Appendix to the Operations Manual

Transmitter Series22

(EC22, CC22, CS22, ZD22 etc.)

TRM22 Modbus Implementation

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1. General information

The Series22 transmitters (TRM22 for short, including types EC22, CC22, CS22, ZD22 etc.) support digital communication via an RS485 interface. Communication takes place according to the Modbus protocol in RTU mode.

The transmitter operates in slave mode and is used for communication with the connected GMA200 and PC software, if required. Only data from an external master device (e.g. central unit or gateway to the control station) can be read from the GMA and processed further.

This document describes what data and how it can be read from the TRM.

2. Interface

RS485 (Multipoint)

- Bus connection of master and slaves via a two-core screened cable; e.*g. LIYCY 4x0.75mm2* (terminal connection)

3. Bus Structure

The maximum bus length should not exceed 1200m (specification limit RS485), and a maximum of 64 transmitters and one master can be connected. The transmission rate depends on the cable length and can be set to a maximum of 38400 Baud.
The supply of the connected devices is essential to the structure of the bus, therefore the cable cross-section used depends on the following parameters:

- Number of devices and the expansion stage (power requirement)
- Cable length (voltage drop at cable resistance)
- Quality of the supply voltage (24V DC)

The real maximum of line length and transmission rate depends greatly on the construction of the network. In particular, star topologies should be avoided due to the resulting long spur lines. The daisy chain structures are advantageous.
The bus levels are defined by the master and the bus must be terminated at both ends with 120Ω . For this purpose, a terminating resistor can be switched on in the transmitter.

4. Parameter of Communication

Bus Address	1 ... 247 (in slave mode) Note: Specification of the address also defines the operating mode of the bus node. Address 0 deactivates bus operation and an address other than 0, activates bus operation).
Transfer Rate	9600, 19200, 38400 Baud
Data Format	1 start bit 8 data bits 1 parity bit (*even parity*) with 1 stop bit (8E1)
Transmission Mode	RTU (Remote Terminal Unit) according to [MoSL]

The settings are made via the service menu of the transmitters.
(see operating instructions; delivery status: addr.1, 19200, 8E1).

5. Implementatio of Protocol

In reference to the ISO/OSI model, the Modbus protocol consists of the application, backup and physical layer according to the following table. The remaining four layers remain unused.

Shift	ISO/OSI Model	Modbus Protocol	Reference
7	Application Layer	MODBUS Application Protocol	[MAPS]
6	Presentation Layer	vacuous	
5	Session Layer (Session Layer)	vacuous	
4	Transport Layer (Transport Layer)	vacuous	
3	Network Layer	vacuous	
2	Link Layer (Data Link Layer)	MODBUS Serial Line Protocol	[MoSL]
1	Physical Layer (physical layer)	EIA/TIA-485	

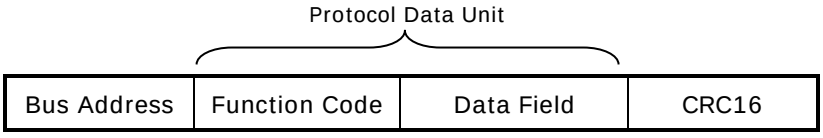
The subsequent protocol description refers exclusively to the application layer.

5.1 Modbus Function Codes

Data can be read and written from the TRM via the Modbus. Data access is based on mapped registers within the TRM, which can be read and/or written by the master using the following specified Modbus Function Codes [MAPS].

- **Read Input Registers 04 (0x04)**
- **Write Multiple Registers 16 (0x10)**
- **Read/Write Multiple Registers 23 (0x17)**

The registers are 16-bit values with a 16-bit address range. The allocation of the transmission data to the register addresses will be described in section 5.3 "Register Map". The following figure shows the general structure of a Modbus frame consisting of the bus address, the function code, the data field and a CRC16 Modbus checksum.



General Modbus Frame

5.2 Telegram description

As shown in the figure above, each telegram begins with the bus address and the function code and ends with a CRC16-Modbus-checksum. In between there is the application-specific data field.

