General Specifications

NR800
MODBUS Communication

InfraSpec

GS 12Y03A04-01E

1. GENERAL

The MODBUS protocol is used for DCS communication with the NR800.

This communication protocol was first established for the Programmable Logic Controller (PLC) made by Gould, Inc., and is now used as a standard communication protocol between different systems.

In this specification we describe the MODBUS communication used in the NR800.

For general specification of MODBUS, please refer to the MEDICON document MODBUS Protocol Reference Guide.

[MODBUS Configuration]

MODBUS was started as a method to allow a master device to control multiple slave devices. Each device with a device number is connected to the master device.

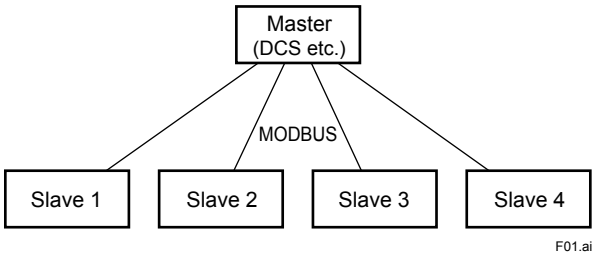

Figure 1 MODBUS configuration

The master can send a query (i.e. poll) or command to a slave on a regular basis or when required. In either case, the master starts signal transmission and the slave responds.

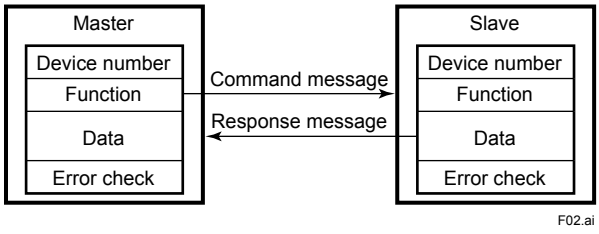

Figure 2 Master-slave command and response cycle

A message transmitted between devices contains the device number, function, data, and error check code. The function is encoded and depends on the message characteristics and data type.

The error check code checks the validity of the entire message.

2. Specifications

2.1 Communication Transmission Modes

There are two modes between the master and slave; RTU (Remote Terminal Unit) mode and ASCII mode.

Table 1 RTU mode and ASCII mode

Item	ASCII mode	RTU mode
Number of data bits	7 bits (ASCII)	8 bits (binary)
Message starting character	Colon " : "	None
Message ending character	Carriage return/line feed "<CR><LF>"	None
Message length	2N+1	N
Time interval of data	1 second or shorter	24 bit-time or shorter
Error detection	LRC (logical redundancy check)	CRC-16 (cyclic redundancy check)

2.2 Message Configuration

A message consists of four fields: device number, function, data and error check. It is always sent in this sequence.

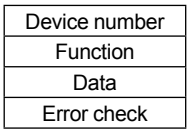

Figure 3 Message configuration

In ASCII mode, a colon ":" is the starting character and carriage return/line feed "<CR><LF>" is the ending message string. The portion between the starting character and ending string is the message body. The communication message is entirely ASCII codes, i.e. the message excluding the starting character and ending string consists of "0" to "9" and "A" to "F" representing hexadecimal numbers.

In the RTU mode, binary-coded messages are transmitted faster than in the ASCII mode. A lapse of the specified silent interval is regarded as the start of a new message. This interval, called the inter-character time out, is set to 100 ms in this system.

(1) Device number

The device number is user pre-assigned for each slave and ranges from 1 to 240. This number is the same as the Analyzer ID. The master performs signal transmission to each slave simultaneously.

Each slave checks the device number in the message to determine whether the received message is directed to the slave itself and if so, returns a response message.

(2) Functions

The master specifies the function to be executed by the slave. The NR800 supports the following functions in the MODBUS protocol.

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Table 2 Function supported in NR800

Function No.	Function	Description
01	Coil status read	Reads the ON/OFF status of a series of coils.
02	Input relay status read.	Reads the ON/OFF status of a series of input relays.
03	Holding register content read.	Reads the current value of a series of holding registers.
04	Input register content read.	Reads the current value of a series of input registers.
05	Single coil status change	Forcibly changes the status of a coil.
06	Single holding register write	Writes a value to a holding register.
08	Loop back test	Sends back the same message as the command message.

