

|   |  |                                  |   |
|---|--|----------------------------------|---|
|  | <h1>MRU SWG100biogas<br/>(including -EX and syngas)</h1> | Release no<br><b>20</b>          | date of last<br>modification<br><b>25.03.2021</b> |
| laid down by<br>Matthias Erck   | <h2>Modbus/Profibus<br/>Slave Specification</h2>         | valid since<br><b>25.03.2021</b> | replaces<br>release no<br><b>19</b>               |

## 1 General information

- The Modbus/Profibus Slave function requires the analyser firmware version V1.11.00 dated 12.07.2016 or later.
- Multi byte values are transmitted in Motorola® byte order (Big-Endian). Only the CRC16 at the end of each frame is transmitted in Intel® byte order (Little-Endian).  
In case you need Little-Endian byte order in the master's system:
  - 16bit values (occurs only in the frame): swap bytes 0<=>1
  - 32bit values (occurs only in the data): swap bytes 0<=>3 and swap bytes 1<=>2
- All addresses written in this document are decimal (not hexa-decimal)
- All readable data are 32bit values, therefore the analyser only accepts even addresses end even number of registers to be read.
- Data types (used in table below):
  - U32 32 bit unsigned integer value (0...4.294.967.295)
  - U16 16 bit unsigned integer value (0...65.553)
  - FL 32 bit floating point value (reads -1E38, when not available)
- Some values are optional (e.g. gas-cooler).

### 1.1 Special informationen about the Modbus Slave function

- The analysers are able to work as modbus slave using the RS232 or RS485 port (possibly with external RS232/RS485 adapter)
- supports RS485 interface with 2/4 wires (half/full duplex)
- supports only the binary Modbus protocol (RTU)
- supports modbus command *Read Holding Register* (command no 3)
- supports modbus command *Read Input Register* (command no 4)
- the slave modbus address is user definable from 1 to 238
- communication parameter are user definable as follows:
  - 9600 baud or 19200 baud (recommended)
  - odd, even or none parity
  - 1 or 2 stop bits
- The maximal number of 32bit-values to be read with one single read command is 63 (126 modbus registers)

## 1.2 Special informationen about the Profibus Slave function

- The Profibus Slave function requires a modbus/profibus-converter "Seneca HD67561", which is configured and installed in the analyser.
- Usually MRU sets the Profibus ID to 84.

## 2 Defined registers to be read by the master

| modbus address  | profibus address | data type | register content  |
|---|------------------|-----------|---|
| <b>Status &amp; Device info</b>                               |                  |           |   |
| 0   | 0                | U32       | Analyser Status (more details read below)               |
| 2   | 4                | U32       | System Alarm (more details read below)                  |
| 4   | 8                | U32       | Serial number   |
| 6   | 12               | U32       | Analyser type (11060 = SWG100biogas)                    |
| 8   | 16               | U32       | Firmware version (e.g. 12345 = V1.23.45)                |
| 10  | 20               | U32       | Elapsed seconds since Power-On                          |
| 12  | 24               | U32       | Counter Modbus Frame Error                              |
| 14  | 28               | FL        | CH4 amb. [%]  |
| 16  | 32               | FL        | CH4 amb. [% LEL]  |
| 18  | 36               | FL        | T-sensor [°C/°F] (unit depends on user settings)        |
| 20  | 40               | FL        | Sample Flow [l/h]                                       |
| 22  | 44               | FL        | T-gascooler [°C/°F] (unit depends on user settings)     |
| 24  | 48               | FL        | Case fan rotations [rpm]                                |
| 26  | 52               | FL        | Gas pump rotations [rpm]                                |
| 28  | 56               | FL        | P-barometric [hPa] (= [mbar])                           |
| 30  | 60               | FL        | P-barometric [inchHG]                                   |
| 32  |                  | FL        | T-pre-gascooler [°C/°F] (unit depends on user settings) |
| 34  |                  | U32       | not (yet) defined (reads zero)                          |
| 36  |                  | U32       | not (yet) defined (reads zero)                          |
| 38  |                  | U32       | not (yet) defined (reads zero)                          |
| <b>Status &amp; current measurement values (live values!)</b> |                  |           |   |
| 40  |                  | U32       | Analyser Status (more details read below)               |
| 42  |                  | U32       | System Alarm (more details read below)                  |
| 44  |                  | FL        | O2 [%]  |
| 46  |                  | FL        | CO2 [%] (or CO2 [ppm], if CO2 [%] isn't available)      |
| 48  |                  | FL        | CH4 [%] (or CH4 [ppm], if CH4 [%] isn't available)      |
| 50  |                  | FL        | H2S [ppm] (optional)                                    |
| 52  |                  | FL        | H2 [ppm] or [%] (optional)                              |
| 54  |                  | FL        | Net calorific value [MJ/kg]                             |
| 56  |                  | FL        | Gross calorific value [MJ/kg]                           |