The CRC16-Modbus-checksum is Modbus-specific and has the polynomial 0xA001 (see specification according to [MoSL]). With the exception of the checksum, all data is transmitted in Big-Endian-Format (MSB first), and the checksum in Little-Endian-Format (LSB first).

The telegrams for the various general function codes and the functionalities implemented in the TRM are described below.

5.2.1 Read Input Registers

For the reading out of information, the master sends the start address and the number of registers. The slave responds with the contents of the requested registers.

Request	Length	Content
Bus Address	1 byte	1 … 247
Function Code	1 byte	0x04
Start Address	2 bytes	0x0000 … 0x06F2
Number of Registers	2 bytes	N*
Modbus Checksum	2 bytes	(0x0000 … 0xFFFF)

N* = Number of registers (1...49)

Response	Length	Content
Bus Address	1 byte	1 … 247
Function Code	1 byte	0x04
Number of Bytes	1 byte	2 x N*
Register Content	N* x 2 Bytes	data
Modbus Checksum	2 bytes	(0x0000 … 0xFFFF)

N* = Number of registers (1...49)

5.2.2 Write Multiple Registers

The master sends the start address, the number and the content of the registers in the request for writing registers. The slave sends the start address and the number of registers as confirmation.

Request	Length	Content
Bus Address	1 byte	1 … 247
Function Code	1 byte	0x10
Start Address	2 bytes	0x1000
Number of Registers	2 bytes	1
Number of Bytes	1 bytes	2
Register Content	2 bytes	data
Modbus Checksum	2 bytes	(0x0000 … 0xFFFF)

Response	Length	Content
Bus Address	1 byte	1 … 247
Function Code	1 byte	0x10
Start Address	2 bytes	0x1000
Number of Registers	2 bytes	1
Modbus Checksum	2 bytes	(0x0000 … 0xFFFF)

5.2.3 Read / Write Multiple Registers

In the request, the master sends start address and number of registers to be read and start address, number and content of the registers to be written. The slave responds with the contents of the requested registers.

Request	Length	Content
Bus Address	1 byte	1 … 247
Function Code	1 byte	0x17
Start Address (R)	2 bytes	0x0000 ... 0x06F2
Number of Registers (R)	2 bytes	N*
Start Address (W)	2 bytes	0x0000
Number of Registers (W)	2 bytes	1
Number of Bytes (W)	1 bytes	2
Register Content (W)	2 bytes	data
Modbus Checksum	2 bytes	(0x0000 ... 0xFFFF)

(R) = Read
N* = Number of registers (1...49)
(W) = Write

Response	Length	Content
Bus Address	1 byte	1 … 247
Function Code	1 byte	0x17
Number of Bytes	1 byte	2 x N*
Register Content	N* x 2 Bytes	data
Modbus Checksum	2 bytes	(0x0000 ... 0xFFFF)

N* = Number of registers (1...49)

5.2.4 Exception Code

If an error occurs during reading or writing, the slave responds with an error code (exception code) instead of the expected response and sets the bit with the highest value (MSB) in the function code.

Error Response	Length	Content
Bus Address	1 byte	1 … 247
Function Code	1 byte	0x84 / 0x90 / 0x97
Exception Code	1 byte	0x01 ... 0x04
Modbus Checksum	2 bytes	(0x0000 ... 0xFFFF)

The following four exception codes are possible for the implemented function codes.

Exception Code	**Designation**	**Error Description**
0x01	Illegal Function	Invalid Function Code
0x02	Illegal Data Address	Invalid Register Address
0x03	Illegal Data Value	Invalid Number of Registers
0x04	Slave Device Failure	Error when reading the registers

5.3 Register Map

Most of the registers are divided into two separate areas. Only the read access of the one range is possible (Read Input Registers) while the other allows only the write access (Write Multiple Registers). Only one register (0x0000) is for both read and write access.
Processes of reading and writing can also be combined (Read/Write Multiple Registers) in a communication cycle (Request ←→ Response).

