English

Modbus

PROTOCOL MANUAL

GDR

GDR450

GDR400

GDR300

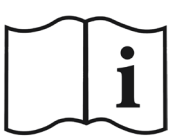
GDR453

GDR403

Tecno Control

MADE IN ITALY

TABLE OF CONTENTS



The Use and Maintenance Manual must be kept for the entire life of the device in use, near the device itself, inside a suitable container and, above all, protected from any element or substance that could compromise its perfect readability.

1.0 Introduction

The MODBUS standard defines an application-level messaging protocol, positioned at level 7 of the OSI model, which provides "client/server" communications between connected devices on different types of buses or networks. It is a specific protocol on a serial line for exchanging MODBUS requests between a master and one or more slaves.

MODBUS is a request/response protocol and offers services specified by function codes.

The aim of this document is to present the MODBUS protocol used by Tecnocontrol, so that it can be used to communicate gas detectors on a serial line.

In Tecnocontrol gas detectors, this protocol has been adapted to provide the user with a standard protocol for access to the equipment's resources. Some memory locations serve certain purposes in reading and/or writing, allowing the user to access the values of the registers and variables of the equipment, as well as enable specific commands such as ZERO CALIBRATION and SPAN CALIBRATION.

The type of MODBUS used in Tecnocontrol detectors is called MODBUS RTU. It is therefore possible to put the Tecnocontrol detectors in communication with any equipment that has the MODBUS RTU protocol, such as gas detection systems, computers or PLCs.

It is beyond the scope of this manual to explain the MODBUS RTU specifications. Those who wish to deepen their knowledge of this protocol can download from the MODICON website the specifications of PI-MBUS-300 Rev.J which are the de facto standard of the protocol.

1.1 Communication parameters

The Tecnocontrol detector communicates via RS-485 serial port in half duplex mode.

The setting parameters of this port are permanent and are as follows:

- Half Duplex
- Baud Rate: selectable from 2400 to 38400, default 9600 (see instruction manual).
- Parity: N (no parity)
- Start bit: 1
- Data bits: 8
- Stop bit: 1

The detector must be considered a slave (it can never take the initiative to transmit, it can only respond to a query).

The slave address can be set from 1 to 247 (see instruction manual). The address 0 (zero) in MODBUS identifies a broadcast message, it cannot be assigned to any device.

2.0 Definition of memory areas

Since MODBUS provides 16-bit registers while the Tecnocontrol gas detector has contiguous data structures, 32-bit, 16-bit and 8-bit registers and variables, access to these memory areas must always take place both through access to 16-bit registers, therefore to several consecutive registers in the case of data structures, to 2 consecutive registers in the case of 32-bit float variables and through access to a register in the case of 16-bit and 8-bit variable units (in the latter case, masking the byte that does not concern).

3.0 Calculation of the CRC

To calculate the CRC of MODBUS communication (little endian) use the following parameters:

- Type: CRC-16
- Initial value: 0xFFFF
- Polynomial: 0x8005
- XOR Out: 0
- Reflection In: ON
- Reflection Out: ON

4.0 Modbus functions supported

The Tecnocontrol detector supports the following Modbus functions:

- 01h -> Coils reading
- 05h -> Single Coil writing
- 03h -> Holding Registers reading
- 04h -> Input Registers (Datalive) reading

5.0 Input registers

By reading 5 consecutive registers (from address 0x0000 to address 0x0004 included) it is possible to access real-time information on the operating status of the Tecnocontrol detector.

Register	Byte	R/W	Identifier	Format	Registers quantity
0x0000		R	Concentration	Float (32 bit)	2
0x0002	MSB	R	WarningCode	uint 8 (8 bit)	1 (MSB)
	LSB	R	ErrorCode	uint 8 (8 bit)	1 (LSB)
0x0003	MSB	R	MachineStatus	uint 8 (8 bit)	1 (MSB)
	LSB	R	AlarmStatus	uint 8 (8 bit)	1 (LSB)
0x0004	MSB	R	CalibrationStatus	uint 8 (8 bit)	1 (MSB)
	LSB	R	ConcentrationDivider	uint 8 (8 bit)	1 (LSB)
0x0005		R	Reserved for future use	uint16 (16 bit)	

5.1 Concentration

Concentration defines, together with other parameters, the gas concentration value detected.
Concentration is in float format but is always expressed as an integer value. It must be read together with the "ConcentrationDivider" value which defines the quantity to be divided at the Concentration to obtain the correct gas concentration value.
If ConcentrationDivider = 0, then no quantity should be divided to the concentration value.

