ESP32 4-Channel Modbus RTU Relay Module - Command Manual

Quick Start

Default Settings: Slave Address `1`, Baud Rate `115200`, Data Format `8N1` (8 data bits, no parity, 1 stop bit)

Wiring: Connect the module's RS485 A/B terminals to your host/USB-to-RS485 adapter. Open a serial debug tool (e.g. SSCOM), set baud rate to 115200, enable HEX mode, and send the commands below.

Quick Test Commands (HEX format, copy & send directly):

Action	Command
Turn ON Relay #1	`01 05 00 00 FF 00 8C 3A`
Turn OFF Relay #1	`01 05 00 00 00 00 CD CA`
Turn ON All Relays	`01 0F 00 00 00 04 01 0F 7E 92`
Turn OFF All Relays	`01 0F 00 00 00 04 01 00 3E 96`
Read Relay Status	`01 01 00 00 00 04 3D C9`
Read Optocoupler Input Status	`01 02 00 00 00 04 79 C9`

1. Module Specifications

Parameter	Value
MCU	ESP32
Communication Interface	RS485 / TTL UART
Protocol	Modbus RTU
Slave Address	1 (Fixed)
Baud Rate	115200 bps (Fixed)
Data Format	8N1 (8 data bits, no parity, 1 stop bit)
Relay Channels	4 (#1 ~ #4)
Optocoupler Inputs	4 (#1 ~ #4)

Pin Assignment

Function	GPIO Pin
Relay 1	GPIO 23
Relay 2	GPIO 5

Function	GPIO Pin
Relay 3	GPIO 4
Relay 4	GPIO 13
Optocoupler Input 1	GPIO 25
Optocoupler Input 2	GPIO 26
Optocoupler Input 3	GPIO 27
Optocoupler Input 4	GPIO 33
RS485 Direction Control	GPIO 32
Serial TX	GPIO 19
Serial RX	GPIO 18

2. Supported Modbus Function Codes

Function Code	Name	Purpose
0x01	Read Coils	Read relay ON/OFF status
0x02	Read Discrete Inputs	Read optocoupler input HIGH/LOW status
0x05	Write Single Coil	Control a single relay ON/OFF
0x0F	Write Multiple Coils	Control multiple relays ON/OFF simultaneously

Address Mapping

Coil Addresses (Relay Control):

Address	Mapping
0x0000	Relay #1
0x0001	Relay #2
0x0002	Relay #3
0x0003	Relay #4

Discrete Input Addresses (Optocoupler Input):

Address	Mapping
0x0000	Optocoupler Input #1
0x0001	Optocoupler Input #2
0x0002	Optocoupler Input #3

Address	Mapping
0x0003	Optocoupler Input #4

3. Modbus RTU Command Reference

> All commands below are in HEX format. The last 2 bytes are CRC-16/MODBUS checksum. If you modify any parameter, the CRC must be recalculated.

3.1 Turn ON a Single Relay (Function Code 05)

Example: Turn ON **Relay #1**

Send: `01 05 00 00 FF 00 8C 3A`

Field	Value	Description
Slave Address	01	Fixed at 1
Function Code	05	Write Single Coil
Coil Address	00 00	Relay #1 address (see address mapping)
Command	FF 00	0xFF00 = ON, 0x0000 = OFF
CRC16	8C 3A	CRC-16/MODBUS checksum

Response (echo back): `01 05 00 00 FF 00 8C 3A`

Turn ON commands for all relays:

Relay	Command
Turn ON Relay #1	`01 05 00 00 FF 00 8C 3A`
Turn ON Relay #2	`01 05 00 01 FF 00 DD FA`
Turn ON Relay #3	`01 05 00 02 FF 00 2D FA`
Turn ON Relay #4	`01 05 00 03 FF 00 7C 3A`

3.2 Turn OFF a Single Relay (Function Code 05)

Example: Turn OFF **Relay #1**

Send: `01 05 00 00 00 00 CD CA`

Field	Value	Description
Slave Address	01	Fixed at 1
Function Code	05	Write Single Coil
Coil Address	00 00	Relay #1 address

Field	Value	Description
Command	00 00	0x0000 = OFF
CRC16	CD CA	CRC-16/MODBUS checksum

Response (echo back): `01 05 00 00 00 00 CD CA`

Turn OFF commands for all relays:

