Annex to the Operation Manual

D-ReX

Modbus Implementation

Version 3

Translation of the original operation manual
245-002.32_AOM_DReX-Modbus

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1 Introduction

For data exchange, the D-ReX can be communicated with via the following Modbus interfaces:

- Modbus/RTU (RS-485, server operation)
- Modbus/TCP (Ethernet, TCP server)

This document describes the structure of the telegrams and of the transmission data and is only valid in conjunction with the current operating instructions [1].

As far as possible, identical data contents are transmitted for all Modbus interfaces. Differences will be explained at the respective passages.

As an option, the D-ReX can also be equipped with a LON® interface. For this purpose, an integrated LON module is used, which communicates with the processor via Modbus RTU. The data contents are mostly identical to those of the above interfaces. Differences will be explained at the respective passages. The data structures of the LON interface, however, are not identical to this and are described in a separate document [4].

1.1 Changed Designations

The Modbus protocol exchanges information using a request-reply mechanism between a master (client) and a slave (server). The master-slave principle is a model for a communication protocol in which one device (the master) controls one or more other devices (the slaves). Modbus client ID was formerly known as Master and Modbus server ID was formerly known as Slave. In the following, only the terms client and server are used instead of master and slave.

2 Interfaces

2.1 Modbus RTU

A D-ReX has three Modbus RTU ports (RS-485). One of them, the Modbus-3, can be used in server mode for data exchange with a PLC or a visualization tool (Modbus client) by appropriate parameterization. The description of data transmission in this document refers to this.

2.1.1 Cable

The bus connection between client and server is made via shielded 2-core cable (terminal connection); e. *g. cable 1x2x0.22mm² BUS-LD or cable Y(St)Y 2x2x0.8*.

2.1.2 Bus structure

The maximum length of the bus must not exceed 1200 m (see RS-485 specification). A maximum of 64 servers can be connected to the Modbus. The transmission rate depends on the line length and can be set to a maximum of 230400 baud.
The actual maximum line length and the maximum transmission rate are also highly dependent on the structure of the network. Star topologies in particular should be avoided due to the long stub lines that result. A chain structure (daisy chain) is advantageous. As a rough guideline for the transmission rate, you can use the maximum baud rates depending on the line length listed in the following table.

Line length	max. baud rate
up to 500 m	230400 baud
up to 1000 m	115200 baud
up to 1200 m	57600 baud

The bus levels are defined via the client. The bus must be terminated on both sides with 120 Ω terminating resistors. The D-ReX has a terminating resistor internally at the Modbus 3 port, which can be activated or deactivated via an electronic switch via configuration.

2.1.3 Communication parameters

Bus Address	1 ... 247 (in server mode) Note: Setting the address also determines the operating mode of the bus node. Address 0 activates client operation and an address not equal to 0 activates server operation.
Transmission rate	9600, 19200, 38400, 57600, 115200, 230400 baud
Data format	1 start bit 8 data bits 1 parity bit *(even parity*) with 1 stop bit (8E1)
Bus termination	120 Ω terminating resistor on/off

The bus address, baud rate and termination are set via the configuration program on the computer (see operating instructions [1]). The data format is fixed and cannot be changed.

2.2 Modbus TCP

The D-ReX has an Ethernet port (RJ-45 connector) and can thus be used as a Modbus TCP server for exchanging data with Modbus TCP clients by setting the appropriate parameters.

2.2.1 Cable

Suitable cables for Modbus TCP connection:

- Cat 5e shielded
- Cat 6 shielded
- Cat 6a shielded
- Cat 7 shielded

2.2.2 Bus structure

The permissible total length of the transmission line is 100 m for copper lines. Included are:

- 90 m installation cable
- 10 m patch cable (2 × 5m)
- 2 plug connections (e.g. socket and patch field)

Patch cables have poorer transmission properties. If the patch cables are longer than 10 m, the permissible length of the installation cable is reduced by 1.5 m for each meter exceeded. If the line consists only of patch cables, the permissible length is approx. 70 m.

2.2.3 Communication parameters

IP address	32-bit IPv4 address on the network
Subnet mask	32-bit masking of the IP address (for network and host part)
IP address gateway	Optional IP address of a gateway in the network
Port number	For Modbus TCP by default 502
Bus address	1 (invariable, since the device is uniquely addressed via the IP address)

The settings are made via the configuration program on the computer (see operating instructions [1]).

2.3 Modbus RTU/LON®

The D-ReX optionally comes with a LON bus connection. For this purpose, an internal LON module is used, that serves as an internal bus converter from Modbus-RTU to LON.
The description of the communication in this document refers exclusively to the internal Modbus communication between the processor and the LON module. The data structures of the LON bus are described in a separate document [4].

2.3.1 Communication parameters

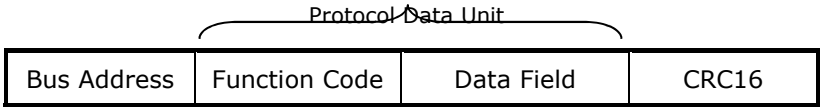
Bus address	1 (invariable, because of the point-to-point connection between processor and LON module)
Transmission rate	9600, 19200, 38400, 57600, 115200, 230400 baud
Data format	1 start bit 8 data bits 1 parity bit *(even parity*) with 1 stop bit (8E1)

The baud rate is set via the configuration program on the computer (see operation manual [1]). Bus address and data format are invariable and cannot be changed.

3 Telegram structure

3.1 Modbus RTU

As shown in the following image, each telegram starts with the bus address and the function code (1 byte each) and ends with the CRC16 Modbus checksum (2 bytes). In between is the application specific data field.



Structure of a Modbus frame (RTU)

The CRC16 checksum is Modbus specific and has the polynomial 0xA001 (see specification [3]). Except for the checksum, all data is transmitted in big-endian format (MSB first), but the checksum is transmitted in little-endian format (LSB first).

3.2 Modbus TCP

With Modbus-TCP a TCP header is attached to the RTU telegram (see above section 3.1) according to the following structure.

Byte index	Content	Description
0	0x00	Transaction number. Is not needed and can therefore always be set to zero.
1	0x00	
2	0x00	Fixed protocol flag with the value zero.
3	0x00	
4	0x00	Byte length [n] of the Modbus telegram consisting of Bus Address, Function Code and Data Field (without checksum).
5	[n]	

Structure of the Modbus TCP header

3.3 Modbus Function Codes

Data access via Modbus is based on mapped registers within the device, which can be read and/or written to by the client using the following standard Modbus Function Codes [2].

