N83624 Series Programming Guide
Modbus Protocol

Version: V20211019

Contents

1 Preface

Dear Customers,

First of all, we greatly appreciate your choice of N83624 series battery simulator (N83624 for short). We are also honored to introduce our company, Hunan Next Generation Instrumental T&C Tech. Co.,Ltd. (NGI for short).

About Company

NGI is a professional manufacturer of intelligent equipment and test & control instruments, committed to developing, manufacturing battery simulators, power supplies, electronic loads, and many more instruments. The products can be widely used in the industries of battery, power supply, fuel cell, consumer electronics, new energy vehicle, semiconductor, etc.

NGI maintains close cooperation with many universities and scientific research institutions, and maintains close ties with many industry leaders. We strive to develop high-quality, technology-leading products, provide high-end technologies, and continue to explore new industry measurement and control solutions.

About Manual

This manual is applied to N83624 series battery simulator, including programming guide based on standard Modbus protocol. The copyright of the manual is owned by NGI. Due to the upgrade of instrument, this manual may be revised without notice in future versions.

This manual has been reviewed carefully by NGI for the technical accuracy. The manufacturer declines all responsibility for possible errors in this operation manual, if due to misprints or errors in copying. The manufacturer is not liable for malfunctioning if the product has not correctly been operated.

To ensure the safety and correct use of N83624, please read this manual carefully, especially the safety instructions.

Please keep this manual for future use.

Thanks for your trust and support.

2 Safety Instructions

In the operation and maintenance of the instrument, please strictly comply with the following safety instructions. Any performance regardless of attentions or specific warnings in other chapters of the manual may impair the protective functions provided by the instrument.
NGI shall not be liable for the results caused by the neglect of those instructions.

2.1 Safety Notes

- **Confirm the AC input voltage before supplying power**.
- **Reliable grounding**: Before operation, the instrument must be reliably grounded to avoid the electric shock.
- **Confirm the fuse**: Ensure to have installed the fuse correctly.
- **Do not open the chassis**: The operator cannot open the instrument chassis. Non-professional operators are not allowed to maintain or adjust it.
- **Do not operate under hazardous conditions**: Do not operate the instrument under flammable or explosive conditions.
- **Confirm the working range**: Make sure the DUT is within N83624's rated range.

2.2 Safety Symbols

Please refer to the following table for definitions of international symbols used on the instrument or in the user manual.

Table 1

Symbol	Definition	Symbol	Definition
⎓	DC (direct current)	N	Null line or neutral line
~	AC (alternating current)	L	Live line
≂	AC and DC	I	Power-on
3~	Three-phase current	O	Power-off
⏚	Ground	⏻	Back-up power
⏚	Protective ground	▭	Power-on state
⏚	Chassis ground	▯	Power-off state
⊥	Signal ground	⚠	Risk of electric shock
WARNING	Hazardous sign	⚠	High temperature warning
Caution	Be careful	⚠	Warning

3 Modbus Overview

Modbus protocol was originally developed by Modicon. At the end of 1979, Modicon became part of Schneider Automation. Now Modbus is the most popular protocol in industrial field. This protocol supports traditional serial link RS-232, RS-422, RS-485 and Ethernet. Many industrial equipment including PLC, DCS, smart meters, etc. are adopting Modbus protocol as the communication standard among them.

Modbus protocol includes ASCII, RTU, TCP, etc., which does not specify the physical layer. This protocol defines the message structure which the controller can recognize and use, regardless of what kind of network they communicate through. The standard Modicon controller uses RS232C to achieve serial Modbus. Modbus's ASCII and RTU protocols stipulate the structure of messages and data, the way of inquiry and answer. The data communication adopts master/slave method. The master station sends out a data request message. The slave station sends data to the master station for responding to the request after receiving the correct message. The master station can also directly send messages to modify the data of slave station to realize bidirectional reading and writing.

