolt input, isolation between channels
- 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
- Support Profibus-DP protocol, maximum baud rate 12Mbps
- Field calibration
- RTD cold junction temperature compensation
- Over-limit alarm
- Over range alarm
- Line broken alarm
- Isolation between the system and the field
- Hot swapping

1.10.2 Operating Principle

The 24 VDC system power supply of the LK442 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, 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, and then it is read by the microprocessor in the module, then uploaded to the controller module via the Profibus-DP bus.

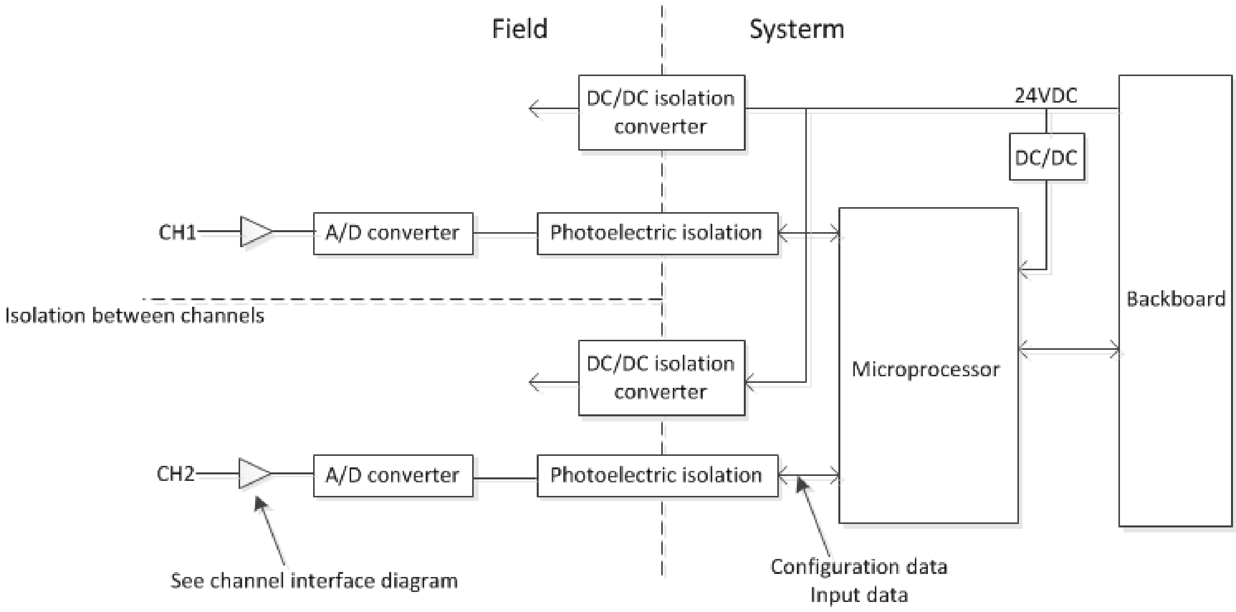


Figure 203　Internal Structure Block Diagram of LK442

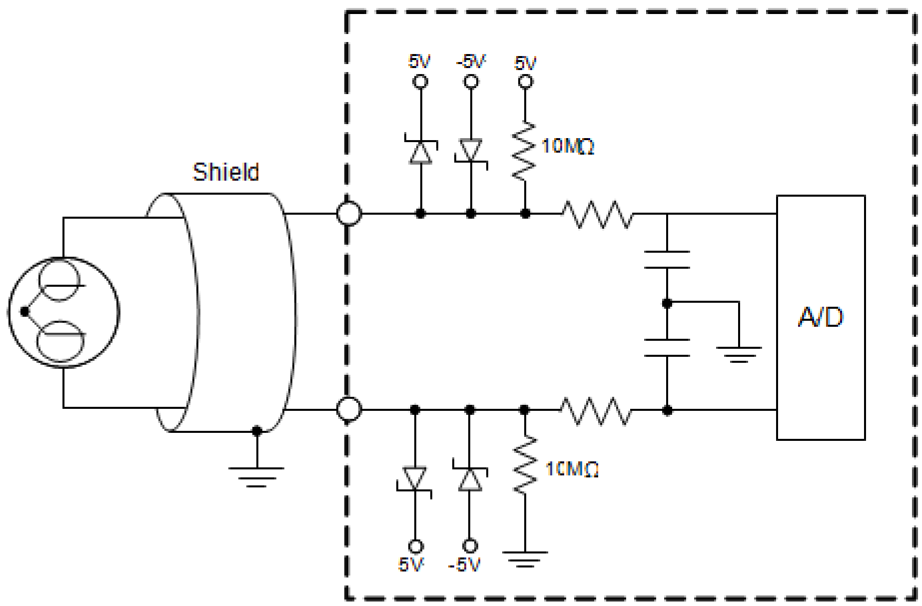


Figure 204　LK442 Channel Interface Circuit Diagram

1.10.3 Indicators

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

The LK442 module supports field calibration. The meanings of the indicator indicator are different when in the running mode and the calibration mode.

Table 153 Definition of LK442 Indicators

Name	Status	Description
RUN indicator (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 (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 indicator flashing based on a frequency of 4 times/second.
  - Upon the completion of initialization, the green indicator 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 indicator keeps flashing. Check whether the DP is connected properly and the communication parameters are set properly.
  - When the module works well, the green indicator is normally on; when the communication is disconnected, the green indicator flashes; when the communication is established again, the green indicator is turned normally on again.
  - The yellow indicator is normally off when the module is in the running mode.

Table 154 Definition of LK442 Indicators in Running Mode

Name	Status	Description
RUN indicator (green)	On	The communication is established
	Flash	The communication is not established or incorrect
	Off	The module is not powered on
CAL calibration indicator (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 indicator flashing based on a frequency of 4 times/second.
  - Upon the completion of initialization, the green indicator is turned normally on. In case of any error in the initialized data, the green indicator 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 indicator

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 indicator then flashes again.

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

Table 155 Definition of LK442 Indicators in Calibration Mode

	RUN Indicator	CAL Indicator	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

1.10.4 Wirings

The LK442 module is installed on the extension backplane.

Table 156 Definition of LK442 Backplane 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
Cold-conjunction Compensation Channel	To connect the RTD temperature measurement element	
7	13	14

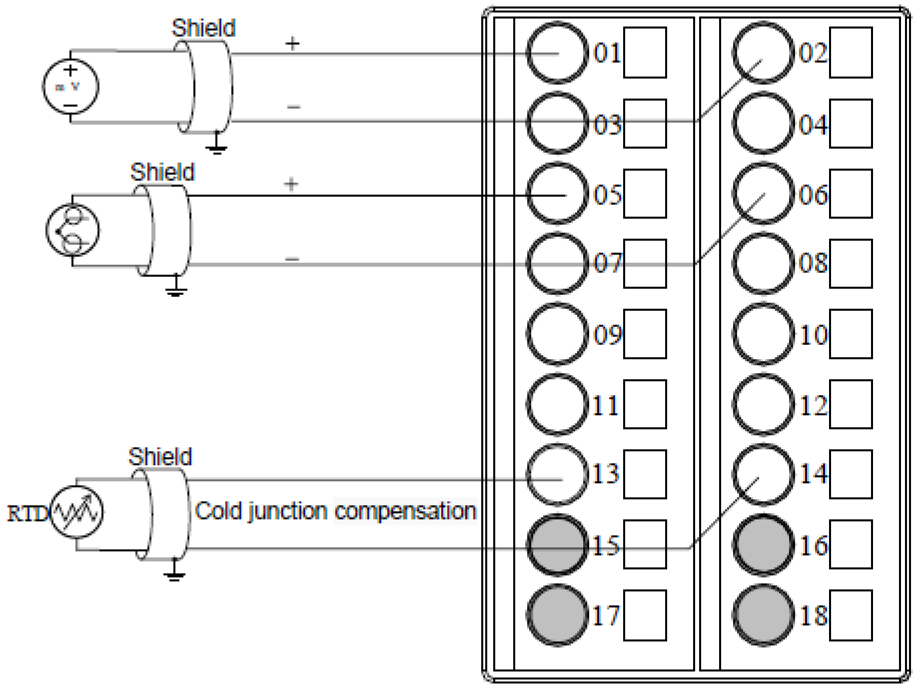


Figure 205 LK442 Backplane Terminal Wiring Diagram

Pay attention to the following during wiring:

- Each thermocouple or millivolt signal is separately connected to the terminals via two conductors (shielded cable) in the field.Copper wire is used as connecting wire.
- Terminals 1-12 are field thermocouple or millivolt signal channels. The odd terminal is connected to the positive terminal of thermocouple/millivolt signal; the even terminal is connected to the negative terminal of the thermocouple/millivolt signal.
- Terminals 13 and 14 are cold junction compensation channels.
- Terminals 15, 16, 17 and 18 are not used. When adopting set cold junction temperature compensation, Terminals 13 and 14 cannot be used.

1.10.5 Functions

1.10.5.1 Measured Data Output Format

LK442 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 LK442, 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 Safety FA-AutoThink, it can convert the 2-byte millivolt digital 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.

1.10.5.2 Cold-conjunction Compensation

LK442 can adopt the following two methods for cold junction compensation. Both methods require configuring LK442 with a thermocouple range, with the measured data reported to the controller representing a temperature value (that is, to report the temperature digital code).

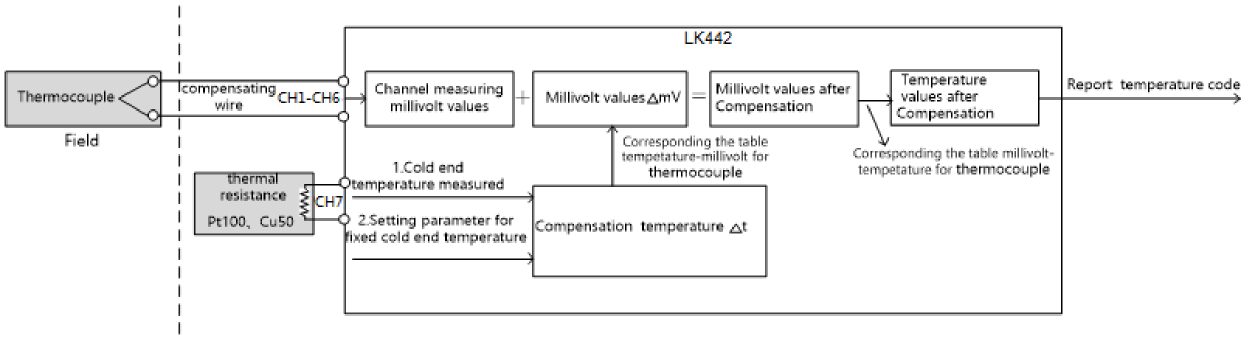


Figure 206 LK442 Cold-conjunction Temperature Compensation Block Diagram

- RTD measured cold junction temperature compensation

  Each LK442 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 LK442 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 controller. The specific compensation algorithm is completed automatically in LK442. The controller obtains the compensation temperature directly.

  The external RTD temperature measurement element of LK442 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 LK442).

  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 7), 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. LK442 compensates according to the set cold junction temperature.

  Each LK442 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 LK442 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 controller. The specific compensation algorithm is completed automatically in LK442. The controller 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 LK442. 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.

1.10.6 Diagnosis

The LK442 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), diagnosis data is saved to the output parameters DiagData1~ DiagData25 of function block. Diagnostic information of LK442 up to 25 bytes, wherein 2 bytes are device-related diagnosis, 2 bytes are identification diagnosis and 21 bytes are channel diagnosis. 7 channels in LK442, wherein, the forward 6-channel as thermocouple or millivolt signal input, channel 7 for the cold junction compensation terminal. the diagnosis information for each channel 3 bytes.

Diagnosis information DiagData1~ DiagData25 of function block sysGetDPSlaveState (Get Diagnosis of DP Slave) is shown in Table 146.

Table 157 Output parameter DiagData1~ DiagData31

Output parameter	Data type	Description
DiagData1~ DiagData2	BYTE	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.
DiagData3~ DiagData4	BYTE	Identification diagnosis information The 2-byte identification diagnosis information is 0x42, 0x01 when diagnosis information is reported.
DiagData5~ DiagData7	BYTE	Channel 1 diagnosis information, see Table 147 for channel . diagnosis information
DiagData8~ DiagData10	BYTE	Channel 2 diagnosis information
…	BYTE	…
DiagData23~ DiagData25	BYTE	Channel 7 diagnosis information

Table 158 Specifications for LK442 Channel 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. 1~8 Decimal online value 64~72
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, 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.

1.10.6.1 Optional Alarms

The alarms that are provided by each range for the LK442 module are different, as shown in Table 148.

Table 159 LK442 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.

1.10.6.2 Over Range Alarm

The LK442 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 LK442, not all the ranges are capable of over range alarm. Each range supports different alarm types. Refer to Chapter 1.10.6.1 Optional Alarms.

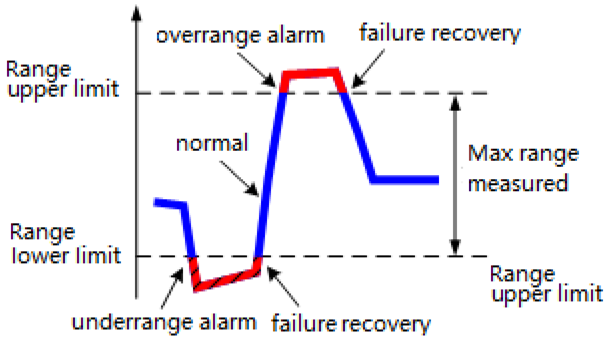


Figure 207 LK442 Over Range Alarm Schematic Diagram

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 149. When the signal is recovered to the normal range, the channel diagnosis byte then reports 0xA0.

The LK442 module only reports the diagnosis data once separately when over range occurs and is recovered.

Table 160 Handling of LK442 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 digital 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 digital 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

1.10.6.3 Over-limit Alarm

The LK442 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 safety 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 LK442 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 value digital code (when millivolt is selected for the range). Refer to Table 150 for the conversion formula.

Table 161 Calculation of LK442 Alarm Limit Value Digital code

Range Type	Upper Limit Value (Decimal)	Lower Limit Value (Decimal)

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 LK442 module cannot report the diagnosis message properly.

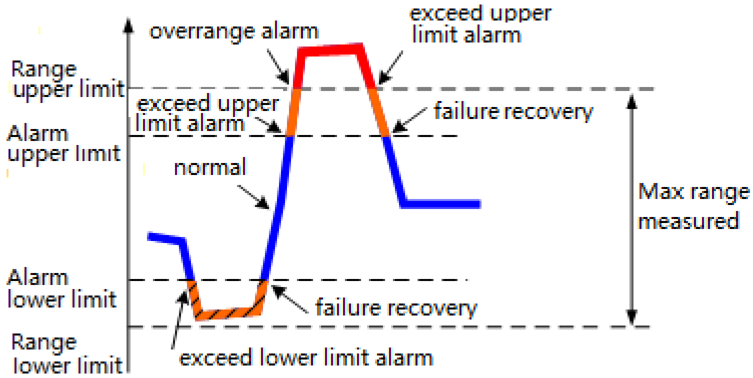


Figure 208　LK442 Over-limit Alarm Schematic Diagram

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 151. When the signal is recovered to the normal range, the channel diagnosis area then reports 0xA0.

