USR-IO424T-GR User Manual

File Version: V1.0.5.01

Contents

Features

- Support 4-way Relay output
- Support 4-way input, default is dry contact
- Support 2-way analog input, default are voltage detection
- Support 1-way PT100 temperature input
- Support 8 conditional control command
- Support various function code: 0x01, 0x02, 0x03, 0x04, 0x05, 0x06, 0x0F, 0x10
- Support socket to connect to remote server and TCP Client
- Support two work modes: Master mode and Slave mode. Master mode supports connecting to multiple Modbus RTU devices by RS485 cascading connection.
- Adopt Modbus RTU protocol data processing. Support Modbus TCP/RTU protocol adaptation.
- Support connecting to USR Cloud.
- Support FTP remote upgrade.
- Support upgrading by RS485.
- Support hardware watchdog.
- Support various LED to indicate work status.
- Support power supply over-current, over-voltage, anti-reverse connection protection.

1. Get Start

If user has any question, please submit it back to customer center: **h.usriot.com**.

1.1. Product introduction

USR-IO424T-GR is network IO product which supports 4-way input/output, 2-way analog quantity detection, 1-way temperature detection and Modbus RTU/TCP protocol. Take 'Remote control' as core function and have high usability. User can easily and quickly integrate USR-IO424T-GR into own system to realize remote control which based on GPRS network.

1.2. Basic parameters

Parameter		Value
Wireless parameters	Wireless standard	GSM/GPRS
	Standard frequency band	850/900/1800/1900MHz
	Transmitting power	GSM900 class4(2W)
		DCS1800 class1(1W)
	GPRS Terminal Device Class	Class B
	GPRS Multi-slot Class	GPRS Class 10
	GPRS Coding Schemes	CS1~CS4
Hardware parameters	Data interface	Serial port: Support RS485. Baud rate: 300bps~230400bps
	Working voltage	12V~36V
	Voltage acquisition	Range: 0V~10V
	Temperature detection	Range: -100℃~200 ℃
	Working temperature	-20℃~+70℃
	Storage temperature	-40℃~+85℃
	Working humidity	5%~95%
	Storage humidity	1%~95%
	Dimension	123*114*28mm
Software parameters	Wireless network type	GSM/GPRS
	Work mode	Master mode, slave mode
	Configuration command	Modbus RTU
	Network protocol	Modbus TCP, Modbus RTU
	Application software	Support configuration software
Software function	DNS	Support
	Data transmission mode	Support TCP Client
EMC level	ESD	IEC61000-4-2, Level 4
	Surge	IEC61000-4-5, Level 3
	Group pulse	IEC61000-4-4, Level 3

Figure 1 Basic parameters

1.3. Hardware

## 1.3.1. Interface
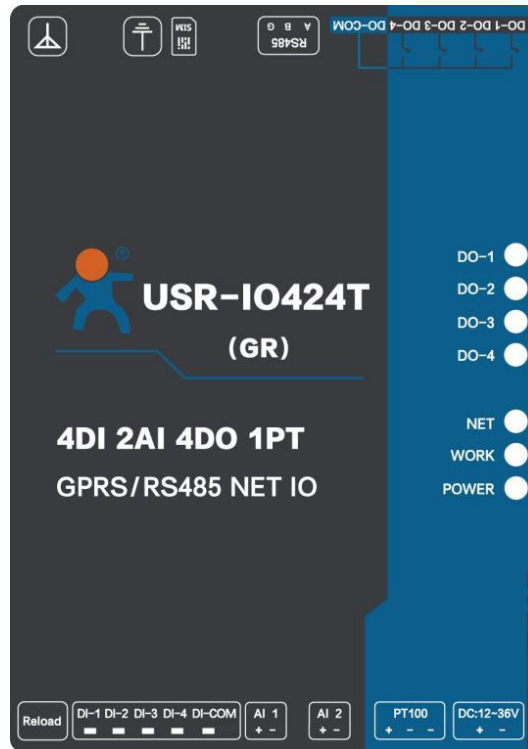
Figure 2 Product interface diagram

➢ Antenna: GPRS antenna.
➢ SIM card slot.
➢ RS485: RS485 interface.
➢ DO: DO1~DO4 are 4-way output and DO-COM is common interface.
➢ DI: Dry contact input and DI-COM is common interface.
➢ AI1, AI2: Analog input interface and reference ground connects to power supply negative pole. Default is voltage acquisition mode and please contact to sales personnel if user needs current acquisition mode.
➢ PT100: PT100 three-wire system interface.
➢ Power supply: DC 12~36V power supply. Low power supply will cause IO424T-GR can't start.

1.3.2. LED

| LED	Function	Status
POWER	Indicate power status	Light after powering module
WORK	Indicate system running status	Blink every 1 second after product system running; Blink every 0.2 second during upgrading firmware process.
NET	Indicate network connection status	Light after connecting to remote server

Figure 3 LED

1.3.3. Dimension
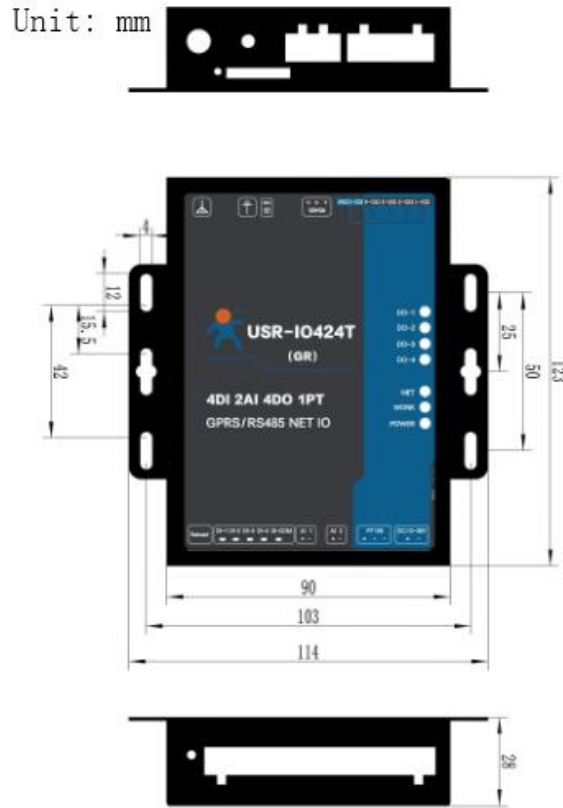
Figure 4 Dimension diagram

1.4. Test

User can refer to following application diagram to test the USR-IO424T-GR.
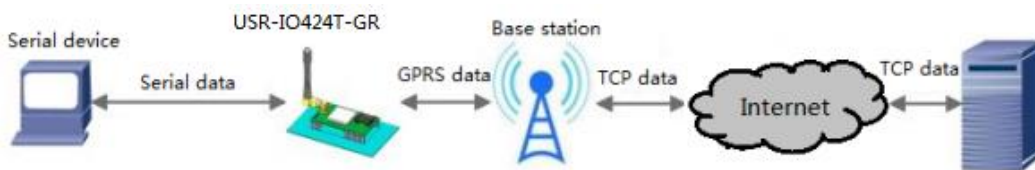
Figure 5 Test diagram