| modbus address   | profibus address | data type | register content                                   |
|--|------------------|-----------|--|
| 58   |                  | FL        | Net calorific value [MJ/m <sup>3</sup> ]           |
| 60   |                  | FL        | Gross calorific value [MJ/m <sup>3</sup> ]         |
| 62   |                  | FL        | CO [ppm] (optional)                                |
| 64   |                  | FL        | CH4 [ppm] (optional, when CH4 [%] also available)  |
| 66   |                  | FL        | CO2 [ppm] (optional, when CO2 [%] also available)  |
| 68   |                  | FL        | N2 [%]   |
| <b>Status &amp; measurement values of sample point 1</b>               |                  |           |  |
| 70   |                  | U32       | Analyser Status (more details read below)          |
| 72   |                  | U32       | System Alarm (more details read below)             |
| 74   | 64               | FL        | O2 [%]   |
| 76   | 68               | FL        | CO2 [%] (or CO2 [ppm], if CO2 [%] isn't available) |
| 78   | 72               | FL        | CH4 [%] (or CH4 [ppm], if CH4 [%] isn't available) |
| 80   | 76               | FL        | H2S [ppm] (optional)                               |
| 82   | 80               | FL        | H2 [ppm] or [%] (optional)                         |
| 84   | 84               | FL        | Net calorific value [MJ/kg]                        |
| 86   | 88               | FL        | Gross calorific value [MJ/kg]                      |
| 88   | 92               | FL        | Net calorific value [MJ/m <sup>3</sup> ]           |
| 90   | 96               | FL        | Gross calorific value [MJ/m <sup>3</sup> ]         |
| 92   | 100              | FL        | CO [ppm] (optional)                                |
| 94   | 104              | FL        | CH4 [ppm] (optional, when CH4 [%] also available)  |
| 96   |                  | FL        | CO2 [ppm] (optional, when CO2 [%] also available)  |
| 98   |                  | FL        | N2 [%]   |
| <b>Status &amp; measurement values of sample point 2 (optional)</b>    |                  |           |  |
| 100  |                  | U32       | Analyser Status (more details read below)          |
| 102  |                  | U32       | System Alarm (more details read below)             |
| 104  | 108              | FL        | O2 [%]   |
| 106  | 112              | FL        | CO2 [%] (or CO2 [ppm], if CO2 [%] isn't available) |
| 108  | 116              | FL        | CH4 [%] (or CH4 [ppm], if CH4 [%] isn't available) |
| 110  | 120              | FL        | H2S [ppm] (optional)                               |
| 112  | 124              | FL        | H2 [ppm] or [%] (optional)                         |
| 114  | 128              | FL        | Net calorific value [MJ/kg]                        |
| 116  | 132              | FL        | Gross calorific value [MJ/kg]                      |
| 118  | 136              | FL        | Net calorific value [MJ/m <sup>3</sup> ]           |
| 120  | 140              | FL        | Gross calorific value [MJ/m <sup>3</sup> ]         |
| 122  | 144              | FL        | CO [ppm] (optional)                                |
| 124  | 148              | FL        | CH4 [ppm] (optional, when CH4 [%] also available)  |
| 126  |                  | FL        | CO2 [ppm] (optional, when CO2 [%] also available)  |
| 128  |                  | FL        | N2 [%]   |
| <b>Status &amp; measurement values of sample point 3-10 (optional)</b> |                  |           |  |
| 130-369  | 152...           | ...       | add 30/44 to the addresses for each sample point   |