The LK442 module only reports the diagnosis data once separately when occurrence over-limit occurs and is recovered.

Table 162　Handling of LK442 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 code
	Lower limit exceeded	1. The channel diagnosis area reports the fault value 0xA8 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 LK442 module then reports the over range.

1.10.6.4 Line Broken Detection

The LK442 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 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 1.10.6.1 Optional Alarms. For a millivolt signal range, the LK442 module does not support line broken detection.

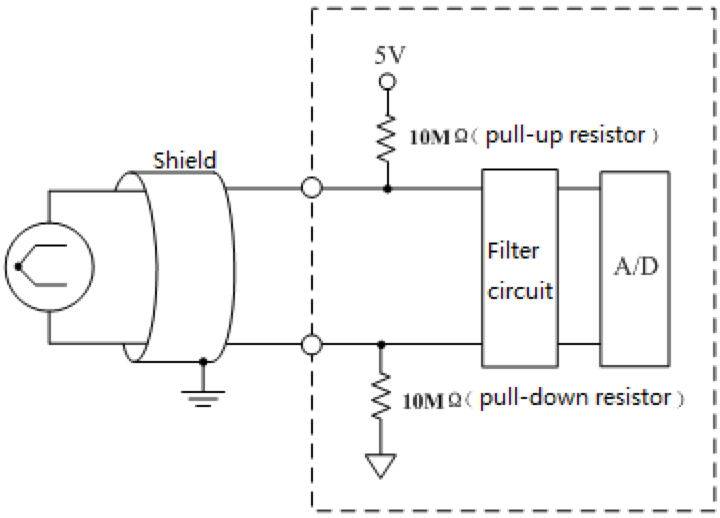


Figure 209 LK442 Line Broken Detection Schematic Diagram

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 value 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 7 diagnosis area (ChDiag.Module.Channel[7].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 7 diagnosis area reports 0xA0.

1.10.7 Parameters

The user parameter is used to set the operation mode of the module. The controller 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 LK442 is up to 39 bytes.

Table 163 LK442 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: 50Hz Filter, 50 Hz filtering, , Full-channel Scanning Time＜50 ms (default) 1: 60Hz Filter, 60 Hz filtering, Full-channel Scanning Time＜50 ms
TC Line Broken 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 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	
CH1 Cold Junction Compensation	To enable cold junction compensation for Channel 1	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	
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 Broken 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 ℉)

Parameter Name	Meaning	Value
		Compensation=Compensation Temperature×10, defaulted to 0
CH1 Digital Filter	To select software filtering of Channel 1	0: None, without software filtering (default) 1: 4Points, to select the latest 4 historical data for software filtering 2: 8 Points, to select the latest 8 historical data for software filtering 3: 16 Points, to select the latest 16 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	
CH6 Digital Filter	To select software filtering of Channel 6	
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	
CH1 Upper Limit Value	To set Upper Limit Value of Channel 1	Range of Lower Limit Value: 0 (default)~65534 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	

1.10.8 Technical Specifications

LK442 6-channel isolated thermocouple analog input module		
System Power		
Operating Voltage	24VDC (-15%~+15%)	
Power consumption	120 mA max. @ 24 VDC	
Input channel		
Number of Input Channels	7 (6-channel thermocouple or millivolt signals, 1-channel RTD cold junction compensation)	
Signal type	B, C, E, J, K, N, R, S, T	
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)
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	
Temperature Drift	±15 ppm/℃	

<table>
<tr><th colspan="3">LK442 6-channel isolated thermocouple analog input module</th></tr>
<tr><td>Differential Mode Rejection Ratio</td><td colspan="2">60 dB</td></tr>
<tr><td>Common Mode Rejection Ratio</td><td colspan="2">100 dB</td></tr>
<tr><td>Input Impedance</td><td colspan="2">10 MΩ min.</td></tr>
<tr><td>Sampling Period (Full-channel Scanning Time)</td><td colspan="2">＜50ms</td></tr>
<tr><td>Setting Time for full-scall 1%</td><td colspan="2">1 s max., in the ±1% error range of the full-scall</td></tr>
<tr><td>Channel Bandwidth</td><td colspan="2">15 Hz</td></tr>
<tr><td>Calibration Accuracy</td><td colspan="2"><0.06%</td></tr>
<tr><td>Calibration Period</td><td colspan="2">12 months</td></tr>
<tr><td>Isolation Voltage between Channel</td><td colspan="2">500 VAC@1 min, leaking current: 5 mA</td></tr>
<tr><td>Isolation Voltage between Field and System</td><td colspan="2">500 VAC@1 min, leaking current: 5 mA</td></tr>
<tr><td colspan="3">Uploaded Data Format (0~65,535)</td></tr>
<tr><td>Millivolt Range</td><td colspan="2">65,535×(Millivolt Voltage+12)/Range</td></tr>
<tr><td>Thermocouple range</td><td colspan="2">Acquisition temperature ×10+10000</td></tr>
<tr><td colspan="3">Cold-conjunction Compensation Channel</td></tr>
<tr><td>Implementation Method</td><td colspan="2">To acquire the cold junction temperature of thermal resistance (RTD)</td></tr>
<tr><td>Type of Thermal Resistance</td><td colspan="2">Chinese_Cu 50 ohm, Pt385 100 ohm, Pt3916 100 ohm</td></tr>
<tr><td rowspan="3">Temperature Value Accuracy in Working Range (0~60°C)</td><td>Chinese_Cu 50 ohm</td><td>The absolute deviation is ±1.1℃</td></tr>
<tr><td>Pt385 100 ohm</td><td>The absolute deviation is ± 0.7℃</td></tr>
<tr><td>Pt3916 100 ohm</td><td>The absolute deviation is ± 0.8℃</td></tr>
<tr><td>Line broken detection</td><td colspan="2">RTD line broken alarm</td></tr>
<tr><td colspan="3">Failure Diagnosis and Hot Plug</td></tr>
<tr><td>Over range alarm</td><td colspan="2">When the signal exceeds the upper/lower limit of the range, the diagnosis byte then reports 0xA3/0xA2</td></tr>
<tr><td>Over-limit alarm</td><td colspan="2">When the signal exceeds Upper Limit Value/Lower Limit Value that is set in the configuration, the diagnosis byte then reports 0xA7/0xA8</td></tr>
<tr><td>Line broken detection</td><td colspan="2">When an line broken occurs, the diagnosis byte reports 0xA6.
The measured channel data reports the full-range valule or the normal value prior to the line broken</td></tr>
<tr><td>Line broken detection of Cold Junction Compensation Thermal Resistance</td><td colspan="2">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</td></tr>
<tr><td>Hot Plugging</td><td colspan="2">Supported</td></tr>
<tr><td colspan="3">Communication Bus</td></tr>
<tr><td>Protocol</td><td colspan="2">Profibus-DP</td></tr>
<tr><td>Baud Rate</td><td colspan="2">1.5Mbps, 500Kbps, 187.5Kbps , 93.75Kbps, 45.45Kbps, 31.25Kbps, 19.2Kbps, 9.6Kbps adaptive</td></tr>
</table>

LK442 6-channel isolated thermocouple analog input module	
Media	Communication bus is connected to the backplane through euro connector, hot redundant communication media
Physical Property	
Protection Key	B2
Installation Position	Extension backplane
Module Dimension (W*H*D)	35 mm×100 mm×100 mm
Weight	180 g

1.11 LK511 4-channel Inter-channel Isolated Current Type Analog Output Module

1.11.1 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

1.11.2 Operating Principle

The controller 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.

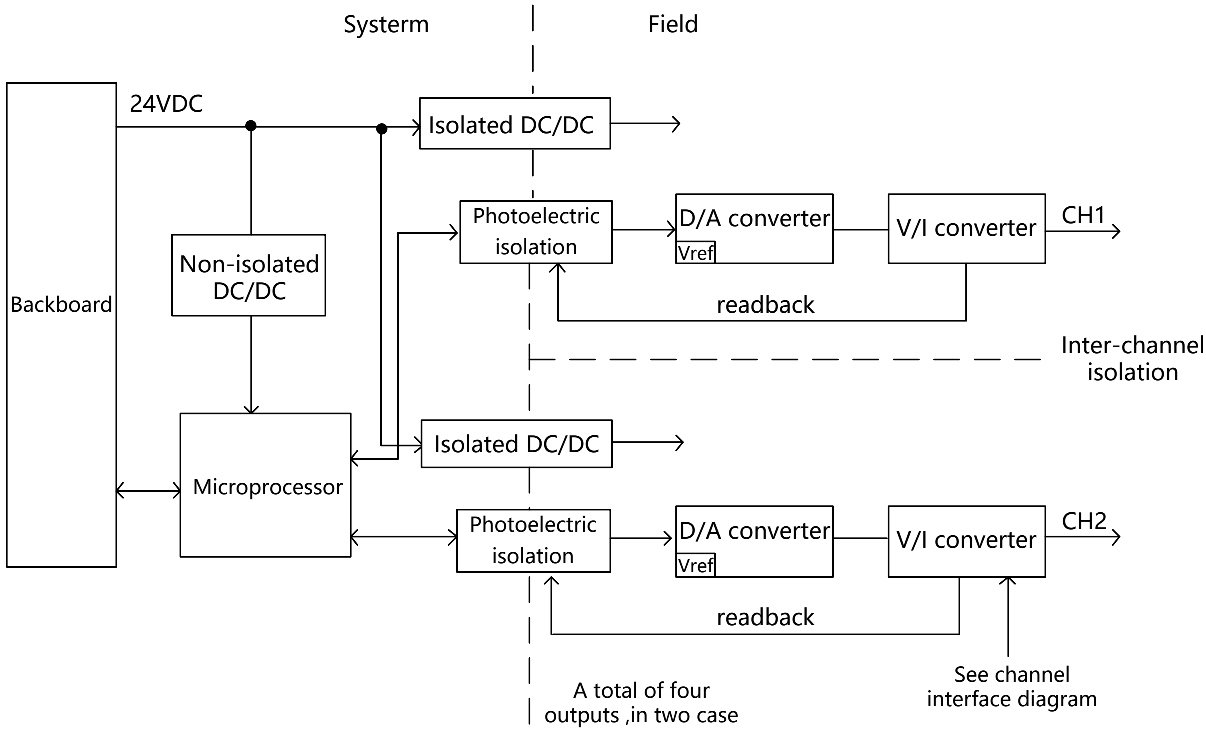


Figure 210 Internal Structure Block Diagram of LK511

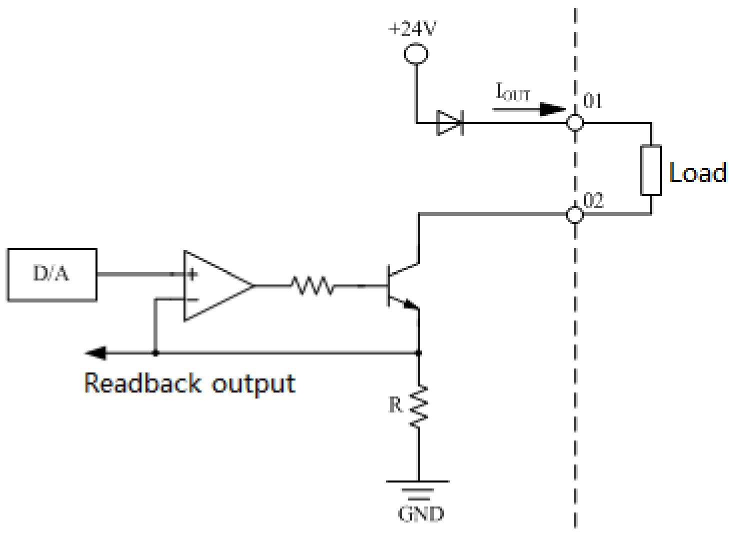


Figure 211 LK511 Channel Interface Circuit Diagram

1.11.3 Indicators

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

The LK511 module supports field calibration. The meanings of the indicator 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 indicator flashing based on a frequency of 4 times/second.
  - Upon the completion of initialization, the green indicator 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 indicator keeps flashing. Check whether the communication parameters are set correctly.
  - When the communication is normal, the green indicator is normally on. When the communication is disconnected, the green indicator flashes. When the communication is established again, the green indicator is turned on again.
  - The yellow indicator is normally off when in the running mode.

Table 164 Definition of LK511 Status Indicators in Running Mode

	RUN Lamp	CAL Indicator	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 indicator 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 indicator flashing based on a frequency of 4 times/second. When the controller 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 indicator then flashes again.
  - During calibration and detection, the green indicator is normally no. When the communication is disconnected, the green indicator flashes. When the communication is established again, the green indicator is turned normally on again
  - When the communication is not established or disconnected, the yellow indicator then goes out.

Table 165 Definition of LK511 Indicator Light in Calibration Mode

	RUN Lamp	CAL Indicator	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

1.11.4 Wirings

The LK511 module is installed on the extension backplane.

Table 166 Definition of LK511 Backplane 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

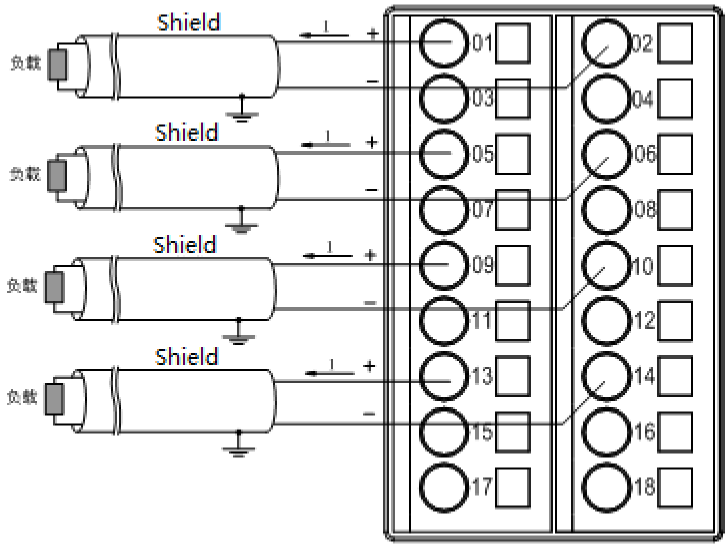


Figure 212 LK511 Backplane Terminal Wiring Schematic Diagram

Pay attention to the following during wiring:

- The two-row 18-channel terminals are fixed on the backplane, right located under the installation position of the LK511 module.
- The terminals that are not listed in Table 166 cannot be used, with wiring forbidden.
- The 4-channel current type AO only uses the 4 terminal pairs as shown in Figure 212, 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.