- **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 assignment of the transmission data to the register addresses is described in section 4.3. The telegram structure for the various Function Codes and the functionalities implemented in the device are described below.

3.3.1 Read Input Registers

The client sends the start address and number of registers in the request to read registers. The server sends back the contents of the requested registers in the response.

Request	Length	Content
Bus Address	1 byte	1 ... 247
Function Code	1 byte	0x04
Start Address	2 bytes	0x0000 … 0xA111
Number of registers	2 bytes	1 ... N*
Modbus checksum	2 bytes	(0x0000 ... 0xFFFF)

Response	Length	Content
Bus Address	1 byte	1 ... 247
Function Code	1 byte	0x04
Byte count	1 byte	2 x N*
Register content	N* x 2 bytes	Data
Modbus checksum	2 bytes	(0x0000 ... 0xFFFF)

N* = Number of registers

3.3.2 Write Multiple Registers

The client sends in the request the start address and the number of registers to be read as well as the start address, the number and the content of the registers to be written. The server sends back 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	0x0000 … 0xA111
Number of registers	2 bytes	1 … 5
Byte count	1 byte	2 … 10
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	0x0000 … 0xA111
Number of registers	2 bytes	1 … 5
Modbus checksum	2 bytes	(0x0000 ... 0xFFFF)

3.3.3 Read/Write Multiple Registers

The client sends in the request start address and number of registers to be read and start address, number and content of registers to be written. The server sends back the contents of the requested registers in the response.

Request	Length	Content	
Bus Address	1 byte	1 ... 247	
Function Code	1 byte	0x17	
Start Address (R)	2 bytes	0x0000 … 0xA111	(R) = read
Number of registers (R)	2 bytes	1 … N*	
Start Address (W)	2 bytes	0x0000 … 0xA111	(W) = write
Number of registers (W)	2 bytes	1 … 5	
Byte count (W)	1 byte	2 … 10	
Register content (W)	2 bytes	Data	
Modbus checksum	2 bytes	(0x0000 ... 0xFFFF)	

Response	Length	Content	
Bus Address	1 byte	1 ... 247	
Function Code	1 byte	0x17	
Byte count	1 byte	2 x N*	N* = Number of registers
Register content	N* x 2 bytes	Data	
Modbus checksum	2 bytes	(0x0000 ... 0xFFFF)	

3.3.4 Exception Code

If an error occurs when reading or writing to the registers, the server sends back an exception code instead of the expected response and sets the most significant bit (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, 0x06
Modbus checksum	2 bytes	(0x0000 ... 0xFFFF)

The following 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	Number of registers invalid
0x04	Server Device Failure *1	Error during write access: - Incorrect password entry - Parameter value invalid (outside the valid value range or inversion incorrect) - Parameter input without activation (password) - Switching on a relay that is not assigned to Modbus
0x06	Server Device Busy *1	Internal task for parameter write access currently busy: Repeat the process.

*1 These Exception Codes can only occur with write accesses in combination with the Modbus-RTU/LON connection (see also table in section 4.3)

4 Transmission Data

4.1 Data formats

In the following the assignment of the used data formats to the Modbus register structure (16-bit) is described.

4.1.1 Uint8_t / Int8_t

Unsigned / signed 8-bit integer.
Up to two values are stored in one Modbus register.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Byte 1								Byte 0							
Modbus Register															

4.1.2 Uint16_t / Int16_t

Unsigned / signed 16-bit integer.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Byte 1								Byte 0							
Modbus Register															

4.1.3 Uint32_t / Int32_t

Unsigned / signed 32-bit integer.
The value is split between two Modbus registers.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Byte 3								Byte 2								Byte 1								Byte 0							
Modbus High Register																Modbus Low Register															

4.1.4 Float32_t

Float representation according to IEEE754 with single precision (32 bit), 1 bit sign, 8 bit exponent and 23 bit mantissa. The value is split between two Modbus registers.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
VZ	Exponent								Mantissa																						
Byte 3								Byte 2								Byte 1								Byte 0							
Modbus High Register																Modbus Low Register															

4.1.5 String (UTF8)

With UTF8, a character can be up to four bytes long. That means a string with 10 characters can be up to 40 bytes long, then without termination. If the string is shorter, a 0 termination occurs. 2 bytes per register are transferred. Example string: "1€"

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
2. character, 3. byte: 0xAC								2. character, 2. byte: 0x82								2. character, 1. byte: 0xE2								1. character, 1‘ (0x31)							
Byte 3								Byte 2								Byte 1								Byte 0							
Modbus Register 1																Modbus Register 0															

4.1.6 String (ASCII)

Each character is encoded in an 8-bit value. Each string has a maximum length. If this is shorter, a 0 termination occurs. Two characters are transmitted per register. Example string: "Ok"

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
2. character 'k' (0x6B)								1. character 'O' (0x4F)							
Byte 1								Byte 0							
Modbus Register															

4.2 Telegram Signature

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).** Therefore, each register block in chapter 4.3 starts with the signature register. The client sends a signature with a request to write to the signature register and at the same time requests this signature along with other register values from the server, which are then sent back to the client as a response. The signature that is transmitted by the client for this purpose can, for example, be a counter value that is incremented before each request. The client will then recognize if the received telegram is indeed the response to its request by checking whether the signature sent the one given as a response by the server.

After the signature is read, it is automatically decremented within the server. If the Client repeatedly accesses the signature and data in read-only mode **(Read Input Registers 0x04)**, the Servers can still recognize that the responses of the slave are consecutively created and sent telegrams because of the automatic signature decrementation.

4.3 Register Map

The following table provides an overview of the different register blocks and shows for which interface an address range is available.