Relay	Command
Turn OFF Relay #1	`01 05 00 00 00 00 CD CA`
Turn OFF Relay #2	`01 05 00 01 00 00 9C 0A`
Turn OFF Relay #3	`01 05 00 02 00 00 6C 0A`
Turn OFF Relay #4	`01 05 00 03 00 00 3D CA`

3.3 Turn ON All Relays (Function Code 0F)

Send: `01 0F 00 00 00 04 01 0F 7E 92`

Field	Value	Description
Slave Address	01	Fixed at 1
Function Code	0F	Write Multiple Coils
Start Address	00 00	Starting from Relay #1
Quantity	00 04	4 relays to control
Byte Count	01	1 byte of coil data follows
Coil Data	0F	Binary 0000 1111: Bit0~Bit3 = Relay #1~#4, 1=ON, 0=OFF. 0x0F = all ON
CRC16	7E 92	CRC-16/MODBUS checksum

Response: `01 0F 00 00 00 04 54 08`

Field	Value	Description
Slave Address	01	Slave address
Function Code	0F	Write Multiple Coils
Start Address	00 00	Starting from Relay #1
Quantity	00 04	4 relays operated
CRC16	54 08	CRC-16/MODBUS checksum

3.4 Turn OFF All Relays (Function Code 0F)

Send: `01 0F 00 00 00 04 01 00 3E 96`

Field	Value	Description
Slave Address	01	Fixed at 1
Function Code	0F	Write Multiple Coils
Start Address	00 00	Starting from Relay #1
Quantity	00 04	4 relays to control
Byte Count	01	1 byte of coil data follows
Coil Data	00	0x00 = all OFF
CRC16	3E 96	CRC-16/MODBUS checksum

Response: `01 0F 00 00 00 04 54 08`

(Same response format as "Turn ON All Relays")

3.5 Selective Relay Control (Function Code 0F)

You can control any combination of the 4 relays by modifying the **Coil Data** byte. Bit0~Bit3 correspond to Relay #1~#4 respectively.

Bit Definition:

Bit	Bit3	Bit2	Bit1	Bit0
Relay	#4	#3	#2	#1
Value	1=ON / 0=OFF	1=ON / 0=OFF	1=ON / 0=OFF	1=ON / 0=OFF

Common Combinations:

Action	Data Byte	Binary	Full Command
All ON	0x0F	1111	`01 0F 00 00 00 04 01 0F 7E 92`
All OFF	0x00	0000	`01 0F 00 00 00 04 01 00 3E 96`
Only #1 & #3 ON	0x05	0101	`01 0F 00 00 00 04 01 05 FE 95`
Only #1 ON	0x01	0001	(CRC recalculation required)
Only #2 & #4 ON	0x0A	1010	(CRC recalculation required)

> Tip: After modifying the data byte, the CRC checksum must be recalculated. Use an online CRC-16/MODBUS calculator.

3.6 Read Relay Status (Function Code 01)

Send: `01 01 00 00 00 04 3D C9`

Field	Value	Description

Field	Value	Description
Slave Address	01	Fixed at 1
Function Code	01	Read Coils
Start Address	00 00	Starting from Relay #1
Quantity	00 04	Read 4 relay states
CRC16	3D C9	CRC-16/MODBUS checksum

Response Example (only Relay #1 is ON): `01 01 01 01 90 48`

Field	Value	Description
Slave Address	01	Slave address
Function Code	01	Read Coils
Byte Count	01	1 byte of status data
Status Data	01	Bit0~Bit3 = Relay #1~#4, 1=ON, 0=OFF
CRC16	90 48	CRC-16/MODBUS checksum

Status Data Interpretation:

Data	Binary	#1	#2	#3	#4
0x00	0000	OFF	OFF	OFF	OFF
0x01	0001	ON	OFF	OFF	OFF
0x05	0101	ON	OFF	ON	OFF
0x0F	1111	ON	ON	ON	ON

3.7 Read Optocoupler Input Status (Function Code 02)

Send: `01 02 00 00 00 04 79 C9`

Field	Value	Description
Slave Address	01	Fixed at 1
Function Code	02	Read Discrete Inputs
Start Address	00 00	Starting from Optocoupler #1
Quantity	00 04	Read 4 optocoupler states
CRC16	79 C9	CRC-16/MODBUS checksum

Response Example (Optocoupler #1 triggered): `01 02 01 01 60 48`

Field	Value	Description

Field	Value	Description
Slave Address	01	Slave address
Function Code	02	Read Discrete Inputs
Byte Count	01	1 byte of status data
Status Data	01	Bit0~Bit3 = Optocoupler #1~#4, 1=triggered (active low), 0=inactive
CRC16	60 48	CRC-16/MODBUS checksum

Status Data Interpretation:

Same as relay status interpretation. Bit0~Bit3 correspond to Optocoupler Input #1~#4.