1.11.5 Data Format

As shown in Table 167, the AO channel output data that is sent by the controller to LK411, is expressed in form of 2-byte positive integer (decimal: 0~65,535) digital code.

Table 167 Corresponding Relationship between LK511 Output Current and Digital Code

Output Range	Corresponding Decimal Digital Code Value
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 Safety FA-AutoThink, it can convert the engineering data into the 2-byte digital code value data. Refer to the *LKS Safety Control System 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 168.

Table 168 Data Conversion Formula LK511 Module

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 213 for the relevant user parameter settings.

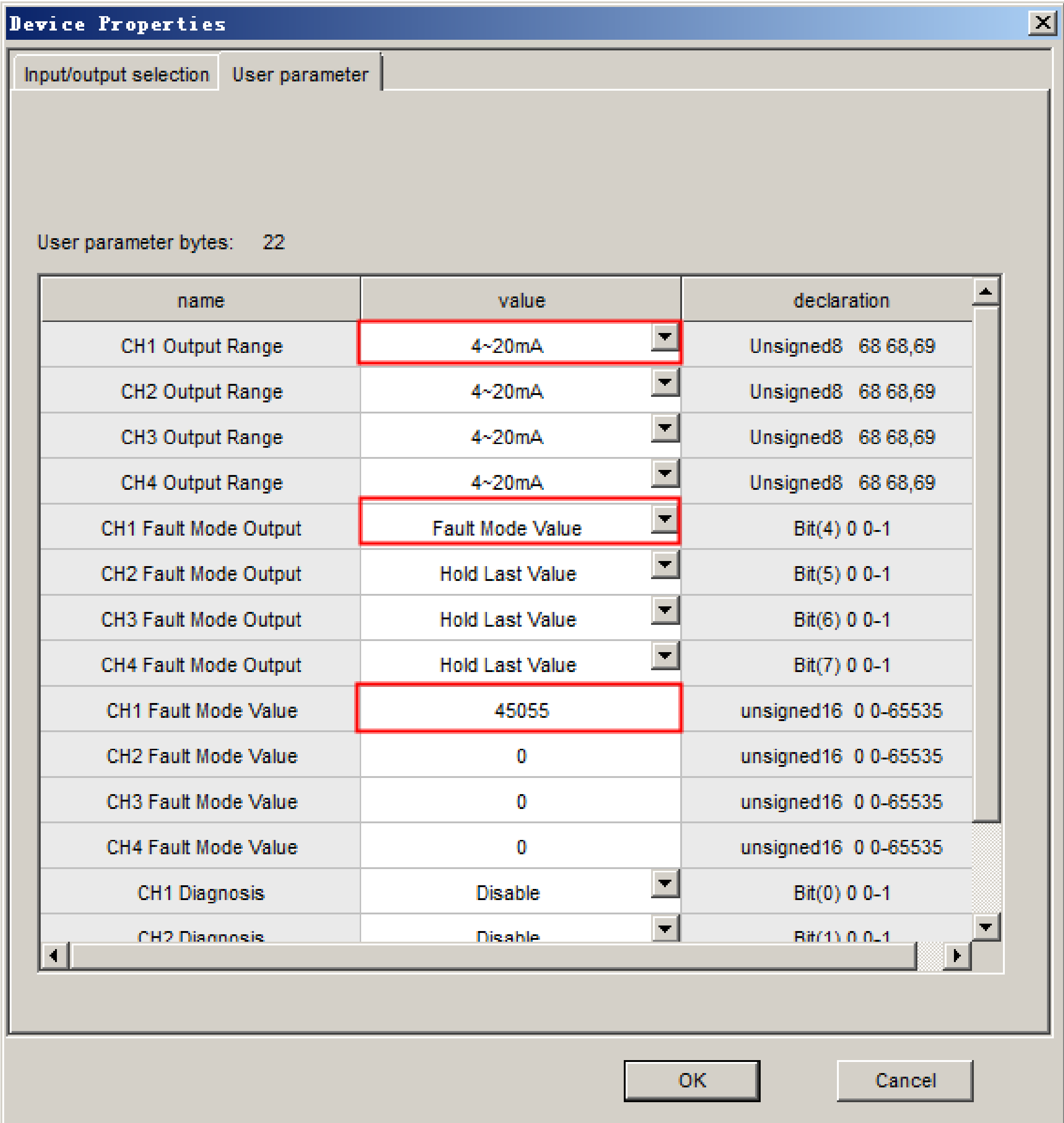


Figure 213 Examples of Fault Mode Parameter Settings Based on Selected Range

1.11.6 Functions

1.11.6.1 Output Enable

After the output module is powered on, if the output instruction given from the controller 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 controller 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 controller 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.

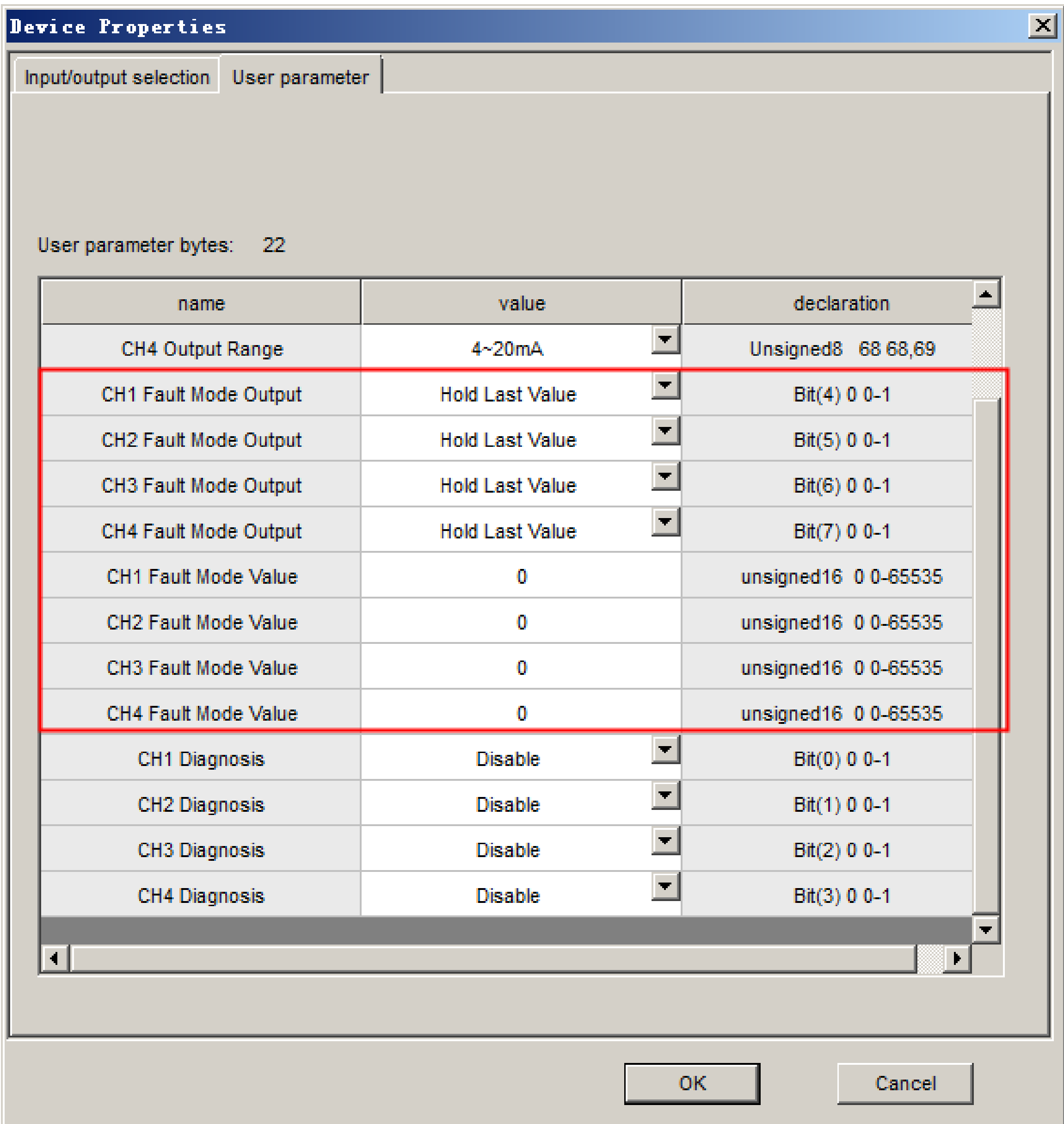
In summary, whether output has been enabled after powering on the output module, shall affect the output status in the fault modes.

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 controller, the output is re-enabled.

1.11.6.2 Communication Fault

In case of a communication fault, the communication between the module and the controller is disconnected, with the **RUN** indicator 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).



name	value	declaration
CH4 Output Range	4~20mA	Unsigned8 68 68,69
CH1 Fault Mode Output	Hold Last Value	Bit(4) 0 0-1
CH2 Fault Mode Output	Hold Last Value	Bit(5) 0 0-1
CH3 Fault Mode Output	Hold Last Value	Bit(6) 0 0-1
CH4 Fault Mode Output	Hold Last Value	Bit(7) 0 0-1
CH1 Fault Mode Value	0	unsigned16 0 0-65535
CH2 Fault Mode Value	0	unsigned16 0 0-65535
CH3 Fault Mode Value	0	unsigned16 0 0-65535
CH4 Fault Mode Value	0	unsigned16 0 0-65535
CH1 Diagnosis	Disable	Bit(0) 0 0-1
CH2 Diagnosis	Disable	Bit(1) 0 0-1
CH3 Diagnosis	Disable	Bit(2) 0 0-1
CH4 Diagnosis	Disable	Bit(3) 0 0-1

Figure 214 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 1.11.5 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.

1.11.7 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), diagnosis data is saved to the output parameters DiagData1~ DiagData16 of 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 DiagData1~ DiagData16 of function block sysGetDPSlaveState (Get Diagnosis of DP Slave) is shown in Table 169.

Table 169 Output parameter DiagData1~ DiagData16

Output parameter	Data type	Description
DiagData1~ DiagData2	BYTE	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.
DiagData3~ DiagData4	BYTE	Identification diagnosis information The 2-byte identification diagnosis information is 0x42, 0x01 when diagnosis information is reported.
DiagData5~ DiagData7	BYTE	Channel 1 diagnosis information, see Table 170 for channel . diagnosis information
DiagData8~ DiagData10	BYTE	Channel 2 diagnosis information
…	BYTE	…
DiagData14~ DiagData16	BYTE	Channel 4 diagnosis information

Table 170 Specifications for LK511 Channel Diagnosis Information

Diagnosis Information	Meaning

<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 controller 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 scale.

The LK511 can conduct line broken and output fault diagnosis to the output channel via the read-back value. The controller 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 scale, 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 breaken 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 171. When all the channel faults are recovered and outputs normally, the channel diagnosis byte reports 0xA0.

Table 171　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	The channel read-back data reports 0xA0

Output Range	Effective Diagnosis Range	Fault Type	Handling, Read-back Data and Diagnosis Byte
		broken	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 scale 2. The channel diagnosis byte reports the output fault value 0xB2
0~21 mA	4~21 mA	Line broken	1. The digital 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 scale 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.

1.11.8 Parameters

The [User parameter] is used to set the operation mode of the module. The controller 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 172 Table of LK511 User Parameters

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 1.11.5 Data Format for the calculation

Parameter Name	Meaning	Value
CH2 Fault Mode Value	Fault mode settings for Channel 2	method.
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.

1.11.9 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 controller 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 controller via LK511, which occupies four character variables, with each character variable (0~255) corresponding to one channel read-back data.

Table 173 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	
	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	

1.11.10 Technical Specifications

LK511 4-channel Inter-channel Isolated Current Type Analog Output Module	
System Power	
Operating Voltage	24VDC（-15%~20%）

<table>
<tr><th colspan="5">LK511 4-channel Inter-channel Isolated Current Type Analog Output Module</th></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>
<tr><td rowspan="2">Stability</td><td colspan="2">Output</td><td colspan="2">0.05% F.S.@ 25℃</td></tr>
<tr><td colspan="2">Readback</td><td colspan="2">2.5% F.S.@ 25℃</td></tr>
<tr><td colspan="5">Failure Diagnosis and Hot Plug</td></tr>
<tr><td colspan="3">Line broken detection</td><td colspan="2">When the channel is broken (Configure Enable), the diagnosis then reports 0xA6. When the fault recovered, it then reports 0xA0</td></tr>
<tr><td colspan="3">Output Fault Detection</td><td colspan="2">In case of a channel output fault (Configure Enable), the diagnosis then reports 0xB2. When the fault recovered, it then reports 0xA0</td></tr>
<tr><td colspan="3">Hot swapping</td><td colspan="2">Supported</td></tr>
<tr><td colspan="5">Physical Property</td></tr>
<tr><td colspan="3">Protection Key</td><td colspan="2">C1</td></tr>
<tr><td colspan="3">Installation Position</td><td colspan="2">Extension backplane</td></tr>
<tr><td colspan="3">Module Dimension (W*H*D)</td><td colspan="2">35 mm×100 mm×100 mm</td></tr>
<tr><td colspan="3">Enclosure Protection Rating</td><td colspan="2">IEC60529 IP20</td></tr>
<tr><td colspan="3">Weight</td><td colspan="2">180 g</td></tr>
</table>

1.12 LK233 Profibus-DP Bus Optoelectronic Transceiver

1.12.1 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 backplane
- Hot swapping

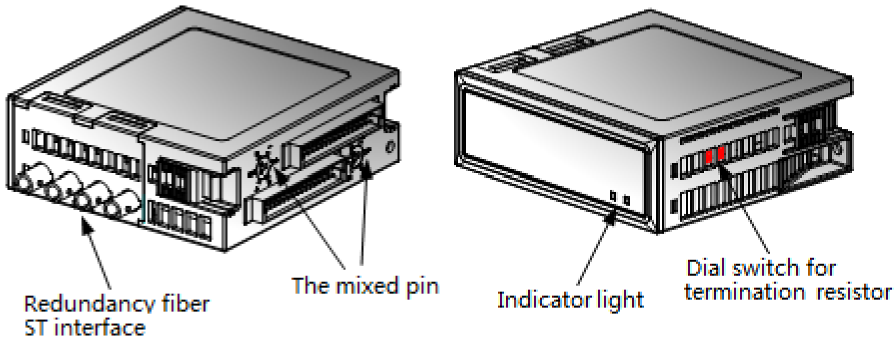


Figure 215 External View of LK233 Module

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 backplane, with the protection key coded as A5. The LK232S repeater module is installed in the communication slot of the backplane, used jointly with LK233.

The LK233 modules are used in pairs, realizing data exchange and communication between the controller and the remote I/O module. The near-end LK233 module converts the electrical signal of the controller 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 controller.

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 216 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 backplanes, 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 backplane are allocated in sequence, the LK233 module still occupies a slave station address.

