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This document describes MODBUS communication by the Zirconia Oxygen/Humidity Analyzer, Converter ZR802G/ZR802S.

Before communicating using the MODBUS protocol for details of the parameters, refer to the User's Manual as follows:

- ZR22G and ZR802G Zirconia Oxygen/Humidity Analyzer (IM 11M12G01-02EN)
- ZR22S and ZR802S Explosion-proof Zirconia Oxygen Analyzer (IM 11M13G01-02EN).

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1. General

ZR802G/ZR802S configures or obtains process data by using Modbus TCP protocol on physical application: Ethernet, RS485.

MODBUS RTU is supported but not ASII.

1.1 MODBUS setup

● Ethernet

ZR802G/ZR802S uses Modbus TCP, connection port 502.

For Modbus TCP, IP address, subnet mask, default gateway or DHCP should be set in advance from HMI device.

The Ethernet configuration is reflected onto the system, after ZR802G/ZR802S reboots.

● RS485

ZR802G/ZR802S communicates via RS485 MODBUS.

The following list shows the required setting by HMI to establish communication between a master device and ZR802G/ZR802S via RS485 MODBUS.

Converter address: 1 to 247 (initial value 1)

Transmission speed: 9600[bps], 38400[bps], 115200[bps]

Parity : Even, Odd, None

When Parity is Even or Odd, Stop bit is 1bit, when None, Stop bit is 2 bit.
Even or Odd is recommended for Parity.

1.2 MODBUS master

● Data memory

YOKOGAWA GX series with RS485 MODBUS are recommended for process data saving. MODBUS communication enables to store larger amount of process data than ZR802G/ZR802S mA output.

1.3 Function code/Exception code

MODBUS Function code used for ZR802G/ZR802S

Function	Function Code (hex)
Read Coils	01
Write Single Coil	05
Write Multiple Coils	0F
Read Input Register	04
Read Holding Registers	03
Write Single Register	06
Write Multiple Register	10
Read Device Identification	2B

Exception responses

Exception Code	Name	Meaning
0x01	Illegal Function	The Function Code received in the query is not an allowable action for the server or slave.
0x02	Illegal Data Address	The data address received in the query is not an allowable address for the server or slave.
0x03	Illegal Data Values	The value contained in the query data field is not an allowable value for the server or slave.

If parameter setting fails because the setting is out of the range, Exception code 0x03 is replied indicating a fail setting. When multiple parameters are to be set, even a single forbidden setting makes all the other parameter setting fail.

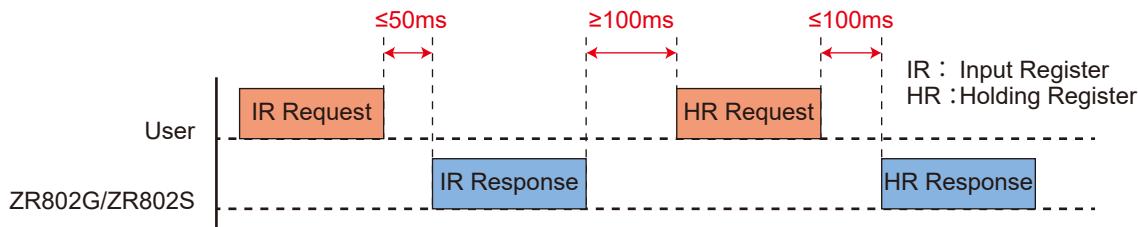
1.4 MODBUS communication

The following must be cared when master devices are used.

● MODBUS response timing

IR (Input Register) response to IR Read request within 50 ms after ZR802G/ZR802S receives the message. To the other request, ZR802G/ZR802S replies within 100 ms after it receives the request.

Another request must be sent at least 100 ms after the last response was received from ZR802G/ZR802S.



● Input Register renewal cycle

Process value sent in Input Register is renewed every 200 ms. It is better to Read the process value every 200 ms.

● How to change the setting

Change the Coil/Holding register.

NOTE

You cannot change settings while screens locked by HMI password, such as setting are being shifted, or Calibration, Blow back, Simple-cell impedance are being conducted/measured. If you try to write setting parameters in this status, an error response (Error code 03) is replied.

1.5 MODBUS password

Entering password on “MODBUS password” protects parameter setting and prohibits data input except for “cancel MODBUS password” and “gain access authority.”

MODBUS password protects parameter setting and prohibits data input except for “cancel MODBUS password”.