**Note: Optional AUX values are not available via Profibus!  
(at least not with the delivered Profibus configuration)**

| protocol address                         | data type | numb. of registers | register content                         |
|--|-----------|--------------------|--|
| AUX-values (read by up to 10 IO-modules) |           |                    |  |
| 370                                      | FL        | 2                  | AUX-value read by IO-module 1 - Input 1  |
| 372                                      | FL        | 2                  | AUX-value read by IO-module 1 - Input 2  |
| 374                                      | FL        | 2                  | AUX-value read by IO-module 1 - Input 3  |
| 376                                      | FL        | 2                  | AUX-value read by IO-module 1 - Input 4  |
| 378                                      | FL        | 2                  | AUX-value read by IO-module 2 - Input 1  |
| 380                                      | FL        | 2                  | AUX-value read by IO-module 2 - Input 2  |
| 382                                      | FL        | 2                  | AUX-value read by IO-module 2 - Input 3  |
| 384                                      | FL        | 2                  | AUX-value read by IO-module 2 - Input 4  |
| 386                                      | FL        | 2                  | AUX-value read by IO-module 3 - Input 1  |
| 388                                      | FL        | 2                  | AUX-value read by IO-module 3 - Input 2  |
| 390                                      | FL        | 2                  | AUX-value read by IO-module 3 - Input 3  |
| 392                                      | FL        | 2                  | AUX-value read by IO-module 3 - Input 4  |
| 394                                      | FL        | 2                  | AUX-value read by IO-module 4 - Input 1  |
| 396                                      | FL        | 2                  | AUX-value read by IO-module 4 - Input 2  |
| 398                                      | FL        | 2                  | AUX-value read by IO-module 4 - Input 3  |
| 400                                      | FL        | 2                  | AUX-value read by IO-module 4 - Input 4  |
| 402                                      | FL        | 2                  | AUX-value read by IO-module 5 - Input 1  |
| 404                                      | FL        | 2                  | AUX-value read by IO-module 5 - Input 2  |
| 406                                      | FL        | 2                  | AUX-value read by IO-module 5 - Input 3  |
| 408                                      | FL        | 2                  | AUX-value read by IO-module 5 - Input 4  |
| 410                                      | FL        | 2                  | AUX-value read by IO-module 6 - Input 1  |
| 412                                      | FL        | 2                  | AUX-value read by IO-module 6 - Input 2  |
| 414                                      | FL        | 2                  | AUX-value read by IO-module 6 - Input 3  |
| 416                                      | FL        | 2                  | AUX-value read by IO-module 6 - Input 4  |
| 418                                      | FL        | 2                  | AUX-value read by IO-module 7 - Input 1  |
| 420                                      | FL        | 2                  | AUX-value read by IO-module 7 - Input 2  |
| 422                                      | FL        | 2                  | AUX-value read by IO-module 7 - Input 3  |
| 424                                      | FL        | 2                  | AUX-value read by IO-module 7 - Input 4  |
| 426-441                                  | FL        | 16                 | 8 AUX-values read by IO-modules 8 & 9    |
| 442                                      | FL        | 2                  | AUX-value read by IO-module 10 - Input 1 |
| 444                                      | FL        | 2                  | AUX-value read by IO-module 10 - Input 2 |
| 446                                      | FL        | 2                  | AUX-value read by IO-module 10 - Input 3 |
| 448                                      | FL        | 2                  | AUX-value read by IO-module 10 - Input 4 |