If the data format is not easy for understanding, it is recommended to use the tools "Modbus Poll", "Modbus Slave" to send and receive data packets, and "AccessPort" to capture the contents of data packets for analysis.

4 Modbus RTU/TCP Description

1) Multiple bytes apply Big-Endian.
2) The starting addresses of all readable and writable registers are even numbers.
3) The readable and writable numbers are even numbers.
4) 4 bytes are applied.
   For example, the value of register address 2 is written as 0x12345678. Then the hexadecimal number of the written data packet is:
   01 10 00 02 00 02 04 56 78 12 34 EE 90
5) The read register adopts the function code 0x03. The write register adopts the function code 0x10. Other function codes are reserved.
6) ID in the following ranges from 1 to 248. Value 255 means a broadcast packet which does not need to be returned.

5 Modbus RTU Protocol Format

5.1 Master Computer Reading Multiple Registers (0x03)

5.1.1 Master Computer Sending

ID	FunctionCode	StartReg	RegCount	Checksum

Field	No. of Bytes	Definition
ID	1	Device/card ID
FunctionCode	1	Fixed as 0x03
StartReg	2	To read start register
RegCount	2	To read register counts
Checksum	2	CRC value of all data except itself

5.1.2 Slave Computer Correct Return

ID	FunctionCode	RegDataBytes	RegData	Checksum

Field	No. of Bytes	Definition
ID	1	Device/card ID
FunctionCode	1	Fixed as 0x03
RegDataBytes	1	Register data bytes, RegCount*2 in practice
RegData	2* RegCount	Register data
Checksum	2	CRC value of all data except itself

5.2 Master Computer Writing Multiple Registers (0x10)

5.2.1 Master Computer Sending

ID	FunctionCode	StartReg	RegCount	RegDataBytes	RegData	Checksum

Field	No. of Bytes	Definition
ID	1	Device/card ID
FunctionCode	1	Fixed as 0x10
StartReg	2	To write start register
RegCount	2	To write register counts

RegDataBytes	1	Register data bytes, RegCount*2 in practice
RegData	2* RegCount	Register data
Checksum	2	CRC value of all data except itself

5.2.2 Slave Computer Correct Return

ID	FunctionCode	StartReg	RegCount	Checksum

Field	No. of Bytes	Definition
ID	1	Device/card ID
FunctionCode	1	Fixed as 0x10
StartReg	2	To write start register
RegCount	2	To write register counts
Checksum	2	CRC value of all data except itself

6 Modbus TCP Protocol Format

The data frame of Modbus TCP protocol is composed of MBAP message header and data unit. The MBAP message header has a total of 7 bytes, and the format is as follows.

Transaction ID	Protocol ID	Length	Unit ID

Field	No. of Bytes	Definition
Transaction ID	2	Transaction identifier
Protocol ID	2	Protocol identifier, Modbus=0
Length	2	Data length, from the next byte to the end
Unit ID	1	Unit identifier, remote terminal identifier on serial link or other bus

6.1 Master Computer Reading Multiple Registers (0x03)

6.1.1 Master Computer Sending

MBAP Header	FunctionCode	StartReg	RegCount

Field	No. of Bytes	Definition
MBAP Header	7	MBAP message header
FunctionCode	1	Fixed as 0x03
StartReg	2	To read start register
RegCount	2	To read register counts

6.1.2 Slave Computer Correct Return

MBAP Header	FunctionCode	RegDataBytes	RegData

Field	No. of Bytes	Definition
MBAP Header	7	MBAP message header
FunctionCode	1	Fixed as 0x03
RegDataBytes	1	Register data bytes, RegCount*2 in practice
RegData	2* RegCount	Register data