On the password-setting screen, enter a password you created to “cancel MODBUS password” then you can cancel the password.

NOTE

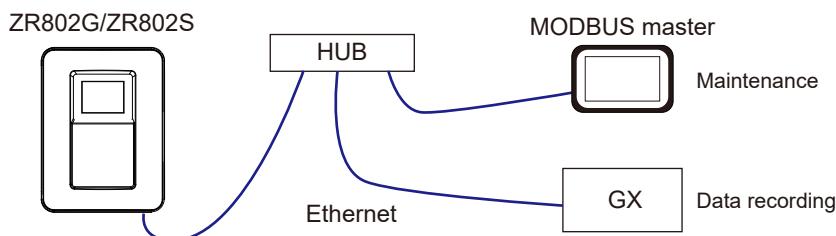
- On the password-setting screen, when a data input is being allowed but no message to input data comes from MODBUS master for 10 minutes, data input is automatically prohibited again.
- Those three parameters in MODBUS password addresses shall be accessed with correct Quantity corresponding to the address.
- Be sure to access Write Multiple Register (Function Code 0x10) to input data.

1.6 Connection

● Ethernet

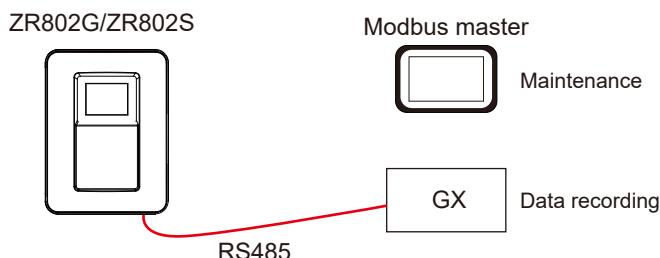
On the ZR802G/ZR802S network, Ethernet MODBUS allows 2 sessions.

First session provides communication to Read process value periodically by connecting constantly.



● RS485

ZR802G/ZR802S communicates with one MODBUS master via RS485 MODBUS. RS485 is connected constantly and provides communication for reading process value.



NOTE

- Although connections other than these mentioned above are available, they might disable obtaining process value, if Read and setting change are implemented in a single session/communication.
- Option code shall be specified to use GX. Refer to a user's manual of GX for details.

2. MODBUS map

Data type for ZR802G/ZR802S MODBUS map

Data type	Definition
float	floating point (4byte) IEEE754 NaN: 0x7FFFFFFF
int16	16 bit signed integer
uint16	16 bit unsigned integer
uint32	32 bit unsigned integer
ASCII	character set (using one byte per character), multiple registration possible
bit fields	data assigning information on bit

Access (load/import) to multiple registration such as float, uint32, ASCII etc. must be implemented at once.

2.1 Coil register

Address	Item name	Value/description
0	Reserved	all 0 Do not change.
30	WRITE_STATUS	Read only Shows access authority. ON: disables change of setting via Modbus. Off: enables change of setting via Modbus.
31	PASSWORD_STATUS	Read only Shows MODBUS password lock state. On: Lock Off: Unlock
50	CONVERTER_RESTART	Restarts the converter
51	CAL_AUTO_START	Starts semi-auto calibration.
52	CAL_AUTO_CELINP_START	Starts Cell impedance measurement.
66	AD_TOUCH_SCREEN_FLAG	HMI of the converter switches from Adjust panel to Touch panel.

2.2 Input Register (IR)

MODBUS address are assigned to parameters of the converter status including IO. Address from 100 to 199 are for the measured value obtained from sensors.

Address	Name	Comment
0 to 31	Converter	Status on Converter, IO, HART. See 2.2.1 through 2.2.3.
100 to 157	Sensor measured value	Input Register for sensor. For IR map, see "2.2.3 Sensor measured value".
52017 to 52056	Reserved	-