➤ Connect PC to USR-IO424T-GR by USB -> RS485 cable
➤ Insert SIM card before powering IO424T-GR
➤ Power the IO424T-GR(Range from DC 12V to DC 36V)
➤ After powering on, use Modbus protocol to control IO424T-GR by serial.

Initial parameters:

Work mode	Network data transparent transmission
Server address	clouddata.usr.cn
Remote port	15000
RS485 serial port parameters	9600, 8, 1, None

Figure 6 Initial parameters

1.4.1. Control by serial

Power IO424T-GR and connect IO424T-GR's RS485 interface to PC. Run setup software ***USR-IO V1.0.28.exe*** and choose IO424T-GR. Choose correct COM and configure correct serial port parameters as follow(Default settings is 9600, None, 8, 1):
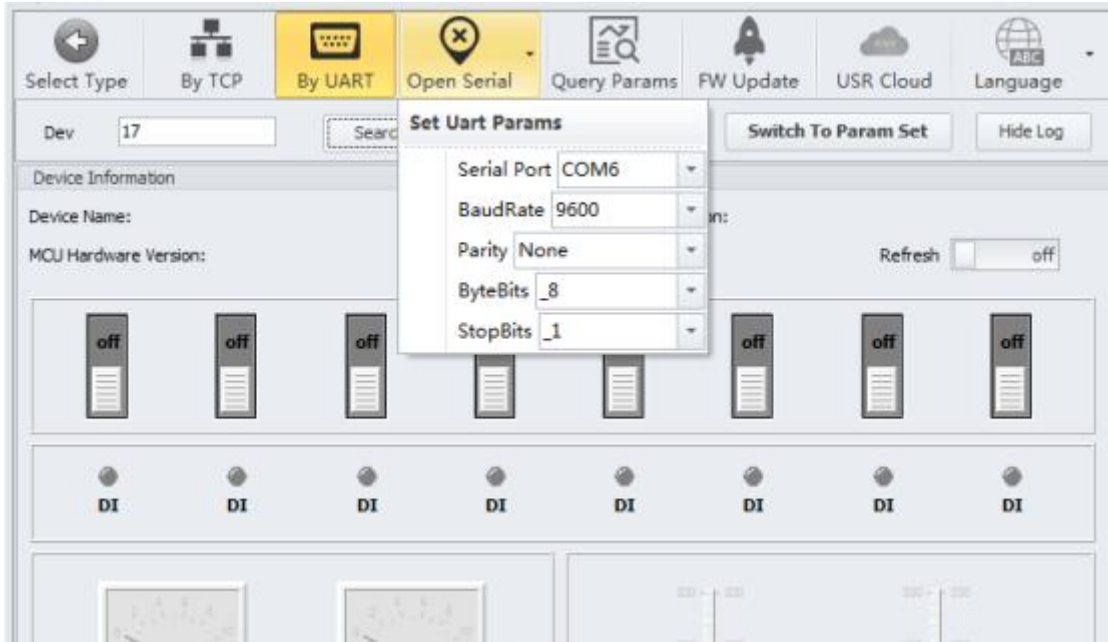
Figure 7 Open serial

After opening serial port, click 'Search' to search IO network controller and click '停止' to stop searching after finding IO network controller. Then choose IO network controller that user wants to configure.

Figure 8 Search IO network controller

Then user can control devices.
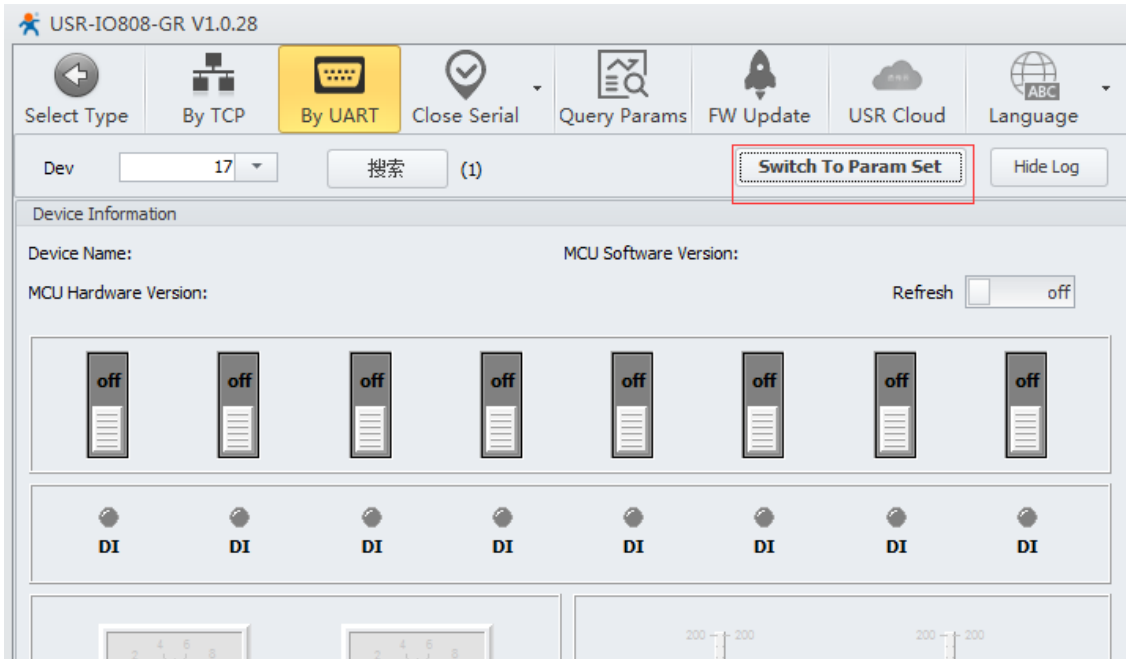
Figure 9 Control devices