Block	Address	Content	Modbus		
			RTU	TCP	RTU/LON
D-ReX Parameterization	0x0000 … 0x0068	Device type, connection ID, FW/HTML version, UTF8 texts	X	X	X
	0x0080 … 0x00AA	ASCII texts	X		X
D-ReX Cyclic data	0x0200 ... 0x0205	Device status, relay states	X	X	X
	0x0206 … 0x0208	Modbus assignment relay/horn	X	X	X
D-ReX: set temporary states	0x0300 ... 0x0301	Alarm acknowledgement	X	X	X
	0x0302 ... 0x0309	Set relay/horn states	X#	X#	X (PW)#
Measured value parameterization	0x?000 ... 0x?014*	Measuring range, alarm, average value	X	X	X
Change measured value parameterization	0x?100 ... 0x?122*	Change alarm settings	X#	X#	X (PW)#
Data on sensors that provide a measured value	0x?200 ... 0x?210*	Serial number, MK number, calibration data, operating time	X	X	X
Measured value designation	0x?300 ... 0x?328*	UTF8 texts	X	X	X
	0x?340 … 0x?34A*	ASCII texts	X		X
Measured value: cyclic data	0x?400 ... 0x?408*	Measured value, status, average value	X	X	X
Reset measured value alarms and set temporary states	0x?500 ... 0x?501*	Alarm acknowledgement	X	X	X
	0x?502 … 0x?503*	Set temporary states (Alarm, FLT, SRV, SRQ)	X#	X#	X (PW)#
LON status message to D-ReX	0xA000 ... 0xA016	FW/HW version, Neuron ID			X
Fehler! Verweisquelle konnte nicht gefunden werden.	0xA100 ... 0xA004	Enter password (login)	X	X	X
	0xA105 … 0xA111	Password change	X#	X#	X (PW)#

(PW) = write access only allowed after password entry (login)
* ? = 1...8 for measured values 1...8

4.3.1 Controller (D-ReX) Data

The D-ReX gas detection unit can manage up to 8 measured values. In the first shared memory area, only information from the controller is provided.

4.3.1.1 D-ReX Parameterization

GfG products use the device type to detect which remote station is present. Depending on this, the further data contents are defined.
Therefore, the first thing to do is to read out the device type (in this case D-ReX = 40d) and check for consistency. Only if there is a match, the further register map is valid.

Offset Register Address	Access Information	Register Type (16 bit)	Parameter	Explanation:
0x0000	Read/Write	Unsigned	Signature	Signature to identify the telegram (will be decremented after readout).
0x0001	Read	Unsigned	Low byte: D-ReX = 40d High byte: = 0	Low byte: Device type High byte: Data structure version number The data structure number would increase in case of a later modification of the content.
0x0002	Read	Unsigned	Connection ID	Low byte: 01: Connection via Ethernet (Modbus/TCP) 02: otherwise allocated by GfG 03: Connection via Modbus-3 (Modbus/RTU) 04: Connection via Modbus RTU/LON 05...255: Not occupied High byte: Unused (= 0)
0x0003	Read	Unsigned	Unused	Value = 0
0x0004	Read	Unsigned	Unused	Value = 0
0x0005	Read	Unsigned	FW version 1 (MC1)	Bit 0...7: Main version number Bit 8...15: Unused (= 0)
0x0006	Read	Unsigned	FW version 1 (MC1)	Bit 0...7: Patch version number Bit 8...15: Subversion number
0x0007	Read	Unsigned	FW version 2 (MC2)	(see Register 0x0005)
0x0008	Read	Unsigned	FW version 2 (MC2)	(see register 0x0006)
0x0009	Read	Unsigned	FW version 3 (LON)	(see register 0x0005) without LON = 0
0x000A	Read	Unsigned	FW version 3 (LON)	(see register 0x0006) without LON = 0
0x000B	Read	Unsigned	Version HTML	(see Register 0x0005)
0x000C	Read	Unsigned	Version HTML	(see register 0x0006)
0x0020	Read/Write	Unsigned	Signature	Signature to identify the telegram (will be decremented after readout).
0x0021	Read	Unsigned	Serial number	10-digit (UTF8) Max 40 bytes 2 bytes per register, see chapter 4.1.5
…	Read	Unsigned	Serial number	
0x0034	Read	Unsigned	Serial number	
0x0040	Read/Write	Unsigned	Signature	Signature to identify the telegram (will be decremented after readout).
0x0041	Read	Unsigned	D-ReX designation	20-digit (UTF8) Max 80 bytes 2 bytes per register, see chapter 4.1.5
…	Read	Unsigned	D-ReX designation	
0x0068	Read	Unsigned	D-ReX designation	
0x0080	Read/Write	Unsigned	Signature	Signature to identify the telegram (will be decremented after readout).
0x0081	Read	Unsigned	Serial number	10-digit (ASCII) Max 10 bytes 2 Characters per register, see chapter 4.1.6
…	Read	Unsigned	Serial number	
0x0085	Read	Unsigned	Serial number	
0x00A0	Read/Write	Unsigned	Signature	Signature to identify the telegram (will be decremented after readout).
0x00A1	Read	Unsigned	D-ReX designation	20 characters (ASCII) Max 20 bytes 2 characters per register, see chapter 4.1.6
…	Read	Unsigned	D-ReX designation	
0x00AA	Read	Unsigned	D-ReX designation	

4.3.1.2 D-ReX Cyclic data

The variable data of the gas detection unit can be retrieved here.
The query must be cyclic for LON. If no query is received within 3 s, the connection is reported as faulty (timeout).