6.2 Master Computer Writing Multiple Registers (0x10)

6.2.1 Master Computer Sending

MBAP Header	FunctionCode	StartReg	RegCount	RegDataBytes	RegData

Field	No. of Bytes	Definition
MBAP Header	7	MBAP message header
FunctionCode	1	Fixed as 0x10
StartReg	2	To write start register
RegCount	2	To write register counts
RegDataBytes	1	Register data bytes, RegCount*2 in practice
RegData	2* RegCount	Register data

6.2.2 Slave Computer Correct Return

MBAP Header	FunctionCode	StartReg	RegCount

Field	No. of Bytes	Definition
MBAP Header	7	MBAP message header
FunctionCode	1	Fixed as 0x10
StartReg	2	To write start register
RegCount	2	To write register counts

7 Operation

7.1 Basic Operation

7.1.1 Status Register

Address: 2
Attribute: RO
Type: Uint32
Byte: 4Byte
Parameters: Bit0: OnOff state
Bit16-18: Real-time range of readback value (0-high range, 2-low range)

7.1.2 Readback Voltage

Address: 6
Attribute: RO
Type: Float
Byte: 4Byte

7.1.3 Readback Current

Address: 8
Attribute: RO
Type: Float

Byte: 4Byte

7.1.4 Readback Power

Address: 10
Attribute: RO
Type: Float
Byte: 4Byte

7.1.5 Readback Resistance

Address: 12
Attribute: RO
Type: Float
Byte: 4Byte

7.1.6 Charging Capacity

Address: 14
Attribute: RO
Type: Float
Byte: 4Byte

7.1.7 ON/OFF Switch

Address: 20
Attribute: WR
Type: Uint32
Byte: 4Byte
Parameters: 0 for disabling output, 1 for enabling output

7.1.8 Function Mode

Address: 22
Attribute: WR
Type: Uint32

Byte: 4Byte
Parameters: 0: source mode
1: charge mode
3: battery SOC test mode. The maximum output current is the maximum current allowed by the device.
128: SEQ test

Note: Users can select current range in source mode. For other modes, it defaults as high range.

7.2 Source Mode

7.2.1 Current Range

Address: 24
Attribute: WR
Type: Uint32
Byte: 4Byte
Parameters: 0: high range
2: low range
3: auto range

7.2.2 Constant Voltage Value

Address: 40
Attribute: WR
Type: Float
Byte: 4Byte

7.2.3 Current Limit Value

Address: 42
Attribute: WR
Type: Float
Byte: 4Byte

7.2.4 Example

Select Source mode and set constant voltage value to 5V, output current limit to 1000mA and current range to auto.

Address	Data Type	Read/Write	Register Value	Description
20	n	WR	0	Shut off output for the selected channel
22	n	WR	0	Set operation mode to Source mode
40	f	WR	5	Set constant voltage value to 5V
42	f	WR	1000	Set output current limit to 1000mA
24	n	WR	3	Select current range to Auto
20	n	WR	1	Enable the output for the selected channel

Note: The ID is same as the selected channel. It is corresponding. For example, the selected channel is 2. The ID is also 2.

7.3 Charge Mode

7.3.1 Output Voltage Value

Address: 60
Attribute: WR
Type: Float
Byte: 4Byte

7.3.2 Output Current Limit Value

Address: 62
Attribute: WR
Type: Float
Byte: 4Byte

7.3.3 Resistance Value

Address: 64

Attribute: WR
Type: Float
Byte: 4Byte

7.3.4 Output Voltage Readback Value

Address: 66
Attribute: RO
Type: Float
Byte: 4Byte

7.3.5 Example

Charge mode includes constant voltage value, current limit value and resistance value. Under Charge mode, the current range defaults to high range and nonadjustable.

Select Charge mode and set constant voltage value to 5V, output current limit value to 1000mA and resistance to 3.0mΩ.

Address	Data Type	Read/Write	Register Value	Description
20	n	WR	0	Shut off output for the selected channel
22	n	WR	1	Set operation mode to Charge mode
60	f	WR	5	Set constant voltage value to 5V
62	f	WR	1000	Set output current limit to 1000mA
64	f	WR	3	Set resistance to 3mΩ
20	n	WR	1	Enable the output for the selected channel

Note: The ID is same as the selected channel. It is corresponding. For example, the selected channel is 2. The ID is also 2.