5.3.1 Read Input Registers

Basically the transmission data, which can be read from the TRM, can be divided into four groups:

Register Addresses	Transmission Data
0x0000 ... 0x000D	Identification parameters of the transmitter
0x0100 ... 0x0108	Status and measured values of the transmitter
0x0200 ... 0x031B	Measured value-related configuration parameters of the transmitter

Section 5.6 "Chronological sequence of the measured value enquiry" describes when and what data should be read out by the TRM.

The following table describes the allocation of the transmission data to the register addresses and the data structure in detail. . By reading the register it should be ensured that the access to not specified register between the data segments in the register map should be deniedTherefore, depending on the register start address, only a limited number of registers can be read out in a telegram.

REGISTER MAP - READ INPUT REGISTERS 04 (0x04)

Register Address	Max. Requestable Registers	Register Type (16 bit)	Parameter	Statement
0x0000	14	Unsigned	signature	Signature for telegram identification (decremented after readout).
0x0001	13	Unsigned	TRM type	Coding: *117 = EC28 131 = IR22* *120 = EC22 132 = CC228* *121 = CC22 133 = CC33* *122 = CS22 134 = EC33* *123 = CI22 135 = PI22* *124 = ZD22 136 = EV22* *125 = TC22*
0x0002	12	Unsigned	FW Version 1.uC	Firmware version of the mainboard *e.g. : 209 = v2.09*
0x0003	11	Unsigned	FW Version 2.uC	without function with TRM22
0x0004	10	Unsigned	TRM Serial Number	First ASCII character (UTF-8) of the serial number with a maximum of 10 digits.
...	...	...	...	*e.g.: 49,50,49,49,49,57,50,55,0,0 = "12111927"* *(here with zero termination)*
0x000D	1	Unsigned	TRM Serial Number	Last ASCII character (UTF-8) of the serial number with a maximum of 10 digits.

Continuation see next page

Register Address	Max. Requestable Registers	Register Type (16 bit)	Parameter	Statement
0x0100	9	Unsigned	Signature	Signature for telegram identification (decremented after readout).
0x0101	8	Unsigned	TRM status	Bit definition: b0: LSB b1: ..... b2: MSB } state b3: LSB b4: MSB } error group b5: LSB b6: b7: MSB } Bits not used b8: Maintenance requestgb9: Underrange (AD) b10: Underrange b11: Alarm 1 b12: Alarm 2 b13: Alarm 3 b14: Overrange b15: Overrange (AD) } 1=active 0=Inactiv **state** **high priority** 7=SRV-Config 1=Startup 5=SRV-ZERO 6=SRV-SPAN 4=SRV-MENU 2=General fault 3=Measuring fault 0=Measuring **error group** 01: System error 10: Sensor error 11: Measuring
0x0102	7	Signed	TRM measured value (instantaneous value)	Measured value as instantaneous value related to scaling factor, unit and gas type *Example:* *- Measured value = 209* *- Scaling factor = -1* *- Unit = 2* *- Gas type = 89* *→ Gas reading = 20.9 Vol.% O2*
0x0103	6	Signed	TRM measured value (averaging interval 1)	Measured value as average over the averaging interval 1 (Function is available from v2.07.)
0x0104	5	Signed	TRM measured value (averaging interval 2)	Measured value as average over the averaging interval 2 (Function is available from v2.07.)
0x0105	4	Signed	TRM measured value (averaging interval 3)	Measured value as average over the averaging interval 3 (Function is available from v2.07.)
0x0106	3	Signed	temperature	Transmitter Temperature in 1/10 °C *e.g. 355 = 35.5°C*
0x0107	2	Unsigned	Uin Supply voltage	measured supply voltage of the transmitter 1/100 Volt *e.g.: 2415 = 24,15V*
0x0108	1	Unsigned	Iges total current	Maximum current of the transmitter in mA *e.g. 70 = 70mA*