Offset Register Address	Access Information	Register Type (16 bit)	Parameter	Explanation:	
0x0200	Read/Write	Unsigned	Signature	Signature to identify the telegram (will be decremented after readout).	
0x0201	Read	Unsigned	D-ReX status	Bit0: Startup Bit1: Fault Bit2: Maintenance Bit3: Maintenance request Bit4: Configuration mode Bit5: Bit6: Bit7:	Bit8: Bit9: Bit10: Bit11: Bit12: Bit13: Bit14: Bit15:
0x0202	Read	Unsigned	Relay state* Base unit	Bit0: Relay 1 logical Bit1: Relay 2 logical Bit2: Relay 3 logical Bit3: Relay 4 logical Bit4: Relay 5 logical Bit5: Bit6: Bit7:	Bit8: Relay 1 physical Bit9: Relay 2 physical Bit10: Relay 3 physical Bit11: Relay 4 physical Bit12: Relay 5 physical Bit13: Bit14: Bit15:
0x0203	Read	Unsigned	Relay state* Relay module	Relay module Bit0: Relay 1 logical Bit1: Relay 2 logical Bit2: Relay 3 logical Bit3: Relay 4 logical Bit4: Relay 5 logical Bit5: Relay 6 logical Bit6: Relay 7 logical Bit7: Relay 8 logical	Relay module Bit8: Relay 9 logical Bit9: Relay 10 logical Bit10: Relay 11 logical Bit11: Relay 12 logical Bit12: Relay 13 logical Bit13: Relay 14 logical Bit14: Relay 15 logical Bit15: Relay 16 logical
0x0204	Read	Unsigned	Relay state* Relay module	Relay module Bit0: Relay 1 physical Bit1: Relay 2 physical Bit2: Relay 3 physical Bit3: Relay 4 physical Bit4: Relay 5 physical Bit5: Relay 6 physical Bit6: Relay 7 physical Bit7: Relay 8 physical	Relay module Bit8: Relay 9 physical Bit9: Relay 10 physical Bit10: Relay 11 physical Bit11: Relay 12 physical Bit12: Relay 13 physical Bit13: Relay 14 physical Bit14: Relay 15 physical Bit15: Relay 16 physical
0x0205	Read	Unsigned	Relay state Relay module	Relay module Bit0: Horn logical Bit1...15: Unused (= 0)	
0x0206	Read	Unsigned	Modbus assignment of the relays of the base unit	Bit0: Assignment relay 1 Bit1: Assignment relay 2 Bit2: Assignment relay 3 Bit3: Assignment relay 4 Bit4: Assignment relay 5 Bit5: Bit6: Bit7:	Bit8: Bit9: Bit10: Bit11: Bit12: Bit13: Bit14: Bit15:
0x0207	Read	Unsigned	Modbus assignment of the relays of the relay module	Bit0: Assignment relay 1 Bit1: Assignment relay 2 Bit2: Assignment relay 3 Bit3: Assignment relay 4 Bit4: Assignment relay 5 Bit5: Assignment relay 6 Bit6: Assignment relay 7 Bit7: Assignment relay 8	Bit8: Assignment relay 9 Bit9: Assignment relay 10 Bit10: Assignment relay 11 Bit11: Assignment relay 12 Bit12: Assignment relay 13 Bit13: Assignment relay 14 Bit14: Assignment relay 15 Bit15: Assignment relay 16
0x0208	Read	Unsigned	Modbus assignment of the horn of the relay module	Bit0: Assignment horn Bit1...15: Unused (= 0)	

* A distinction is made between the logical and physical relay states. The logical state corresponds to the relay setting (e.g. alarm), and the physical state corresponds to the contact state of the relay. With closed-circuit current parameterization, the logical and physical relay states are different. With working current parameterization, both are the same.

4.3.1.3 D-ReX: set temporary states

Relay and horn states can be set temporarily. After a restart, these states are reset.
The write accesses as of register 0x0302 are only possible after permissible password entry (if active).

Offset Register address	Access Information	Register Type (16 bit)	Parameter	Explanation:
0x0300	Read/Write	Unsigned	Signature	Signature to identify the telegram (will be decremented after readout).
0x0301	Read/Write	Unsigned	Acknowledgement	Bit0: Acknowledgement alarms (global) Measured value specific, see 4.3.2.6. Bit1...15: Unused (= 0)
0x0302	Read/Write	Unsigned	Signature	Signature to identify the telegram (will be decremented after readout).
0x0303	Read/Write	Unsigned	Internal relays 1...5 *1	Bits 0 and 1: Relay 1 =0 no change =1 relay logically on =2 relay logically off =3 no change Bits 2 and 3: Relay 2 Bits 4 and 5: Relay 3 Bits 6 and 7: Relay 4 Bits 8 and 9: Relay 5 Bit 10 to 15: Unused (= 0)
0x0304	Read/Write	Unsigned	Signature	Signature to identify the telegram (will be decremented after readout).
0x0305	Read/Write	Unsigned	Relay module Relay 1 to 8 *1	Bits 0 and 1: Relay 1 =0 no change =1 relay logically on =2 relay logically off =3 no change Bits 2 and 3: Relay 2 Bits 4 and 5: Relay 3 Bits 6 and 7: Relay 4 Bits 8 and 9: Relay 5 Bits 10 and 11: Relay 6 Bits 12 and 13: Relay 7 Bits 14 and 15: Relay 8
0x0306	Read/Write	Unsigned	Signature	Signature to identify the telegram (will be decremented after readout).
0x0307	Read/Write	Unsigned	Relay module Relay 9 to 16 *1	Bits 0 and 1: Relay 9 =0 no change =1 relay logically on =2 relay logically off =3 no change Bits 2 and 3: Relay 10 Bits 4 and 5: Relay 11 Bits 6 and 7: Relay 12 Bits 8 and 9: Relay 13 Bits 10 and 11: Relay 14 Bits 12 and 13: Relay 15 Bits 14 and 15: Relay 16
0x0308	Read/Write	Unsigned	Signature	Signature to identify the telegram (will be decremented after readout).
0x0309	Read/Write	Unsigned	Relay module horn *1	Bits 0 and 1: =0 no change =1 Horn logically on =2 Horn logically off =3 no change Bits 2 to 15: Unused (= 0)

*1 A relay or the horn can only be switched via Modbus if it is also assigned to Modbus in the D-ReX parameterization. Otherwise there is an exception response (see chapter 3.3.4)

4.3.2 Measured value data

All measured value data are defined in a block with the distance 0x1000.

Address	Assignment	Insert
0x1000	Measured value 1	? = 1
0x2000	Measured value 2	? = 2
0x3000	Measured value 3	? = 3
0x4000	Measured value 4	? = 4
0x5000	Measured value 5	? = 5
0x6000	Measured value 6	? = 6
0x7000	Measured value 7	? = 7
0x8000	Measured value 8	? = 8

In further tables, the variability is marked with the "?" in the address and the following descriptive texts.

4.3.2.1 Measured value parameterization

The parameterization of the measured values can be read out here.

