SIEMENS

ELAN Interface

Description 04/98

C79000-B5276-C176-02

Contents

1 General

This ELAN interface description (Economical Local Area Network) is valid for the SIEMENS analyzers:

- ULTRAMAT 6
- OXYMAT 6
- FIDAMAT 6
- ULTRAMAT 23
- SIPAN 34 (in preparation)

The following definitions are used in this description:

- Analyzer: independent analyzer unit with electronics, sample chamber(s) and tubing in a housing
- Channel: analyzer unit with electronics (1 motherboard), connected component(s) and tubing
- Component: unit comprising sample chamber or sensor and associated electronics

The characters used in this description have the following formats:

- xxH: hex format
- 'x': ASCII format
- Other characters are decimal
- Commas are used to separate characters

Example: 54H = 'T' = 84

1.1 Features

ELAN is designed as an economic serial interface for transmitting measured values between analyzers (for correction of cross-interference) and for simple PC communication for test and service purposes.
A small network can be implemented if the requirements for speed (data refresh rate 500 ms) and number of measured components (max. 12) are not too high.

Communication is based on the following specifications:

- Serial data communication (RS 485) with protocol (see Chapter 3)
- Bus capability: connection to up to 2 control systems/PCs and up to 12 components (the number of analyzers and components may differ because one analyzer may measure several components)
- All analyzers connected to the ELAN have equal rights
- To avoid bus conflicts, each analyzer must check the status of the bus and stop the transmission immediately if necessary (CSMA/CD)
- A new command may only be sent if the previous command has been answered completely (except 'broadcast', see Section 1.2).

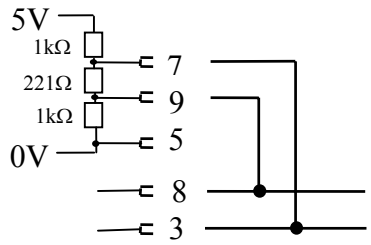
1.2 Broadcast Operation

Analyzers are mainly restricted to answering requests. An exception is the automatic cyclic transmission of all measured values present in a channel (every 500 ms, identical to the answer to command 'k', 2) (see Section 4.9).
The broadcast address is used as the target address (see Sections 3.2 and 4.9). All received messages with this address are neither confirmed nor answered. This procedure allows correction of cross-interference between analyzers. Another feature is the reduced load of the bus as no request telegrams are needed.
The broadcast function can be switched off remotely by a command or directly on the analyzer panel. This master/slave operation requires that the control system/PC must take over the correction of cross-interference.

1.3 Interface Parameters

Level	RS485
Baud rate	9600
Data bits	8
Stop bit	1
Start bit	1
Parity	none
no ECHO	

Pin assignments

ULTRAMAT 6, OXYMAT 6, FIDAMAT 6, ULTRAMAT 23	XMT +	3
	XMT -	8
	switchable Termination	
SIPAN 3	XMT +	Terminal 17
	XMT -	Terminal 18
	GND	Terminal 19