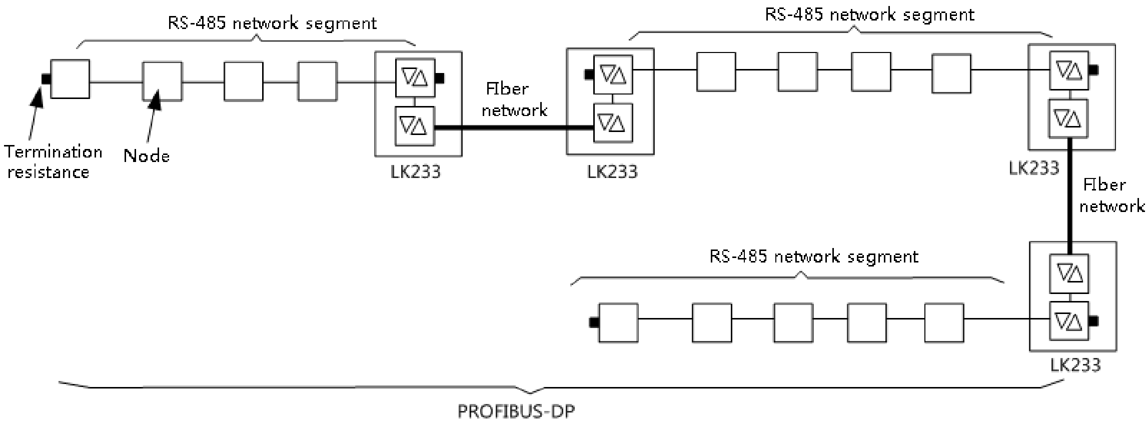


Figure 216　Network Topology Structure Connected with Optical Fiber

1.12.2 Operating Principle

As shown in Figure 217, 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 backplane. 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 backplane.

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

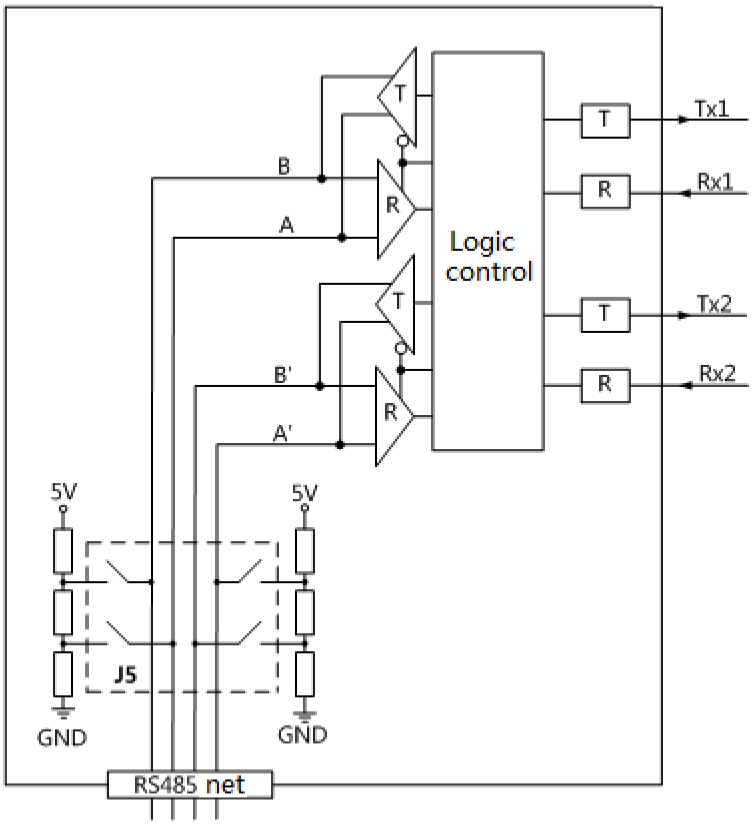


Figure 217　Internal Structure Diagram of LK233

1.12.3 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 218.

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.

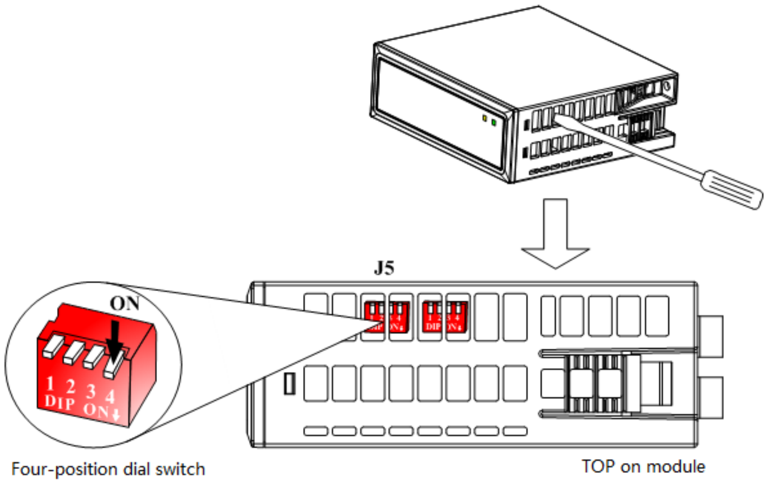


Figure 218 Position of LK233 DIP Switch

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. The start terminal matching resistor is provided by the LKA104 in Profibus-DP between master control backboard and the first extended backboard, the dialing switch is set to ON. The end terminal matching resistor is provided by the LK232S, and the J4 is set to ON.

The terminal matching resistors at both ends of the Profibus-DP in extended backboard are provided by LK232S, and J5, J6 are set to ON. You can install LK233 in any I/O slot, and the dialing switch is set to OFF, as shown in Figure 219.

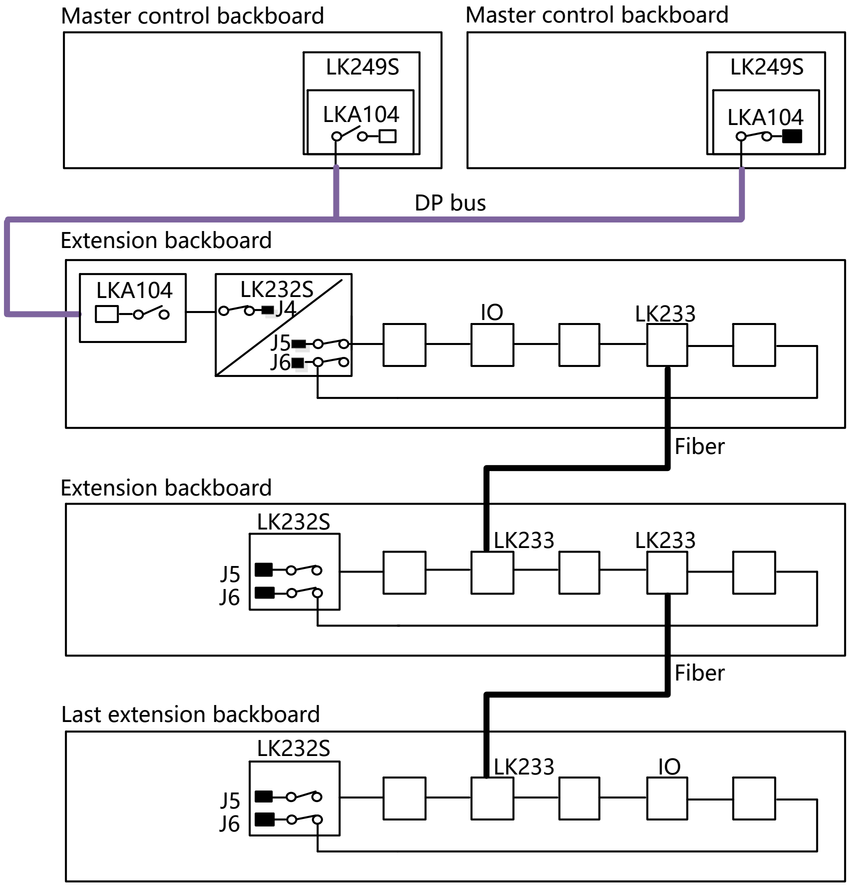


Figure 219 Terminal Resistance Connection Working with LK233 and LK232S

When LKA104 and LK233 are used to extend backplane, the extended backboard where LK233 is used cannot be extended to next backboard by LKA104.

1.12.4 Indicators

Refer to Table 174 for the definitions of the indicators of the LK233 modules. The **RUN** indicates the communication link between LK233 and the controller. The **COM** indicates the communication link between LK233 and the extension I/O module.

Table 174 Definition of Indicators of LK233

Lamp Name	Status	Meaning
RUN (green)	Flash	No data transmission is available for the Profibus-DP bus between LK233 and the controller
	On	Data transmission is available for the Profibus-DP bus between LK233 and the controller
	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.

1.12.5 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 is 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 is shown in Figure 220.

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 175 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 backplanes 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.

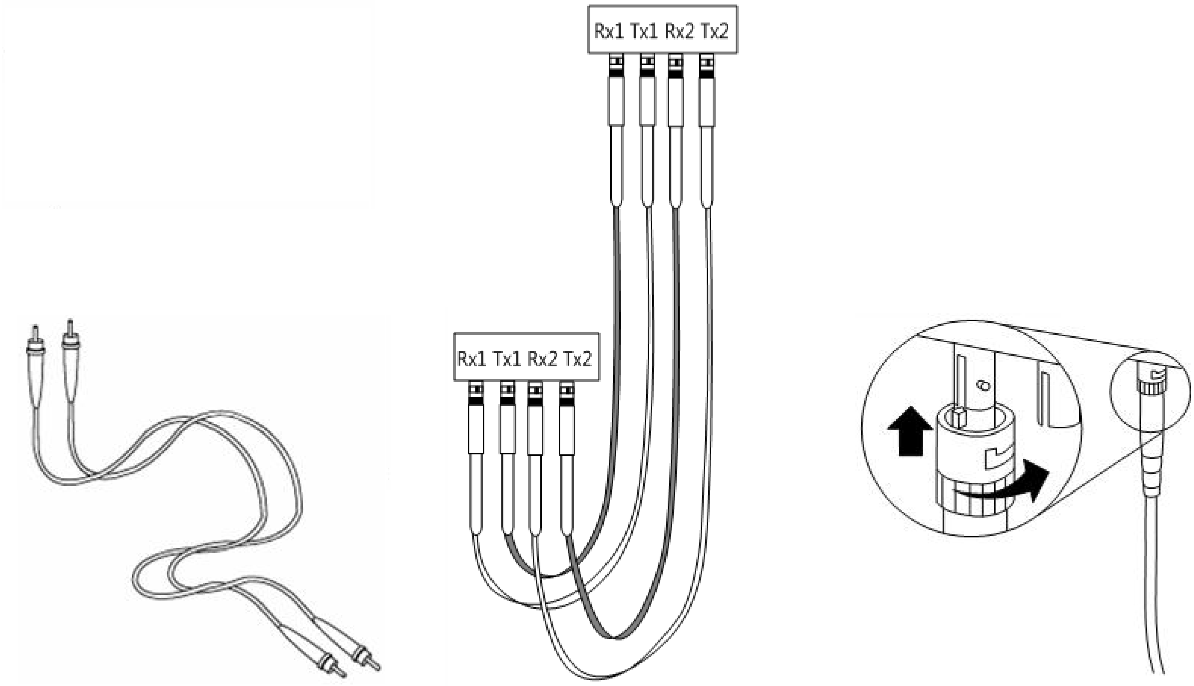


Figure 220 Optical Fiber Connection of LK233

1.12.6 Technical Specifications

LK233 Profibus-DP Bus Optoelectronic Transceiver	
System Power	
Operating Voltage	24VDC（-15%~20%）
Backplane 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 backplane
Protection Key	A5
Module Dimension (W*H*D)	35 mm×100 mm×100 mm
Hot swapping	Supported

1.13 LK239　Modbus Master/Slave Communication Extension Module

1.13.1 Basic Features

- Support the Profibus-DP slave protocol
- To support the Modbus master /slave protocol
- To connect the LK controller and the external Modbus master /slave station
- Installed in the I/O slot
- Hot swapping

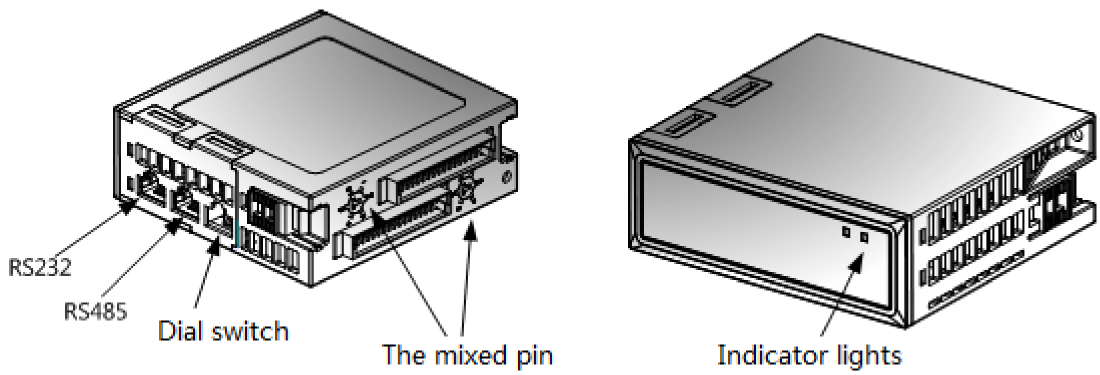


Figure 221　External View of LK239 Module

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 controller.

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 controller, 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.

- The LK239 module cannot transmit the REAL, DINT and DWORD data directly by configuring the input/output data. You need to configure the Data Split and Merge Functions to achieve Modbus communication of floating point data.

The LK239 module is installed in the I/O slot of the LK backplane. The module itself provides the Modbus communication interface and the Modbus terminal matching DIP switch, as shown in Figure 221.

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.

1.13.2 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 controller) 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.