7.4 SOC Edit/SOC Test

7.4.1 Total Steps

Address: 100
Attribute: WR
Type: Uint32
Byte: 4Byte
Parameter: 0-200

7.4.2 Initial Capacity

Address: 102
Attribute: RO
Type: Float
Byte: 4Byte

7.4.3 Step No.

Address: 104
Attribute: WR
Type: Uint32
Byte: 4Byte
Parameters: 1-200

7.4.4 Present Step Capacity

Address: 106
Attribute: WR
Type: Float
Byte: 4Byte
Parameters: less than capacity value of the previous step

7.4.5 Constant Voltage Value

Address: 108

Attribute: WR
Type: Float
Byte: 4Byte

7.4.6 Resistance Value

Address: 110
Attribute: WR
Type: Float
Byte: 4Byte

7.4.7 Present Step

Address: 112
Attribute: RO
Type: Uint32
Byte: 4Byte

7.4.8 Present Capacity

Address: 114
Attribute: RO
Type: Float
Byte: 4Byte

7.4.9 Output Current Limit

Address: 116
Attribute: WR
Type: Float
Byte: 4Byte

7.4.10 Initial Voltage

Address: 118
Attribute: WR

Type: Float
Byte: 4Byte

Note: The initial voltage value should be lower than the maximum voltage and higher than the minimum voltage in the SOC steps.

7.4.11 Example

SOC simulates battery discharge function by battery simulator output. The parameters for battery discharge need to be set, such as capacity, constant voltage and resistance.

Select SOC mode, set total steps to 3, initial voltage to 4.8V and set below parameters for total three steps.

Step No.	Capacity(mAh)	Constant Voltage(V)	Output Current Limit(mA)	Resistance(mΩ)
1	14	5.0	1200	100
2	13	4.0	1100	100
3	12	3.0	1000	100

Address	Data Type	Read/Write	Register Value	Description
20	n	WR	0	Shut off output for the selected channel
22	n	WR	3	Set operation mode to SOC mode
100	n	WR	3	Set the total steps to 3
104	n	WR	1	Set step No. to 1
106	f	WR	14	Set capacity to 14mAh for step 1
108	f	WR	5	Set constant voltage value to 5.0V for step 1
116	f	WR	1200	Set output current limit to 1200mA for step 1
110	f	WR	100	Set resistance to 100mΩ for step 1
104	n	WR	2	Set step No. to 2
106	f	WR	13	Set capacity to 13mAh for step 2
108	f	WR	4	Set constant voltage value to 4.0V for step 2
116	f	WR	1100	Set output current limit to 1100mA for step 2
110	f	WR	100	Set resistance to 100mΩ for step 2
104	n	WR	3	Set step No. to 3
106	f	WR	12	Set capacity to 12mAh for step 3
108	f	WR	3	Set constant voltage value to 3.0V for step 3
116	f	WR	1000	Set output current limit to 1000mA for step 3
110	f	WR	100	Set resistance to 100mΩ for step 3
118	f	WR	4.8	Set initial voltage to 4.8V

20	n	WR	1	Enable the output for the selected channel
112	n	RO		Obtain present operation step
114	f	RO		Obtain present capacity