2 ELAN Network

2.1 Principle Connection

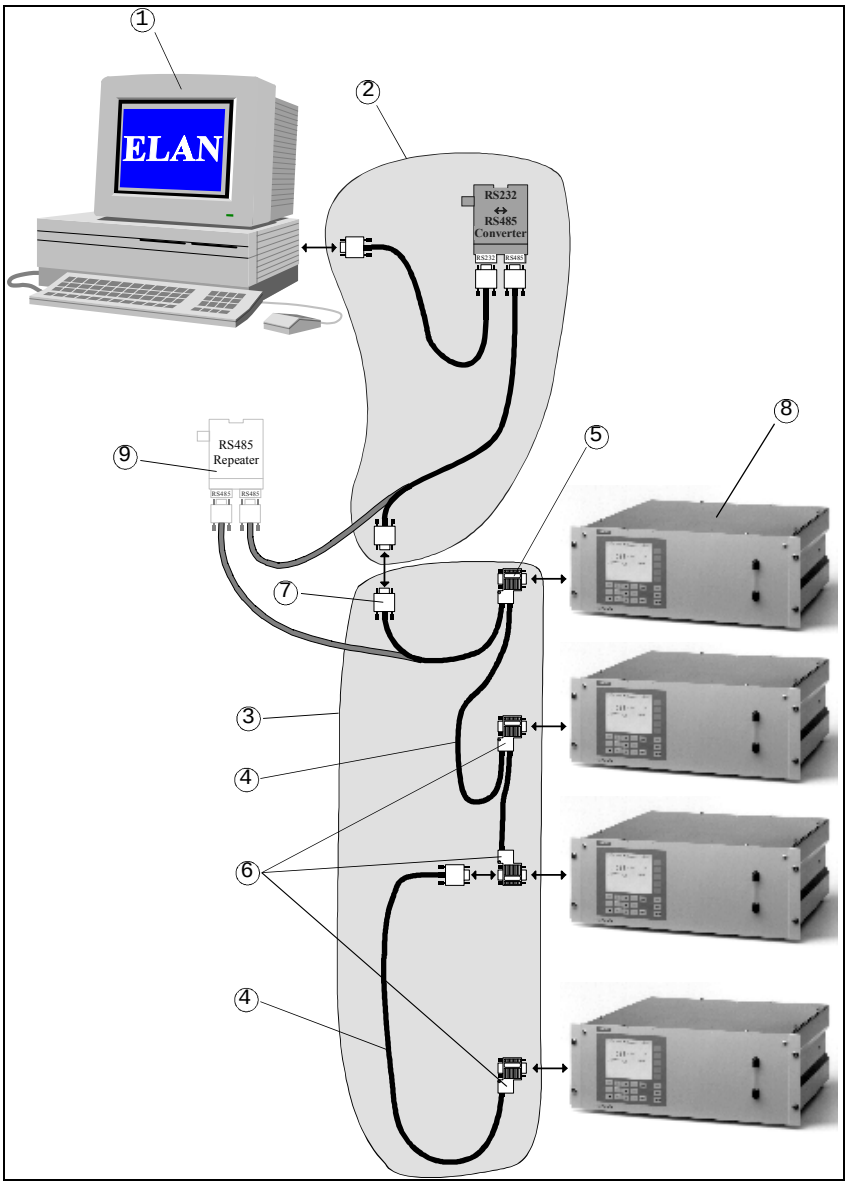


Fig. 02-1 Principle connection

2.2 Elements of ELAN Network

Item	Name
1	Computer
2	RS485 ↔ RS232 converter with connection cable between RS232 and ELAN [1]
3	ELAN network
4	ELAN cable [2]
5	RS485 bus plug [3] with bridge
6	RS485 bus plug[3]
7	9-contact DSUB plug[4]
8	Analyzers
9	Option: RS485 repeater

2.3 Structure of ELAN Network

- Specifications of ELAN cable (item 4)

Cable impedance	100 to 300 Ohm, at frequency > 100 kHz
Cable capacitance	Typ. < 60 pF per meter
Wire diameter	> 0.22 mm^2, corresponding to AWG 23
Type of cable	Twisted pair, 2 wires
Attenuation	Max. 9 dB along the whole cable
Shield	Copper braiding or braided shield and foil

- The cable is easy to install and is highly resistant to noise due to its double shield. It can be used for distances up to 500 m without repeaters.
- The double shield means that the bus cable is particularly suitable for routing in electromagnetically loaded industrial environments.
  Further information:
  - EIA-485
  - ISO 8482:1997 (Twisted Pair Multipoint Interconnections)
  - DIN 66259
- The first plug on an analyzer (item 5) needs a bus termination. The termination is made using the bridges described in Section 0.
- The switches on the plugs (items 5 and 6) have to be OFF. The internal resistances on the plugs are not needed.

Note
A repeater (item 9) should be used at the analyzer end with a cable length of more than 500 m or high interferences.

2.4 Order Numbers

Item	Purveyor	Brief description	Type	Order No.
[1] Converter (item 3)	SIEMENS AG		RS485<--->RS232 converter	C79451-Z1589-U1
[2] Cable (item 4)	SIEMENS AG		Bus cable	6XV1 830-0AH10
[3] Plug (items 5, 6)	SIEMENS AG	Bus cable for PROFIBUS	SIMATIC bus connector	6ES7972-0BB20-0XA0
[4] 9 pin DSUB plug (item 7)	Commercially available			
[5] Repeater (item 9)	Wieseman & Theis GmbH Wittener Str. 312 D-42279 Wuppertal (Germany)		RS422 isolator/ RS485 repeater 1 kV isolated Type 66201	#40 10344 66201 3

3 Protocol

3.1 Protocol Steps

Source	Target	Comments
DLE (10H), SOH (01H)		Start
USED DATA (target address, source address, collective status, channel status, command, data)		Max. characters: 68; 10H is doubled (only when channel answers) (only when channel answers)
DLE (10H), ETX (03H)		End of transmission
BCC, BCC		CRC-16 checksum of all transmitted characters from DLE + SOH onwards
	DLE (10H), ACK (06H) or NAK (15H)	Confirms communication NAK with checksum error

The confirmation of the communication does not occur if the broadcast address is used as the target address.

3.2 Features

Timeout The block timeout is 500 ms. The block timeout is the time in which the answer must have been started. The character timeout is 5 ms.

Block length The maximum useful data length is 68 characters, exceeding data will be ignored.

Control character Each control character is started with DLE (10H). A 10H within the useful data will be doubled (10H, 10H). The transmission is code-transparent as a result of this.

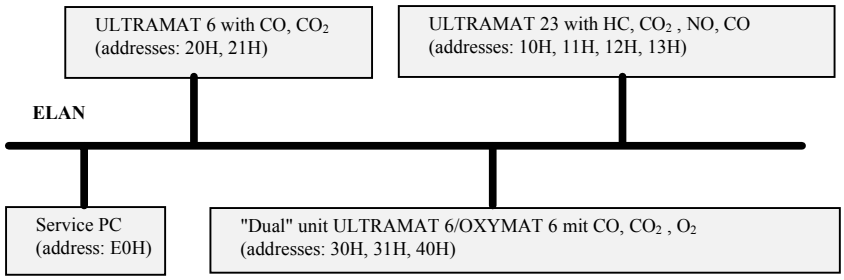
Addressing

The address consists of a channel address (device address with controllers) and a component address:

channel address * 16 + component address = address (1 byte)

0 - 8	(components 1 - 9; depending on channel) (only checked if channels are used)	
1 - 12	(channels 1 - 12)	
13	(DCS/PC)	
14	(service PC)	
15	(broadcast address)	

Example



To find the addresses of the components from a channel, use command 'k', 2 (= *read all measured values of this channel*).
The channels only react if their target address is received correctly. If 'broadcast' is received as the target address there will be neither confirmation nor answer.

Collective status of the channel

When the channel answers, the collective status (1 byte) is transmitted after the addresses.
If the collective status is 0, the transmitted measured values are valid.