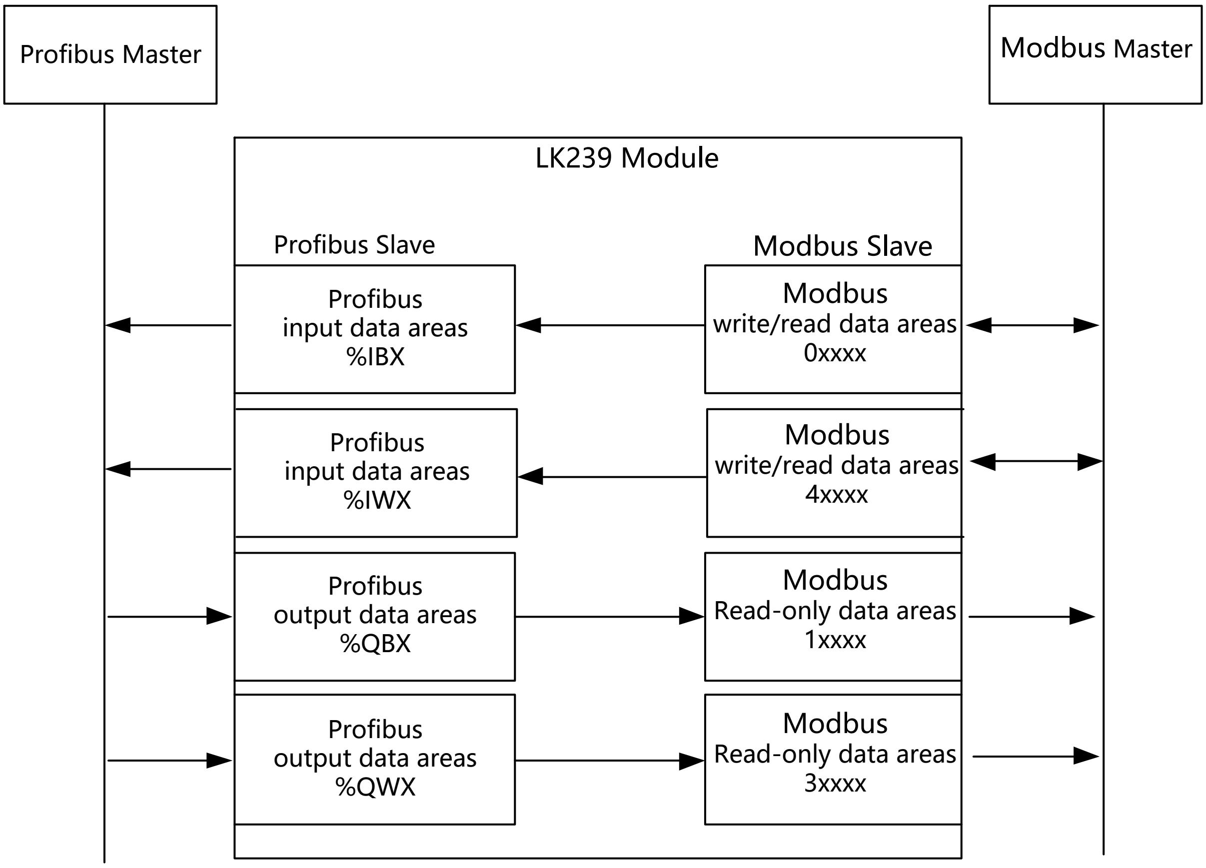


Figure 222　Schematic Diagram of Data Exchange Realization of LK239 Module as Slave

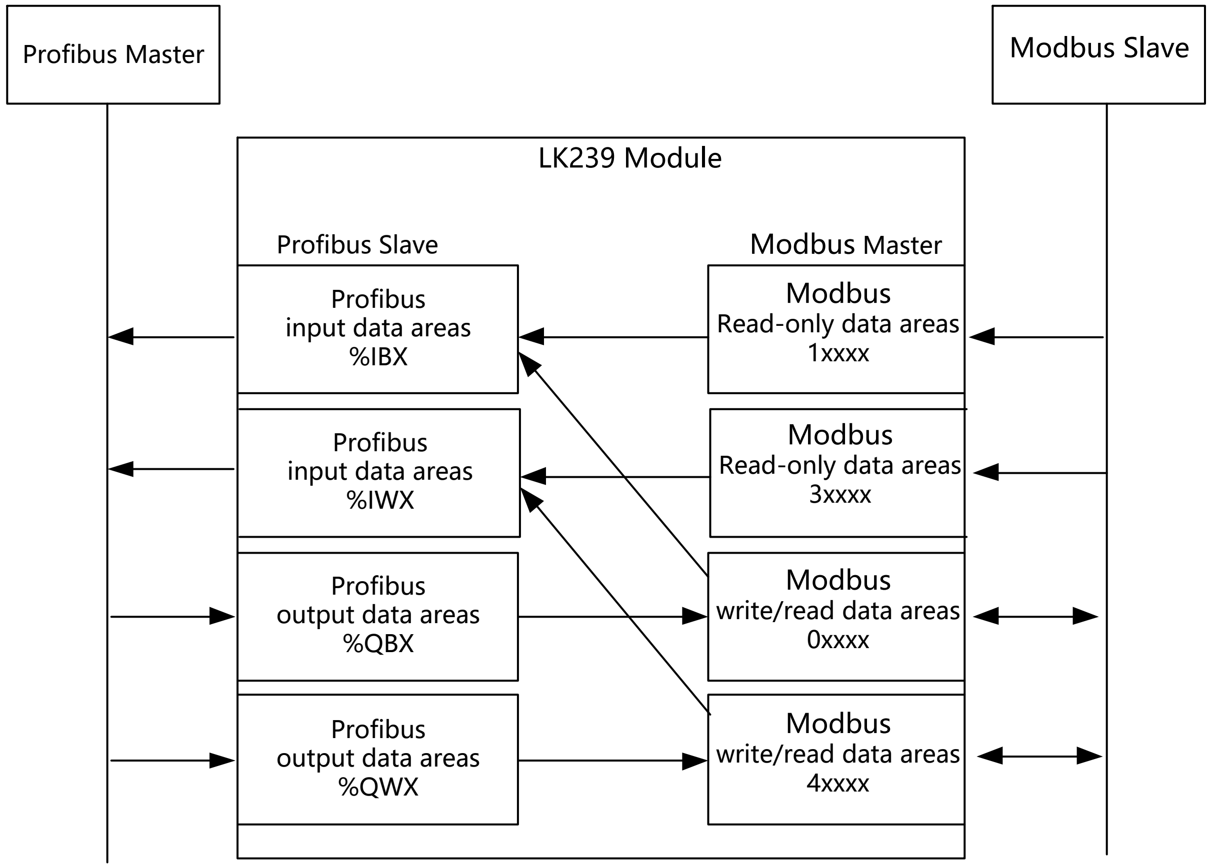


Figure 223 Schematic Diagram of Data Exchange Realization of LK239 Module as Master

1.13.3 Indicators

Refer to Table 176 for the definitions of the indicators of the LK239 module, the **RUN** indicates the communication link with the controller. The **COM** indicates the Modbus communication link.

Table 176 Definition of LK239 Indicators

Name	Status	Description
RUN (green)	On	The communication between LK239 and the LK controller is normal
	Flash	It is just powered up and establishing the communication, or a communication error occurs between LK239 and the LK controller, 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

1.13.4 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 177 for the cable information.

Table 177 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.

1.13.5 Terminal Matching

On the Modbus, 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 224, 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.

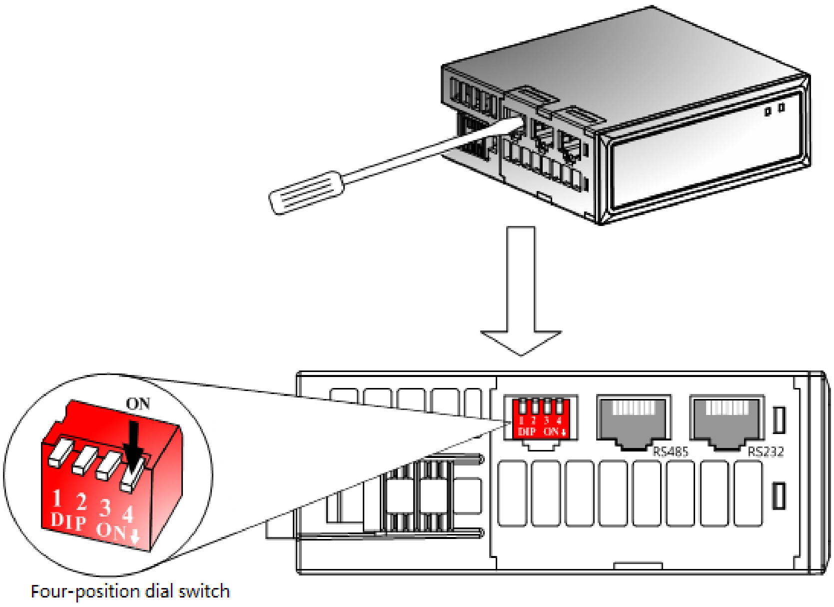


Figure 224 Setup of LK239 DIP Switch

1.13.6 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.

1.13.6.1 Modbus Storage Area

The device storage area relating to Modbus is identified with 0xxxx, 1xxxx, 3xxxx and 4xxxx, as shown in Table 178.

Table 178 Specifications for Modbus Storage Area

Modbus Storage Area	Type	Write/Read	Name	Storage Unit Address
0xxxx	Bit	Write and read	Coil	00000~0xxxx
1xxxx	Bit	Read only	Input of discrete magnitude	10000~1xxxx
3xxxx	Word	Read only	Input register	30000~3xxxx
4xxxx	Word	Write and read	Holding register	40000~4xxxx

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

1.13.6.2 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 179 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 179 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)

1.13.6.3 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 one-byte diagnosis information codes (Bit4~Bit1 of status byte) sent at the same time. Diagnosis information codes 1~7 separately represents various error types, as shown in Table 180. You can view diagnosis information codes of status byte in Device Informaiton window.

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

Table 180 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

Error Code	Meaning	Cause
6	Busy now, with the request refused	The slave device is busy
7	Request received without no confirmation	The request is not executed

1.13.7 Configuration

On the Modbus side, LK239 can not only be used as a master station and a slave station, but also supports the free protocol, with different GSD files selected during configuration, as shown in Figure 225.

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

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

When LK239 adopts the free protocol, add a LK239-Free.

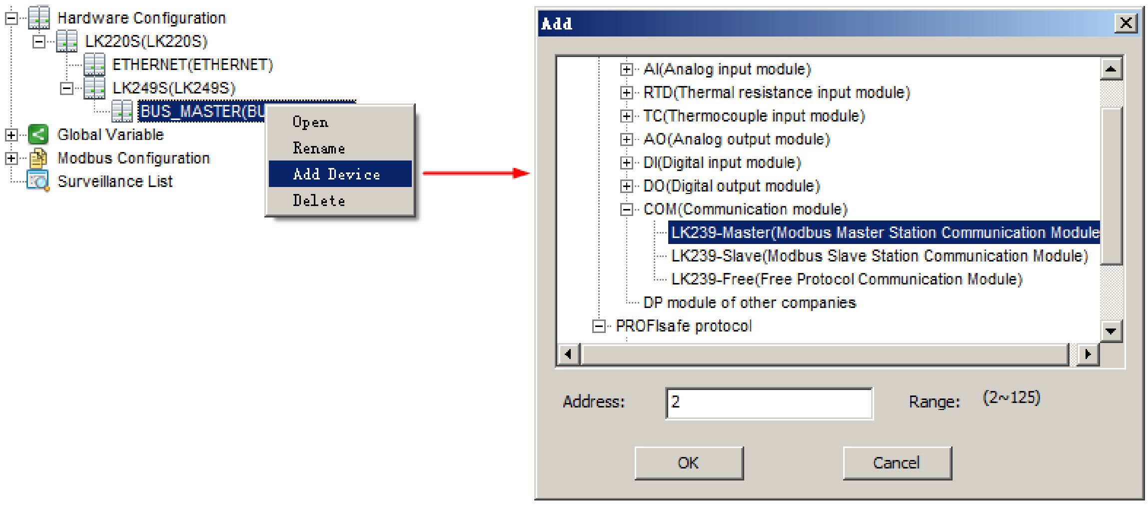


Figure 225 Adding a LK239 Module

1.13.7.1 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 backplane number and a slot number. During configuration, double-click the **Device Address** item, as shown in Figure 226. Enter a physical communication address in **New** address, and click **OK**.

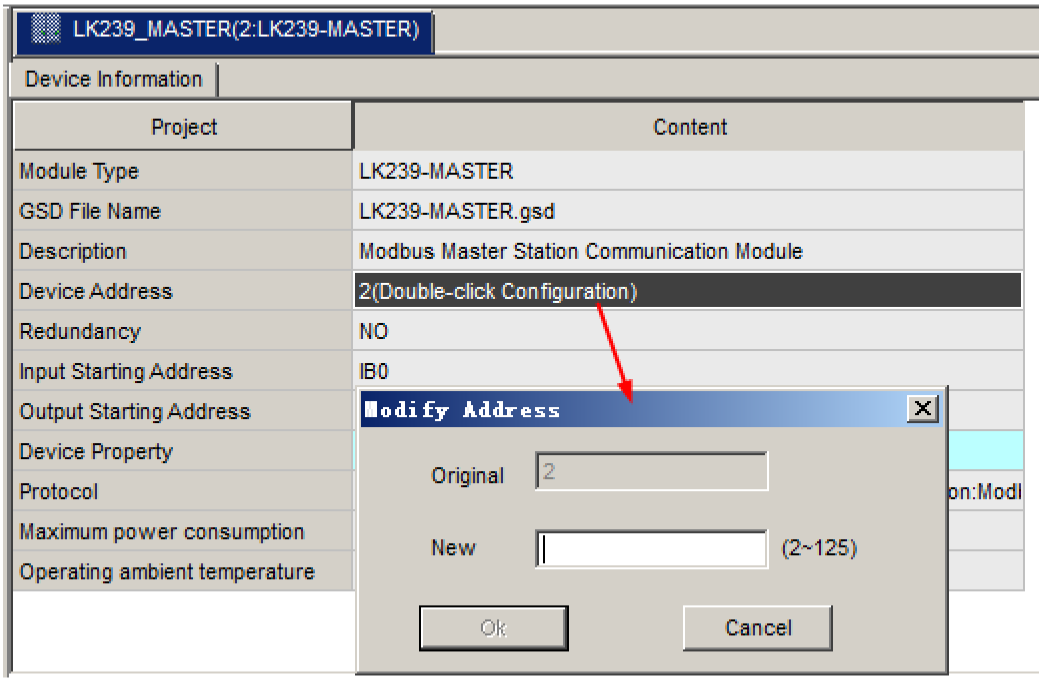


Figure 226 Set Station Address

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 227, 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**.