2.2.1 Status

Address	Item name	Type	Value/description										
0, 1	ALARM_DEVICE_FAILURE	uint32 (bit fields)	For bit assignment, see "3.1 Alarm list". See the table of alarms for bit assignment.										
2, 3	ALARM_MEASURE_1	uint32 (bit fields)	-										
4, 5	ALARM_MEASURE_2	uint32 (bit fields)	-										
6, 7	ALARM_MAINTENANCE_STATUS	uint32 (bit fields)	-										
8	ALARM_NE107	uint16 (bit fields)	<p>Integrated information on alarms of the converter or connected sensors. See the table of alarms to know the bit assignment.</p> <table border="1"> <thead> <tr> <th>Bit</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>Failure</td> </tr> <tr> <td>1</td> <td>Out of spec</td> </tr> <tr> <td>2</td> <td>Check</td> </tr> <tr> <td>3</td> <td>Maintenance</td> </tr> </tbody> </table>	Bit	Description	0	Failure	1	Out of spec	2	Check	3	Maintenance
Bit	Description												
0	Failure												
1	Out of spec												
2	Check												
3	Maintenance												
10, 11	LAST_CELL_VOLTAGE_ERROR	float	EMF of the Last Cell Voltage Error										
12, 13	LAST_TC_VOLTAGE_HAETER_ERROR		TC EMF of the Last TC Voltage Heater Error										

2.2.2 mA Output, mA Input, Contact Output, Contact Input

Address	Item name	Type	Value/description
20, 21	AO_PROCESS_PARAM_1	float	The measured value of process parameter assigned to mA1 to mA2
22, 23	AO_PROCESS_PARAM_2		
24, 25	AO_mA1	float	Output value of mA1 to mA4 Analog output: current (3.6-22mA)
26, 27	AO_mA2		
28, 29	AI_CURRENT	float	Analog input [mA] mA input information, confirmable by unit
30	CONTACT_INPUT_OUTPUT	uint16 (bit fields)	Contact Output, Contact Input status, ZERO, SPAN. When the bit is set, contact closes. bit0: S1 bit1: S2 bit2: S3 bit3: S4 bit4-7: Reserved bit8: DI1 bit9: DI2 bit12: ZERO bit13: SPAN bit14-15: Reserved
31	CONTACT_FUNCTIONAL_STATUS	uint16 (bit fields)	Contact Output, Contact Input status, ZERO, SPAN. When the bit is set, contact becomes ON. bit0: S1 bit1: S2 bit2: S3 bit3: S4 bit4-7: Reserved bit8: DI1 bit9: DI2 bit12: ZERO bit13: SPAN bit14-15: Reserved

2.2.3 Sensor measured value

Address	Item name	Type	Value/description
100	ALARM_SENSOR_FAILURE	uint16 (bit fields)	See "3.1 Alarm list" to see the same bit assignment as "2.2.1 Status" - ALARM_DEVICE_FAILURE 16-bit slave.
101, 102	ALARM_MEASURE	uint32 (bit fields)	See "3.1 Alarm list" to see the same bit assignment as "2.2.1 Status" - ALARM_MEASURE_2.
103	ALARM_MAINTENANCE_STATUS	uint16 (bit fields)	See "3.1 Alarm list" to see the same bit assignment as "2.2.1 Status" - ARM_MAINTENANCE_STATUS.
104, 105	OXYGEN_CONC	float	-
106, 107	HUMIDITY_CONC	float	-
108, 109	MIXING_RATIO	float	-
110, 111	RELATIVE_HUMIDITY	float	-
112, 113	DEW_POINT	float	-
114, 115	EXCES_AIR_RATIO	float	-
116, 117	MOISTURE_CONTENT	float	-
118, 119	CELL_TEMPERATURE	float	-
120, 121	CJ_TEMPERATURE	float	-
122, 123	CELL_VOLTAGE	float	-
124, 125	THERMO_VOLTAGE	float	-
126, 127	CJ_PT1000_RESISTANCE	float	-
128, 129	CJ_TR_VOLTAGE	float	-
130, 131	AI_CURRENT	float	-
132, 133	EXHAUST_PRESSURE	float	-
134, 135	EXHAUST_TEMPERATURE	float	-
136, 137	SIMPLE_CELL_RESISTANCE	float	-
138, 139	SIMPLE_CELL_DATE	float	-
140, 141	CELL_HEATER_DUTY	float	-
142	POWER_SUPPLY_VOLTAGE_MODE	uint16	Power supply status to the heater temperature controller (1: 100V, 2: 200V)
143	POWER_FREQUENCY_MODE	uint16	Power supply frequency mode (1: 50Hz, 2: 60Hz)
144	SIMPLE_CELL_ROBUSTNESS	uint16	Simple cell robustness 1: life span < 1 month 2: life span > 3 months 3: life span > 6 months 5: life span > 1 year