Table 03-1 Collective status of a channel

Bit 0: 1 =>	Error
Bit 1: 1 =>	Maintenance request
Bit 2: 1 =>	Not ready (not measure)
Bit 3: 1 =>	Maintenance switch on
Bit 4: 1 =>	Function check on
Bit 5: 1 =>	Command not accepted
Bit 6, 7 = >	0

Channel status

When the channel answers, the channel status (1 byte) is transmitted after the collective status.

Table 3-2 Channel status

1	Warm-up
2	Pause
3	Standby
4	Measure
5	Zero calibration
6	Adjust component slope
7	Not yet defined
8	Adjust curve dip
9	Adjust linearization sensitivity
10	Adjust temperature compensation
11	Adjust pressure compensation
12	Adjust linearization zero
13	Adjust flow sensor
14	Autocal
15	Adjust phase
16	Zero calibration of O_2 sensor
17	Synchronous zero calibration
18	Purging for synchronous zero calibration
19	Adjust analog output
20	Adjust analog input
21	Cleaning

3.3 CRC-16 Checksum (Cyclic Redundancy Check)

The CRC-16 is used for the checksum.
The block check is carried out for all transmitted characters including control characters and DLE doubling.

The CRC-16 is performed as follows:

- The characters to be transmitted are treated as a binary number X.
- X is multiplied by 2^{16} (shifted to the left sixteen times) and then divided by the polynomial $2^{16} + 2^{15} + 2^2 + 1$. The 16-bit remainder of this operation is the CRC-16 value.
- This reminder is preset to FFFFH to prevent a telegram from only consisting of zeros.

This could look as follows:

1. Preset remainder (K0) to FFFFH
2. XOR K0 with the first byte of the message, result to K0
3. Shift K0 by 1 bit to the right
4. If step 3 shifted a bit '1' to the right:
   K0 XOR 0A001H
   otherwise: K0 remains unchanged
5. Repeat steps 3 and 4 eight times
6. XOR next byte with K0
7. Repeat steps 3 to 6 until all bytes of the message have been processed
8. The CRC-16 is now stored in K0

Example program using language 'C':

```
static word k0;
void CrcCheck (byte bb) {
byte bitanzahl;
word flag;
        k0 ^= bb;
        for (bitanzahl = 8; bitanzahl > 0; bitanzahl--) {
                flag = k0 & 1;
                k0 = k0 >> 1;
                if(flag) {
                        k0 ^= 0xA001;
                }
        }
}
```

4 Commands

4.1 General

Commands

- All commands consist of two characters.
  - 1st character: ASCII letter
    2nd character: a number between 1 and 255.
  - Commands for setting/writing statuses or values start with an upper-case letter ('A' to 'Z').
  - Commands for reading start with a lower-case letter ('a' to 'z').
- Commands for setting statuses or values are only executed in remote operation. Commands for reading are always allowed.
- Executed commands are answered with the same command. Answer in case of command not accepted (bit 5 in collective status is set):
  - '??' unknown command
  - 'CE' unknown component
  - 'OF' data input or status selection is not possible because channel is not set to remote
  - 'BS' data input or status selection is not currently possible (function being executed, or wrong mode of operation)
  - 'SE' wrong number of data
  - 'DE' wrong data value
- There are component-related and channel-related commands, and (with SIPAN 34) also parameter-related commands.
  - Channel-related commands are accepted with any valid component address.
  - Parameter-related commands are only valid for the set input/output parameter set ('K', 14).
- Only reading commands are valid while the analyzer is in calibration mode. Exceptions are the commands to control the calibration, the abort commands *Standby* ('Z', 3) and *Measure* ('Z', 4), as well as *Reset* ('Z', 1).

Data

- Transmitted data are values (ASCII format, possibly with added dimension) and control characters (1 byte between 1 and 255). All data are separated by a separation sign (1 byte: 0).
- Excess data are ignored.
- If data are requested within a known command which do not belong to this channel, the answer is finished, or a blank (' ') is inserted if other data follow.

4.2 List of all Commands

	Set channel status	U6	O6	F6	U23	S3
'Z', 1	Reset	b	b	b	b	-
2	Pause	b	b	b	b	-
3	Standby	b	b	b	b	-
4	Measure	b	b	b	b	-
5	Zero calibration	k	k	k	b	-
6	Adjust component slope	k	k	k	k	-
7	Not yet defined					
8	Adjust curve dip	k	-	-	k	-
9	Adjust linearization sensitivity	k	-	-	k	-
10	Adjust temperature compensation	b	b	b	b	-
11	Adjust pressure compensation	b	-	b	-	-
12	Adjust linearization zero	k	-	-	-	-
13	Adjust flow sensor	-	-	-	-	-
14	Autocal (once)	b	b	b	b	-
15	Adjust phase	k	k	-	-	-
16	Zero calibration of O_2 sensor	-	-	-	b	-
17	Not yet defined					
18	Not yet defined					
19	Adjust analog output	k	k	k	k	-
20	Adjust analog output	b	b	b	-	-
21	Cleaning	-	-	-	-	b

U6 = ULTRAMAT 6
O6 = OXYMAT 6
F6 = FIDAMAT 6
U23 = ULTRAMAT 23
S3 = SIPAN 34 (in preparation)

b = channel-related command
k = component-related command
# = read-only command
- = command not implemented
p = parameter-set-related command