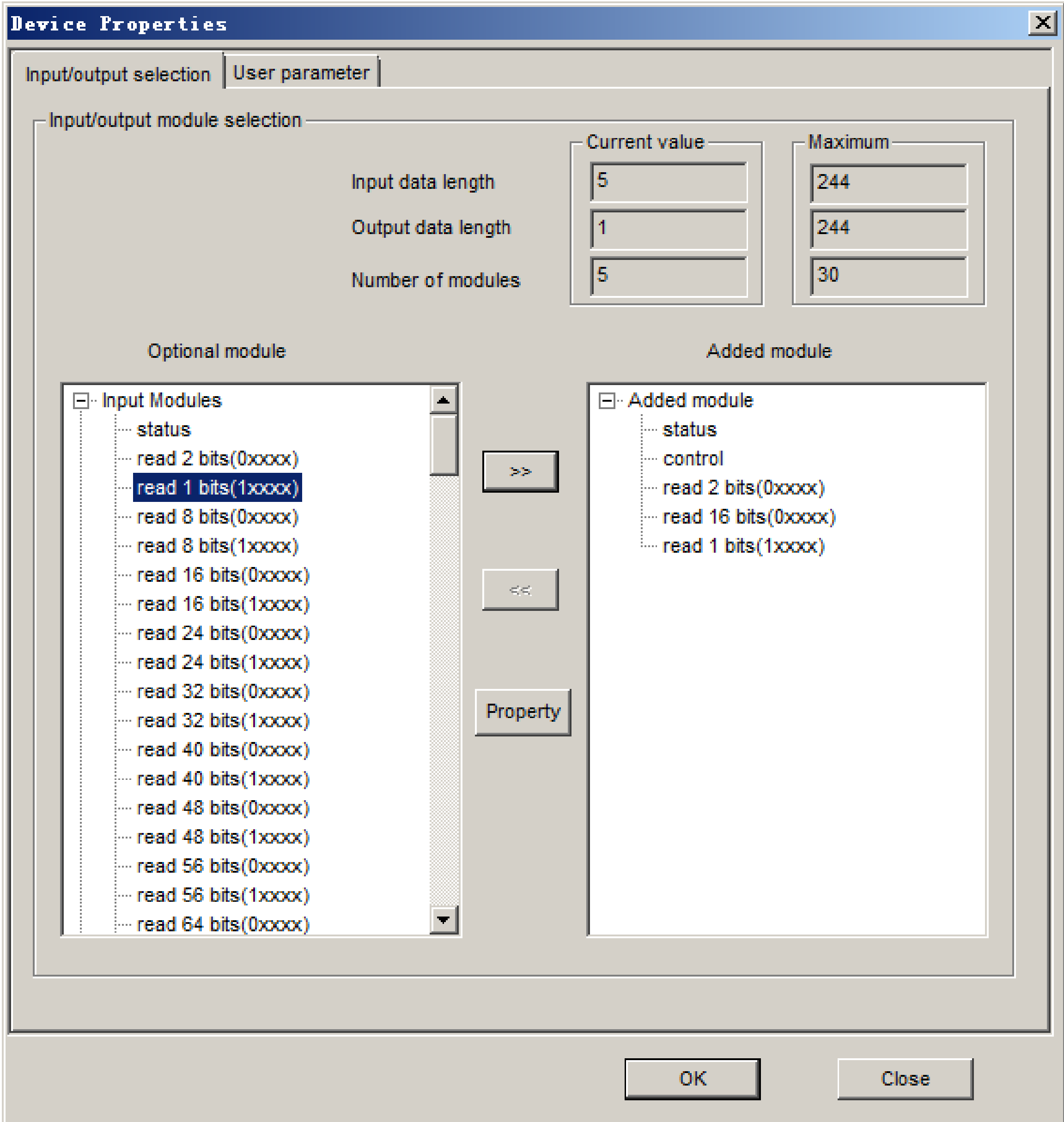
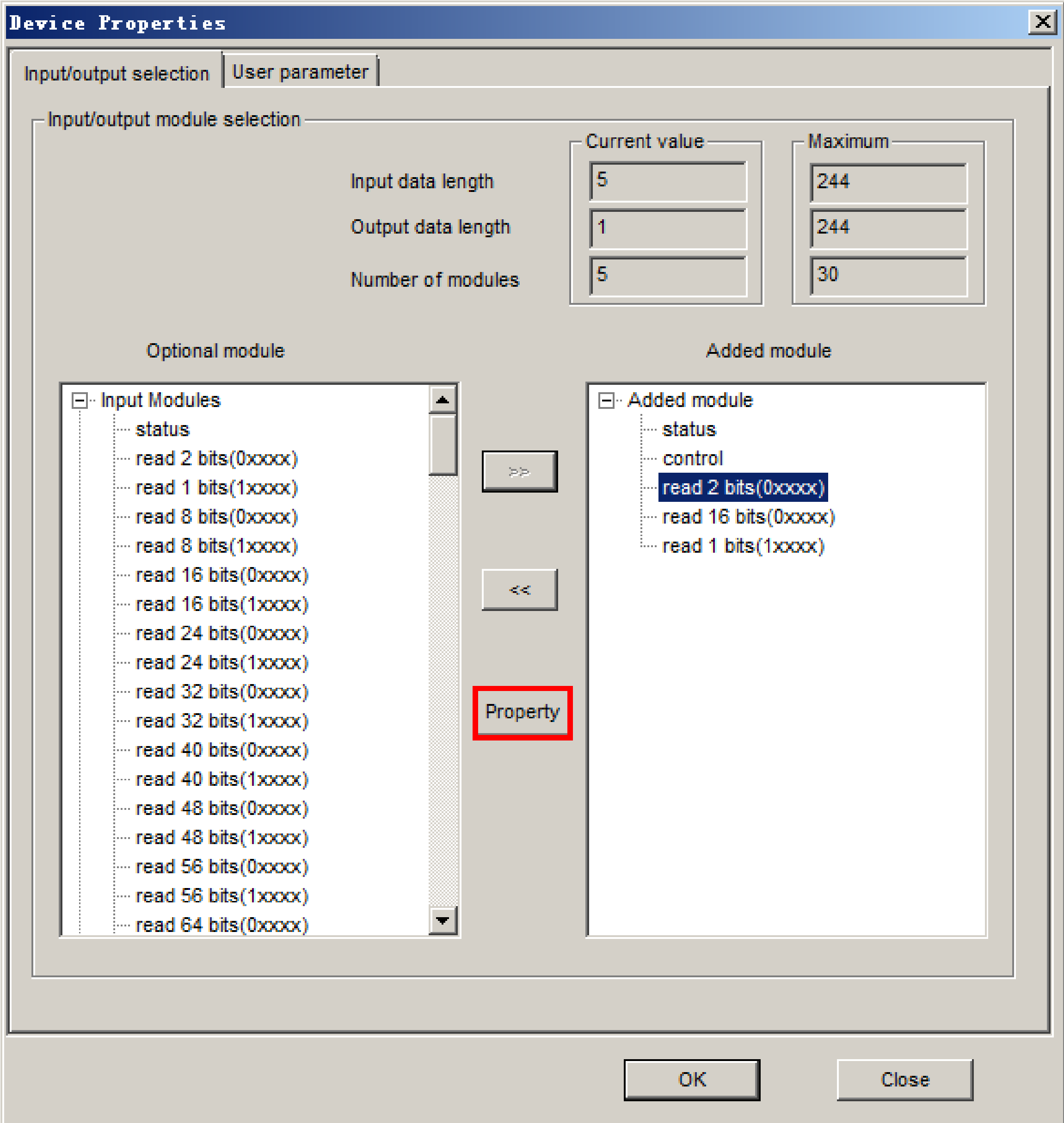


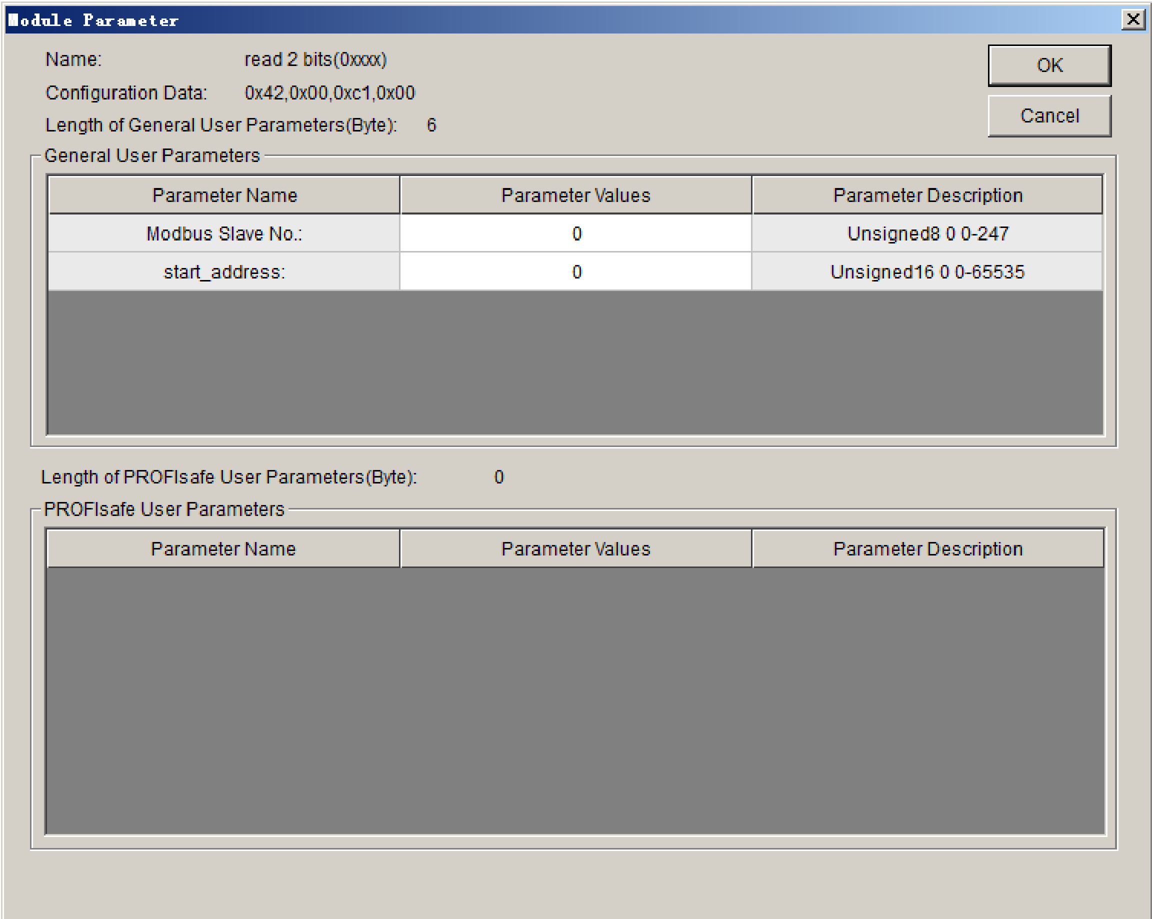
Figure 227 Input/output Module of Modbus Master Station

When LK239 is used as a master station, the Modbus data area includes Input Modules and Output Modules, as shown in Figure 227. 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 default added. Refer to current Chapter Status and Control Byte for the specific meanings.

When LK239 is used as a 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 228 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
5
244
Output data length
1
244
Number of modules
5
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 228　Slave Station Parameter Setup

Table 181　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 a Modbus master station, the user parameter length is 8 bytes. Refer to Table 182 for the meaning.

Table 182　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

Parameter Name	Meaning	Value
Modbus Master	To select the Modbus master and slave stations	=Modbus Master, master station
Transmission Mode	Modbus data transmission mode	= RTU, RTU transmission mode
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

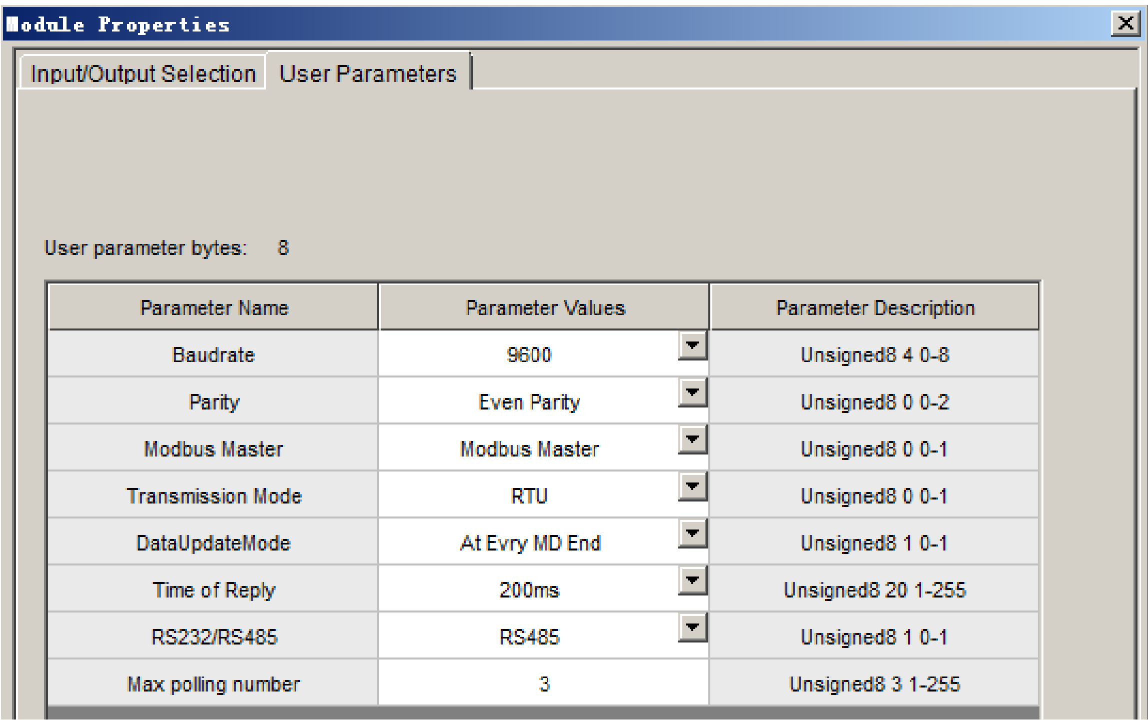


Figure 229 User Parameters for Modbus Master Station

4. Status and Control Byte

Definitions of the status (device status) byte and the control (device control) byte when LK239 is used as a 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 default added.

- The LK239 module cannot transmit the REAL, DINT and DWORD data directly by configuring the input/output data. You need to configure the Data Split and Merge Functions to achieve Modbus communication of floating point data.

When LK239 is used as the master station, each module in the Modbus data area indicates one function code supported by Modbus. Refer toTable 183 for the function codes represented by each module.

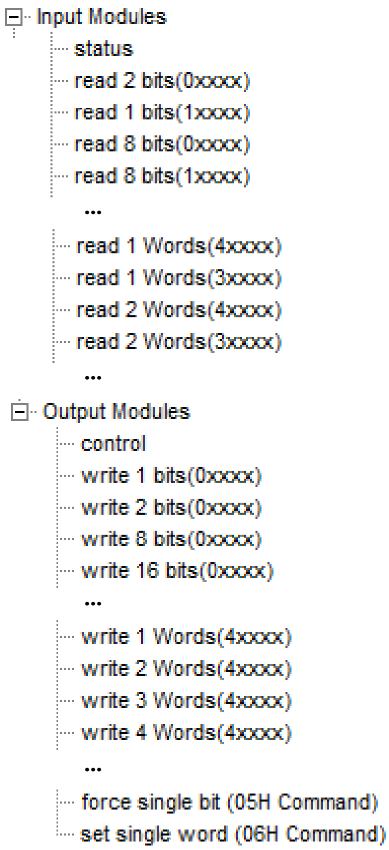


Figure 230　Modbus Master Station Data Area

Table 183　Function Codes Represented by Each Module

Module Types	Modbus Storage Area	Function Codes
Input module	0xxxx	01 (DO read-back)
	1xxxx	02 (read DI)
	4xxxx	03 (AO read-back)
	3xxxx	04 (read AI)
Output module	0xxxx	15 (multiple DO)
	4xxxx	16 (multiple AO)
	05H Command	05 (single DO)
	06H Command	06 (single AO)

1.13.7.2　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 backplane number and a slot number. During configuration, double-click the **Device Address** item, as shown in Figure 231. Enter a physical communication address in **New** address, and click **OK**.