(3) Data

There are two types of data “coil” and “relay” in bits, and “register” in 16 bits. The coil uses two values (ON/OFF or 0/1), while the register ranges from 0 to 65535. In the coil/relay, coils are both readable and writable from the master, while input relays are read-only. There are read/write data holding registers, read-only input registers, and write-only holding registers for real numeric data.

Table 3 Types of data

Data			Address	Max. read	Application
Bit	Coil	Read/write	0XXXX	800	Command
	Input relay	Read only	1XXXX	2000	Status
Register	Holding register	Read/write	4XXXX	100	Set value
	Input register	Read only	3XXXX	125	Measured value

xxxx: 0001 to 9999

(4) Error check

All messages are followed by an error check code to detect a Signal transmission error (i.e. bit changes). In ASCII mode, an error check code according to LRC (logical redundancy check) is used. In RTU mode, an error check code according to CRC-16 (cyclic redundancy check) is used.

2.3 Slave Response

When the slave receives a command from the master, it performs an error check of the command then sends back a normal response if the command message is normal, and an error response or no response if the command message is faulty.

(1) Normal response

For the single coil status change, single holding register write, and loop back function, the same message as the command message is sent back. As a response message, the read function returns the retrieved data appended to the device number and function code. If an address to which data is not allocated is read, an error is not generated but zero (0) is responded as the read data.

(2) Error response

If the command message is faulty, the slave does not execute the command but sends back an error response.

The master can check whether the command is accepted successfully by checking the function in the response message. If an error is identified, the details can be checked from the error code.

In addition, access to the data consisting of several registers will return an error unless the correct start address of data has been given. Therefore, the correct data boundary must be specified.

Device number
Error function (command function + 128)
Error code
Error check

Figure 4 Message configuration

Table 4 Error code

Error code	Description
01	Function code error (non-existent function)
02	Address error of coil, input relay, or register (out of range)
03	Number error of coils, input relays, or registers (out of range)
04	An unrecoverable error occurred on the slave while the command message was being executed.
11	Set data error (out of range)

(3) No response

In the following cases, the slave ignores the command message and does not send back a response (no response).

1. When a transmission error (overrun, framing error, parity error or CRC error) is detected in the command message
2. When the device number in the command message does not match the slave number assigned to the slave

Note: The master should set a timer to watch the response from the slave, and re-send the same command or the message to the slave when the slave does not respond within the time set by the timer. We recommend 3 to 5 seconds for the timer.

3. Communication specifications

- **General specifications**

The NR800 has two serial communication ports, and Port 2 is available for Modbus communication.

Communication standard:
RS-422
Start-stop synchronization:
1 start bit, 7 data bits (ASCII)/8 data bits (RTU), 1 parity bit, 1 stop bit
Communication speed:
4800 / 9600 / 19200 bps (selectable)
Parity check: Odd / even / none (selectable)
Transmission mode:
ASCII mode / RTU mode (selectable)
Inter-character time-out detecting time:
100 ms
Allowable communication frequency:
one command per second or lower for ensuring the measuring performance

Note: When the measurement load increases in the NR800, it may not respond to command messages. Re-send the message at least five times. If there is still no response, consider it as a time-out error.

- **Specifications for connecting to CS3000**

When connecting to CS3000 FCS via an ALR111 or ALR121 serial communication module, set the CS3000 FCS as follows.

Transmission speed: 4800 / 9600 / 19200 bps
Time monitor of inter-character gap: 1000 ms
No response time: 2 sec.
Number of transmission retries: 5 times
Communication recovery period: 30 sec.

4. System configuration

4-Wire RS-422 serial communication is used for the communication port. To connect it to a DCS, it is converted into RS-232C by a communication converter (K9404LD). This converter terminates communications automatically if the NR800 becomes unable to maintain explosionproof requirements.