Offset Register Address	Access Information	Register Type (16 bit)	Parameter	Explanation:
0x?000	Read/Write	Unsigned	Signature	Signature to identify the telegram (will be decremented after readout).
0x?001	Read	Unsigned	Unit / Gas type Measured value ?	Bits 0 to 7: Gas type, see GfG list chapter 5.2 Bits 8 to 15: Unit, see GfG list chapter 5.1
0x?002	Read	Float32_t	Lower threshold value Measured value ?	High
0x?003	Read			Low
0x?004	Read	Float32_t	Upper threshold value Measured value ?	High
0x?005	Read			Low
0x?006	Read	Unsigned	Alarm directions Measured value ?	Bit 0: Direction alarm threshold AL1, 0=falling below Bit 1: Direction alarm threshold AL2, 0=falling below Bit 2: Direction alarm threshold AL3, 0=falling below Bit 3: Direction alarm threshold AL4, 0=falling below Bit 4: Unused (= 0) Bit 5: Unused (= 0) Bits 6-7: AL1 for current, average1 and average2 values Bits 8-9: AL2 for current, average1 and average2 values Bits 10-11: AL3 for current, average1 and average2 values Bits 12-13: AL4 for current, average1 and average2 values Bits 14-15: Unused (= 0) Bits 6-7, 8-9, 10-11, 12-13: 0= current value alarm 1= average1 alarm 2= average2 alarm 3= alarm off
0x?007	Read	Float32_t	Alarm threshold 1 Measured value ?	High
0x?008	Read			Low
0x?009	Read	Float32_t	Alarm threshold 2 Measured value ?	High
0x?00A	Read			Low
0x?00B	Read	Float32_t	Alarm threshold 3 Measured value ?	High
0x?00C	Read			Low
0x?00D	Read	Float32_t	Alarm threshold 4 Measured value ?	High
0x?00E	Read			Low
0x?00F	Read	Unsigned	Averaging time 1 Measured value ?	0 to 24 h in minutes
0x?010	Read	Unsigned	Averaging time 2 Measured value ?	0 to 24 h in minutes
0x?011	Read	Unsigned	Switch-on delay	Measured value ? Alarm 1 switch-on delay *1 Bits 0-7 = 0 to 900 s (0 to 15 min) Bits 8-15: Unused (= 0)
0x?012	Read	Unsigned	Switch-on delay	Measured value ? Alarm 2 switch-on delay *1 Bits 0-7 = 0 to 900 s (0 to 15 min) Bits 8-15: Unused (= 0)

0x?013	Read	Unsigned	Switch-on delay	Measured value ? Alarm 3 switch-on delay *1 Bits 0-7 = 0 to 900 s (0 to 15 min) Bits 8-15: Unused (= 0)
0x?014	Read	Unsigned	Switch-on delay	Measured value ? Alarm 4 switch-on delay *1 Bits 0-7 = 0 to 900 s (0 to 15 min) Bits 8-15: Unused (= 0)

*1 For >60 seconds, the value is only stored internally in a 5 second grid. Conveyed values are rounded down to this grid. When reading back, this may lead to discrepancies with the conveyed value.

4.3.2.2 Change measured value parameterization

Changes made are stored in the parameter memory and can also be read back. Write accesses are only possible after permissible password entry (if active).

Offset Register Address	Access Information	Register Type (16 bit)	Parameter	Explanation:
0x?100	Read/Write	Unsigned	Signature	Signature to identify the telegram (will be decremented after readout).
0x?101	Read/Write	Float32_t	Alarm 1	Measured value ? Valid: Lower threshold value ... upper threshold value
0x?102	Read/Write			
0x?103	Read/Write	Float32_t	Alarm 1 inverted	Measured value ?
0x?104	Read/Write			
0x?105	Read/Write	Unsigned	Signature	Signature to identify the telegram (will be decremented after readout).
0x?106	Read/Write	Float32_t	Alarm 2	Measured value ? Valid: Lower threshold value ... upper threshold value
0x?107	Read/Write			
0x?108	Read/Write	Float32_t	Alarm 2 inverted	Measured value ?
0x?109	Read/Write			
0x?10A	Read/Write	Unsigned	Signature	Signature to identify the telegram (will be decremented after readout).
0x?10B	Read/Write	Float32_t	Alarm 3	Measured value ? Valid: Lower threshold value ... upper threshold value
0x?10C	Read/Write			
0x?10D	Read/Write	Float32_t	Alarm 3 inverted	Measured value ?
0x?10E	Read/Write			
0x?10F	Read/Write	Unsigned	Signature	Signature to identify the telegram (will be decremented after readout).
0x?110	Read/Write	Float32_t	Alarm 4	Measured value ? Valid: Lower threshold value ... upper threshold value
0x?111	Read/Write			
0x?112	Read/Write	Float32_t	Alarm 4 inverted	Measured value ?
0x?113	Read/Write			
0x?114	Read/Write	Unsigned	Signature	Signature to identify the telegram (will be decremented after readout).
0x?115	Read/Write	Unsigned	Inhibit	Measured value ? Bits 0-1: Alarm 1 Inhibit =0 no change =1 activate inhibit =2 disable inhibit =3 no change Bits 2-3: Latching alarm 1 =0 no change =1 activate latching =2 disable latching =3 no change Bits 4-7: Alarm 2, for function see alarm 1 Bits 8-11: Alarm 3, for function see alarm 1 Bits 1-15: Alarm 4, for function see alarm 1
0x?116	Read/Write	Unsigned	Inhibit	Bit inversion of the previous register
0x?117	Read/Write	Unsigned	Signature	Signature to identify the telegram (will be decremented after readout).
0x?118	Read/Write	Unsigned	Switch-on delay	Measured value ? Alarm 1 switch-on delay *1 Bits 0-15 = 0 to 900 s (0 to 15 min)
0x?119	Read/Write	Unsigned	Switch-on delay	Bit inversion of the previous register

0x?11A	Read/Write	Unsigned	Signature	Signature to identify the telegram (will be decremented after readout).
0x?11B	Read/Write	Unsigned	Switch-on delay	Measured value ? Alarm 2 switch-on delay *1 Bits 0-15 = 0 to 900 s (0 to 15 min)
0x?11C	Read/Write	Unsigned	Switch-on delay	Bit inversion of the previous register
0x?11D	Read/Write	Unsigned	Signature	Signature to identify the telegram (will be decremented after readout).
0x?11E	Read/Write	Unsigned	Switch-on delay	Measured value ? Alarm 3 switch-on delay *1 Bits 0-15 = 0 to 900 s (0 to 15 min)
0x?11F	Read/Write	Unsigned	Switch-on delay	Bit inversion of the previous register
0x?120	Read/Write	Unsigned	Signature	Signature to identify the telegram (will be decremented after readout).
0x?121	Read/Write	Unsigned	Switch-on delay	Measured value ? Alarm 4 Switch-on delay *1 Bits 0-15 = 0 to 900 s (0 to 15 min)
0x?122	Read/Write	Unsigned	Switch-on delay	Bit inversion of the previous register

*1 For >60 seconds, the value is only stored internally in a 5 second grid. Conveyed values are rounded down to this grid. When reading back, this may lead to discrepancies with the conveyed value.