Example:
1) if Concentration = 209.0F and ConcentrationDivider = 0 → gas concentration value = 209
2) if Concentration = 209.0F and ConcentrationDivider = 10 → gas concentration value = 209/10 = 20.9

NOTE: It is possible to trace the unit of measurement of the concentration by reading the sensor_model register (0x200) of the Sensor Values structure and masking it with 0x0C00:

- sensor model & 0x0C00 = 0x0000→ **%LFL**
- sensor model & 0x0C00 = 0x0400→ **%vol**
- sensor model & 0x0C00 = 0x0800 → **ppm**
- sensor model & 0x0C00 = 0x0C00 → **ppb**

5.2 WarningCode

Defines any active warnings in the gas detector (see specific chapter in the instruction manual).

Value	Status
0	No Warning
1	Sensor expired (end of life)
2	Maximum operating temperature exceeded
3	Minimum operating temperature exceeded

5.3 ErrorCode

Defines the code associated with a possible error or fault (see specific chapter in the instruction manual).

Value	Status
0	No error
1	Internal program memory error
2	Internal Data memory error
3	RAM internal memory error
4	Sensor cartridge memory error
5	Sensor cartridge generic error
6	Sensor cartridge communication error
7	Sensor value acquisition circuit error
8	Sensitive element power supply voltage error
9	Incorrect sensor cartridge model
10	Sensor cartridge replaced without switching the detector off and on again
11	Sensor Under-Range error (the sensor detects a gas concentration that is too low)
12	Sensor Over-Range error (the sensor detects a gas concentration beyond full scale)
13	Error in the generation of the 4-20mA signal (available only on SIL detectors)
14	Internal voltage reference error
15	AL1 relay error (available only on SIL detectors)
16	AL2 relay error (available only on SIL detectors)
17	Dip-Switch configuration error (available only on detectors with DipSwitch)
18	Generic error
19	Electrochemical sensor error in short circuit or open circuit (only for models with electrochemical cell sensor)

5.4 MachineStatus:

Defines the operating status of the detector (see specific chapter in the instruction manual).

Value	Status (English)
0	Initialisation
1	Warm Up
2	Active
3	Zero Calibration
4	Span Calibration
5	Fault
6	FS+ fault
7	FS- fault
8	Autotest
9	Electrical Test
10	Bump Test

5.5 AlarmStatus:
Defines the status of the detector alarms. The individual bits of the value are considered: if set to 1, the relative pre-alarm or alarm is active.

Bit	Status
0	Led AL1 flashing (pre-alarm 1)
1	Led AL2 flashing (pre-alarm 2)
2	Relay AL1 active (Alarm 1)
3	Relay AL2 active (Alarm 2)

5.6 CalibrationStatus:
Defines the operating status of the calibration (zero or span) in progress (see specific chapter in the instruction manual).

Value	Cal Status (English)
0	No calibration
1	Stable concentration
2	Wait
3	Gas standby
4	High concentration
5	Calibration OK

6.0 Holding Registers:

Address	type	R/W	Name	Description	Unit of measure-ment	Registers quantity
0x0000	Struct	R	Detector Values	All Detector configuration values	-	26
0x0200	Struct	R	Sensor Values	All sensor cartridge values	-	12
0x0300	Struct	R	HW_model	Hardware model	-	5
0x0310	Struct	R	FW_version	Firmware version	-	1
0x0320	Struct	R	Serial	Serial Number	-	2

6.1 Detector Values (0x0000)

The reading of the 26 registers of the "Detector Values" structure allows you to know the complete configuration of the Tecnocontrol gas detector.