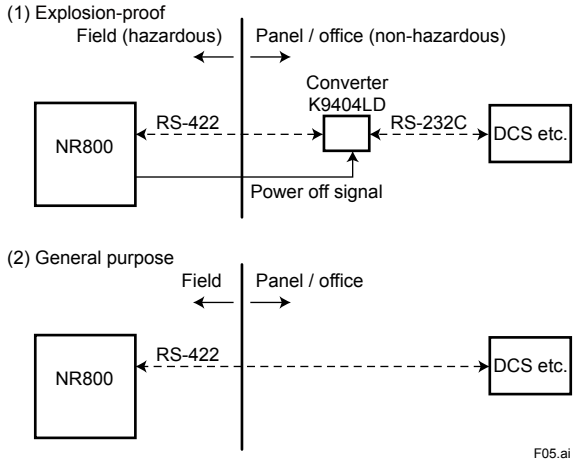

Figure 5 System configuration

* Note: Components, wiring cables and construction materials are not supplied by Yokogawa; these must be provided by the customer.

5. Communication data

5.1 Coils (command contacts)

(1) RUN Mode Command
Commands the NR800 to change the basic operating mode to RUN mode (on-line, continuous analysis).

The command is activated when the master sets the basic operating mode to 1. When the slave receives the command, the slave resets the value to 0. However, this does not guarantee that the slave NR800 has changed its mode but only shows that the slave has received the command from the master. Use input relays and other functions to check the status of the NR800 if necessary. (Follow the same procedure to check all of the commands listed below.)

(2) MAINT Mode Command
Commands the NR800 to change the basic operating mode to MAINT (maintenance) mode.

(3) CH1 AUTO Mode Command
Commands the NR800 to change the channel operating mode of channel 1 to AUTO mode.

(4) CH1 MAN Mode Command
Commands the NR800 to change the channel operating mode of channel 1 to MAN (manual) mode.

(5) CH2 AUTO Mode Command
Commands the NR800 to change the channel operating mode of channel 2 to AUTO mode.

(6) CH2 MAN Mode Command
Commands the NR800 to change the channel operating mode of channel 2 to MAN mode.

(7) CH3 AUTO Mode Command
Commands the NR800 to change the channel operating mode of channel 3 to AUTO mode.

(8) CH3 MAN Mode Command
Commands the NR800 to change the channel operating mode of channel 3 to MAN mode.

(9) CH4 AUTO Mode Command
Commands the NR800 to change the channel operating mode of channel 4 to AUTO mode.

(10) CH4 MAN Mode Command
Commands the NR800 to change the channel operating mode of channel 4 to MAN mode.

(11) CH1 Measurement Command
When the CH1 Measurement Command is set to 1, measurement of channel 1 is enabled.

When the CH1 Measurement Command is set to 0, measurement of channel 1 is disabled.

When you try reading the value, it always reads 0. However, this action does not change the actual value.

(12) CH2 Measurement Command
When the CH2 Measurement Command is set to 1, measurement of channel 2 is enabled.

When the CH2 Measurement Command is set to 0, measurement of channel 2 is disabled.

When you try reading the value, it always reads 0. However, this action does not change the actual value.

(13) CH3 Measurement Command
When the CH3 Measurement Command is set to 1, measurement of channel 3 is enabled.

When the CH3 Measurement Command is set to 0, measurement of channel 3 is disabled.

When you try reading the value, it always reads 0. However, this action does not change the actual value.

(14) CH4 Measurement Command
When the CH4 Measurement Command is set to 1, measurement of channel 4 is enabled.

When the CH4 Measurement Command is set to 0, measurement of channel 4 is disabled.

When you try reading the value, it always reads 0. However, this action does not change the actual value.

(15) Read Measurement Conditions command
Commands the NR800 to read measurement conditions regarding streams and constituents specified in the holding registers (40011/40012) from the database into the input registers.

(16) Write Measurement Conditions Command
Commands the NR800 to write measurement conditions specified in the holding registers (40013-40028) into the database of streams and constituents specified in the holding registers (40011/40012). This command is valid only when the specified stream is in MAN mode.