4.3.2.3 Data on sensors that provide a measured value

The key data of the sensor belonging to a measured value can be read out here. This only applies to smart sensors. Sensors for internal measured values (supply voltage, temperature, flow rate, ...) are not smart. The value is therefore always = 0 for these sensors.

Offset Register Address	Access Information	Register Type (16 bit)	Parameter	Explanation:
0x?200	Read/Write	Unsigned	Signature	Signature to identify the telegram (will be decremented after readout).
0x?201	Read	ASCII[10]	MK number of the sensor	
0x?202	Read			
0x?203	Read			
0x?204	Read			
0x?205	Read			
0x?206	Read	ASCII[10]	Serial number of the sensor	
0x?207	Read			
0x?208	Read			
0x?209	Read			
0x?20A	Read			
0x?20B	Read	2xUint8_t	LowByte = day HighByte = month	Date of the first span adjustment
0x?20C	Read	Uint16_t	year	
0x?20D	Read	2xUint8_t	LowByte = day HighByte = month	Date of the last span adjustment
0x?20E	Read	Uint16_t	year	
0x?20F	Read	2xUint8_t	LowByte = day HighByte = month	Date of the first zero adjustment
0x?210	Read	Uint16_t	year	
0x?211	Read	2xUint8_t	LowByte = day HighByte = month	Date of the last zero adjustment
0x?212	Read	Uint16_t	year	
0x?213	Read	Float32_t	First span signal size	Signal size in relation to nominal value at first span adjustment
0x?214	Read			
0x?215	Read	Float32_t	Last span signal size	Signal size in relation to nominal value at last span adjustment
0x?216	Read			
0x?217	Read	Float32_t	First deviation of the zero signal	Signal deviation from nominal value at first zero adjustment
0x?218	Read			
0x?219	Read	Float32_t	Last deviation of the zero signal	Signal deviation from nominal value at last zero adjustment
0x?21A	Read			
0x?21B	Read	2xUint8_t	LowByte = Unit	Unit of the span signal size
			HighByte = Unit	Unit of the deviation of the zero signal
0x?21C	Read	Uint16_t	Current service life	Current service life (days)
0x?21D	Read	Uint16_t	Max. service life	Maximum service life (days)

4.3.2.4 Measured value designation

The parameterized measured value designation can be read out here.

Offset Register Address	Access Information	Register Type (16 bit)	Parameter	Explanation:
0x?300	Read/Write	Unsigned	Signature	Signature to identify the telegram (will be decremented after readout).
0x?301	Read	Unsigned	Transmitter Measured value ? Text 1	Designation buffer start (10x Utf8 characters) 2 bytes per register, see chapter 4.1.5
…	Read	Unsigned		
0x?314	Read	Unsigned		Designation buffer end
0x?315	Read	Unsigned	Transmitter Measured value ? Text 2	Designation buffer start (10x Utf8 characters) 2 bytes per register, see chapter 4.1.5
…	Read	Unsigned		
0x?328	Read	Unsigned		Designation buffer end
0x?340	Read/Write	Unsigned	Signature	Signature to identify the telegram (will be decremented after readout).
0x?341	Read	Unsigned	Transmitter Measured value ? Text 1	Designation buffer start (10x ASCII characters) (2 characters per register, see chapter 4.1.6)
…	Read	Unsigned		
0x?345	Read	Unsigned		Designation buffer end
0x?346	Read	Unsigned	Transmitter Measured value ? Text 2	Designation buffer start (10x ASCII characters) (2 characters per register, see chapter 4.1.6)
…	Read	Unsigned		
0x?34A	Read	Unsigned		Designation buffer end

4.3.2.5 Measured value: cyclic data

The variable data of the respective measured value can be read out here.

Offset Register Address	Access Information	Register Type (16 bit)	Parameter	Explanation:	
0x?400	Read/Write	Unsigned	Signature	Signature to identify the telegram (will be decremented after readout).	
0x?401	Read	Unsigned	Status of the measured value (#1)	Bit 0: Enabled Bit 1: Inhibit Bit 2: Simulation Bit 3: Measured value valid Bit 4: Fault Bit 5: Maintenance Bit 6: Maintenance request Bit 7: Pre-Alarm (D-ReX)	Bit 8: Alarm 1 (D-ReX) Bit 9: Alarm 2 (D-ReX) Bit 10: Alarm 3 (D-ReX) Bit 11: Alarm 4 (D-ReX) Bit 12: Unused (= 0) Bit 13: Unused (= 0) Bit 14: Unused (= 0) Bit 15: Ambiguity
0x?402	Read	Unsigned	Status of the measured value (#2)	Bit 0: Over-/Underrange 0 Bit 1: Over-/Underrange 1 Bit 2: Over-/Underrange 2 0:Normal operation 1:Underrange AD 2:Underrange fault 3:Underrange 4:Overrange 5:Overrange fault 6:Overrange AD 7:Measured value undefined Bit 3: FLT: Pyrolizer Bit 4: FLT: Gas flow Bit 5: FLT: Line integrity Bit 6: Unused (= 0) Bit 7: Unused (= 0)	Bit 8: Alarm 1 (TRM) Bit 9: Alarm 2 (TRM) Bit 10: Alarm 3 (TRM) Bit 11: Unused (= 0) Bit 12: State bits 0 Bit 13: State bits 1 Bit 14: State bits 2 Bit 15: State bits 3 0:Normal operation 1:Startup 2:Unused (= 0) 3:Fault:FLT-TRM 4:Maintenance:SRV menu 5:Maintenance:SRV zero 6:Maintenance:SRV span 7:Maintenance:SRV config 8:Communication error 9:Config.inconsistent 10:Maintenance:General 11:Fault:Gateway 12-15:Unused (= 0)
0x?403	Read	Float32_t	Measured value	The current measured value (instantaneous value) is returned.	
0x?404	Read				
0x?405	Read	Float32_t	Mean value 1	The mean value 1 is returned according to the parameterization.	
0x?406	Read				
0x?407	Read	Float32_t	Mean value 2	The mean value 2 is returned according to the parameterization.	
0x?408	Read				

4.3.2.6 Reset measured value alarms and set temporary states

Temporary states can be set to test signaling in the visualization.
After a restart, these influences are reset.
The write accesses as of register 0x0502 are only possible after permissible password entry (if active).