Continuation see next page

Register Address	Max. Requestable Registers	Register Type (16 bit)	Parameter	Statement
0x0200	14	Unsigned	Signature	Signature for telegram identification (decremented after readout).
0x0201	13	Signed	Scaling Factor	of the TRM measured value –3: 0,001 –2: 0,01 –1: 0,1 0: 1
0x0202	12	Unsigned	Unit	of the TRM measured value *Coding by no. according to table for units and gas types (see section 6)*
0x0203	11	Unsigned	Gas Type	
0x0204	10	Signed	MBB	Start and end of measuring range related to scaling factor
0x0205	9	Signed	MBE	
0x0206	8	Unsigned	Sensor type (MK-No.)	*Example: 39800 = MK398-0*
0x0207	7	Unsigned	Alarm Directions	Direction of alarms AL3,AL2,AL1 with bit definition b2, b1, b0. Value=1: exceeding alarm Value=0: falling alarm
0x0208	6	Signed	AL1	Alarm thresholds 1, 2, 3 related to scaling factor. (value=0: alarm deactivated)
0x0209	5	Signed	AL2	
0x020A	4	Signed	AL3	
0x020B	3	Unsigned	Averaging interval 1	Interval 1 for measured value averaging in minutes. If the value=0, no averaging takes place. and the current gas value is transmitted.
0x020C	2	Unsigned	Averaging interval 2	Interval 2 for measured value averaging in minutes. If the value=0, no averaging takes place. and the current gas value is transmitted.
0x020D	1	Unsigned	Averaging interval 3	Interval 3 for measured value averaging in minutes. If the value=0, no averaging takes place. and the current gas value is transmitted.

Register Address	Max. Requestable Registers	Register Type (16 bit)	Parameter	Statement
0x0300	28	Unsigned	Signature	Signature for telegram identification (decremented after readout).
0x0301	27	Signed	Scaling Factor Order Test Gas Concentration	of the TRM measured value –3: 0,001 –2: 0,01 –1: 0,1 0: 1
0x0302	26	Signed	Value of the test gas concentration	Value related to scaling factor, unit and gas type *Example:* *- Measured value = 209* *- Scaling factor = -1* *- Unit = 2* *- Gas type = 89* *→ Gas reading = 20.9 Vol.% O2*
0x0303	25	Unsigned	Sensor Serial Number	First ASCII character (UTF-8) of the maximum 10-digit SN
…	…	…	…	*e.g.: 49,50,49,49,49,57,50,55,0,0 = "12111927" (with zero termination)*
0x030C	16	Unsigned	Sensor Serial Number	Last ASCII character (UTF-8) of the maximum 10-digit SN
0x030D	15	Unsigned	Sensor Production Date	*Days since 01.01.1980* *(e.g. 12613 = 14 July 2014)*
0x030E	14	Unsigned	Act. Nr. of sensor operating days	
0x030F	13	Unsigned	max. nr.r of sensor operating days	*e.g. 1100 days*
0x0310	12	Unsigned	Sensor operating days or date for ZERO adjustment [0].	Value <=10958: Operating days (no date available) Value > 10958: Date (days since 1.1.1980) *e.g. 15 = Calibrated on 15th operating day (0= not calibrated)*
0x0311	11	Unsigned	Sensor operating days or date for SPAN adjustment [0].	Value <= 10958: Operating days (no date available) Value > 10958: Date (days since 1.1.1980) *e.g. 15 = Calibrated on 15th operating day (0= not calibrated)*
0x0312	10	Signed	Signal value at ZERO adjustment [0].	*100 = 1% of the nominal delta*
0x0313	9	Signed	Signal value at SPAN adjustment [0]	*10000 = 100% of the nominal delta*
0x0314	8	Unsigned	Sensor operating days or date for ZERO adjustment [1].	Value <= 10958: Operating days (no date available) Value > 10958: Date (days since 1.1.1980) *e.g. 8 = Calibrated on the 8th operating day (0= not calibrated)*
0x0315	7	Unsigned	Sensor operating days or date for SPAN adjustment [1].	Value <= 10958: Operating days (no date available) Value > 10958: Date (days since 1.1.1980) *e.g. 8 = Calibrated on the 8th working day (0= not calibrated)*
0x0316	6	Signed	Signal value at ZERO adjustment [1].	*100 = 1% of the nominal delta*
0x0317	5	Signed	Signal value during SPAN adjustment [1]	*10000 = 100% of the nominal delta*
0x0318	4	Unsigned	Sensor operating days or date at ZERO adjustment [2].	Value <= 10958: Operating days (no date available) Value > 10958: Date (days since 1.1.1980) *e.g. 1 = adjusted on 1st day of operation (0= not adjusted)*
0x0319	3	Unsigned	Sensor operating days or date at SPAN adjustment [2].	Value <= 10958: Operating days (no date available) Value > 10958: Date (days since 1.1.1980) *e.g. 1 = adjusted on 1st day of operation (0= not adjusted)*
0x031A	2	Signed	Signal value at ZERO adjustment [2].	*100 = 1% of the nominal delta*
0x031B	1	Signed	Signal value with SPAN adjustment [2]	*10000 = 100% of the nominal delta*