Modbus Address	Byte	R/W	Register name	Description	Measurement unit
0x0000 (MSB)	uint8	R	Setting_detector_model	Detector model ('S' , 'R' name)	ASCII character from "A" to "Z" or 255
0x0000 (LSB)	uint8	R	Setting_detector_model2	Detector model2 (number hundreds)	number from 0 to 9 (no ASCII)
0x0001 (MSB)	uint8	R	Setting_detector_model3	Detector model3 (number dozens)	number from 0 to 9 (no ASCII)
0x0001 (LSB)	uint8	R	Setting_detector_model4	Detector model4 (number hunits)	number from 0 to 9 (no ASCII)
0x0002 (MSB)	uint8	R	Setting_detector_model5	Detector model5 (sensor type)	ASCII character from "A" to "Z" or from '0' to '9' or 255
0x0002 (LSB)	uint8	R	Setting_detector_model6	Detector model2 (gas type 1)	ASCII character from "A" to "Z" or from '0' to '9' or 255
0x0003 (MSB)	uint8	R	Setting_detector_model7	Detector model2 (gas type 2)	ASCII character from "A" to "Z" or from '0' to '9' or 255
0x0003 (LSB)	uint8	R	Setting_detector_model8	Detector model8 (H version)	ASCII character from "A" to "Z" or from '0' to '9' or 255
0x0004 (MSB)	uint8	R	Setting_detector_model9	Detector model9 (for future use)	ASCII character from "A" to "Z" or from '0' to '9' or 255
0x0004 (LSB)	uint8	R	Setting_detector_model10	Detector model10 (options -Bluetooth, Hart, RS485, Relay)	number from 0 to 255
0x0005 (MSB)	uint8	R	Setting_fw_version	Firmware version	number from 0 to 255
0x0005 (LSB)	uint8	R	Setting_fw_version2	Firmware version2	number from 0 to 255
0x0006	uint16	R	Setting_dac_value_4mA	reserved	
0x0007	uint16	R	Setting_dac_value_420mA	reserved	
0x0008 (MSB)	uint8	R	Setting_language	Display language	number from 0 to 2 (no ASCII)
0x0008 (LSB)	uint8	R	Setting_gas_detected	Gas detected	number from 0 to 255
0x0009	uint16	R	Setting_cartridge_full_scale	Sensor full scale value	number from 0 to 65535
0x000A (MSB)	uint8	R	Setting_relay_logic	Alarm Relays logic (positive or negative)	number from 0 to 1
0x000A (LSB)	uint8	R	Setting_relay_latch	Alarm2 Relay latch (on or off)	number from 0 to 3
0x000B	uint16	R	setting_relay_AL1_threshold	Alarm1 threshold	number from 0 to 65535
0x000C	uint16	R	setting_relay_AL2_threshold	Alarm2 threshold	number from 0 to 65535
0x000D	uint16	R	setting_relay_AL1_hysteresis	Alarm1 hysteresis	number from 0 to 65535
0x000E	uint16	R	setting_relay_AL1_delay	Alarm1 delay	number from 0 to 99
0x000F	uint16	R	setting_relay_AL2_hysteresis	Alarm2 hysteresis	number from 0 to 65335
0x0010	uint16	R	setting_relay_AL2_delay	Alarm2 delay	number from 0 to 99
0x0011	uint16	R	setting_RS485_bitrate	RS485 bitrate	2400, 4800, 9600, 19200, 38400
0x0012 (MSB)	uint8	R	setting_rs485_address	RS485 address	number from 1 to247

0x0012 (LSB)	uint8	R/W	setting_digital_on_off	BLuetooth ON (1) or OFF (0)	number from 0 to 1
0x0013	uint16	R	setting_gas_calibration_conc	Gas Calibration concentration	number from 0 to 65535
0x0014 (MSB)	uint8	R	setting_zero_gas_type	reserved	
0x0014 (LSB)	uint8	R	setting_data_structure_id	reserved	
0x0015	uint16	R	setting_password_level_1	level 1 password	number from 0 to 9999
0x0016	uint16	R	setting_password_level_2	level 2 password	number from 0 to 9999
0x0017	uint16	R	setting_cartridge_type	Cartridge identifier	number from 0 to 65535
0x0018 (MSB)	uint8	R	setting_serial_number	serial number 1	ASCII character from 'A' to 'Z'
0x0018 (LSB)	uint8	R	setting_serial_number2	serial number 2	number from 0 to 99
0x0019	uint16	R	setting_serial_number3	serial number 3	number from 0 to 65535

6.1.1 setting_detector_model*n* (0x0000 – 0x0004)

The values from setting_detector_model to setting_detector_model9 define the model, if a value is 255 it means that it should not be considered.