Offset register address	**Access Information**	Register Type (16 bit)	Parameter	Explanation
0x?500	Read/Write	Unsigned	Signature	Signature to identify the telegram (will be decremented after readout).
0x?501	Read/Write	Unsigned	Acknowledgement	Bit 0: Acknowledgement alarms (Always 0 when reading) Bits 1-15: Unused (= 0)
0x?502	Read/Write	Unsigned	Signature	Signature to identify the telegram (will be decremented after readout).
0x?503	Read/Write	Unsigned	Status bits	Measured value ? Bit 0=1 -> Set fault manually Bit 1=1 -> Set maintenance manually Bit 2=1 -> Set maintenance request manually Bit 3=1 -> Set failed sensor selftest manually Bit 4=1 -> Set alarm 1 =0 Control at D-ReX Bit 5=1 -> Set alarm 2 =0 Control at D-ReX Bit 6=1 -> Set alarm 3 =0 Control at D-ReX Bit 7=1 -> Set alarm 4 =0 Control at D-ReX Bit 8...15 Unused (= 0)

4.3.3 LON Specific Registers

4.3.3.1 LON status message to D-ReX

Offset Register Address	**Access Information**	**Register Type (16 bit)**	**Parameter**	**Explanation:**
0xA000	Read/Write	Unsigned	Signature	Signature to identify the telegram (will be decremented after readout).
0xA001	Write	Unsigned	Reserved	
0xA010	Read/Write	Unsigned	Signature	Signature to identify the telegram (will be decremented after readout).
0xA011	Write	Unsigned	Version	Bits 0-7: Main version number (LON) Bits 8-15: Unused (= 0)
0xA012	Write	Unsigned	Version	Bits 0-7: Patch version number (LON) Bits 8-15: Subversion number (LON)
0xA013	Write	Unsigned	HW version	Bits 0-7: Hardware version, currently =0 Bits 8-15: Unused (= 0)
0xA014	Write	Unsigned	Neuron ID	Bits 0-15:
0xA015	Write	Unsigned	Neuron ID	Bits 16-31:
0xA016	Write	Unsigned	Neuron ID	Bits 32:47

4.3.4 D-ReX Password

Write access to some register areas for changing parameters and setting temporary states is password protected. This means that a password must be entered beforehand (login) in order to have write access to these areas. The protected areas are marked accordingly in the overview in chapter 4.3. Access to reading the information is always given (except for the password) even without entering the password. The password itself is only shown after entering the password.

After entering the correct password, the protection is removed for 30 minutes. Any number of changes can be made within the 30 minutes. After the timeout has expired, the temporary states are also retained and are NOT reset.

Offset Register address	Access Information	Register Type (16 bit)	Parameter	Explanation:
0xA100	Read/Write	Unsigned	Signature	Signature to identify the telegram (will be decremented after readout).
0xA101	Write	Unsigned	ID	Transfer of ID+PIN for enabling the parameter changes and the simulations (login)
0xA102	Write	Unsigned		
0xA103	Write	Unsigned	PIN	
0xA104	Write	Unsigned		
0xA105	Read/Write	Unsigned	Signature	Signature to identify the telegram (will be decremented after readout).
0xA106	Read/Write	Unsigned	Password Flags	Bit 0: 1= password active, 0= password disabled *2 Bit 1-15: Unused (= 0)
0xA107	Read/Write	Unsigned		Bit inversion of the previous register
0xA108	Read/Write	Unsigned	Signature	Signature to identify the telegram (will be decremented after readout).
0xA109	Read/Write	Unsigned	ID	Change three-digit ID *1
0xA10A	Read/Write	Unsigned		'LON' is defined as the ID.
0xA10A	Read/Write	Unsigned		Bit inversion of the previous register
0xA10A	Read/Write	Unsigned		
0xA10A	Read/Write	Unsigned	Signature	Signature to identify the telegram (will be decremented after readout).
0xA10A	Read/Write	Unsigned	PIN	Change four-digit PIN *1
0xA10A	Read/Write	Unsigned		Default PIN is defined as '0000'.
0xA110	Read/Write	Unsigned		Bit inversion of the previous register
0xA111	Read/Write	Unsigned		

*1: Valid restricted ASCII character set:
/-+9876543210 ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz%&?!.()

*2: Password check can be disabled only if the ID+PIN combination is correct beforehand.

5 GfG Coding Tables

5.1 Unit table

No.	Abbreviation	Designation	No.	Abbreviation	Designation
1	ppm	parts per million	**24**	°F	degrees Fahrenheit
2	Vol%	percent by volume	**25**	g	gram
3	%LEL	lower explosion limit	**26**	kg	kilogram
4	ppb	parts per billion	**27**	Pa	pascal
5	µg	microgram	**28**	kPa	kilopascal
6	mg	milligram	**29**	bar	bar
7	%	percent	**30**	psi	pound per square inch
8	%%	per mil	**31**	s	second
9	m/s	meter per second	**32**	min	minute
10	°C	degree Celsius	**33**	kB	kilobyte
11	mV	millivolt	**34**	MB	megabyte
12	V	volt	**35**	GB	gigabyte
13	mA	milliampere	**36**	mg/l	milligrams per liter
14	A	ampere	**37**	Slpm	standard liters per minute
15	Ohm	ohm	**38**	µA	microamp
16	Dig	digit	**39**	W	watt
23	Grd	degree			

5.2 Table gases and measurands

No.	Molecular formula or abbreviation	Name	No.	Molecular formula or abbreviation	Name
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	NH_3	Ammonia	**39**	C_2H_6	Ethan
7	$C_5H_{12}O$	Amyl alcohol	**40**	C_2H_6O	Ethanol
8	Benzine	Gasoline 60/95	**41**	$C_4H_8O_2$	Ethyl acetate
9	Benzine	Gasoline 80/110	**42**	C_2H_6O	Ethyl alcohol
10	Gasoline	Gasoline 100/140	**43**	C_2H_4	Ethylene
11	C_6H_6	Benzene	**44**	C_2H_4O	Ethylene oxide
12	Cmb.gas	Combustible gas	**45**	Benzine	FAM Regular grade fuel 65/95
13	$CBrF_3$	Bromotrifluoromethane	**46**	Benzine	Aviation fuel 40/180
14	C_4H_6	1,3-Butadiene	**47**	CH_2O	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 (n)	**52**	C_6H_{14}	i-Hexane
20	$C_6H_{12}O_2$	Butyl acetate (n)	**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**	$C_6H_{12}O$	Butyl methyl ketone
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)