5.3.2 Write Multiple Registers

Only three registers can be written to set the telegram signature. The same register is always accessed within internal memory, there is only one signature for all accesses, regardless of whether they are read or write access.
In addition, a time stamp can be added to the transmitter. This function can only be accessed with the write function. Only the two time stamp registers can be written at any one time.

REGISTER MAP - WRITE MULTIPLE REGISTERS 16 (0x10)				
Register Address	**Number of Transferable Registers**	**Register Type (16 bit)**	**Parameter**	**Statement**
0x0000	6	Unsigned	Signature	Signature for telegram identification (for monitoring the telegram sequence).
0x0001	5	Unsigned	Time stamps (seconds since 01.01.1980)	Bits0:15 from 32-bit time stamp e.g.:02.09.2015 19:21:16 = 1125688876s= 0x4318a62c
0x0002	4	Unsigned		Bits16:31 from 32-bit timestamp e.g.:02.09.2015 19:21:16 = 1125688876s= 0x4318a62c
0x0003	3	Unsigned	Averaging interval 1	Interval 1 for measured value averaging in minutes. A value change restarts the averaging filter. The value "0" deactivates averaging for the alarm, instead the current gas value is used.
0x0004	2	Unsigned	Averaging interval 2	Interval 2 for measured value averaging in minutes. A value change restarts the averaging filter. The value "0" deactivates averaging for the alarm, instead the current gas value is used.
0x0005	1	Unsigned	Averaging interval 3	Interval 3 for measured value averaging in minutes. A value change restarts the averaging filter. The value "0" deactivates averaging for the alarm, instead the current gas value is used.

5.3.3 Read/Write Multiple Registers

The read/write function can only access the registers described above in read **and** write mode. It has no further functional scope beyond that.

5.4 Unique Telegram Identification

For unique telegram identification, a signature can be transmitted as register content in conjunction with the Function Code for reading and writing registers **(Read/Write Multiple Register 0x17) for the** standard Modbus protocol. Therefore, the master (e.g. GMA200) sends a signature with the request for writing the signature request and simultaneously requesting this signature in addition to other register values from the transmitter, which are then sent back to the master as a response. The signature, which therefore is transmitted by the Master, can be counter value, for example, which gets incremented before every request. By comparing the sent signature with the signature received from the transmitter, the master can then recognize whether the received telegram is the response to the sent request.

All data segments begin with a signature register, which can be read along with the attached data register of the single segments. The same signature is accessed in the signature register of the different segments. However, this signature can only be described by a single register with the address 0x0000 (see section 5.4 "Register Map").

After the signature has been read out, it is automatically decremented within the transmitter. If the master repeatedly accesses the signature and data segments in read-only mode **(Read Input Registers 0x04), the** automatic signature decrementation allows the master to recognize that the transmitter responses are continuously generated and transmitted telegrams.