User can also click 'Switch To Param Set' on above figure to enter IO424T-GR configuration page.
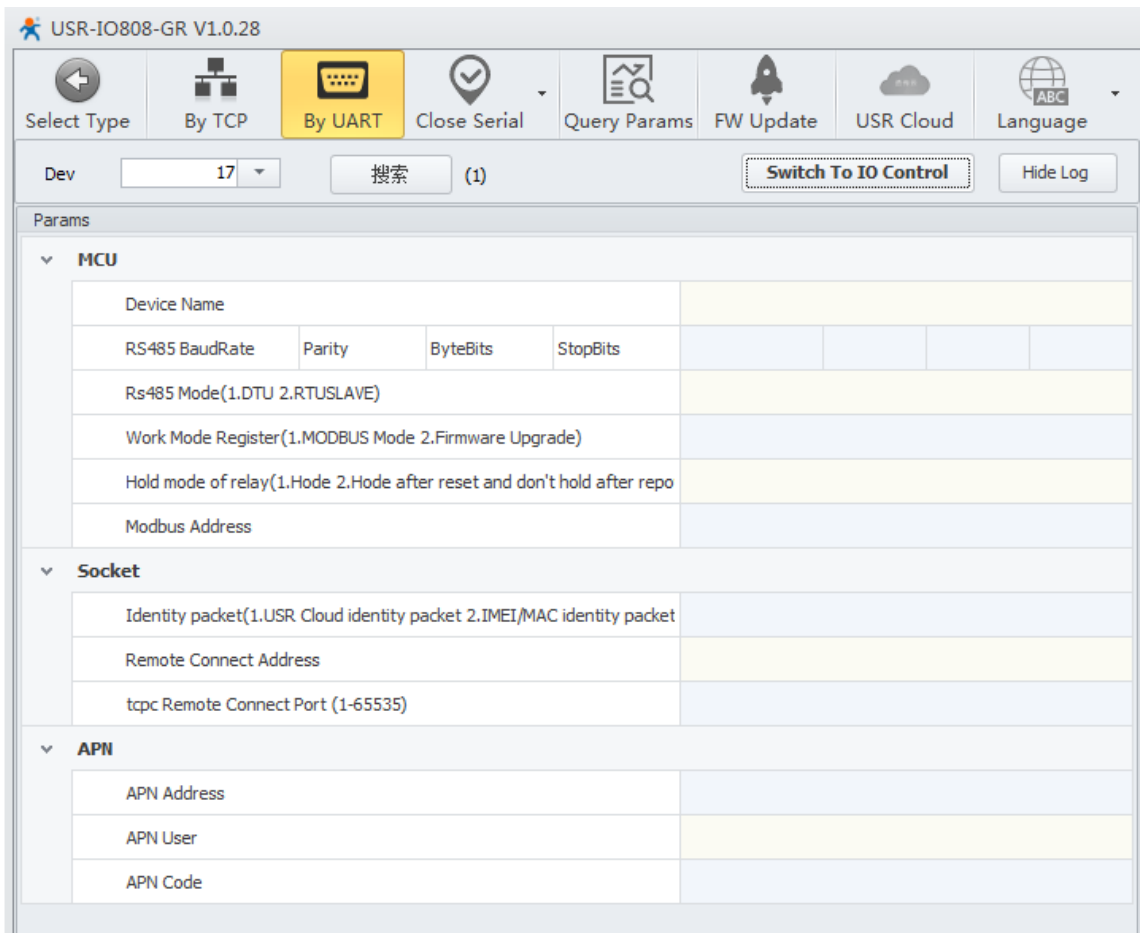
Figure 10 Configuration page