All measurement conditions in the holding registers are written into the database. Thus, all conditions including unchanged ones must have been written in the holding registers (40013-40028) in advance.

5.2 Input relays (status contacts)

(1) NR800 Normal
Indicates that the NR800 runs normally. This relay is set to 1 when no alarms are occurring.

(2) NR800 High/Medium-priority Failure
Indicates that high- or medium-priority failure(s) are occurring in the NR800. This relay is set to 1 whenever any alarm is occurring. If a high-priority failure and a low-priority failure coincidentally occur in the NR800, this relay is set to 1.

001, 002, 003, 005, 006, 007, 008, 009, 011, 012, 013, 014, 015, 101, 104, 105, 106, 107, 108, 109, 110, 111

(3) NR800 Low-priority Failure
Indicates that low-priority failure(s) are occurring in the NR800. This relay is set to 1 whenever any alarm is occurring. If a high-priority failure and a low-priority failure coincidentally occur in the NR800, this relay is not set to 1.

200, 201

(4) Outlier Error
Indicates that outlier error(s) occurred during measurement. This relay is set to 1 if any of outlier status relays is ON.

(5) Alarm Status Change
Indicates whether there has been a change in alarm statuses of the NR800. When a new alarm occurs, this relay is set to 1. Then, when this relay's status (= 1) is read and an alarm status read after that, this relay is reset to 0. Namely, if an alarm status is read before this relay status is read, the relay status is left as 1.

When an alarm is removed (an alarm condition disappears), this relay is set to 1.

(6) Basic Operating Mode
This relay is set to 1 when the NR800 is in RUN mode and 0 when in MAINT mode.

(7) CH1 Channel Operating Mode
This relay is set to 1 when the channel 1 of the NR800 is in AUTO mode and 0 when in MAN mode.

(8) CH2 Channel Operating Mode
This relay is set to 1 when the channel 2 of the NR800 is in AUTO mode and 0 when in MAN mode.

(9) CH3 Channel Operating Mode
This relay is set to 1 when the channel 3 of the NR800 is in AUTO mode and 0 when in MAN mode.

(10) CH4 Channel Operating Mode
This relay is set to 1 when the channel 4 of the NR800 is in AUTO mode and 0 when in MAN mode.

(11) Property Value Update
Indicates whether the property values for each sample stream have been updated and are ready to be read. When the property values are updated and ready to be read, this relay is set to 1. Then, when this relay's status (= 1) is read and a property value read after that, this relay is reset to 0. Namely, if a property value is read before this relay status is read, the relay status is left as 1.

(12) Outlier Status
Indicates the status of outlier errors for each property value. The relay is set to 1 when an outlier error is occurring. If no outlier error is found after the measurement of the same stream and constituent, the relay is reset to 0. The outlier status remains unchanged and reflects the most recently measured result, even if the mode has been changed.

The address of an outlier status relay can be obtained by the following equation:

$$\text{Address} = (N_{STRM} - 1) \times 12 + N_{CNST}$$

Where, N_{STRM} = stream number
N_{CNST} = constituent number

For example, the address of the relay containing the outlier status of Constituent 3 in Stream 2 is obtained as in:

$$(2-1) \times 12 + 3 = 15$$

Hence, the address of the relay is 11015.

(13) Alarm Status
Indicates the status of alarm occurrences in order of alarm number. The relay is set to 1 when an alarm is occurring and 0 when no alarm is occurring.

Only the address with the allotment of the alarm number is effective. The data of the address without the alarm number are unsettled.

5.3 Holding registers (setting data)

(1) CH1 Stream Number
Specifies the stream number for channel 1 of the NR800.

Set the "Contact input module" to "Out of use" in the system parameters of the NR800. The default value is 0. Make sure to specify a stream number before changing the mode of the CH to RUN, or an error will occur.

(2) CH2 Stream Number
Specifies the stream number for channel 2 of the NR800.