**Note: User definable modbus values are not available via Profibus!  
(at least not with the delivered Profibus configuration)**

Since firmware V1.19.00 the user can configure a user definable modbus value list according to the configuration of the measurement window. This happens by a command at once. The analyzer will store this modbus configuration and won't change it until the command will be started again. The analyzer stores a list in CSV format on the SD card (if available).

| protocol address             | data type | numb. of registers | register content                                      |
|------------------------------|-----------|--------------------|---|
| User definable modbus values |           |                    |   |
| 3000                         | FL        | 2                  | Live value from 1st page 1st line                     |
| 3002                         | FL        | 2                  | Live value from 1st page 2nd line                     |
| 3004                         | FL        | 2                  | Live value from 1st page 3rd line                     |
| 3006                         | FL        | 2                  | Live value from 1st page 4th line                     |
| 3008                         | FL        | 2                  | Live value from 1st page 5th line                     |
| 3010                         | FL        | 2                  | Live value from 1st page 6th line                     |
| 3012                         | FL        | 12                 | Live values from 2nd page 1st-6th line                |
| 3024                         | FL        | 12                 | Live values from 3rd page 1st-6th line                |
| 3036                         | FL        | 12                 | Live values from 4th page 1st-6th line                |
| 3048                         | FL        | 48                 | Sample point 1 values from 1st-4th page 1st-6th line  |
| 3096                         | FL        | 48                 | Sample point 2 values from 1st-4th page 1st-6th line  |
| 3144                         | FL        | 48                 | Sample point 3 values from 1st-4th page 1st-6th line  |
| 3192                         | FL        | 48                 | Sample point 4 values from 1st-4th page 1st-6th line  |
| 3240                         | FL        | 48                 | Sample point 5 values from 1st-4th page 1st-6th line  |
| 3288                         | FL        | 48                 | Sample point 6 values from 1st-4th page 1st-6th line  |
| 3336                         | FL        | 48                 | Sample point 7 values from 1st-4th page 1st-6th line  |
| 3384                         | FL        | 48                 | Sample point 8 values from 1st-4th page 1st-6th line  |
| 3432                         | FL        | 48                 | Sample point 9 values from 1st-4th page 1st-6th line  |
| 3480                         | FL        | 48                 | Sample point 10 values from 1st-4th page 1st-6th line |

## 2.1 Analyser Status (address 0 and some mirror addresses)

The Analyser Status is a 32bit-word and must be interpreted bitwise.

| Bit   | Description  |
|-------|--|
| 0     | Power-On (until the first zeroing has been done)                             |
| 1     | System-Alarm, see table below  |
| 2     | Air Purging (zeroing)  |
| 3     | Gas Sampling (preparing measurement, not measurement!)                       |
| 4-7   | Currently sampled sample point number (1..10, reads 0 while air purging)     |
| 8     | One sensor (e.g. CO or H <sub>2</sub> S) is currently purged                 |
| 9     | One sensor (e.g. CO or H <sub>2</sub> S) is currently cut-off the sample gas |
| 10    | Sniffing case gas (only EX analysers)  |
| 11    | Stand-By   |
| 12    | Auto-Calibration   |
| 13    | Due For Service  |
| 14    | Warning 'Gas sum is over 100%'   |
| 15-27 | reserved for later applications (reads zero)                                 |
| 28-31 | External Control's state, range 0..15  |