1.4.2. Control by USR Cloud

User can type http://console.usr.cn/ into browser address bar to enter USR Cloud web page and login with username and password. Then user can add device as follow:
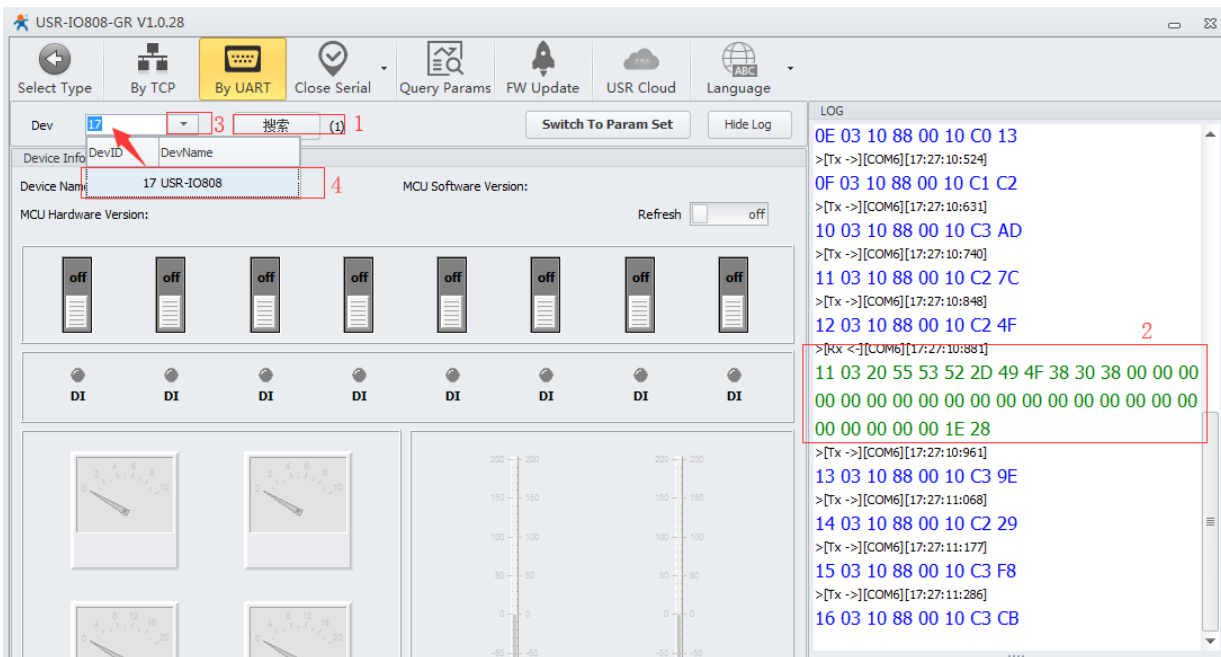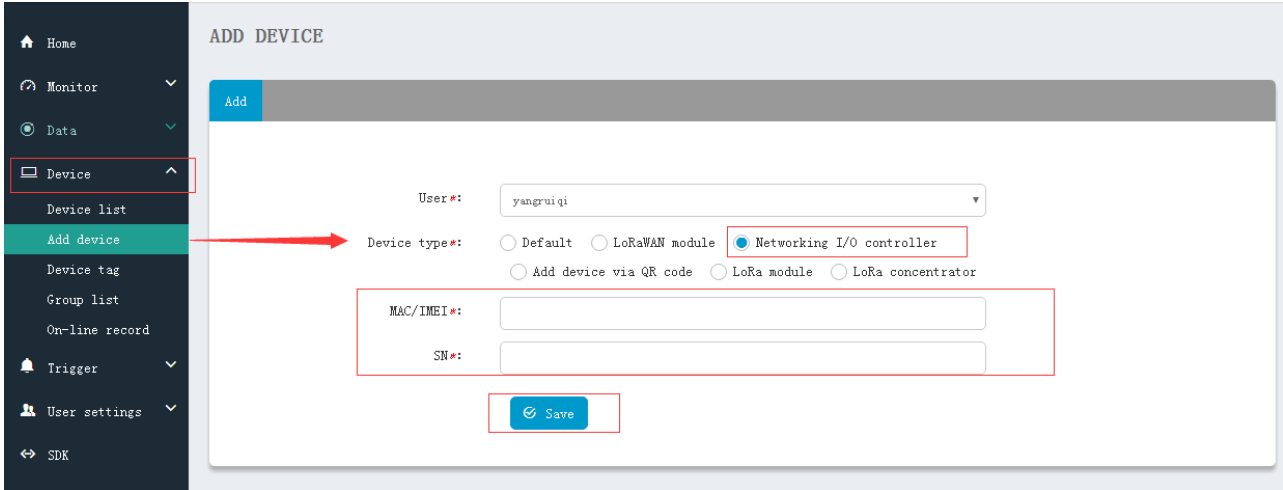

Figure 11 Add IO424T-GR

Choose 'Networking I/O controller' as 'Device type', write IMEI and SN on IO424T-GR's label and click 'Save' to add IO424T-GR.

After adding IO424T-GR, power IO424T-GR and wait LED 'NET' light which means IO424T-GR connects to USR Cloud. Then user can remotely look over, record and control IO424T-GR status in real time through USR Cloud(Monitor->Data list).

2. Product function

USR-IO424T-GR functional diagram as follow:

Figure 12 Functional diagram

2.1. DI input

2.1.1. Electrical level detection

➢ Register address range: 32~35(0x0020~0x0023)
➢ Supported function code: 02(Read discrete input), 03(Read holding register)
➢ Connection: Default is dry contact input. Short-circuit DI and COM will change input status. If user needs wet contact input can contact to our sales personnel
➢ Electrical level detection: Default status is 0, after short-circuiting DI and COM, status will be 1. Detection method: 02 function code of Modbus protocol.
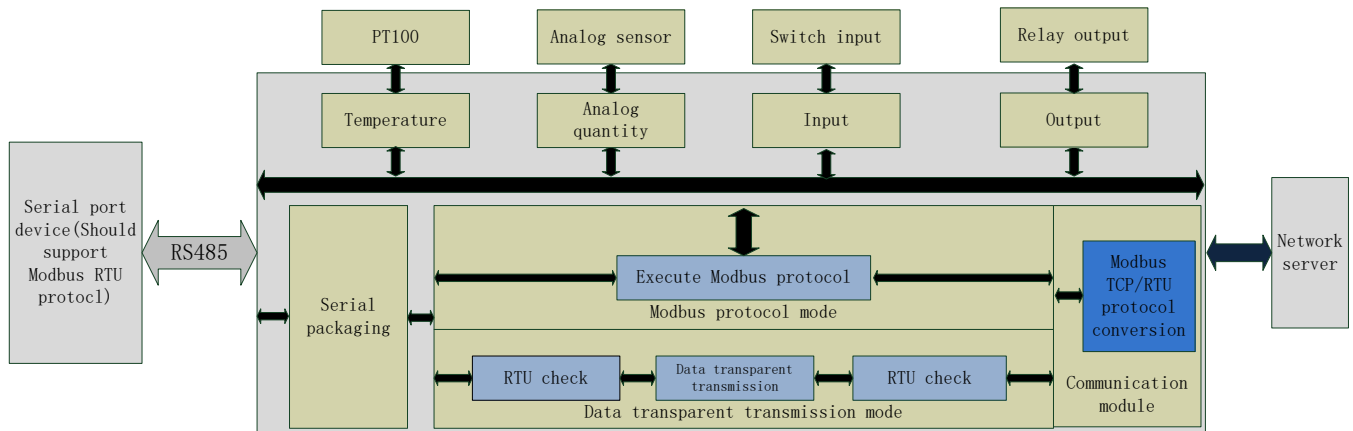
Example:
Detect input of the first way, send: 11 02 00 20 00 01 BA 90
Short-circuiting will return: 11 02 01 01 64 88
No short-circuiting will return: 11 02 01 00 A5 48

2.1.2. Buttons detection

➢ Register address range: 48~51(0x0030~0x0033)
➢ Supported function code: 03(Read holding register), 04(Read input register)
➢ Connection: Default is dry contact input. Short-circuit DI and COM will change input status. If user needs wet contact input can contact to our sales personnel
➢ Electrical level detection: Default status is 0000, after short-circuiting DI and COM and then releasing, status will be FF00. Detection method: Read button register value by 03 function code of Modbus protocol. After reading once button register, status will recover to 0000; after executing conditional control, status will recover to 0000. too.