Example:
detector_model = 'R'
detector_model2 = 4
detector_model3 = 5
detector_model4 = 0
detector_model5 = 'I'
detector_model6 = 'C'
detector_model7 = '2'
detector_model8 = '5'
detector_model9 = 255
The model is: (GD)R450IC25

The **detector_model10** value defines the installed interfaces, based on the set bits (several bits can be set at the same time):

Bit	Interface present
0	Relay
1	RS485
2	HART
3	Bluetooth

6.1.2 setting_fw_version (0x0005)

The firmware version is given by:
settings_fw_version. settings_fw_version2

Example:
FW_version = 1
FW_version2 = 2
The firmware version is: **1.2**

6.1.3 setting_gas_detected (0x0009)
Contains the identification of the detected gas (only for catalytic sensors and pellistors).

6.1.4 setting_relay (0x000A – 0x0010)
They contain the setting of the parameters of the relay interface, in particular:

- **setting_relay_logic** = operating logic of relays AL1 and AL2 and can have values: **0** (positive logic), **1** (negative logic);
- **setting_relay_AL1_threshold** = AL1 relay activation threshold (unit of measurement of the detected gas concentration)
- **setting_relay_AL2_threshold** = AL2 relay activation threshold (unit of measurement of the detected gas concentration)
- **setting_relay_AL1_delay** = AL1 relay activation delay (unit of measurement of the detected gas concentration)
- **setting_relay_AL2_delay** = AL2 relay activation delay (unit of measurement of the detected gas concentration)

setting_relay_AL1_thresold and setting_relay_AL2_threshold must be read together with the **"ConcentrationDivider"** parameter of the Datalive struct (0x0000 - 0x0004) which defines the quantity to be divided into setting_relay_AL1_thresold and setting_relay_AL2_threshold to obtain the correct threshold values.

If ConcentrationDivider = 0, then no quantity should be divided to the value of AL1_thresold and AL2_threshold.

Example:

1)
if ConcentrationDivider = 0 and setting_relay_AL1_thresold is **50** → the relay activation threshold value AL1 is **50**.

2)
if ConcentrationDivider = 100 and setting_relay_AL1_thresold is **250,** → the AL1 relay activation threshold value is **2.5.**
The unit of measurement is that of the gas concentration detected.

setting_relay_AL1_delay and setting_relay_AL2_delay are expressed in seconds.

6.1.5 setting_rs485 (0x0011 – 0x0012 (MSB))
- **setting_rs485_address** can have values: **from 1 to 247.**
- **setting_rs485_bitrate** can have values: **2400, 4800, 9600, 19200, 38400bps**

6.1.6 setting_gas_calibration_conc (0x0013)
Contains the gas concentration value for the span calibration.
setting_gas_calibration_conc gas must be read together with the **"ConcentrationDivider"** parameter of the Datalive struct (0x0000 - 0x0004) which defines the quantity to be divided to obtain the correct calibration value.

If ConcentrationDivider = 0, then no quantity should be divided to the value of setting_gas_calibration_concentration.

Example:
1)
if ConcentrationDivider = 0 and setting_gas_calibration_concentration is 50 → the calibration concentration value is **50.**

2)
if ConcentrationDivider = 100 and setting_gas_calibration_concentration is 250 → the calibration concentration value is **2.5**
The unit of measurement is that of the gas concentration detected.