7.5 SEQ Edit

7.5.1 SEQ File No.

Address: 120
Attribute: WR
Type: Uint32
Byte: 4Byte
Parameters: 1-10

7.5.2 Total Steps

Address: 126
Attribute: WR
Type: Uint32
Byte: 4Byte
Parameters: 0-200

7.5.3 File Cycle Times

Address: 128
Attribute: WR
Type: Uint32
Byte: 4Byte
Parameters: 0-100

7.5.4 Step No.

Address: 130
Attribute: WR
Type: Uint32
Byte: 4Byte

Parameters: 1-200

7.5.5 Constant Voltage Value of Editing Step

Address: 132
Attribute: WR
Type: Float
Byte: 4Byte

7.5.6 Current Limit of Editing Step

Address: 134
Attribute: WR
Type: Float
Byte: 4Byte

7.5.7 Resistance Value of Editing Step

Address: 136
Attribute: WR
Type: Float
Byte: 4Byte

7.5.8 Dwell Time of Editing Step

Address: 138
Attribute: WR
Type: Uint32
Byte: 4Byte

7.5.9 Link Start Step

Address: 140
Attribute: WR
Type: Uint32
Byte: 4Byte

Parameters: -1 to 200. -1 means no link.

7.5.10 Link Stop Step

Address: 142
Attribute: WR
Type: Uint32
Byte: 4Byte
Parameters: -1 to 200. -1 means no link.

7.5.11 Link Cycle Times

Address: 144
Attribute: WR
Type: Uint32
Byte: 4Byte
Parameters: range: 0-100

7.5.12 Example

SEQ mode will perform the operation steps one by one in the selected SEQ file. One step can link to another step. Cycle times can also be adjustable.

Select SEQ mode and set SEQ file No. to 1, total steps to 3 and cycle times to 1.

Step No.	Constant Voltage	Current Limit	Resistance	Dwell Time	Link Start Step	Link Stop Step	Link Cycle Times
1	5	500	50	10	-1	-1	0
2	4	800	50	15	-1	-1	0
3	3	1000	50	20	-1	-1	0

Address	Data Type	Read/Write	Register Value	Description
20	n	WR	0	Shut off output for the selected channel
22	n	WR	128	Set operation mode to SEQ Edit
120	n	WR	1	Set SEQ file No. to 1
126	n	WR	3	Set total steps to 3
128	n	WR	1	Set SEQ file cycle times to 1
130	n	WR	1	Set step No. to 1

132	f	WR	5	Set voltage to 5V for step 1
134	f	WR	500	Set current to 500mA for step 1
136	f	WR	50	Set resistance to 50mΩ for step 1
138	f	WR	10	Set dwell time to 10s for step 1
140	n	WR	-1	Set link start step number to -1 for step 1
142	n	WR	-1	Set link stop step number to -1 for step 1
144	n	WR	0	Set link cycle times to 0 for step 1. Zero means no link.
130	n	WR	2	Set step No. to 2
132	f	WR	4	Set voltage to 4V for step 2
134	f	WR	800	Set current to 800mA for step 2
136	f	WR	50	Set resistance to 50mΩ for step 2
138	f	WR	15	Set dwell time to 15s for step 2
140	n	WR	-1	Set link start step number to -1 for step 2
142	n	WR	-1	Set link stop step number to -1 for step 2
144	n	WR	0	Set link cycle times to 0 for step 2. Zero means no link.
130	n	WR	3	Set step No. to 3
132	f	WR	3	Set voltage to 3V for step 3
134	f	WR	1000	Set current to 1000mA for step 3
136	f	WR	50	Set resistance to 50mΩ for step 3
138	f	WR	20	Set dwell time to 20s for step 3
140	n	WR	-1	Set link start step number to -1 for step 3
142	n	WR	-1	Set link stop step number to -1 for step 3
144	n	WR	0	Set link cycle times to 0 for step 3. Zero means no link.

7.6 SEQ Test

7.6.1 SEQ File No.

Address: 122
Attribute: WR
Type: Uint32
Byte: 4Byte
Parameters: 1-10

7.6.2 Present Step No.

Address: 124
Attribute: RO
Type: Uint32
Byte: 4Byte

7.6.3 Present Step Dwell Time

Address: 146
Attribute: RO
Type: Float
Byte: 4Byte

7.6.4 Present File Cycle Times

Address: 148
Attribute: RO
Type: Uint32
Byte: 4Byte

7.6.5 Example

Run SEQ file No. 1 and obtain the corresponding parameters.