> Note: Optocoupler inputs are **active-low** — the corresponding bit is set to 1 when a low-level signal (or GND) is applied to the input.

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4. Optocoupler-to-Relay Linkage

This module has a built-in optocoupler linkage feature. Without sending any Modbus commands, optocoupler inputs can directly control the corresponding relays:

- **Low-level signal on optocoupler input** → Corresponding relay **closes (ON)**
- **High-level / disconnected optocoupler input** → Corresponding relay **opens (OFF)**

Mapping:

Optocoupler Input	Linked Relay
Optocoupler #1	Relay #1
Optocoupler #2	Relay #2
Optocoupler #3	Relay #3
Optocoupler #4	Relay #4

Priority: When both optocoupler input and Modbus commands act on the same relay, the **optocoupler input has the highest priority** and will override the Modbus command.

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5. Command Quick Reference

Single Relay Control (Function Code 05)

Action	HEX Command
Turn ON Relay #1	`01 05 00 00 FF 00 8C 3A`
Turn OFF Relay #1	`01 05 00 00 00 00 CD CA`
Turn ON Relay #2	`01 05 00 01 FF 00 DD FA`

Action	HEX Command
Turn OFF Relay #2	`01 05 00 01 00 00 9C 0A`
Turn ON Relay #3	`01 05 00 02 FF 00 2D FA`
Turn OFF Relay #3	`01 05 00 02 00 00 6C 0A`
Turn ON Relay #4	`01 05 00 03 FF 00 7C 3A`
Turn OFF Relay #4	`01 05 00 03 00 00 3D CA`

Batch Relay Control (Function Code 0F)

Action	HEX Command
Turn ON All Relays	`01 0F 00 00 00 04 01 0F 7E 92`
Turn OFF All Relays	`01 0F 00 00 00 04 01 00 3E 96`
Turn ON Relay #1 & #3	`01 0F 00 00 00 04 01 05 FE 95`

Status Reading

Action	HEX Command
Read Relay Status	`01 01 00 00 00 04 3D C9`
Read Optocoupler Input Status	`01 02 00 00 00 04 79 C9`

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6. Communication Frame Format

Modbus RTU frame structure:

```
[Slave Address (1 byte)] [Function Code (1 byte)] [Data (N bytes)] [CRC (2 bytes, LSB first)]
```

- **Slave Address**: Fixed at `0x01` for this module
- **Function Code**: Determines the operation type (01/02/05/0F)
- **Data**: Content and length vary depending on the function code
- **CRC**: CRC-16/MODBUS, least significant byte first, most significant byte second

CRC Checksum Calculation

The last 2 bytes of every command are the CRC-16/MODBUS checksum. After modifying any parameter in a command, the CRC must be recalculated.

Search "CRC-16 MODBUS online calculator" to find free calculation tools.

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7. Troubleshooting / FAQ

Q: No response after sending a command?

- Check wiring — make sure RS485 A/B lines are not swapped
- Confirm baud rate is set to **115200**
- Confirm data format is **8N1**
- Make sure **HEX send mode** is enabled
- Verify the slave address is **1** (0x01)

Q: Relay does not respond to Modbus commands?

- Check if the optocoupler input port has a signal. Optocoupler input has higher priority than Modbus — when a low-level signal is present on the optocoupler, Modbus commands cannot override it

Q: How to change the slave address or baud rate?

- In this firmware version, the slave address (1) and baud rate (115200) are hardcoded. To change them, modify `SLAVE_ID` and `mySerial.begin()` parameters in the source code and re-flash the firmware

Q: What is the optocoupler trigger logic?

- Optocouplers are **active-low**: a low-level signal (or GND connection) on the input activates it (status bit = 1); no input or high-level results in status bit = 0