Set switching function	U6	O6	F6	U23	S3
'F', 1 *Remote* on/off	b	b	b	b	b
2 Pressure switch for sample gas on/off	b	b	-	b	-
3 Pressure switch for reference gas on/off	-	b	-	-	-
4 Total/single calibration	b	b	b	k	-
5 Maintenance switch on/off	b	b	b	b	b
6 Solenoid valve for zero gas on/off	-	-	-	b	-
7 Ignite flame on/off	-	-	b	-	-
8 Magnetic field on/off	-	b	-	-	-
9 Solenoid valve for calibration gas on/off	-	-	-	b	-
10 Broadcast on/off	b	b	b	b	-
11 Pump on/off	-	-	-	b	-
12 Radiator voltage on/off	b	-	-	-	-
13 Lock logbook on/off	b	b	b	-	-
14 Sample point switching on/off	b	b	b	-	-
15 Suppress negative measured values on/off	k	k	k	-	-
16 Signal violation of calibration tolerance	k	k	k	-	-
17 Cleaning on/off	-	-	-	-	b
18 Zero calibration before slope calibration	-	-	-	k	-

Read/set control function		U6	O6	F6	U23	S3
's'/'S', 1	Limit 1	k	k	k	k	kp
2	Limit 2	k	k	k	k	kp
3	Analog output range	b	b	b	b	bp
4	Relay outputs (standard)	b	b	b	b	-
5	Relay outputs (with optional board)	b	b	b	-	-
6	Binary inputs (standard)	b	b	b	-	-
7	Binary inputs (with optional board)	b	b	b	-	-
8	Current measuring range	k	k	k	k	-
9	Current parameter set	-	-	-	-	b
10	Measuring head heating	-	b	-	-	-
11	*Autocal* mode	b	b	b	-	-
12	*Autocal* steps	b	b	b	b#	-
13	Compensation/calibration step	b	b	b	b	-
14	Temperature compensation	-	-	-	-	b
15	Pressure compensation	k	k	-	-	-
16	Correction of cross-interference	k	k	-	k	-
17	Alarm status	-	-	-	-	k
18	Controller status	-	-	-	-	b
19	Save measured value	b	b	b	b	-
20	Valves	b	b	-	-	-
21	AK parameters	b	b	b	-	-
22	Sync input/pump	-	-	-	b	-
23	External interference component	k	k	k	k	-
24	Dimension of measured value	-	-	-	k	-
25	Internal interference component	-	-	-	k	-
26	Relay outputs / binary inputs	b#	b#	b#	-	-
27	Language selection	b	b	b	b	-

Read/write values		U6	O6	F6	U23	S3
'w'/'W', 1	Start-of-scale values	k	k	k	k#	kp
2	Full-scale values	k	k	k	k	kp
3	Slope gas concentrations	k	k	k	k	-
4	Linearization gas concentrations	k	-	-	k	-
5	Zero gas concentration	k	k	k	k#	-
6	*Autocal* cycle parameters	b	b	b	b	-
7	Purge times for *Autocal* steps 1 to 6	b	b	b	b	-
8	Purge times for *Autocal* steps 7 to 12	b	b	b	-	-
9	Limit 1	k	k	k	k	bp
10	Limit 2	k	k	k	k	bp
11	Integration times	k	k	k	k	b
12	Autorange hysteresis (% measuring range)	k	k	k	k	-
13	Pump capacity	-	-	-	b	-
14	Date of O_2 sensor installation	-	-	-	b	-
15	Not yet defined					
16	Time	b	b	b	-	-
17	Not yet defined					
18	Barometric pressure	b	b	b	b	-
19	Analog output	k	k	k	k	-
20	LCD contrast	b	b	b	b	-
21	Frequency	b	b	-	-	-
22	Reduction value	k	k	-	-	-
23	Phase	k#	k	-	-	-
24	Noise signal suppression	k	k	k	-	-
25	Calibration tolerances	k	k	k	b	-
26	Shock compensation	-	b	-	-	-
27	Parameters of external pressure sensor	k	k	-	-	-
28	Parameters of external interfering gas 1	k	k	-	k	-
29	Sample point times	b	b	-	-	-
30	Relay delay times	-	-	-	-	b
31	Reference temperature	-	-	-	-	bp
32	Basic controller parameters	-	-	-	-	b
33	Controller setpoint	-	-	-	-	b
34	Controller start-of-scale and full-scale values	-	-	-	-	b
35	Controller characteristic point 1	-	-	-	-	b
36	Controller characteristic point 2	-	-	-	-	b
37	Alarm limits	-	-	-	-	kp
38	Cleaning times	-	-	-	-	b
39	Center value of analog output	-	-	-	-	bp
40	Autorange lower limits (absolute value)	k	k	k	-	-
41	Autorange upper limits (absolute value)	k	k	k	-	-
42	Full-scale value of linearization curve	k	k#	k	k	-
43	Deviation in zero and slope calibration	k#	k#	k#	k#	-
44	Parameters of external interfering gas 2	-	-	-	k	-
45	Parameters of internal interfering gas 1	-	-	-	k	-
46	Parameters of internal interfering gas 2	-	-	-	k	-