2.2.4 Sensor cell, calibration information

Address	Item name	Type	Value/description
150	CELL_RESPONSE_TIME	uint16	-
151	CELL_ROBUSTNESS	uint16	1: life span < 1 month 2: life span > 3 months 3: life span > 6 months 5: life span > 1 year
152, 153	CELL_RESISTANCE	float	-
154, 155	SPAN_CORRECTION_RATIO	float	-
156, 157	ZERO_CORRECTION_RATIO	float	-

2.3 Holding Register

2.3.1 Calibration setting (0-)

Address	Item name	Type	Value/description
0	SELECT_CALIB_MODE	uint16	Auto calib. (0), Semi auto calib. (1), Auto, Semi-auto calib. (2)
1	SELECT_CALIB_SKIP	uint16	Span Zero (0), Span only (1), Zero only (2)
2	CALIB_ZERO_CONC	Float	0.3 to 100
3			
4	CALIB_SPAN_CONC	Float	4.5 to 100
5			
6	STABILIZING_TIME_MINUTE	uint16	0 to 60
7	STABILIZING_TIME_SECOND	uint16	0 to 59
8	CALIBRATION_TIME_MINUTE	uint16	0 to 60
9	CALIBRATION_TIME_SECOND	uint16	0 to 59
10	CALIBRATION_CYCLE_DAYS	uint16	0 to 255
11	CALIBRATION_CYCLE_HOURS	uint16	0 to 23
12	CALIB_START_TIME_YEAR	uint16	0 to 99
13	CALIB_START_TIME_MONTH	uint16	1 to 12
14	CALIB_START_TIME_DAY	uint16	1 to 31
15	CALIB_START_TIME_HOUR	uint16	0 to 23
16	CALIB_START_TIME_MINUTE	uint16	0 to 60

2.3.2 Modbus Password (100-)

Address	Item name	Type	Value/description
100	MODBUS_PASSWORD_UNLOCK	ASCII	“ ” (Space only)
101			
102			
103			
104			
105			
108	MODBUS_PASSWORD_LOCK	ASCII	“*****” (12 pieces of * (asterisk))
109			
110			
111			
112			
113			
116	MODBUS_PASSWORD_ENABLE	uint16	Unlock (0), Lock (1)

2.3.3 Advanced settings MODBUS setting (200-)

Address	Item name	Type	Value/description	Value/description
200	RS485 setting (RS)	MODBUS address	int16	1 to 247
201		Baud rate	int16	9600 (0), 38400 (1), 115200 (2)
202		Parity	int16	Even (0), Odd (1), None (2)

2.3.4 Advanced settings Ethernet setting (300-)

Address	Item name	Type	Value/description
300	DHCP enable	int16	ONOFF OFF(0), ON(1)
301, 302	IP Address	uint32	Set one byte at a time in Big Endian byte order, when 192.168.1.20: C0A80114
303, 304	Subnet mask	uint32	Set one byte at a time in Big Endian byte order, when 255.255.255.0: FFFFFFF00
305, 306	Default gateway	uint32	Set one byte at a time in Big Endian byte order, when 192.168.1.1: C0A80101

CAUTION

Ethernet setting is reflected onto the system, after ZR802G/ZR802S reboots.

2.3.5 Loop check (1000–)

Address	Item name	Type	Value/description
1000	TEST_VAILIDITY_AO1/AO2	unit16 (bit fields)	mA Loop check valid AO1 (bit0), AO2 (bit1)
1001, 1002	AO1_TEST_OUTPUT	Float	AO1 Loop check output 2.4 to 21.6
1003, 1004	AO2_TEST_OUTPUT	Float	AO2 Loop check output 2.4 to 21.6
1005	TEST_VAILIDITY_DO1_to_DO4	unit16 (bit fields)	DO1(bit0), DO2(bit1), DO3(bit2), DO4(bit3)
1006	TEST_OUTPUT_DO1_to_DO4	unit16 (bit fields)	DO1(bit0), DO2(bit1), DO3(bit2), DO4(bit3) 1: Close 0: Open
1007	TEST_VAILIDITY_CAL_CONTACT	unit16 (bit fields)	ZERO contact (bit 0), SPAN contact (bit 1)
1008	TEST_OUTPUT_CAL_CONTACT	unit16 (bit fields)	ZERO contact (bit0), SPAN contact (bit1) 1: Close 0: Open