Some status examples:

| Decimal | Hexadec. | Binary         | state description   |
|---------|----------|----------------|---|
| 1       | 0001h    | 0000 0000 0001 | Power-On (self-test)  |
| 5       | 0005h    | 0000 0000 0101 | First Air Purging (Power-On + Air Purging)                    |
| 24      | 0018h    | 0000 0001 1000 | Preparing meas. smp.pt.1 (Gas Sampling + smp.pt.1)            |
| 16      | 0010h    | 0000 0001 0000 | Measuring sample point 1                                      |
| 528     | 0210h    | 0010 0001 0000 | Measuring sample point 1 (H <sub>2</sub> S sensor is cut-off) |
| 40      | 0028h    | 0000 0010 1000 | Preparing meas. smp.pt.2 (Gas Sampling + smp.pt.2)            |
| 32      | 0020h    | 0000 0010 0000 | Measuring sample point 2                                      |
| 48      | 0030h    | 0000 0011 0000 | Measuring sample point 3                                      |
| 18      | 0012h    | 0000 0001 0010 | Measuring sample point 1 + System-Alarm                       |
| 0       | 0000h    | 0000 0000 0000 | Adjustment (user interaction at the analyser)                 |
| 1024    | 0400h    | 0100 0000 0000 | Sniffing case gas (only EX analysers)                         |
| 2048    | 0800h    | 1000 0000 0000 | Stand-By  |

## 2.2 Analyser System Alarm (address 2 and some mirror addresses)

The Analyser System Alarm is a 32bit-word and must be interpreted bitwise.

| Bit   | Description  | Meas. halted |
|-------|--|--------------|
| 0     | Mainboard Offline (some communication problems)        | YES          |
| 1     | Mainboard is in bootloader mode                        | YES          |
| 2     | CH4 ambient > threshold value                          | YES          |
| 3     | Condensate   | YES          |
| 4     | Sample flow Alarm                                      | YES          |
| 5     | Sample flow Warning                                    | -            |
| 6     | Case fan rotations < 900 rpm                           | -            |
| 7     | T-gascooler too high                                   | -            |
| 8     | T-gascooler too low                                    | -            |
| 9     | T-Sensor > 55°C  | -            |
| 10    | T-Sensor < 5°C   | -            |
| 11    | T-probe too high                                       | -            |
| 12    | T-probe too low  | -            |
| 13    | T-hose too high  | -            |
| 14    | T-hose too low   | -            |
| 15    | T-NDIR too low   | -            |
| 16    | At least one sensor has a zero error                   | -            |
| 17    | Auto-Cal error   | -            |
| 18    | Only EX: H2S ambient > threshold value                 | -            |
| 19    | Only EX: H2S value too low                             | -            |
| 20-26 | reserved for later applications (reads zero)           |              |
| 27    | “Due For Service” warning                              | -            |
| 28    | Condensate alarm (thermic condensate sensor)           | YES          |
| 29    | Gascooler module Offline (some communication problems) | -            |
| 30    | T-pre-gascooler too high                               | -            |
| 31    | T-pre-gascooler too low                                | -            |

Some system alarm examples:

| Decimal | Hexadecimal | Binary    | state description                            |
|---------|-------------|-----------|--|
| 1       | 0001h       | 0000 0001 | Mainboard is offline, measurement is halted  |
| 8       | 0008h       | 0000 1000 | Condensate Alarm, measurement is halted      |
| 160     | 00A0h       | 1010 0000 | Sample flow Warning and T-gascooler too high |

### 3 Defined registers to be written by the master

| modbus address            | profibus address | data type | register content                               |
|---------------------------|------------------|-----------|--|
| External (remote) Control |                  |           |  |
| 6000                      | 0 or 1           | U16       | External (remote) Control (details read below) |

Values to be written to the External Control Register:

| value | meaning  |
|-------|--|
| 0     | the analyser performs its configured measurement cycle |
| 1     | sampling/measuring sample point 1                      |
| 2     | sampling/measuring sample point 2                      |
| ...   | ...  |
| 10    | sampling/measuring sample point 10                     |
| 11    | analyser goes into stand-by                            |
| 12    | analyser goes into stand-by                            |
| 13    | analyser goes into stand-by                            |
| 14    | remote reset of all system alarms                      |
| 15    | analyser goes into stand-by                            |