Set the "Contact input module" to "Out of use" in the system parameters of the NR800. The default value is 0. Make sure to specify a stream number before changing the mode of the CH to RUN, or an error will occur.

(3) CH3 Stream Number
Specifies the stream number for channel 3 of the NR800.

Set the "Contact input module" to "Out of use" in the system parameters of the NR800. The default value is 0. Make sure to specify a stream number before changing the mode of the CH to RUN, or an error will occur.

(4) CH4 Stream Number
Specifies the stream number for channel 4 of the NR800.

Set the “Contact input module” to “Out of use” in the system parameters of the NR800. The default value is 0. Make sure to specify a stream number before changing the mode of the CH to RUN, or an error will occur.

(5) Stream Number
Specifies the stream number where measurement conditions are to be checked. Range: 1 to 16

(6) Constituent Number
Specifies the constituent number where measurement conditions are to be checked. Range: 1 to 12

(7) Average Number
Specifies the average number of the stream specified in item (5/6) above. Range: 1 to 9999

(8) Resolution
Specifies the resolution of the stream specified in item (5/6) above. Range: 1 to 5

1: 64 [cm^{-1}], 2: 32 [cm^{-1}], 3: 16 [cm^{-1}], 4: 8 [cm^{-1}], 5: 4 [cm^{-1}],

(9) Zero Filling
Specifies the zero filling of the stream specified in item (5/6) above. 1=In Use, 0=Out of use

(10) Apodization
Specifies the apodization of the stream specified in item (5/6) above. Range: 1 to 8

1: Boxcar, 2: Triangular, 3: Norton-Beer Weak,
4: Norton-Beer Medium, 5: Norton-Beer Strong,
6: Bessel, 7: Happ-Genzel, 8: COS

(11) Calibration Model Number
Specifies the calibration model number of the stream and constituent specified in item (5/6) above. Range: 1 to 64, 0=Out of use

(12) Spectrum Saving Condition 1
Specifies whether to save spectrum when an outlier occurs in the stream and constituent specified in item (5/6) above. 1=Save, 0=Not save

(13) Spectrum Saving Condition 2
Specifies whether to save spectrum when an abnormal change in property values occurs in the stream and constituent specified in item (5/6) above. 1=Save, 0=Not save

(14) Property Value Bias (C0)
Specifies the bias to property values of the stream and constituent specified in item (5/6) above.

(15) Property Value Slope (C1)
Specifies the slope to property values of the stream and constituent specified in item (5/6) above.

(16) Outlier Detection Condition 1
Specifies the Mahalanobis upper limit value for the stream and constituent specified in item (5/6) above.

(17) Outlier Detection Condition 2
Specifies the RMSSR (root of mean sum of squared residuals) upper limit value for the stream and constituent specified in item (5/6) above.

(18) AO_20
Specifies the industrial quantity corresponding to analog 20 mA for the stream and constituent specified in item (5/6) above.

(19) AO_04
Specifies the industrial quantity corresponding to analog 4 mA for the stream and constituent specified in item (5/6) above.

(20) Property Value
The property values can be read as a copy of those stored in the input registers (31YYY). This function is for the Honeywell’s DCS.

(21) Mahalanobis
The mahalanobis can be read as a copy of those stored in the input registers (32YYY). This function is for the Honeywell’s DCS.

(22) Spectral Residual
The spectral residual can be read as a copy of those stored in the input registers (33YYY). This function is for the Honeywell’s DCS.

5.4 Input registers (measured data)

(1) CH1 Stream Number
Indicates the stream number selected for channel 1.

(2) CH2 Stream Number
Indicates the stream number selected for channel 2.

(3) CH3 Stream Number
Indicates the stream number selected for channel 3.

(4) CH4 Stream Number
Indicates the stream number selected for channel 4.

(5) Stream Number
Indicates the stream number where measurement conditions can be read.

(6) Constituent Number
Indicates the constituent number where measurement conditions can be read.

(7) Average Number
Indicates the average number of the stream indicated in item (5/6) above.

(8) Resolution
Indicates the resolution of the stream indicated in item (5/6) above.