2.4 Identification

Object id	Object name	Type	Value/description
0x00	vendor_name	ASCII	YOKOGAWA
0x01	product_code		ZR802G/ZR802S
0x02	major_minor_version		create from software revision (e.g. 1.01.01)
Object id	Object name	Type	Value/description
0x03	vendor_url	ASCII	space(64)
0x04	product_name		space(16)
0x05	model_name		space(8)
0x06	user_app_name		space(16)
Object id	Object name	Type	Value/description
0x84	MS_CODE	ASCII[128]	Model code
0x8E	SOFTWARE_REVISION	ASCII[12]	Software revision
0x8F	SERIAL_PROFILE_RS485	ASCII[32]	Display example: 9600 even 1 stop
0x93	INPUT_REG_UPDATE_CYCLE	unit32	200 [ms]
0x94	INPUT_REG_RES_TIME	unit32	50 [ms]
0x95	HOLD_REG_RES_TIME	unit32	100 [ms], expect INPUT_REG_RES_TIME
0x96	NEXT_REQ_WAIT_TIME	unit32	100 [ms], waiting time from receiving a response to sending the next request.
0x97	HART_ADDRESS	unit16	HART setting
0x98	HART_MULTIDROP	unit16	
0x99	HART_DEV_REV	unit16	
0x9A	MODBUS_ADDR	unit16	MODBUS address
0x9B	DHCP_ENABLE	unit16	Ethernet setting
0x9C	IP_ADDR	ASCII[16]	
0x9D	SUBNET_MASK	ASCII[16]	
0x9E	DEFAULT_GATEWAY	ASCII[16]	
0x9F	MAC_ADDR	ASCII[32]	

3. Alarm

For further information on “Alarm settings” see Section 8.4 in the User’s Manual or [IM 11M12G01-02EN](#) or [IM 11M13G01-02EN](#).

3.1 Alarm list

Alarm	Bit	Alarm name	Alarm number	Default (*1)
DEVICE_FAILURE	31	Hardware failure	001	(F)
	30	Internal com. failure	002	(F)
	29	MAC address read failure	003	(F)
	28	Converter user param. failure	004	(F)
	15	Cell voltage failure	016	(F)
	14	Heater temperature failure	017	(F)
	13	A/D converter failure	018	(F)
	12	Sensor EEPROM failure	019	(F)
	11	Sensor user param. failure	020	(F)
MEASURE_1	31	Oxygen concentration high high alarm	101	N
	30	Oxygen concentration high alarm	102	N
	29	Oxygen concentration low alarm	103	N
	28	Oxygen concentration low low alarm	104	N
	27	Humidity high high alarm	105	N
	26	Humidity high alarm	106	N
	25	Humidity low alarm	107	N
	24	Humidity low low alarm	108	N
	23	Mixing ratio high high alarm	109	N
	22	Mixing ratio high alarm	110	N
	21	Mixing ratio low alarm	111	N
	20	Mixing ratio low low alarm	112	N
	19	Relative humidity high high alarm	113	N
	18	Relative humidity high alarm	114	N
	17	Relative humidity low alarm	115	N
	16	Relative humidity low low alarm	116	N
	15	Simple cell resistance alarm	117	M
	14	AO1 saturation	118	(S)
	13	AO2 saturation	119	(S)
	12	Calibration stability alarm	120	C

Alarm	Bit	Alarm name	Alarm number	Default (*1)
MEASURE_2	31	Zero correction ratio high alarm	201	C
	30	Zero correction ratio low alarm	202	C
	29	Span correction ratio high alarm	203	C
	28	Span correction ratio low alarm	204	C
	27	Cold junction temperature high alarm	205	(S)
	26	Cold junction temperature low alarm	206	(S)
	25	Thermocouple voltage high alarm	207	(S)
	24	Thermocouple voltage low alarm	208	(S)
	23	AI current high alarm	209	(S)
	22	AI current low alarm	210	(S)
	21	Input temperature high alarm	211	N
	20	Input temperature low alarm	212	N
	19	Input pressure high alarm	213	N
	18	Input pressure low alarm	214	N
MAINTENANCE_STATUS	31	Battery low alarm	301	M
	21	AO1 fixed	None	(N)
	20	AO2 fixed	None	(N)
	19	Simple cell resistance mode	None	(N)
	18	Maintenance mode	None	(N)
	17	Blow back mode	None	(N)
	16	Calibration mode	None	(N)
	15	Purging	None	(N)
	14	Warm-up mode	None	(N)
	13	Fast warm-up function alarm	319	M

*1: F: Failure, C: Function Check, S: Out of Specification, M: Maintenance required, N: Off
The default in () (parentheses) are fixed, not settable.

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