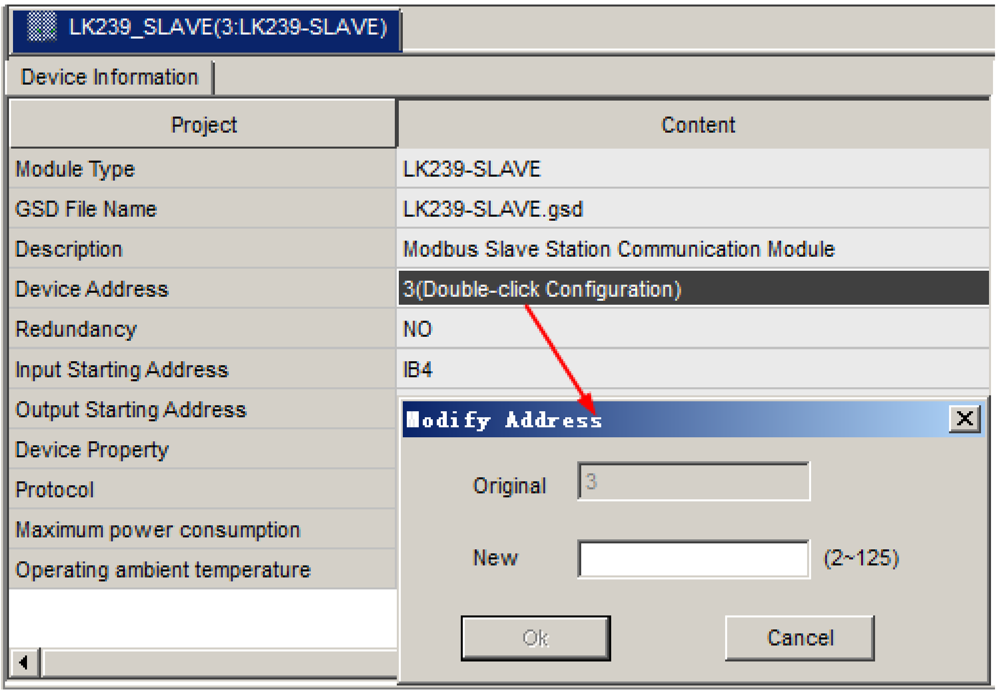


Figure 231 Set Station Address

2. Input/output Parameters

When LK239 is used as a slave station, as shown in Figure 232, the Modbus data area includes Input Modules and Output Modules. The data length of each module is different. Notably, **status** and **control** are default added.

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.

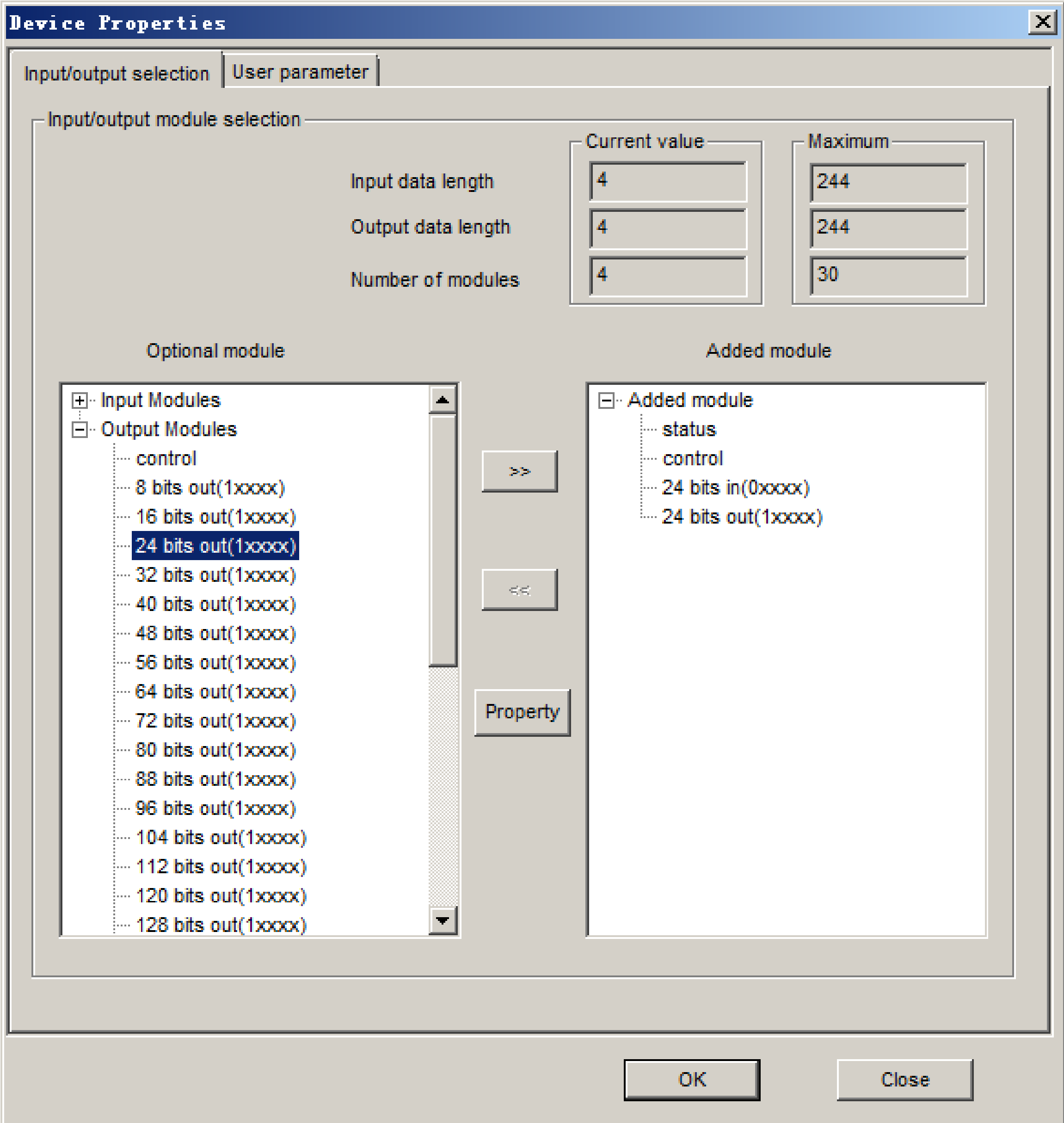


Figure 232　Input/output Module of Modbus Slave Station

LK239 as a Modbus slave station, please add data strictly in the following order: add **the bits** before the **Words**.

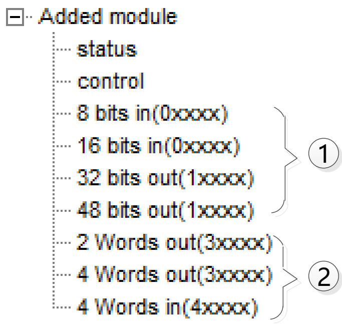


Figure 233 Sequence of Adding Modbus Slave Station Data

3. User Parameter

When LK239 is used as a Modbus slave station, the user parameter length is 6 bytes. Refer to Table 184 for the meaning.

Table 184 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, 57.6Kbps, 115.2Kbps
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

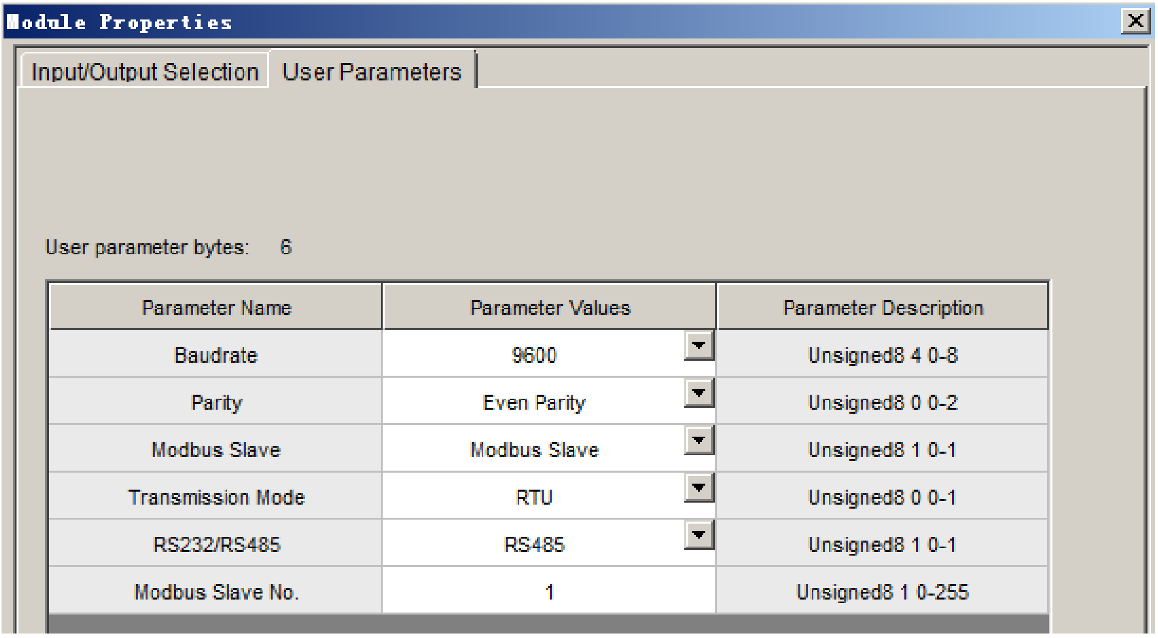


Figure 234 User Parameters for Modbus Slave Station

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: 1 indicates that the Modbus master station does not poll the slave station within 10 seconds.
  - 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 default added.

- The LK239 module cannot transmit the REAL, DINT and DWORD data directly by configuring the input/output data. You need to configure the Data Split and Merge Functions to achieve Modbus communication of floating point data.

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 235.

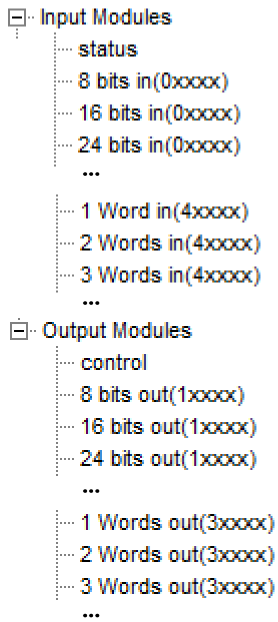


Figure 235　MODUBS Slave Station Data Area

1.13.7.3 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 backplane number and a slot number. During configuration, double-click the **Device Address** item, as shown in Figure 236. Enter a physical communication address in **New** address, and click **OK**.

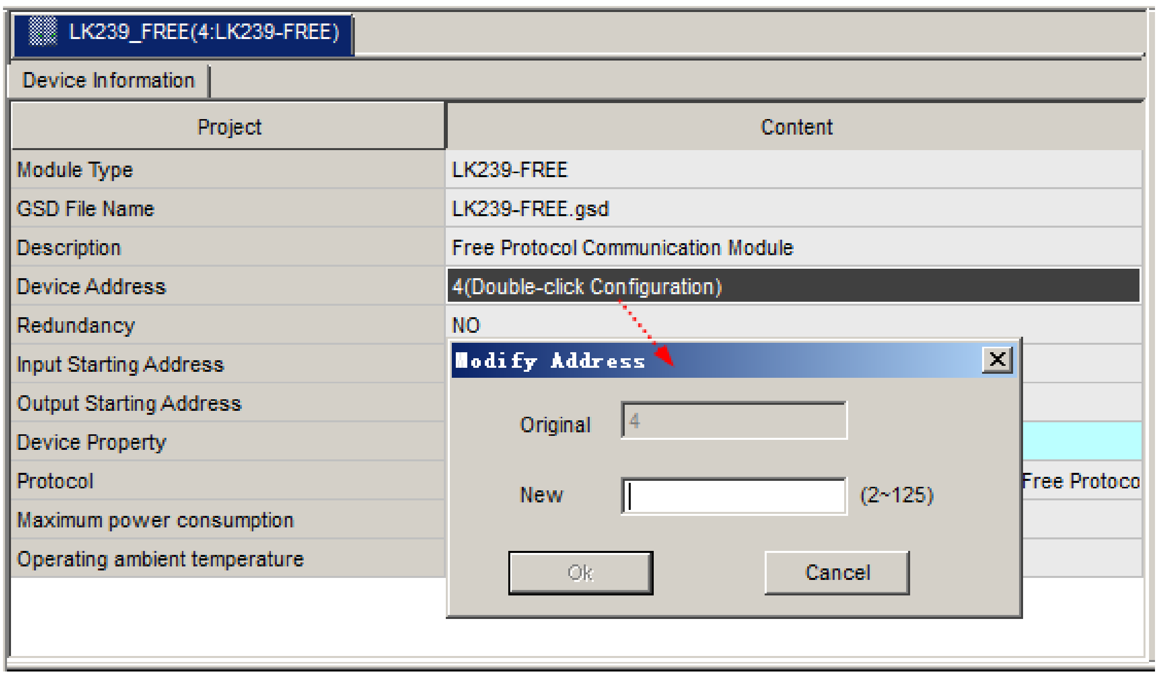


Figure 236　Set Station Address

2. Input/output Parameters

When LK239 is used as a free protocol station, as shown in Figure 237, 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**.