1: 64 [cm^{-1}], 2: 32 [cm^{-1}], 3: 16 [cm^{-1}], 4: 8 [cm^{-1}], 5: 4 [cm^{-1}],

(9) Zero Filling
Indicates the zero filling of the stream indicated in item (5/6) above. 1=In Use, 0=Out of Use

(10) Apodization
Indicates the apodization of the stream indicated in item (5/6) above.

1: Boxcar, 2: Triangular, 3: Norton-Beer Weak,
4: Norton-Beer Medium, 5: Norton-Beer Strong,
6: Bessel, 7: Happ-Genzel, 8: COS

(11) Calibration Model Number
Indicates the calibration model number of the stream and constituent indicated in item (5/6) above.
Range: 1 to 64, 0=Out of use

(12) Spectrum Saving Condition 1
Indicates whether to save spectrum when an outlier occurs in the stream and constituent indicated in item (5/6) above. 1=Save, 0=Not save

(13) Spectrum Saving Condition 2
Indicates whether to save spectrum when an abnormal change in property values occurs in the stream and constituent indicated in item (5/6) above.
1=Save, 0=Not save

(14) Property Value Bias (C0)
Indicates the bias to property values of the stream and constituent indicated in item (5/6) above, as real values.

(15) Property Value Slope (C1)
Indicates the slope to property values of the stream and constituent indicated in item (5/6) above, as real values.

(16) Outlier Detection Condition 1
Indicates the Mahalanobis upper limit value for the stream and constituent indicated in item (5/6) above, as real values.

(17) Outlier Detection Condition 2
Indicates the RMSSR upper limit value for the stream and constituent indicated in item (5/6) above, as real values.

(18) AO_20
Indicates the industrial quantity corresponding to analog 20 mA for the stream and constituent indicated in item (5/6) above.

(19) AO_04
Indicates the industrial quantity corresponding to analog 4 mA for the stream and constituent indicated in item (5/6) above.

(20) Lamp Runtime
Indicates the operating time of the NR800's lamp, in minutes. 2 registers are used.

(21) Laser Runtime
Indicates the operating time of the NR800's laser, in minutes. 2 registers are used.

(22) Lamp Intensity
Indicates the light intensity of the lamp, as real values.

(23) Property Value
These registers contain the property values of each stream-constituent. Two registers are used to store one property value in the IEEE standard real number (floating) form.

The address of a property value register can be obtained by the following equation:

$$\text{Address} = \{(N_{STRM} - 1) \times 12 + (N_{CNST} - 1)\} \times 2 + 1$$

Where, N_{STRM} = stream number
N_{CNST} = constituent number

For example, the address of the register containing the property value of Constituent 3 in Stream 2 is obtained as:

$$\{(2-1) \times 12 + (3 - 1)\} \times 2 + 1 = 29$$

Hence, the property value is stored in addresses 31029 and 31030.

(24) Mahalanobis
2 registers are used.

The address of a mahalanobis register can be obtained by the following equation:

$$\text{Address} = \{(N_{STRM} - 1) \times 12 + (N_{CNST} - 1)\} \times 2 + 1$$

Where, N_{STRM} = stream number
N_{CNST} = constituent number

For example, the address of the register containing the mahalanobis of Constituent 3 in Stream 2 is obtained as:

$$\{(2-1) \times 12 + (3 - 1)\} \times 2 + 1 = 29$$

Hence, the property value is stored in addresses 32029 and 32030.

(25) Spectral Residual

2 registers are used.

The address of a spectral residual register can be obtained by the following equation:

$$\text{Address} = \{(N_{STRM} - 1) \times 12 + (N_{CNST} - 1)\} \times 2 + 1$$

Where, N_{STRM} = stream number
N_{CNST} = constituent number

For example, the address of the register containing the spectral residual of Constituent 3 in Stream 2 is obtained as:

$$\{(2-1) \times 12 + (3 - 1)\} \times 2 + 1 = 29$$

Hence, the property value is stored in addresses 33029 and 33030.