Example:
Detect the first way button, send: 11 03 00 30 00 01 86 95
No button will return: 11 03 02 00 00 79 87

Have button will return: 11 03 02 FF 00 38 77

2.1.3. Pulse counting

➢ Register address range: 64~67(0x0040~0x0043)

➢ Supported function code: 03(Read holding register), 04(Read input register)

➢ Connection: Default is dry contact input. Short-circuit DI and COM will change input status. If user needs wet contact input can contact to our sales personnel

➢ Pulse counting: Default status is 0, short-circuit DI and COM and then release will count 1. Detection method: Read pulse counting register value by 03 function code of Modbus protocol. Maximum value of pulse counting is 65535 and it will restart counting after exceeding 65535. Can't reset count to 0 and restart product won't save count.

➢ **Note**: Pulse counting won't filter input waveform and all pulse in the range of detection will be recorded. So input waveform should keep stable to ensure accurate count.

Example:

Detect count of the first way, send: 11 03 00 40 00 01 87 4E

Return: 11 03 02 00 00 79 87

2.2. DO output

➢ Register address range: 00~03(0x0000~0x0003)

➢ Supported function code: 01(Read coil), 05(Write single coil), 0F(Write multiple coil)

➢ Connection: DO output is Relay passive output and 4-way will use one COM together. Relay close will connect DO with COM.

Take the first way Relay control as example:

Query: 11 01 00 00 00 04 3F 59

Control to close: 11 05 00 00 FF 00 8E AA

Control to disconnect: 11 05 00 00 00 00 CF 5A

2.3. AI input

➢ Register address range: 88~89(0x0058~0x0059, voltage acquisition data), 96~97(0x0060~0x0061, current acquisition data)

➢ Supported function code: 03(Read holding register), 04(Read input register)

➢ Connection: Analog detection adopts public reference ground method to connect(signal + connects to +, signal - connects to - and reference ground short-circuit to power ground). Voltage detection range: 0 ~ 10V; current detection range: 0 ~ 20mA.

Take the first way voltage detection as example:

Query: 11 03 00 58 00 01 07 49

Return: 11 03 02 10 00 74 47

Return data: 0x1000, it's 4096 mV

Note: Analog detection is voltage detection and current detection, default is voltage detection and please ignore current register value. If user needs to do 4~20mA current detection, please contact to our sales personnel.

2.4. Temperature detection

➢ Register address range: 80(0x0050, temperature acquisition data)
➢ Supported function code: 03(Read holding register), 04(Read input register)
➢ Connection: Input signal of temperature detection is PT100 signal and connection adopts three-wire system. Single wire connects to + and two interlinked wires connect to two -.
➢ Temperature calculation formula: Actual temperature=(Return value-10000)/100

Example:
Query: 11 04 00 50 00 01 33 4B
Return: 11 04 02 06 92 FA FE
Return data: 0x0692, it's 1682 and actual temperature=(1682-10000)/100=-83.18℃

2.5. Work mode

Default work mode of USR-IO424T-GR is slave mode. IO424T-GR will be slave both on network side and RS485 side and IO424T-GR will discard data if IO424T-GR receives data not for IO424T-GR local address.

2.5.1. Master mode

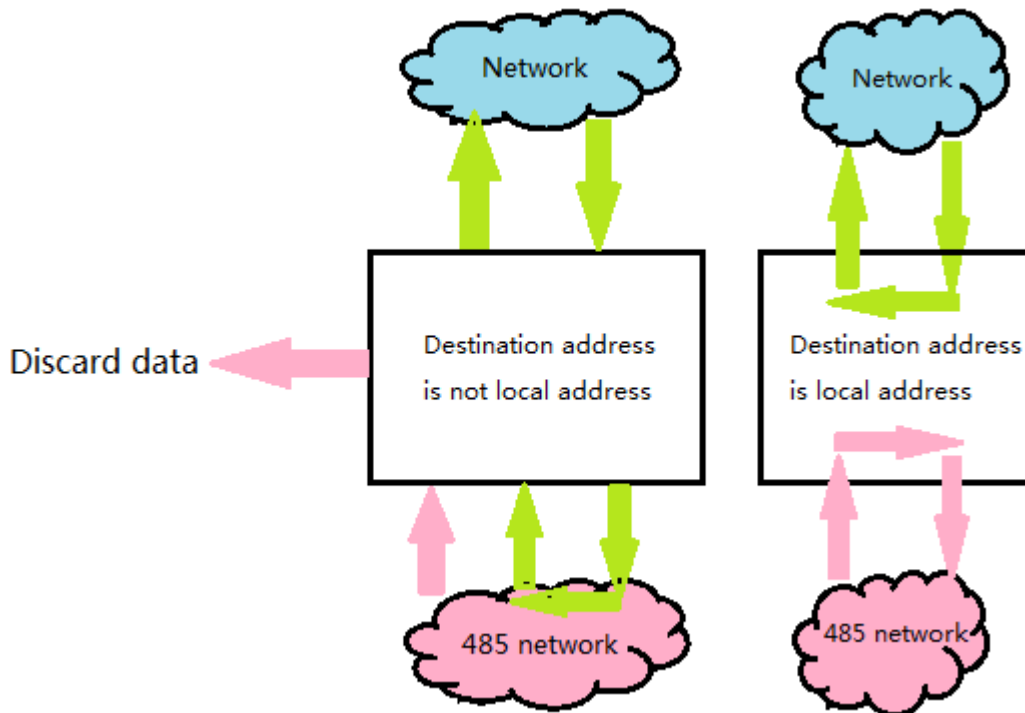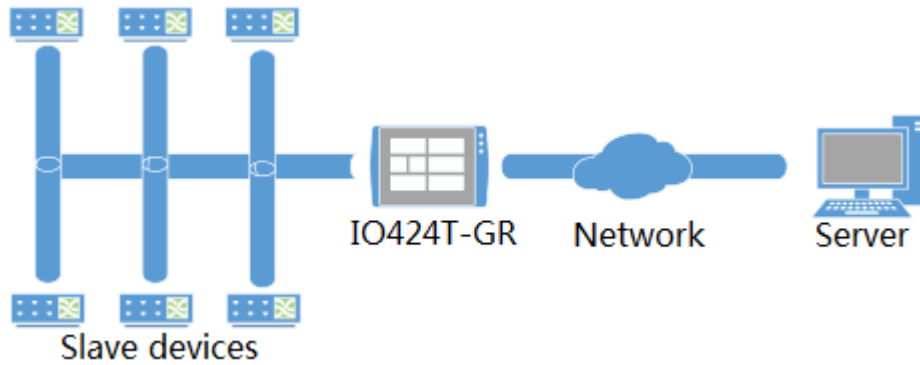Master mode data flow diagram and connecting to network diagram as follows:

Figure 13 Master mode data flow

Figure 14 Connecting to network in Master mode

In master mode, after IO424T-GR receiving data, it will judge destination address firstly. If destination address is local address, IO424T-GR will process data; if destination address isn't local address, IO424T-GR will forward data. In this mode, user can connect to multiple slave devices by RS485 cascading connection.