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No.	Molecular formula or abbreviation	Name	No.	Molecular formula or abbreviation	Name
67	C_4H_8O	Ethyl methyl ketone	**125**	C_4H_8S (THT)	Tetrahydrothiophene
68	$C_3H_8O_2$	Methyl glycol	**126**	TAL	ToxAlert
69	$C_5H_8O_2$	Methyl methacrylate	**127**	R365	Pentafluorobutane ($C_4H_5F_5$)
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**	R11	Trichlorofluoromethane (CCL_3F)
73	C_8H_{18}	Octane (i)	**131**	R245fa	Pentafluoropropane ($C_3H_3F_5$)
74	C_8H_{18}	Octane (n)	**132**	C_3H_4	Propin
75	C_5H_{12}	Pentane (i)	**133**	CS_2	Carbon disulfide
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}	Pentene	**136**	CH_3Br	Bromomethane
79	$C_7H_{14}O_2$	Pentyl acetate	**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	$C_5H_{10}O_2$	Propyl acetate (i)	**141**	Mixture	Kerosene (180/220)
84	$C_5H_{10}O_2$	Propyl acetate (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**	Mixture	Diesel fuel
89	O_2	Oxygen	**147**	R404A	Refrigerant mixture R404A (R125+R143a+R134a)
90	SO_2	Sulfur dioxide			
91	SF_6	Sulfur hexafluoride	**148**	Br_2	Bromine gas
92	H_2S	Hydrogen sulfide	**149**	VOC	VOC
93	$H_2+CH_4+N_2+CO+...$	Town gas	**150**	PID	PID sensor
94	NO_2	Nitrogen dioxide			
95	NO	Nitric Oxide	**151**	R507	Refrigerant mixture R507 (R125+R143a)
96	C_8H_8	Styrene			
97	$C_2H_2Cl_4$	Tetrachloroethane	**152**	$C_3H_6O_2$ (ETF)	Ethyl formate
98	C_7H_8	Toluene	**153**	Ar	Argon
99	$C_2H_3Cl_3$	Trichloroethane	**154**	R113	Trichlorotrifluoroethane ($C_2CL_3F_3$)
100	C_2HCl_3	TRI - Trichloroethylene	**155**	R1234yf	Refrigerant R1234yf ($C_2H_3F_4$)
101	CHF_3	R23 - Trifluoromethane			
102	$C_4H_6O_2$	Vinyl acetate	**156**	R407C	Refrigerant mixture R407C (R32+R125+R134a)
103	C_2H_3Cl	Vinyl chloride			
104	H_2	Hydrogen	**157**	R410A	Refrigerant mixture (R32+R125)
105	$H_2+CO+...$	Syngas (water gas)			
106	C_8H_{10}	Xylene	**158**	NF_3	Nitrogen trifluoride
107	O_3	Ozone	**159**	pH	pH value
108	$COCl_2$	Phosgene	**160**	Redox	Redox
109	PH_3	Phosphine	**161**	TBM	TBM, tert-butyl mercaptan
110	SiH_4	Silane	**162**	HBr	Hydrogen bromide
111	AsH_3	Arsin	**163**	R438A	Refrigerant mixture (R125+ R134a+R32+n-butane+isopentane)
112	ClO_2	Chlorine dioxide			
113	B_2H_6	Diboran	**164**	R449A	Refrigerant mixture R449A (R134a+R125+R1234yf+R32a)
114	$C_2HCl_2F_3$	R123 - Dichlorotrifluoroethane			
115	$C_4H_{10}O$	Diethyl ether	**165**	R1234ze	Refrigerant HFO-1234ze (1,3,3,3-tetrafluoropropene)
116	N_2O	Nitrous Oxide			
117	$C_2H_4O_2$	Acetic acid	**166**	R448A	Refrigerant mixture (R32+R125+ R134a+R1234yf+R1234ze)
118	F_2	Fluorine			
119	HF	Hydrogen fluoride	**167**	Isopar E	Solvent Isopar E, C8-9 isoparaffin
120	GeH_4	Germanium hydrogen			
121	N_2H_4	Hydrazine	**168**	R454B	Refrigerant mixture R454B (R32 + R1234yf)
122	C_6H_6O	Phenol			
123	C_3H_6O	Propylene oxide	**169**	R32	Refrigerant R32 (difluoromethane, CH_2F_2)
124	$C_2H_2F_4$	R134a - Tetrafluoroethane			

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No.	Molecular formula or abbreviation	Name	No.	Molecular formula or abbreviation	Name
170	R513A	Refrigerant mixture Refrigerant mixture R454B (R32 + R1234yf)			
171	R453A (RS-70)	Refrigerant mixture (R134a+R32 +R125+R227ea+R600+R601a)			
172	R508B (C_2F_6 + CF_3)	Refrigerant mixture (54%R116 + 46%R23)			
173	R454C	R454C refrigerant mixture (78.5%R1234yf+21.5%R32)			
174	ClF_3	Chlorine trifluoride			
175	$C_6H_{19}NSi_2$	Hexamethyldisilazane (HMDS)	**224**	Pw	absolute humidity
176	H_2Se	Hydrogen selenide	**225**	Sig.	Signal
177	$C_8H_{20}O_4Si$	Tetraethyl orthosilicate (TEOS)	**226**	Q	Volumetric flow rate
178	$C_3H_9BO_3$	Trimethyl borate (TMB)	**227**	p	Pressure
179	GeF_4	Germanium tetrafluoride	**228**	m	Mass
180	WF_6	Tungsten hexafluoride	**229**	Dir	Wind direction
181	C_4F_6	Hexafluorobutadiene	**253**	T	Temperature
182	C_5F_8	Octafluorocyclopentene	**254**	Va	Wind speed
183	SiH_2Cl_2	Dichlorosilane (DCS)	**255**	rH	Relative humidity

6 References

[1] D-ReX Operation Manual;
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245-002.30b_OM_DReX_PoI.pdf
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[2] MODBUS Application Protocol Specification V1.1b3;
http://www.modbus.org

[3] MODBUS over Serial Line - Specification & Implementation Guide V1.02;
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[4] Annex to the Operation Manual: LON Bus Implementation;
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