6. Numerical Value Form

Numerical values in holding registers and input registers are the MSB (bit zero is 1 and bit 15 is 0x8000) in order of byte from the high-order word to the low-order word.

When two registers are used (for the lamp runtime, etc.), the numerical values are 32-bit integers. In this case, the register with a small number represents the high-order word and the other register (with the number + 1) represents the low-order word.

Table 5 Word Order

High-order word	Register number N
Low-order word	Register number N+1

A value in real number form is stored in two registers: two upper bytes in register number N and two lower bytes in register number N+1.

The real number form uses the IEEE 754 single-precision floating point type.

7. Addressing

- **General Rules**

In case of Modbus communication between a DCS and the NR800 analyzers, the DCS acts as the master device and the NR800 analyzers as slave devices, and the analyzer number of each NR800 is interpreted as the device number.

Operation commands are assigned to the coils and status flags to the input relays. Holding registers are used for set values, and the input registers for measured values such as analysis results. Up to 8000 coils/relays and registers are provided respectively and addresses from 1 to 8000 are assigned to these elements so that the master device can access the desired element.

- **Exception**

Data such as property values are expressed as real values and one data is stored in two registers. Thus, each value uses two sequential addresses. For instance, property values #1, #2, and #3 are stored, as real values, in addresses 31001-31002, 31003-31004, and 31005-31006, respectively. Therefore, an error will occur if an address at improper data delimitation is specified.

8. Address table

	Name	Address	Description
Coil	RUN Mode Command	00001	Changes the basic operating mode to RUN
	MAINT Mode Command	00002	Changes the basic operating mode to MAINT
	CH1 AUTO Mode Command	00003	Changes the channel operating mode of channel 1 to AUTO
	CH1 MAN Mode Command	00004	Changes the channel operating mode of channel 1 to MAN
	CH2 AUTO Mode Command	00005	Changes the channel operating mode of channel 2 to AUTO
	CH2 MAN Mode Command	00006	Changes the channel operating mode of channel 2 to MAN
	CH3 AUTO Mode Command	00007	Changes the channel operating mode of channel 3 to AUTO
	CH3 MAN Mode Command	00008	Changes the channel operating mode of channel 3 to MAN
	CH4 AUTO Mode Command	00009	Changes the channel operating mode of channel 4 to AUTO
	CH4 MAN Mode Command	00010	Changes the channel operating mode of channel 4 to MAN
	CH1 Measurement Command	00011	Starts a measurement of channel 1
	CH2 Measurement Command	00012	Starts a measurement of channel 2
	CH3 Measurement Command	00013	Starts a measurement of channel 3
	CH4 Measurement Command	00014	Starts a measurement of channel 4
	Read Measurement Conditions Command	00015	Reads measurement conditions of specified streams/constituents
	Write Measurement Conditions Command	00016	Writes measurement conditions of specified streams/constituents
Input relays	NR800 Normal	10001	
	NR800 High/Medium-priority Failure	10002	
	NR800 Low-priority Failure	10003	
	Outlier Error	10004	Outlier error(s) exist
	Alarm Status Change	10005	When the DCS reads this relay and then an alarm status relay, the NR800 will reset this relay to 0.
	Basic Operating Mode	10006	1=RUN, 0=MAINT
	CH1 Channel Operating Mode	10007	1=AUTO, 0=MAN/Out of Use
	CH2 Channel Operating Mode	10008	1=AUTO, 0=MAN/Out of Use
	CH3 Channel Operating Mode	10009	1=AUTO, 0=MAN/Out of Use
	CH4 Channel Operating Mode	10010	1=AUTO, 0=MAN/Out of Use
	Property Value Update	101XX	Provided for each stream (XX=01-16) When the DCS read this relay and then a property value relay, the NR800 will reset this relay to 0.
	Outlier Status	11YYY	YYY: 001 to 192 -> (Stream number - 1) x 12 + Constituent number
	Alarm Status	12YYY	YYY: 001 to 400