User can configure IO424T-GR to Master mode by setup software as follow(Configure RS485 mode to 1.DTU):

Params							
∨ **MCU**							
Device Name				USR-IO808			
RS485 BaudRate	Parity	ByteBits	StopBits	9600	NONE	8	1
Rs485 Mode(1.DTU 2.RTUSLAVE)				1			
Work Mode Register(1.MODBUS Mode 2.Firmware Upgrade)				1			
Hold mode of relay(1.Hode 2.Hode after reset and don't hold after repo				2			
Modbus Address				17			
∨ **Socket**							
Identity packet(1.USR Cloud identity packet 2.IMEI/MAC identity packet				2			
Remote Connect Address				118.190.93.90			
tcpc Remote Connect Port (1-65535)				8235			
∨ **APN**							
APN Address				CMNET			
APN User							
APN Code							

Figure 15 Configure IO424T-GR to Master mode

2.5.2. Slave mode

Slave mode data flow diagram and connecting to network diagram as follows:
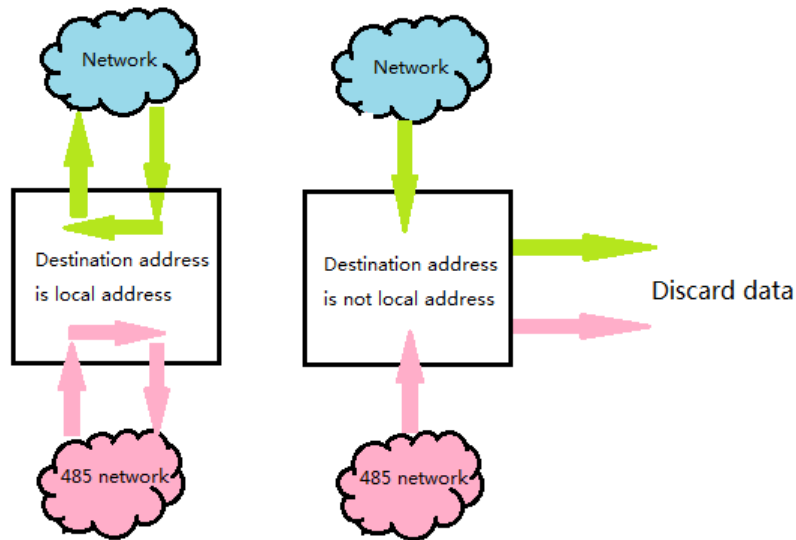
Figure 16 Slave mode data flow

Figure 17 Connecting to network in Slave mode

In this mode, IO424T-GR can connect to master device or work as single device. In this mode, IO424T-GR will analyse and process received data. If destination address is local address, IO424T-GR will make a corresponding reaction; if destination address isn't local address, IO424T-GR will discard data.

User can configure IO424T-GR to salve mode by setup software as follow(Configure RS485 mode to 2.RTUSLAVE):

Figure 18 Configure IO424T-GR to Slave mode

2.6. Upgrade firmware

User can refer to FAQ **<<Upgrading firmware method of USR-IO424T-GR_V1.0.0>>**.

2.7. Serial port

2.7.1. Basic parameters

Parameter	Range
Baud rate	300~230400
Data bits	7, 8
Stop bits	1, 2
Parity	NONE, EVEN, ODD

Figure 19 Serial port basic parameters

2.7.2. Configuration method

Serial port parameters occupy two registers. Length of protocol is 4 bytes and specific protocol content as follow(All examples are in HEX format):

Name	Baud rate	Parameter bit
Number of bytes	3	1
Description	Three bytes represent a baud rate value and high-order in the former	Refer to **Figure 22 Serial port parameter bit**
Example 1(115200, None, 8, 1)	01 C2 00	03
Example 2(9600, None, 8, 1)	00 25 80	03

Figure 20 Serial port parameters protocol

Bit number	Representation	Value	Description
1:0	Data bits	10	7 bits data bits
		11	8 bits data bits
2	Stop bits	0	1 bit stop bits
		1	2 bits stop bits
5:4:3	Parity	000	None
		001	ODD
		011	EVEN
7:6	No definition	00	Please write 0

Figure 21 Serial port parameter bit

2.8. Features

2.8.1. Relay output status hold

User can configure whether hold Relay output status: After restarting IO424T-GR or powering on IO424T-GR again, hold the Relay output status or reset to disconnect status.

➢ Register address: 182(0x00B6)

➤ Parameter values: 1(0x0001):All Relays hold status after restarting or powering off. 2(0x0002):All relays hold status after restarting and don't hold status after powering off.3(0x0003):All relays don't hold status after restarting or powering off.
➤ Supported function code: 0x03, 0x04, 0x06, 0x10

Configuration will take effect after restarting.

2.8.2. Conditional control

Conditional control function supports user configuring the conditions to trigger IO changes. It can make using IO424T-GR more flexibly and extend application scenario. User only needs to modify conditional control function register parameters according to the instructions , it will realize corresponding function.

Conditional control function has 32 registers and 8 conditional control commands(Every command occupies 4 registers). Registers distribution as follow:

Storage content	Input register	Output register	Output action	Condition	Threshold	Reserved
Length	1 byte	1 byte	1 byte	1 byte	2 bytes	2 bytes
Address	Range: 16~109	Range: 1~16	1: Disconnect 2: Close 3: Reversal	1 ~ 255	'Compared register values'/The first two bytes of time-stamp	Reserved/ Last two bytes of time-stamp

Figure 22 Conditional control function register

➤ Output action(Relay output)
   1: Disconnect
   2: Close
   3: Reversal
➤ Condition
   1: Forward direction output follow
   2: Backward direction output follow
   3: Greater than or equal to
   4: Less than or equal to
   255: Button action
➤ Control mode
   Switching value control: DI input control DO output directly
   Semaphore control: DI button semaphore control DO. Press button once, DO act once(Execute action in rising edge of releasing button).