Read diagnostic values (see Appendix)	U6	O6	F6	U23	S3
'h', 1 -n					

Other commands	U6	O6	F6	U23	S3
'k', 1 Read measured value of one component	k	k	k	k	k
'k', 2 Read all measured values of the channel	b	b	b	b	b
'k', 3 Read channel functions	b	b	b	b	b
'k', 4 Read component functions	k	k	k	k	-
'k', 5 Read error status	b	b	b	b	b
'k', 6 Read channel version	b	b	b	b	b
'K', 7 Reset linearization coefficients	-	-	-	k	-
'k', 8 Read remaining time	-	-	-	b	-
'k', 9 Read time to next zero calibration	-	-	-	b	-
'k', 10 Read logbook entry	b	b	b	b	b
'K', 10 Acknowledge logbook entry	b	b	b	b	-
'k', 11 Not yet defined	-	-	-	-	-
'k', 12 Read maintenance request status	b	b	b	b	b
'k', 13 Not yet defined					
'K', 14 Transfer data sectors	b	b	b	b	-
'k', 15 Not yet defined					
'k'/'K', 16 Channel name	b	b	b	b	b
'k'/'K', 17 Number of parameter set for input and output	-	-	-	-	b
'k', 18 Read message status	b	b	b	-	-
'k', 19 Read current *Autocal* step	b	b	-	-	-
'k', 20 Scan boot program errors	b	b	b	b	-
'K', 20 Start boot program	b	b	b	b	-
'K', 21 Run firmware update	b	b	b	b	-
'K', 22 Clear logbook	b	b	b	-	-

4.3 Data Formats

Transmitted data are values and control characters which are separated by 0H.

- Value => ASCII value ('0' - '9', possibly sign, decimal point).
  Any scanned value (read value) additionally contains the dimension (1 byte).
  Values to be set (write value) are always without a dimension since the dimensions cannot be changed.
- Control character (crc.) => 1-byte value (1 - 255; no 0 to avoid separator)

Table 4-1 Dimensions

1	No dimension (only number)	21	S/cm	41	Hz
2	ppm	22	mS/m	42	pH
3	ppb	23	mS/cm	43	µg/l
4	vpm	24	µS/m	44	mg/l
5	vpm C_1	25	µS/cm	45	l/min
6	vpm C_3	26	s	46	µA
7	vpm C_6	27	min	47	mg/dm^3
8	mg C/m^3	28	h	48	kPa
9	mg/m^3	29	pA	49	kΩ * cm
10	%	30	mA	50	MΩ * cm
11	% v/v	31	µV	51	°
12	% of measuring range	32	mV		
13	% saturation	33	V		
14	%/°C	34	mbar		
15	%/K	35	hPa		
16	% w/w	36	ml/min		
17	mV/pH	37	kΩ		
18	mV/mbar	38	MΩ		
19	nA/mbar	39	S		
20	S/m	40	°C		

Examples

Write values:
-3000 V => '-3000', 0
2.84 ppm, 39.0 °C, 1.8 => '2.84', 0, '39.0', 0, '1.8', 0

Read values:
-3000 V => '-3000', 0, 33, 0
2.84 ppm, 39.0 °C, 1.8 => '2.84', 0, 2, 0, '39.0', 0, 40, 0, '1.8', 0, 1, 0

4.4 Set Channel Status

Command structure

Control command:	'Z', number, control character (if required)
Answer:	'Z', number

Example: start *Measure*

Control command:	'Z', 4	
Answer:	'Z', 4	Command has been or is being executed
	or:	
Answer:	'OF'	Command cannot be executed (e.g. channel is not in *Remote* mode)

Reset **'Z', 1**

The channel executes a *Reset* (as if switched off/on).
Starting the boot program is possible within 1 s after *Reset*.
This command is always accepted.

Pause **'Z', 2**

The channel starts the *Pause* status (pump off; gas flow off, ...),
Only valid in S*tandby* status.

Standby **'Z', 3**

The channel starts the *Standby* status (pump off, ...)
This command also aborts running functions (*adjust component slope, adjust temperature compensation etc*.).

Measure **'Z', 4**

The channel starts the *Measure* status.
This command also aborts running functions (*adjust component slope, adjust temperature compensation etc*.).

Zero calibration

'Z', 5

Zero calibration of selected component (slope calibration of O_2 sensor).
Calibration starts by opening the zero gas valve (relay).
The command 'Set compensation/calibration step' ('S', 13) imports the new zero point.
Only valid in *Standby* or *Measure* status.

Adjust component slope

'Z', 6, crc.
|
|_____ Measuring range (1 to 4)

Slope calibration of the selected measuring range of the addressed component (except O_2 sensor). Calibration starts by opening the calibration gas valve (relay).
The command 'Set compensation/calibration step' ('S', 13) imports the new slope.
With a total calibration, the calculated slope is also assigned to the other measuring ranges.
Only valid in *Standby* or *Measure* status.

Adjust curve dip

'Z', 8

The channel calibrates the dip for linearization of the addressed component (except O_2 sensor). The calibration gas must be connected to the sample gas inlet.
The command 'Set compensation/calibration step' ('S', 13) imports the new curve dip value.
Only valid in *Standby* or *Measure* status and with *maintenance switch on*.

Adjust linearization sensitivity

'Z', 9

The channel calibrates the sensitivity for linearization of the addressed component (except O_2 sensor). The calibration gas must be connected to the sample gas inlet.
The command 'Set compensation/calibration step' ('S', 13) imports the new sensitivity.
Only valid in *Standby* or *Measure* status and with *maintenance switch on*.

Adjust temperature compensation **'Z', 10**

The channel carries out a temperature measuring cycle to determine the temperature coefficients.
The command 'Set compensation step' ('S', 13) controls this procedure. Any temperature step must be set for at least 5 hours.
Only valid in *Standby* or *Measure* status and with *maintenance switch on*.

Adjust pressure compensation **'Z', 11**

The channel carries out a pressure measuring cycle to determine the pressure coefficient.
The command 'Set compensation step' ('S', 13) controls this procedure.
Only valid in *Standby* or *Measure* status and with *maintenance switch on*.

Adjust linearization zero **'Z', 12**

The channel carries out a sensitivity calibration for linearization of the addressed component (except O_2 sensor). The zero gas must be connected to the sample gas inlet.
The command 'Set compensation/calibration step' ('S', 13) imports the new zero point.
Only valid in *Standby* or *Measure* status and with *maintenance switch on*.