	Name	Address	Description
Holding registers	CH1 Stream Number	40001	Specifies the stream number for CH1
	CH2 Stream Number	40002	Specifies the stream number for CH2
	CH3 Stream Number	40003	Specifies the stream number for CH3
	CH4 Stream Number	40004	Specifies the stream number for CH4
	Stream Number	40011	Stream number where measurement conditions are to be changed. Range: 1 to 16
	Constituent Number	40012	Constituent number where measurement conditions are to be changed. Range: 1 to 12
	Average Number	40013	Average number of the stream specified in 40011. Range: 1 to 9999
	Resolution [cm^{-1}]	40014	Resolution of the stream specified in 40011. Range: 1 to 5
	Zero Filling	40015	Zero filling of the stream specified in 40011. (0 or 1)
	Apodization	40016	Apodization of the stream specified in 40011. Range: 1 to 8
	Calibration Model Number	40017	Calibration model number to be used. Range: 1 to 64, 0=Out of use
	Spectrum Saving Condition 1	40019	Whether to save spectrum during outlier. (0 or 1)
	Spectrum Saving Condition 2	40020	Whether to save spectrum during abnormal change in property values. (0 or 1)
	Property Value Bias	40021, 40022	Bias to property values (C0)
	Property Value Slope	40023, 40024	Slope to property values (C1)
	Outlier Detection Condition 1	40025, 40026	Mahalanobis upper limit value
	Outlier Detection Condition 2	40027, 40028	RMSSR upper limit value
	AO_20	40029, 40030	Industrial quantity corresponding to analog 20 mA
	AO_04	40031, 40032	Industrial quantity corresponding to analog 4 mA
	Property Value	41YYY	Copy of 31YYY. Read only (For Honeywell)
	Mahalanobis	42YYY	Copy of 32YYY. Read only (For Honeywell)
	Spectral Residual	43YYY	Copy of 33YYY. Read only (For Honeywell)
Input registers	CH1 Stream Number	30001	Stram number of channel 1
	CH2 Stream Number	30002	Stram number of channel 2
	CH3 Stream Number	30003	Stram number of channel 3
	CH4 Stream Number	30004	Stram number of channel 4
	Stream Number	30011	Stream number where measurement conditions are to be changed. Range: 1 to16
	Constituent Number	30012	Constituent number where measurement conditions are to be changed. Range: 1 to 12
	Average Number	30013	Average number of the stream specified in 40011. Range: 1 to 9999
	Resolution [cm^{-1}]	30014	Resolution of the stream specified in 40011. Range: 1 to 5
	Zero Filling	30015	Zero filling of the stream specified in 40011. (0 or 1)
	Apodization	30016	Apodization of the stream specified in 40011. Range: 1- to 8
	Calibration Model Number	30017	Calibration model number to be used. Range: 1 to 64, 0=Out of use
	Spectrum Saving Condition 1	30019	Whether to save spectrum during outlier. (0 or 1)
	Spectrum Saving Condition 2	30020	Whether to save spectrum during abnormal change in property values. (0 or 1)
	Property Value Bias	30021, 30022	Bias to property values (C0)
	Property Value Slope	30023, 30024	Slope to property values (C1)
	Outlier Detection Condition 1	30025, 30026	Mahalanobis upper limit value
	Outlier Detection Condition 2	30027, 30028	RMSSR upper limit value
	AO_20	30029, 30030	Industrial quantity corresponding to analog 20 mA
	AO_04	30031, 30032	Industrial quantity corresponding to analog 4 mA
	Lamp Runtime	30101, 30102	In minutes
	Laser Runtime	30103, 30104	In minutes
	Lamp Intensity	30105, 30106	
	Property Value	31YYY	YYY: 001 to 384 (1 property value/2 registers) -> {(Stream number - 1) x 12 + (Constituent number - 1)} x 2 + 1
	Mahalanobis	32YYY	YYY: 001 to 384 (1 pcs/2 registers) -> {(Stream number - 1) x 12 + (Constituent number - 1)} x 2 + 1
	Spectral Residual	33YYY	YYY: 001 to 384 (1 pcs/2 registers) -> {(Stream number - 1) x 12 + (Constituent number - 1)} x 2 + 1