Detailed explanation:
1. Forward direction output follow
Enable forward direction output follow: Set condition register to 1, input register is corresponding to one way register address of 4-way input and output register is corresponding to one way register address of 4-way output.

For example, if configure as 0x20 0x00 0x01 0x01 0x00 0x00 0x00 0x00, it represents status of DO1 will follow status of DI1 which means DO1 will close if DI1 close and DO1 will disconnect if DI1 disconnect.

2. Backward direction output follow

Enable backward direction output follow: Set condition register to 2, input register is corresponding to one way register address of 4-way input and output register is corresponding to one way register address of 4-way output.

For example, if configure as 0x20 0x00 0x01 0x02 0x00 0x00 0x00 0x00, it represents status of DO1 will be opposite as status of DI1 which means DO1 will close if DI1 disconnect and DO1 will disconnect if DI1 close.

3. Button control

Enable button control: Set condition register to 255, input register is DI button register and output register is DO output register. Action can be 1(disconnect), 2(close), 3(reversal), threshold register and reserved register can't work.

For example, if configure as 0x30 0x00 0x03 0xFF 0x00 0x00 0x00 0x00, it represents detecting DI1 button once will reverse status of DO1 once.

4. Greater than or equal to

Condition of greater than or equal to action is 03. Input register are voltage register, current register and temperature register; output register is DO output register. Action can be 1(disconnect), 2(close), 3(reversal). Threshold register is comparison value and program will compare acquisition results of input register with comparison value. Reserved register can't work.

For example, if configure as 0x50 0x00 0x01 0x03 0x3A 0x98 0x00 0x00, it represents: 0x50 is the first way temperature acquisition and 0X3A98 represents 15000(50℃). This condition represents disconnecting the first way DO output when the first way temperature acquisition result is greater than 50℃.

5. Less than or equal to

Condition of less than or equal to action is 04. Input register are voltage register, current register and temperature register; output register is DO output register. Action can be 1(disconnect), 2(close), 3(reversal). Threshold register is comparison value and program will compare acquisition results of input register with comparison value. Reserved register can't work.

For example, if configure as 0x50 0x00 0x01 0x04 0x3A 0x98 0x00 0x00, it represents: 0x50 is the first way temperature acquisition and 0X3A98 represents 15000(50℃). This condition represents disconnecting the first way DO output when the first way temperature acquisition result is less than or equal to 50℃.
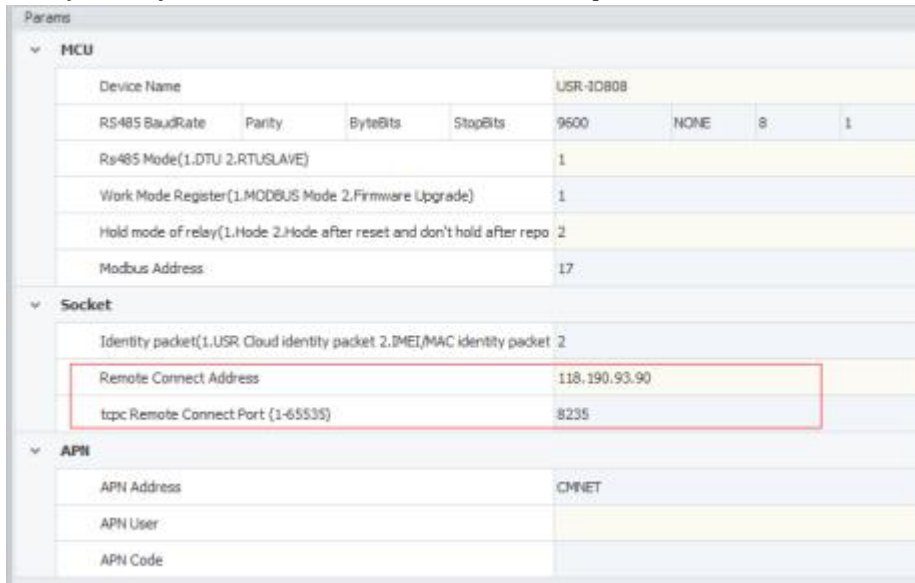
Note:

Input register is 0 means close this conditional control and execute button action once will clear button register. If multiple conditions will lead to paradoxical result, program will execute two results quickly. If forward direction output follow and backward direction output follow lead to paradoxical result, disconnecting and closing will revolve.

2.8.3. Connect to remote server

User can modify related register parameters of remote server to realize IO424T-GR connecting to remote server.

Procedure as follow:

1. Power the IO424T-GR and connect IO424T-GR's RS485 interface to PC. Run setup software(User can refer to ***1.4.1.Control by serial***), modify remote server address and remote port as follow:

Figure 23 Configure remote server parameters

2. Restart IO424T-GR to make configuration take effect.

3. Login remote server and open the port.

4. Wait IO424T-GR LED 'NET' light which means IO424T-GR connect to remote server successfully, Then user can transmit Modbus TCP/RTU command from server side to control IO424T-GR and receive response from IO424T-GR.
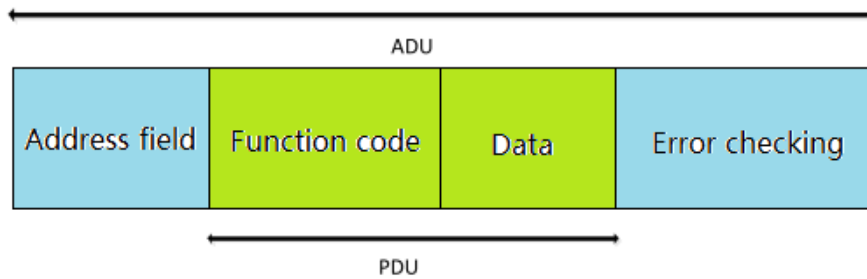
2.8.4. Reset to default by hardware

User can reset to default settings by pressing Reload button. After powering on, press Reload button 3 seconds to 15 seconds, then release it, IO424T-GR will reset to default settings. Less than 3 seconds or more than 15 seconds will be considered as misoperation and don't handle it.
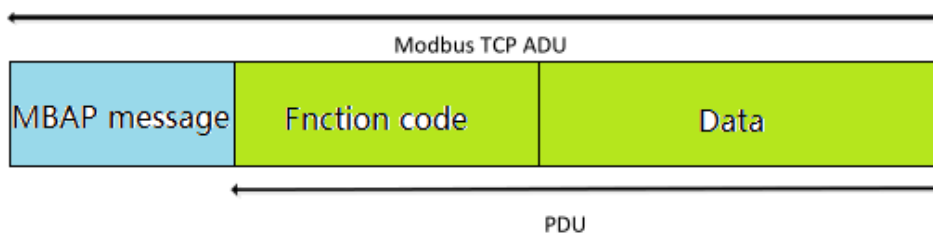
3. Modbus

3.1. Modbus frame

Modbus RTU:

Figure 24 Modbus RTU frame

USR-IO424T-GR data format conform to general Modbus frame format. IO424T-GR can analyse Modbus RTU protocol and execute related operations.