Adjust flow sensor **'Z', 13**

The channel carries out a calibration of the flow sensor to the flow setpoint. Three 'Adjust flow sensor' commands are necessary for the calibration. The first command calibrates a zero flow, the second calibrates the flow setpoint, the third calibrates at twice the flow setpoint.
Only valid in *Standby* or *Measure* status and with *maintenance switch on*.

Autocal **'Z', 14**

The channel starts a single *Autocal.*
Only valid in *Standby* or *Measure* status and with *channel function Autocal on*.
Commands for *Autocal* are only permissible for an ULTRAMAT 6 or OXYMAT 6 if the optional board is fitted.

Adjust phase **'Z', 15**

The component carries out an adjustment to determine the phase.

Zero calibration of O_2 sensor **'Z', 16**

The channel carries out a zero calibration for the O_2 sensor. Zero gas must be connected via the sample gas inlet.
The command 'Set compensation/calibration step' ('S', 13) imports the new zero point.
Only valid in *Standby* or *Measure* status and with *maintenance switch on*.

Adjust analog output **'Z', 19**

The component starts the calibration of the analog current output.
The command 'Set analog output' ('W', 19) controls this procedure.
Only valid in *Standby* or *Measure* status and with *maintenance switch on*.

Adjust analog input **'Z', 20**

The channel starts the calibration of the analog current inputs. The analog current output 1 must be adjusted beforehand.
Calibration steps with ULTRAMAT 6 and OXYMAT 6:

1. Connect analog current output 1 to analog current input 1. Send command 'Z', 20.
2. Send command 'Set compensation/calibration step' ('S', 13) (analog current input 1 is adjusted to 20 mA).
3. Send command 'Set compensation/calibration step' ('S', 13) (analog current input 1 is adjusted to 0 mA).
4. Connect analog current output 1 to analog current input 2.
5. Send command 'Set compensation/calibration step' ('S', 13) (analog current input 2 is adjusted to 20 mA).
6. Send command 'Set compensation/calibration step' ('S', 13) (analog current input 2 is adjusted to 0 mA).

Only valid in *Standby* or *Measure* status and with *maintenance switch on*.

Cleaning (SIPAN 34) **'Z', 21**

The channel performs sensor and tube cleaning.
Only valid if no measuring range signalling.

4.5 Set Switching Function

Command structure

Control command:	'F', number, function ('0' => off; '1' => on)
Answer:	'F', number

Example: maintenance switch on

Control command:	'F', 5, '1', 0
Answer:	'F', 5

***Remote* on/off**

'F', 1, function

'0' => off; '1' => on

The channel starts or finishes *Remote* mode *(*remote control via the interface). When *Remote* is off, the channel automatically leaves the *Standby* status and changes to *Measure*. Without *Remote*, only read commands are accepted. Only valid if the channel is coded (all codes switched off).

Pressure switch for sample gas on/off

'F', 2, function

'0' => off; '1' => on

The channel starts or finishes monitoring the sample gas pressure.

Pressure switch for reference gas on/off

'F', 3, function

'0' => off; '1' => on

The channel starts or finishes monitoring the reference gas pressure.

Total/single calibration

'F', 4, function

'0' => single calibration;
'1' => total calibration

The component performs with total calibration (calibration valid for all ranges) or single calibration (each range is calibrated independent of the others). The multi-component version of the ULTRAMAT 6 only allows a total calibration.

Maintenance switch on/off

'F', 5, function

'0' => off; '1' => on

The channel is being serviced (a code has been entered).

Solenoid valve for zero gas on/off (ULTRAMAT 23)

'F', 6, function

'0' => off; '1' => on

The channel switches the internal solenoid valve and the relay contact for the external solenoid valve on or off.

Ignite flame on/off (FIDAMAT 6)

'F', 7, function

_____

'0' => off; '1' => on

The channel starts or finishes the ignition procedure.

Magnetic field on/off (OXYMAT 6)

'F', 8, function

_____

'0' => off; '1' => on

The channel switches the magnetic field on or off.
If the magnetic field is switched off, the heating of the measuring head is also off.

Solenoid valve for calibration gas on/off (ULTRAMAT 23)

'F', 9, function

_____

'0' => off; '1' => on

The channel switches the relay contact for the external solenoid valve on or off.

Broadcast on/off

'F', 10, function

_____

'0' => off; '1' => on

The channel starts or finishes the automatic transmission (broadcasting) of measured values (identical to answer to command 'k', 2).

Pump on/off (ULTRAMAT 23)

'F', 11, function

_____ '0' => off; '1' => on

The channel switches the internal pump on or off.

Radiator voltage on/off (ULTRAMAT 6)

'F', 12, function

_____ '0' => off; '1' => on

The channel switches the radiator voltage on or off.

Lock logbook on/off

'F', 13, function

_____ '0' => off; '1' => on

The channel stops or allows the input of further messages into the logbook.

Sample point switching on/off

'F', 14, function

_____ '0' => off; '1' => on

The channel stops or allows sample point switching.

Suppress negative measured values on/off

'F', 15, function

_____ '0' => off; '1' => on

Signal violation of calibration tolerance on/off

'F', 16, function

_____ '0' => off; '1' => on

Cleaning on/off (SIPAN 34)

'F', 17, function

_____ '0' => off; '1' => on

Zero calibration before slope calibration on/off (ULTRAMAT 23)

'F', 18, function

_____ '0' => off; '1' => on

The zero is automatically calibrated before the component slope.