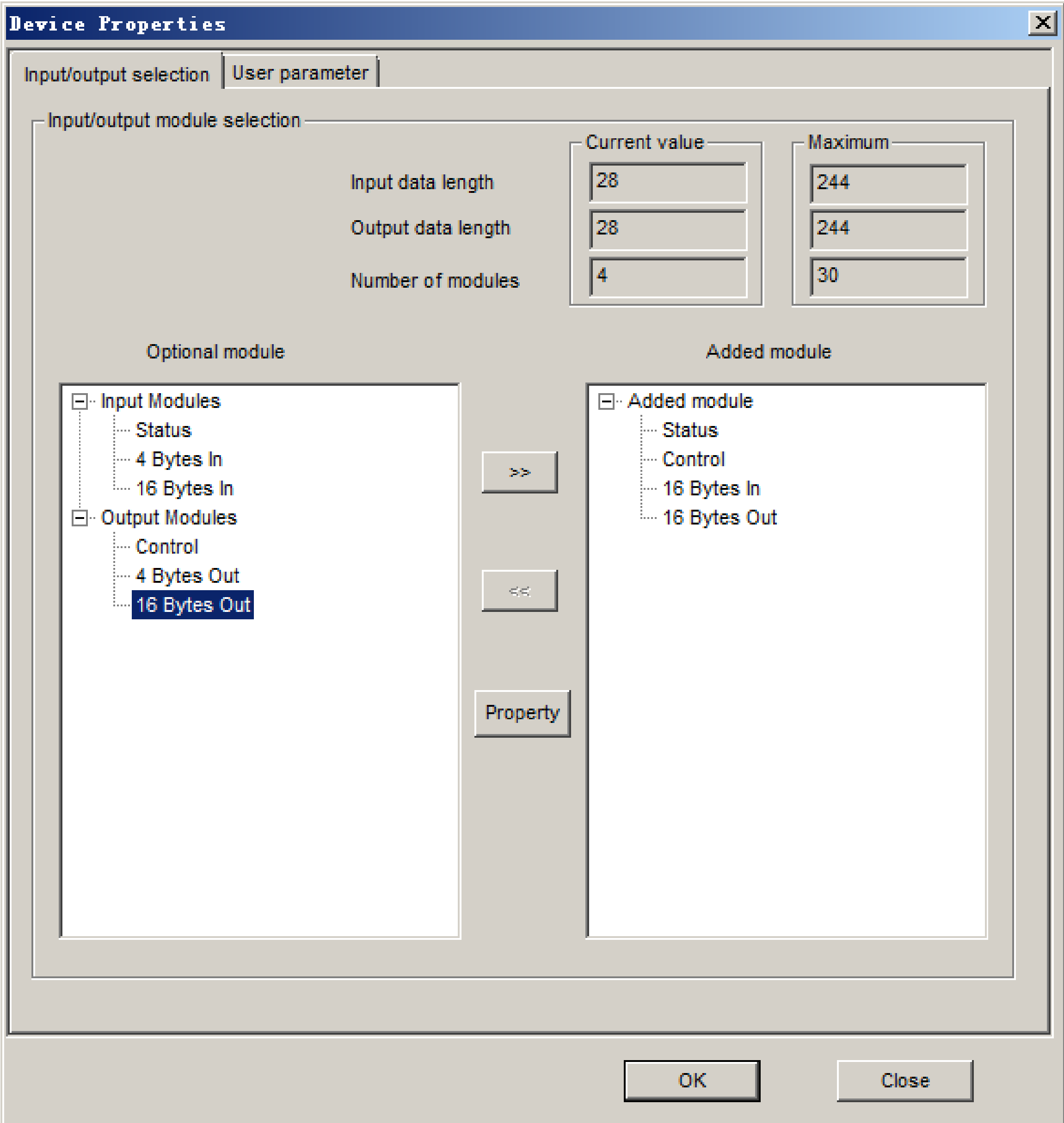


Figure 237 Input/output Module of Free Protocol

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

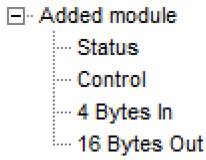


Figure 238 Sequence of Adding Free Protocol Data

3. User Parameter

When LK239 is used as a Free protocol, the user parameter length is 6 bytes. Refer to Table 185 for the specific meaning.

Table 185 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)

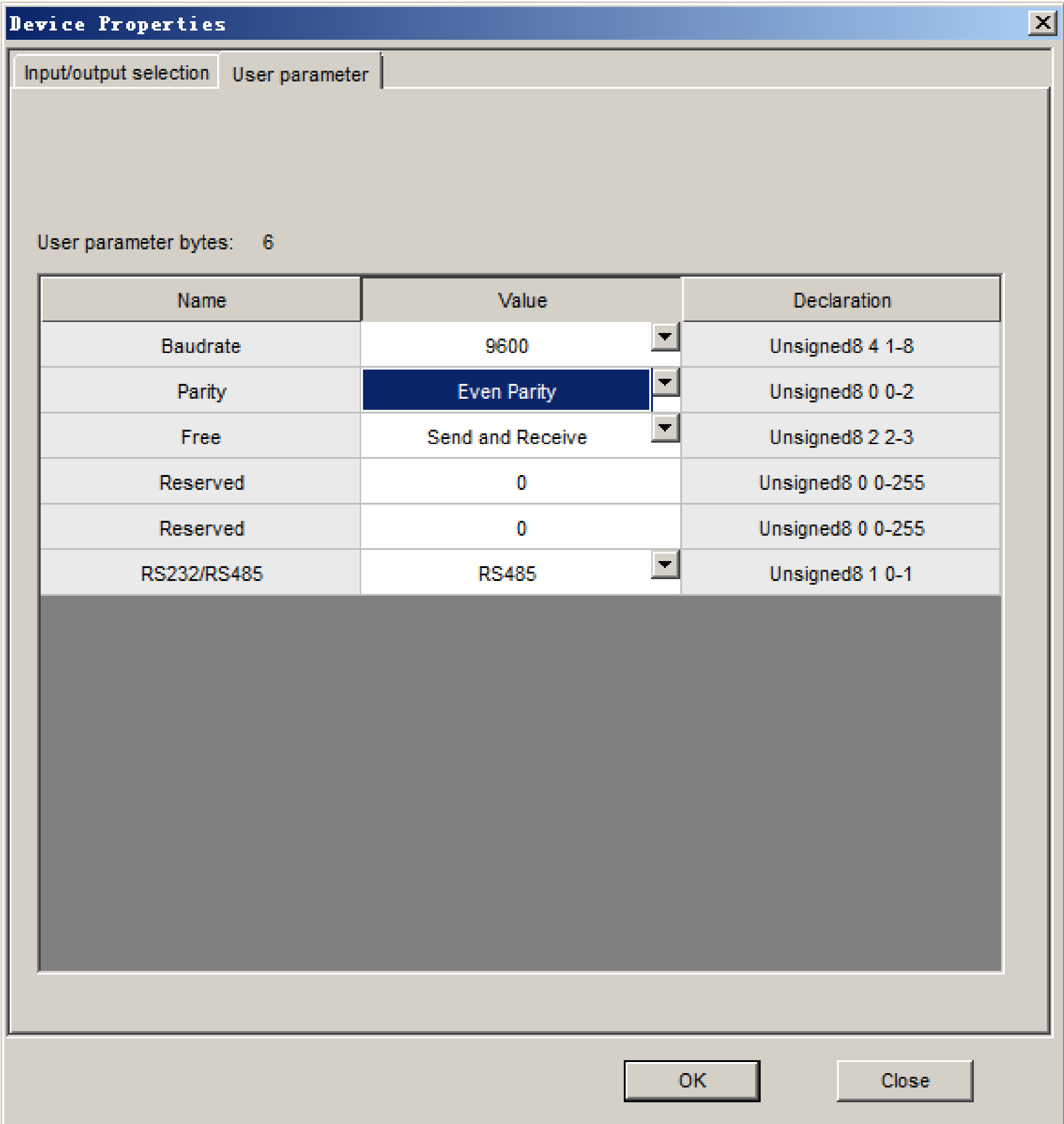


Figure 239 User Parameters for Free Protocol

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 186.

Table 186 Control Byte of Free Protocol in Only Receive Mode

Control	Name	Meaning
Byte0	—	—
Byte1	—	—

Control	Name	Meaning
Byte2	—	—
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 187 when LK239 adopts the **Only Receive** mode of free protocol.

Table 187 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)

Status	Name	meaning
		=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

(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 188.

Table 188 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 189 when LK239 adopts the **Send and Receive** mode of free protocol.

Table 189 Status Byte of Free Protocol in Send and Receive Mode

Status	Name	meaning

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
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 240, 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).

- Input Modules
  - Status
  - 4 Bytes In
  - 16 Bytes In
- Output Modules
  - Control
  - 4 Bytes Out
  - 16 Bytes Out

Figure 240   Optional Data Type of Free protocol

Corresponding input data or output data is displayed in **Device Information** window after data is added for LK239 in [Input/output selection] tab, with status and control data must be selected. As shown in Figure 241.

Status | Control | 16 Bytes In | 16 Bytes Out

Channel Number	Channel Name	Channel Type	Channel Address	Channel description
1	DPIO_2_1_2_1	BYTE	%IB0	
2	DPIO_2_1_2_2	BYTE	%IB1	
3	DPIO_2_1_2_3	BYTE	%IB2	
4	DPIO_2_1_2_4	BYTE	%IB3	
5	DPIO_2_1_2_5	BYTE	%IB4	
6	DPIO_2_1_2_6	BYTE	%IB5	
7	DPIO_2_1_2_7	BYTE	%IB6	
8	DPIO_2_1_2_8	BYTE	%IB7	
9	DPIO_2_1_2_9	BYTE	%IB8	
10	DPIO_2_1_2_10	BYTE	%IB9	
11	DPIO_2_1_2_11	BYTE	%IB10	
12	DPIO_2_1_2_12	BYTE	%IB11	

Figure 241   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), LK239 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 safety main 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 241, 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 242.

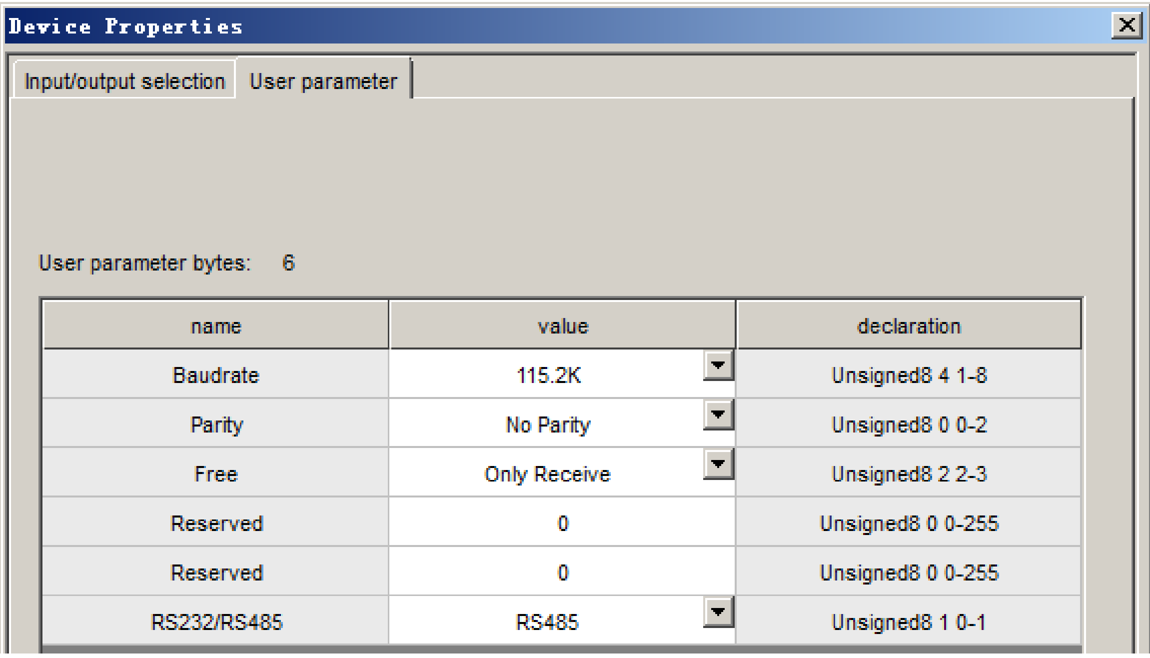


Figure 242 LK239 configured as Only Receive Mode

(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). LK239 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 241, 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 243.

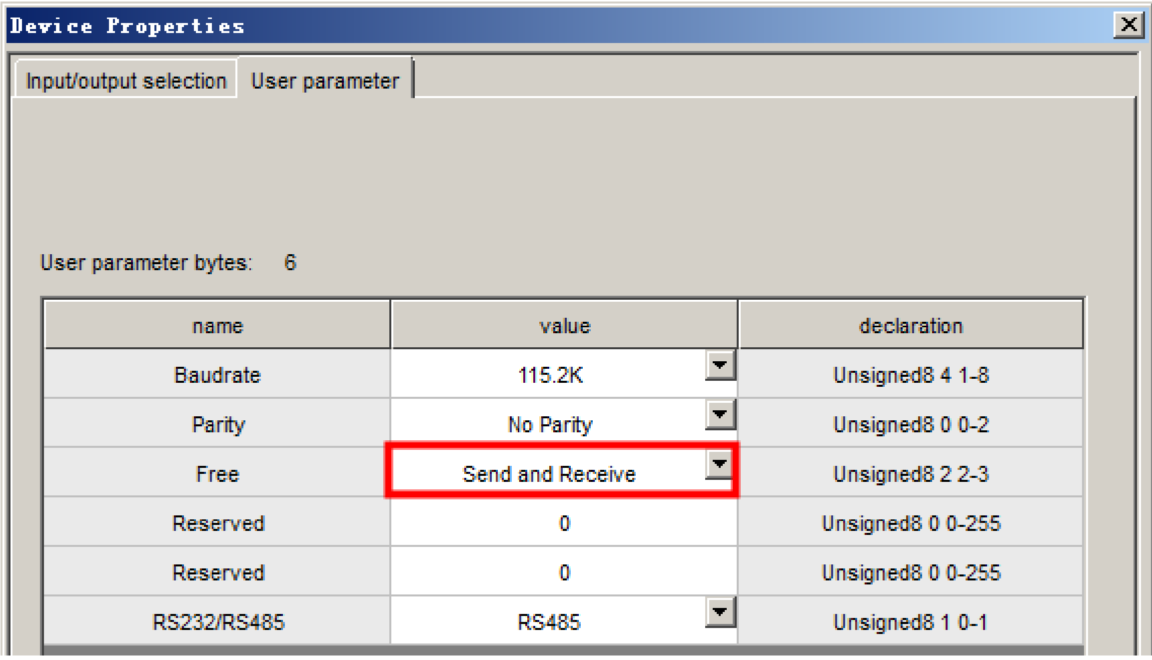


Figure 243 LK239 configured as Send and Receive Mode

- The LK239 module cannot transmit the REAL, DINT and DWORD data directly by configuring the input/output data. You need to configure the Data Split and Merge Functions to achieve Modbus communication of floating point data.

1.13.8 Technical Specifications

LK239 Modbus Master/Slave Communication Extension Module	
System Power	
Operating Voltage	24VDC（-15%~20%）
Backplane 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 backplane 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

LK239　Modbus Master/Slave Communication Extension Module		
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	RUN (green)	Indicator　for Profibus-DP bus communication
	COM (yellow)	Modbus communication/Free protocol indicator
Installation Mode		Slot Installation
Installation Position		I/O slot on the extension backplane
Protection Key		F1
Module Dimension (W*H*D)		35 mm×100 mm×100 mm
Hot swapping		Supported
Weight		180 g

Beijing HollySys Intelligent Technologies Co., Ltd..

Di Sheng Middle Road, No.2

Economic-Technological Development Area

100176 Beijing, China

Tel: 010-5898 1588

Hotline: 4008111999

Fax: 010-5898 1558

http://www.hollysys.com