Modbus TCP:

Figure 25 Modbus TCP frame

USR-IO424T-GR can analyse received network Modbus TCP protocol data and transfer to Modbus RTU protocol to do data processing. IO424T-GR can also be used in Master mode and transfer Modbus RTU protocol to Modbus TCP protocol and transmit to server.

3.2. Register distribution

USR-IO424T-GR register instructions:

1. Register base address is 0x0000.

2. In following register distribution table, MCU parameters and communication module parameters must operate together.

3. Setup software USR-IO adopts UTF-8 coded format.

4. Register store HEX format data.

Register address	Register content	Parameter description	Applicable function code
Device I/O			
0x0000~0x0003	Switch value output	0xFF00 means ON, 0x0000 means OFF; 1 means ON, 0 means OFF	0x01, 0x05, 0x0F
0x0020~0x0023	Switch value input	1 means ON, 0 means OFF	0x02
0x0030~0x0033	Button input	Button detection. Reset to 0 after reading once	0x03, 0x04
0x0040~0x0043	Pulse counting	Count range: 0~0xFFFF. Reset to 0 after reaching maximum	0x03, 0x04

0x0050	Temperature detection	PT100 temperature detection. Range: -100~200℃	0x03, 0x04
0x0058	Voltage 1 detection	0-10V voltage detection	0x03, 0x04
0x0059	Voltage 2 detection	0-10V voltage detection	0x03, 0x04
MCU parameter			
0x0068~0x0069	Time-stamp	Current time-stamp	0x03, 0x04
0x006A~0x006C	Year, month, day, hour, minute, second	The format of 'year, month, day, hour, minute, second' is Bcd code. Such as [0x18,0x01,0x01,0x08,0x24,0x56] represents 2018-1-1 8:24:56	0x03, 0x04, 0x10
0x006D	Week	0x0001-0x0007 represents Monday to Sunday	0x03, 0x04
0x008E~0x0091	Conditional control command 1		
0x0092~0x0095	Conditional control command 2		
0x0096~0x0099	Conditional control command 3		
0x009A~0x009D	Conditional control command 4	Refer to *2.8.2. Conditional control*	0x03, 0x04, 0x10
0x009E~0x00A1	Conditional control command 5		
0x00A2~0x00A5	Conditional control command 6		
0x00A6~0x00A9	Conditional control command 7		
0x00AA~0x00AD	Conditional control command 8		
0x00AE~0x00AF	RS485 interface	Refer to *2.7.2. Configuration method*	0x03, 0x04, 0x10
0x00B0	RS485 mode	Master mode(0x0001) Slave mode(0x0002)	0x03, 0x04, 0x06, 0x10
0x00B1	Modbus address	Slave address(0x0001~0x00FD)	0x03, 0x04, 0x06, 0x10
0x00B2	Work mode	Modbus mode(0x0001) Firmware upgrade(0x0002)	0x03, 0x04, 0x06, 0x10
0x00B3	Global parameters configuration	Default(0x0000), restart(0x0001), reset to user default settings(0x0002),reset to USR default settings(0x5555), save current	0x03, 0x04, 0x06, 0x10

		settings as user default settings(0xAAAA)	
0x00B4	MCU software version	For example, 0x0112 means version V1.1.2	0x03, 0x04
0x00B5	MCU hardware version	For example, 0x0110 means version V1.1	0x03, 0x04
0x00B6	Relay status after restarting	All relays hold status after restarting or powering off(0x0001); All relays hold status after restarting and don't hold status after powering off(0x0002) All relays don't hold status after restarting or powering off(0x0003)	0x03, 0x04, 0x06, 0x10
0x00B7~0x00B8	Temperature self-calibration	Device temperature self-calibration interface	0x03, 0x04, 0x06, 0x10
0x00C7~0x00C8	Voltage 1 self-calibration	Device voltage 1 self-calibration interface	0x03, 0x04, 0x06, 0x10
0x00C9~0x00CA	Voltage 2 self-calibration	Device voltage 2 self-calibration interface	0x03, 0x04, 0x06, 0x10
0x00E7	PIN code	Character string format, 4~8 bits digital value	0x03, 0x04, 0x10
Communication module parameters			
0x1000~0x100A	APN address	Character string format	0x03, 0x04, 0x10
0x100B~0x1015	APN username	Character string format	0x03, 0x04, 0x10
0x1016~0x1020	APN password	Character string format	0x03, 0x04, 0x10
0x1043	Identity packet	USR Cloud identity packet(1); MAC identity packet(2); User editable identity packet(3); Disable identity packet(4)	0x03, 0x04, 0x06, 0x10
0x1055~0x1074	TCP Client remote server address	Remote server address	0x03, 0x04, 0x10
0x1075	TCP Client remote port	Remoter server port	0x03, 0x04, 0x06, 0x10
0x1088~0x1097	Device name	Character string format	0x03, 0x04, 0x10
0x1098	USR-IO424T-GR software version	For example, 0x0112 means version V1.1.2	0x03, 0x04
0x1099	USR-IO424T-GR hardware version	For example, 0x0110 means version V1.1	0x03, 0x04
0x10BA~0x10CD	User editable identity packet	Character string format	0x03, 0x04, 0x10
0x10CE	Identity packet	Send identity packet after	0x03, 0x04, 0x06, 0x10

	sending method	establishing connection(1)/Send before every data package(2)/Both way(3)	

Figure 26 Register distribution

4. Contact Us

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5. Disclaimer

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6. Update History

2018-05-22   V1.0.3.01 established based on Chinese version V1.0.3.
2018-06-13   V1.0.5.01 updated based on Chinese version V1.0.05.