4.6 Read/Set Control Function

Command structure

Read control:

Control command:	's', number
Answer:	's', number, crc.

Example: analog output range

Control command: 's', 3

Answer: 's', 3, 81H, 0

```
    |   |   |
    |   |   |_   Separator
    |   |_____   Range: 2 - 20 mA, not inverted
    |_________   Analog output current range
```

Set control:

Control command:	'S', number, crc.
Answer:	'S', number

Example: limit 1

Control command: 'S', 1, A3H, 0

Answer: 'S', 1

Read/set limit 1

's'/'S', 1, crc.

```
  |
  |_   Bit 7: 1
     Bit 6: 0
     Bit 5: 1 => limit active                (0 => passive)
     Bit 4: 1 => active upward violation     (0 => downward violation)
     Bit 3: 1 => active in meas. range 4     (0 => passive)
     Bit 2: 1 => "                    "" 3      "
     Bit 1: 1 => "                    "" 2      "
     Bit 0: 1 => "                    "" 1      "
```

The range information is ignored for the ULTRAMAT 23 (always measuring ranges 1 and 2).
The data for upward/downward violation for the ULTRAMAT 23 are only observed if "Limit active" is also present.

Read/set limit 2

's'/'S', 2, crc. (as for alarm 1)

Read/set analog output range

's'/'S', 3, crc.

```
|
|_  Bit 7: 1
    Bit 6, 5, 4: 0
    Bit 3: 1 => bilinear          (0 => linear)
    Bit 2: 1 => inverted          (0 => not inverted)
```

Bit 1	Bit 0	
1	0 => 4 - 20 mA	
0	1 => 2 - 20 mA	(not with SIPAN 34)
0	0 => 0 - 20 mA	

The ranges are never inverted with the ULTRAMAT 23 and SIPAN 34.
Linear/bilinear option only with SIPAN 34.

Read/set relay outputs (standard)

's'/'S', 4, crc. 1, crc. .2, crc. 3, crc. 4, crc. 5, crc. 6, crc. 7, crc. 8

```
|   |   |   |   |   |   |   |
|   |   |   |   |   |   |   |_  Relay 8
|   |   |   |   |   |   |_____  Relay 7
|   |   |   |   |   |_________  Relay 6
|   |   |   |   |_____________  Relay 5
|   |   |   |_________________  Relay 4
|   |   |_____________________  Relay 3
|   |_________________________  Relay 2
|_____________________________  Relay 1
```

Control character (crc.)	Function of the relay output	Comment
1	Free	
2	Error	
3	Maintenance request	
4	Calibration	Only U6/O6
5	Component 1 measuring range 1 selected	Only U6/O6
6	Component 1 measuring range 2 selected	
7	Component 1 measuring range 3 selected	Only U6/O6
8	Component 1 measuring range 4 selected	Only U6/O6
9	Component 1 alarm 1 triggered	
10	Component 1 alarm 2 triggered	
11	Function check	
12	Valve for sample gas is open	Only U6/O6
13	Valve for zero gas is open	
14	Valve for calibration gas 1 is open	
15	Valve for calibration gas 2 is open	Only U6/O6
16	Valve for calibration gas 3 is open	Only U6/O6
17	Valve for calibration gas 4 is open	Only U6/O6
18	Measuring point 1	Only U6/O6
19	Measuring point 2	Only U6/O6
20	Measuring point 3	Only U6/O6
21	Measuring point 4	Only U6/O6
22	Measuring point 5	Only U6/O6
23	Measuring point 6	Only U6/O6

Control character (crc.)	Function of the relay output	Comment
24	Signal from measuring point 1	Only U6/O6
25	Signal from measuring point 2	Only U6/O6
26	Signal from measuring point 3	Only U6/O6
27	Signal from measuring point 4	Only U6/O6
28	Signal from measuring point 5	Only U6/O6
29	Signal from measuring point 6	Only U6/O6
30	Signal contact (for synchronization with *Autocal*)/sync signal	
31	Flow of reference gas	Only U6/O6
32	Flow of sample gas	Only U6/O6
33	Valve for zero gas 2 is open	Only U6/O6
34	Component 2 measuring range 1 selected	Only U6/O6
35	Component 2 measuring range 2 selected	
36	Component 2 measuring range 3 selected	Only U6/O6
37	Component 2 measuring range 4 selected	Only U6/O6
38	Component 2 limit 1 triggered	
39	Component 2 limit 2 triggered	
40	Component 3 measuring range 2 selected	Only U23
41	Component 3 limit 1 triggered	Only U23
42	Component 3 limit 2 triggered	Only U23
43	Component 4 measuring range 2 selected	Only U23
44	Component 4 limit 1 triggered	Only U23
45	Component 4 limit 2 triggered	Only U23
46	CAL/MEAS	Only U23

ULTRAMAT 6 and OXYMAT 6 have only 6 relay outputs.
Each function can be set for only one relay.

Read/set relay outputs (with optional board)

's'/'S', 5, crc. 1, crc. 2, crc. 3, crc. 4, crc. 5, crc. 6, crc. 7, crc. 8

```
|   |   |   |   |   |   |   |
|   |   |   |   |   |   |   |__  Relay 8
|   |   |   |   |   |   |______  Relay 7
|   |   |   |   |   |__________  Relay 6
|   |   |   |   |______________  Relay 5
|   |   |   |__________________  Relay 4
|   |   |______________________  Relay 3
|   |__________________________  Relay 2
|______________________________  Relay 1
```

See "Relay outputs (standard)" for explanation of control characters.