The telegram identification described above requires, that only entire data segments with signatures are read from the respective start address.

5.5 Chronological Sequence of the Measured Value Enquiry

The configuration parameters only need to be read out after system startup or after configuration changes, otherwise this data does not change. The parameters should also be read out after longer communication interruptions, as changes made during this time cannot be detected. The three parameter segments (register address ranges: 0x0000..., 0x0200... and 0x0300...) must be read out one after the other.

The status information and measured values are then read out together in cycles. The cycle time should not be less than one second, because this is the acquisition cycle time of the transmitter-internal measured value.

If the transmitter changes to service mode during the cyclic status and measured value enquiry, or if the transmitter cannot be reached or is in the start-up phase due to a restart, then status and measured values do not need to be read out any longer as the integrity of the measured values can no longer be guaranteed due to possible configuration changes. In this case, only the status has to be read out until the transmitter has left the service mode or the startup phase again or the transmitter can be reached again.

Example for Data Query	Bus Address (**#1**)	Function Code	Index Address (R)	Index Number (R)	Index Address (W)	Number of Registers (W)	Byte Number (W)	Index Content (W) (**#2**)	Modbus Checksum
Identification Parameter	0x01	0x17	0x0000	0x000E	0x0000	0x0001	0x02	0x0000	CRC16
Status and Measured Values	0x01	0x17	0x0100	0x0009	0x0000	0x0001	0x02	0x0001	CRC16
Measuring Range & Alarm Thresholds	0x01	0x17	0x0200	0x000B	0x0000	0x0001	0x02	0x0002	CRC16
Calibration and Adjustment Data	0x01	0x17	0x0300	0x001C	0x0000	0x0001	0x02	0x0003	CRC16

Comments to **#1**: Bus address of the transmitter (variable);
to **#2**: This signature should always change (variable).

6. GfG coding tables

6.1 Unit table

No.	Abbreviations	Designation	No.	Abbreviations	Designation
1	ppm	Part per million	24	°F	degrees Fahrenheit
2	vol%	percentage by volume	25	g	gram
3	%UEG (%LEL)	lower explosion limit	26	kg	kilogram
4	ppb	Part per trillion	27	Pa	Pascal
5	ug	micrograms	28	kPa	kilopascal
6	mg	milligram	29	bar	bar
7	%	percentage	30	psi	Pound per square inch
8	%%	per mil	31	s	second
9	m/s	meters per second	32	min	minute
10	°C	degree Celsius	33	kB	kilobyte
11	mV	millivolts	34	MB	megabyte
12	V	volt	35	GB	gigabyte
13	mA	milliamper	36	mg/l	Milligrams per litre
14	A	amp	37	slpm	Standard litres per minute
15	ohm	ohm	38	uA	microampere
16	dig	digit	39	W	watt
23	earth	degree			