Address	Data Type	Read/Write	Register Value	Description
20	n	WR	0	Shut off output for the selected channel
22	n	WR	128	Set operation mode to SEQ Test
122	n	W	1	Set SEQ file No. to 1
20	n	WR	1	Enable the output for the selected channel
122	n	R		Obtain SEQ file No.
124	n	RO		Obtain present step No.
146	f	RO		Obtain the dwell time
148	n	RO		Obtain the cycle times

7.7 Factory Reset

Address: 382
Attribute: WR
Type: Uint32
Byte: 4Byte
Parameters: 1 for factory reset

8 Register List

Address	Name	Read/Write	Data Type	Description
2	Status Register	RO	Uint32	Bit0: OnOff state Bit16-18: Real-time range of readback value (0-high range, 2-low range)
4	Reserved	WR	Uint32	Reserved
6	Readback Voltage	RO	Float	Unit: V
8	Readback Current	RO	Float	Unit: mA
10	Readback Power	RO	Float	Unit: W
12	Readback Resistance	RO	Float	Unit: mΩ
14	Charging Capacity	RO	Float	Unit: mAH
20	ON/OFF Switch	WR	Uint32	0 for disabling output 1 for enabling output
22	Function Mode	WR	Uint32	0: source mode 1: charge mode 3: battery SOC test mode. The maximum output current is the maximum current allowed by the device. 128: SEQ test
Source Mode				
24	Current Range	WR	Uint32	0: high range 2: low range 3: auto range
40	Constant Voltage Value	WR	Float	Unit: V
42	Current Limit Value	WR	Float	Unit: mA
Charge Mode				
60	Output Voltage Value	WR	Float	Unit: V

62	Output Current Limit Value	WR	Float	Unit: mA
64	Resistance Value	WR	Float	Unit: mΩ
66	Output Voltage Readback Value	RO	Float	Unit: V
SOC Edit/SOC Test				
100	Total Steps	WR	Uint32	Range: 0-200
102	Initial Capacity	RO	Float	Unit: mAH
104	Step No.	WR	Uint32	Range: 1-200
106	Present Step Capacity	WR	Float	Range: less than capacity value of the previous step
108	Constant Voltage Value	WR	Float	Unit: V
110	Resistance Value	WR	Float	Unit: mΩ
112	Present Step	RO	Uint32	
114	Present Capacity	RO	Float	
116	Output Current Limit	WR	Float	Unit: mA
118	Initial Voltage	WR	Float	Unit: V
SEQ Edit				
120	SEQ File No.	WR	Uint32	Range: 1-10
126	Total Steps	WR	Uint32	Range: 0-200
128	File Cycle Times	WR	Uint32	Range: 0-100
130	Step No.	WR	Uint32	Range: 1-200
132	Constant Voltage Value of Editing Step	WR	Float	Unit: V
134	Current Value of Editing Step	WR	Float	Unit: mA
136	Resistance Value of Editing Step	WR	Float	Unit: mΩ
138	Dwell Time of Editing Step	WR	Float	Unit: s
140	Link Start Step	WR	Uint32	Range: -1 to 200. -1 means no link.
142	Link Stop Step	WR	Uint32	Range: -1 to 200. -1 means no link.
144	Link Cycle Times	WR	Uint32	Range: 0-100
SEQ Test				
122	SEQ File No.	WR	Uint32	Range: 1-10
124	Present Step No.	RO	Uint32	
146	Present Step Dwell Time	RO	Float	Unit: s
148	Present File Cycle Times	RO	Uint32	
Value Range				
208	Reserved	WR	Uint32	Reserved

382	Factory Reset	WR	Uint32	1 means factory reset.
402	Reserved	RO	Float	Reserved
406	Reserved	RO	Float	Reserved