6.1.7 setting_gas_serial_number (0x0018 – 0x0019)
The serial number is given by:
setting_serial_number setting_serial_number_3 / setting_serial_number_2
(setting_serial_number_3 is always considered 4-digit)
For example, if:
setting_serial_number = 'A'
setting_serial_number_2 = 25
setting_serial_number_3 = 2
The setting_serial number of the detector is **A0002/25**

6.2 Sensor values (0x0200)

Modbus Address	Variable Type	R/W	Register name	Description	Measurement unit
0x0200	uint16	R	sensor_model	Cartridge model	number from 0 to 65535
0x0201	uint16	R	sensor_cal_gas_span	Concentration value of last span calibration	number from 0 to 65535
0x0202	uint16	R	sensor_cal_adc_zero	ADC value of zero calibration	number from -32768 to 32767
0x0203	uint16	R	sensor_cal_adc_span	ADC value of span calibration	number from -32768 to 32767
0x0204(MSB)	uint8	R	sensor_cal_temp_zero	Temperature detected during zero calibration (°C)	number from -40 to 60
0x0204(LSB)	uint8	R	sensor_cal_temp_span	Temperature detected during span calibration (°C)	number from -40 to 60
0x0205	uint16	R	Sensor_cal_number	Span calibration number	number from 0 to 65535
0x0206	uint16	R	sensor_cal_hours_last	Sensor hours life during last span calibration	number from 0 to 5535
0x0207	uint16	R	sensor_life_hours	ADC delta value to decree the stabilization of the zero value	number from 0 to 65535
0x0208(MSB)	uint8	R	sensor_temp_max	Maximum Temperature Detected (°C)	number from -40 to 60
0x0208(LSB)	uint8	R	sensor_temp_min	Minimum Temperature Detected (°C)	number from -40 o 60
0x0209	uint16	R	sensor_gas_max	Maximum gas value detected	number from 0 to 65535
0x020A	uint16	R	sensor_serial_number	Serial number	number from 0 to 65535
0x020B(MSB)	uint8	R	sensor_serial_number2	Serial number 2	ASCII character from 'A' to 'Z'
0x020B(LSB)	uint8	R	sensor_serial_number3	Serial number 3	number from 0 to 99

The sensor_cal_gas_span (0x0201) and sensor_gas_max (0x0209) values are expressed in the unit of measurement of the concentration and
must be read together with the "ConcentrationDivider" parameter of the Datalive struct (0x0000 - 0x0004) which defines the quantity to be divided to obtain the correct value.

If ConcentrationDivider = 0, then no quantity should be divided by the value.

Example:
1)
if ConcentrationDivider = 0 and sensor_cal_gas_span is 50 → the calibration concentration value is **50**
2)
if ConcentrationDivider = 100 and sensor_cal_gas_span is 250 → the calibration concentration value is **2.5**

6.3 HW_model (0x0300)

This structure allows direct reading of the addressed detector model. This register can be read as MULTIPLE HOLDING REGISTERS with address range **0x0300 – 0x0305** (reading of 6 registers).

Register	Byte	Identifier	Format	Description
0x0300	MSB	detector_model	uint 8 (8 bit)	ASCII character from 'A' to 'Z' or 255
	LSB	detector_model_2	uint 8 (8 bit)	number from 0 to 9 (no ASCII)
0x0302	MSB	detector_model_3	uint 8 (8 bit)	number from 0 to 9 (no ASCII)
	LSB	detector_model_4	uint 8 (8 bit)	number from 0 to 9 (no ASCII)
0x0303	MSB	detector_model_5	uint 8 (8 bit)	ASCII character from 'A' to 'Z' or from '0' to '9' or 255
	LSB	detector_model_6	uint 8 (8 bit)	ASCII character from 'A' to 'Z' or from '0' to '9' or 255
0x0304	MSB	detector_model_7	uint 8 (8 bit)	ASCII character from 'A' to 'Z' or from '0' to '9' or 255
	LSB	detector_model_8	uint 8 (8 bit)	ASCII character from 'A' to 'Z' or from '0' to '9' or 255
0x0305	MSB	detector_model_9	uint 8 (8 bit)	ASCII character from 'A' to 'Z' or from '0' to '9' or 255
	LSB	detector_model_10	uint 8 (8 bit)	number from 0 to 255

The values from **detector_model** to **detector_model_9** define the model, if a value is **255** it means that it should not be considered.

Example:
detector_model = 'R'
detector_model_2 = 4
detector_model_3 = 5
detector_model_4 = 0
detector_model_5 = 'I'
detector_model_6 = 'C'
detector_model_7 = '2'
detector_model_8 = '5'
detector_model_9 = 255
The model is: **(GD)R450IC25**

The **detector_model_10** value defines the installed interfaces, based on the set bits (several bits can be set at the same time):

Bit	Interface present
0	Relay
1	RS485
2	HART
3	Bluetooth

6.4 FW_version (0x0310)

This structure allows the complete reading of the firmware version of the addressed detector.
This register can be read as MULTIPLE HOLDING REGISTERS with address range **0x0310 – 0x0311** (reading of 2 registers).