6.2 Table of Gas Types and Measured Variables

No.	Sum Formula	Gas Designation	No.	Sum Formula	Gas Designation
1	C_3H_6O	acetone	34	$C_3H_6CL_2$	dichloropropane
2	C_2H_3N	acetonitrile	35	$C_4H_{11}N$	diethylamine
3	C_2H_2	acetylene	36	C_2H_6O	dimethyl ether
4	C_3H_3N	acrylonitrile	37	C_3H_5CLO	epichlorohydrin
5	C_3H_9N	aminopropane	38	Nat.gas	natural gas
6	NH3	ammonia	39	C_2H_6	ethane
7	$C_5H_{12}O$	amyl alcohol	40	C_2H_6O	ethanol
8	gasoline	Petrol 60/95	41	$C_4H_8O_2$	ethyl acetate
9	gasoline	Petrol 80/110	42	C_2H_6O	ethyl alcohol
10	gasoline	Petrol 100/140	43	C_2H_4	ethylene
11	C_6H_6	benzene	44	C_2H_4O	ethylene oxide
12	Cmb.gas	flammable gases and vapours	45	composite	FAM petrol 65/95
13	$CBrF_3$	bromotrifluoromethane	46	composite	Aviation fuel 40/180
14	C_4H_6	1,3-butadiene	47	$CH2O$	formaldehyde
15	C_4H_{10}	n-butane	48	$CHCLF_2$	R22 - Chlorodifluoromethane
16	C_4H_{10}	i-butane	49	He	helium
17	$C_4H_{10}O$	Butanol (n)	50	C_7H_{16}	n-heptane
18	C_4H_8O	MEK (methyl ethyl ketone)	51	C_6H_{14}	n-hexane
19	$C_6H_{12}O_2$	Butyl acetate (s)	52	C_{6H14}	i-Hexane
20	$C_6H_{12}O_2$	Butyl acetate (i)	53	$C_6H_{12}O$	hexanon
21	$C_4H_{10}O$	Butyl alcohol (n)	54	$C_6H_{12}O_2$	isobutyl acetate
22	C_4H_8	butene	55	CO_2	carbon dioxide
23	CL_2	chlorine	56	CO	carbon monoxide
24	CH_3CL	chloromethane	57	$H_2+CH_4+N_2+CO+$	coke oven gas
25	HCL	hydrogen chloride	58	$N_2+O_2+CO_2+...$	air
26	HCN	hydrogen cyanide	59	CH_4	methane
27	C_6H_{12}	cyclohexane	60	CH_4O	methanol
28	C_5H_{10}	cyclopentane	61	$C_3H_6O_2$	methyl acetate
29	C_3H_6	cyclopropane	62	CH_3OH	methyl alcohol
30	R12	R12 - Dichlorodifluoromethane	63	$C_6H_{12}O$	butylmethylketone
31	$C_2H_4CL_2$	dichloroethane	64	CH_3CL	methyl chloride
32	R21	R21 - Dichlorofluoromethane	65	CH_2CL_2	methylene chloride
33	CH_2CL_2	dichloromethane	66	$C_6H_{12}O$	MIBK (methyl i-butyl ketone)