Register	Byte	R / W	Identifier	Format	Description
0x0310	MSB	R	FW_version	uint8 (8 bit)	number from 0 to 255
	LSB	R	FW_version2	uint8 (8 bit)	number from 0 to 255
0x0311		R	FW_version3	uint16 (16 bit)	Reserved

The firmware version is given by:
FW_version.FW_version2
Example:
FW_version = 1
FW_version2 = 2
The firmware version is: **1.2**

6.5 Serial number (0x0320)

This structure allows the serial number of the addressed detector to be read.
This register can be read as MULTIPLE HOLDING REGISTERS with the initial address 0x0320.
This command requires the content of the holding registers from 0x0320 to 0x0321 to the slave device (reading 2 registers).

Register	Byte	R / W	Identifier	Format	Description
0x0320	MSB	R	serial_number	uint8 (8 bit)	/* ASCII character 'A' to 'Z' */
	LSB	R	serial_number_2	uint8 (8 bit)	/* ASCII character 'A' to 'Z' */
0x0321		R	serial_number_3	uint16 (16 bit)	/* number from 0 to 65535 */

The serial number is given by:
serial_number serial_number_3 / serial_number_2
(serial_number_3 must always be considered as a 4-digit number)
For example, if:

serial_number = 'A'
serial_number_2 = 25
serial_number_3 = 2

The serial number of the detector is **A0002/25**

6.6 Gas Name (0x0480)

By reading the 6 consecutive registers, it is possible to obtain an 11-character string that identifies the gas detected.

Register	Byte	R / W	Identifier	Format	Description
0x0480	MSB	R	Gas_name[0]	char	ASCII character
	LSB	R	Gas_name[1]	char	ASCII character
0x0481	MSB	R	Gas_name[2]	char	ASCII character
	LSB	R	Gas_name[3]	char	ASCII character
0x0482	MSB	R	Gas_name[4]	char	ASCII character
	LSB	R	Gas_name[5]	char	ASCII character
0x0483	MSB	R	Gas_name[6]	char	ASCII character
	LSB	R	Gas_name[7]	char	ASCII character
0x0484	MSB	R	Gas_name[8]	char	ASCII character
	LSB	R	Gas_name[9]	char	ASCII character
0x0484	MSB	R	Gas_name[10]	char	ASCII character
	LSB		Reserved		ASCII character

7.0 Coils

Register	Type	R / W	Name	Description
0x0000	uint16 (16 bit)	R/W	Zero Calibration	Activate the zero calibration routine
0x0010	uint16 (16 bit)	R/W	Span Calibration	Activates the span calibration routine (for all sensors, except for oxygen, performs the zero calibration first and then the span calibration (in gas) in sequence.
0x0020	uint16 (16 bit)	R/W	Electrical Test	Activate the electrical test routine of the device
0x0030	uint16 (16 bit)	R/W	Bump Test	Activate device Bump Test routine
0x0040	uint16 (16 bit)	R/W	Return Active	Returns to the active status if the detector is in calibration zero, span calibration, bump test or electrical test

These instructions have no parameters and do not return values.
NOTE: simply route the coil according to the required function to start it.
To know the functions in detail, consult the instruction manual.
When reading, the addresses related to these instructions return a value of ZERO if the detector is able to perform the requested operation (operating status such as "active"), a value NOT ZERO if the detector is in an operating status other than active, for example: HEATING / ERROR /ZERO CALIBRATION etc., indicating that it is not possible to perform the requested operation.
When a new status is started by writing coils, it is possible to monitor the operation by reading the Datalive registers (for example, CalibrationStatus parameter to know the progress status of the calibration).

Notes:

22 PAP	INSTRUCTION SHEET
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DIRECTIVE 2012/19/EU (Waste Electrical and Electronic Equipment - WEEE):

WEEE

The crossed-out bin label on the product indicates the product must not be disposed of through the normal household waste disposal procedure.
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