Continuation see next page

No.	Sum Formula	Gas Designation	No.	Sum Formula	Gas Designation
67	C_4H_8O	ethylmethylketone	**125**	C_4H_8S	THT - Tetrahydrothiophene
68	$C_3H_8O_2$	methyl glycol	**126**	VALLEY	ToxAlert
69	$C_5H_8O_2$	methyl methacrylate	**127**	$C_4H_5F_5$	R365 - Pentafluorobutane
70	$C_4H_{10}O$	methylpropanol	**128**	$C_5H_{10}O_3$	ethyl lactate
71	$CBrCLF_2$	bromochlorodifluoromethane	**129**	NH_4+	ammonium ion
72	C_9H_{20}	n-Nonan	**130**	CCL_3F	R11 - Trichlorofluoromethane
73	C_8H_{18}	Octane (i)	**131**	$C_3H_3F_5$	R245fa - Pentafluoropropane
74	C_8H_{18}	Octane (n)	**132**	C_3H_4	prophet
75	C_5H_{12}	Pentane (i)	**133**	CS_2	carbon disulphide
76	C_5H_12	Pentane (n)	**134**	BCL_3	boron trichloride
77	$C_5H_{10}O$	pentanone	**135**	BF_3	boron trifluoride
78	C_5H_{10}	pentences	**136**	CH_3Br	bromomethane
79	$C_7H_{14}O_2$	pentylacetate	**137**	$C_4H_{10}O$	2-butanol
80	C_2CL_4	PER (perchloroethylene)	**138**	CH_4+CO_2	landfill gas
81	C_3H_8	propane	**139**	$C_2H_4F_2$	R152a - Difluoroethane
82	C_3H_8O	Propanol (i)	**140**	$C_4H_8O_2$	1,4-Dioxane
83	$C_5H_{10}O_2$	Propylacetate (i)	**141**	composite	Kerosene (180/220)
84	$C_5H_{10}O_2$	Propylacetate (n)	**142**	CH_5N	methylamine
85	C_3H_8O	Propyl alcohol (n)	**143**	$SiCL_4$	silicon tetrachloride
86	C_3H_8O	Propyl alcohol (i)	**144**	N_2	nitrogen
87	C_3H_6	propene	**145**	$C_2H_3F_3$	R143a - trifluoroethane
88	$C_3H_6CL_2$	propylene dichloride	**146**	composite	diesel
89	O_2	Oxygen	**147**	Mixture (C_2HF_5 + $C_2H_3F_3$ + $C_2H_2F_4$)	R404A (refrigerant mixture R125+R143a+R134a)
90	SO_2	sulphur dioxide			
91	SF_6	sulphur hexafluoride	**148**	Br_2	bromine gas
92	H_2S	hydrogen sulphide	**149**	VOC	VOC
93	$H_2+CH_4+N_2+CO+...$	town gas	**150**	PID	PID (synonym for PID sensor)
94	NO_2	nitrogen dioxide			
95	NE	nitrogen monoxide	**151**	Mixture (C_2HF_5 + $C_2H_3F_3$)	R507 (refrigerant mixture R125+R143a)
96	C_8H_8	styrene			
97	$C2H2CL4$	tetrachloroethane	**152**	$C_3H_6O_2$	ETF - ethyl formate
98	C_7H_8	toluene	**153**	Ar	argon
99	$C_2H_3CL_3$	trichloroethane	**154**	$C_2CL_3F_3$	R113 - Trichlorotrifluoroethane
100	C_2HCL_3	TRI - Trichloroethylene	**155**	$C_2H_3F_4$	Refrigerant R1234yf (2,3,3,3-tetrafluoroprop-1-ene)
101	CHF_3	R23 - Trifluoromethane			
102	$C_4H_6O_2$	vinyl acetate	**156**	Mixture (CH_2F_2 + C_2HF_5 + $C_2H_2F_4$)	R407C (refrigerant mixture R32+R125+R134a)
103	$C_2H_3C_L$	vinyl chloride			
104	H_2	hydrogen	**157**	Mixture (CH_2F_2 + C_2HF_5)	R410A (refrigerant mixture R32+R125)
105	$H_2+CO+...$	water gas			
106	C_8H_{10}	xylene	**158**	NF_3	nitrogen trifluoride
107	O_3	ozone	**159**	pH	pH
108	$COCL_2$	phosgene	**160**	redox	redox
109	PH_3	phosphine	**161**	TBM	TBM, tert-butylmercaptan
110	SiH_4	silane	**162**	HBr	hydrogen bromide
111	AsH_3	arsine	**163**	R438A	Refrigerant mixture (R125+) R134a+R32+nButane+Isopentane)
112	CLO_2	chlorine dioxide			
113	B_2H_6	diborane	**164**	R449A	Refrigerant mixture (R134a+) R125+R1234yf+R32a)
114	$C_2HCL_2F_3$	R123 - Dichlorotrifluoroethane			
115	C_4H_{10O}	diethyl ether	**165**	R1234ze	Refrigerant HFO-1234ze (1,3,3,3-tetrafluoropropene)
116	N_2O	nitrous oxide			
117	$C_2H_4O_2$	acetic acid	**225**	Sig.	beacon
118	F_2	fluorine	**226**	Q	flow
119	HF	hydrogen fluoride	**227**	P	pressure
120	GeH_4	germanium hydrogen	**228**	m	mass
121	N_2H_4	hydrazine	**229**	Wdir	wind direction
122	C_6H_6O	phenol	**253**	T	temperature
123	C_3H_6O	propylene oxide	**254**	pair	wind velocity
124	$C_2H_2F_4$	R134a - tetrafluoroethane	**255**	rH	relative humidity

7. References

[MoSL] MODBUS over Serial Line - Specification & Implementation Guide V1.0; *http://www.modbus.org*

[MAPS] MODBUS Application Protocol Specification V1.1; *http://www.modbus.org*

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