Read/set binary inputs (standard)

's'/'S', 6, crc. 1, crc. 2, crc. 3, crc. 4, crc. 5, crc. 6

					_ Binary input 6
				_____	Binary input 5
			_____		Binary input 4
		_____			Binary input 3
	_____				Binary input 2
_____					Binary input 1

Control character	Function of the binary input	Comment
1	Free	
2	Error 1	
3	Error 2	
4	Error 3	
5	Error 4	
6	Maintenance request 1	
7	Maintenance request 2	
8	Maintenance request 3	
9	Maintenance request 4	
10	Acknowledge (clear logbook)	
11	Function check 1	
12	Function check 2	
13	Function check 3	
14	Function check 4	
15	Initiate *Autocal*	
16	Select measuring range 1	
17	Select measuring range 2	
18	Select measuring range 3	
19	Select measuring range 4	
20	Autoranging	
21	Open zero gas valve	
22	Open calibration gas valve	
23	Open sample gas valve	
24	Zero calibration	
25	Sensitivity calibration	
26	Select component 2	
27	Pump on/off	Only U23
28	Synchronous zero calibration	Only U23

Each function can be set for only one binary input.

Read/set binary inputs (with optional board)

's'/'S', 7, crc. 1, crc. 2, crc. 3, crc. 4, crc. 5, crc. 6, crc. 7, crc. 8

|	|	|	|	|	|	|	|_	Binary input 8
|	|	|	|	|	|	|_____	Binary input 7
|	|	|	|	|	|_____		Binary input 6
|	|	|	|	|_____			Binary input 5
|	|	|	|_____				Binary input 4
|	|	|_____					Binary input 3
|	|_____						Binary input 2
|_____								Binary input 1

See "Binary inputs (standard)" for explanation of control characters.

Read/set current measuring range

's'/'S', 8, crc.

\|
\|_ Bit 7: 1
Bit 6, 5, 4, 3: 0
Bit 2: 1 => autorange on

Bit 1	Bit 0
1	1 => measuring range 4
1	0 => " 3
0	1 => " 2
0	0 => " 1

The autorange function is switched off if a measuring range is set.
Ranges 3 and 4 cannot be selected for the ULTRAMAT 23.

Read/set current parameter set (SIPAN 34)

's'/'S', 9, crc.

\|
\|_ Bit 7: 1
Bit 6, 5, 4, 3, 2: 0

Bit 1	Bit 0
1	1 => parameter set 4
1	0 => " 3
0	1 => " 2
0	0 => " 1

Parameter set with which the analyzer is currently working.

Read/write measuring head heating

's'/'S', 10, crc.

```
|
|_  Bit 7: 1
    Bit 6, 5, 4: 0
    Bit 3: 1 => measuring head heating on (0 => off)
    Bit 2: 0
```

Bit 1	Bit 0
1	1 => 100 °C setpoint temperature
1	0 => 90 °C "
0	1 => 80 °C "
0	0 => 75 °C "

Read/set *Autocal* mode

's'/'S', 11, crc.

```
|
|_  Bit 7: 1
    Bit 6, 5, 4, 3: 0
    Bit 2: 1 => Autocal on (0 => off)
    Bit 1: 1 => start by binary input
    Bit 0: 1 => start by cyclic parameter
```

Commands for *Autocal* are only valid for the ULTRAMAT 6 and OXYMAT 6 if the optional board is fitted.

Read/set *Autocal* steps

's'/'S', 12, crc. 1, crc. 2, crc. 3, ... crc. 12

```
|     |     |     |
|     |     |     |____  Step 12
|     |     |__________  "    3
|     |________________  "    2
|______________________  "    1
```

Control character	Step	Comment
1	Not used	
2	Zero gas 1	
3	Zero gas 2	
4	Calibration gas 1	
5	Calibration gas 2	
6	Calibration gas 3	
7	Calibration gas 4	
8	Sample gas purging	
9	Intermediate sample gas mode	
10	Signalling contact	

Commands for *Autocal* are only valid for the ULTRAMAT 6 and OXYMAT 6 if the optional board is fitted.

Read/set compensation/ calibration step

's'/'S', 13, crc.

|
|_ 1 - 255

With multi-step compensation/calibration procedures, a "Set step" command sets the current values for calculation of the compensation and starts the next step. The transmitted control character is ignored.
With "Read step", the control character defines the current step.

Read/set temperature compensation (SIPAN 34)

's'/'S', 14, crc.

|
|_ Bit 7: 1
Bit 6, 5, 4: 0
Bit 3: 1 => temperature compensation in parameter set 4
Bit 2: 1 => " 3
Bit 1: 1 => " 2
Bit 0: 1 => " 1

Read/set pressure compensation

's'/'S', 15, crc. 1, crc. 2

| |
| |_ Bit 7: 1
| Bit 6, 5, 4, 3, 2: 0

Bit 1	Bit 0	Analog input of ext. pressure
1	0 =>	4 - 20 mA
0	1 =>	2 - 20 mA
0	0 =>	0 - 20 mA

|
|_____ Bit 7: 1
Bit 6, 5, 4, 3, 2: 0

Bit 1	Bit 0
1	1 => pressure comp. with ELAN
1	0 => pressure comp. with analog current
0	1 => pressure comp. with int. pressure
0	0 => no pressure compensation

Read/set correction of cross-interference **'s'/'S', 16, crc. 1, crc. 2**

Bit 7: 1
Bit 6: 0
Bit 5: 1 => corr. of cross-interference valid for range 4
Bit 4: 1 => corr. of cross-interference valid for range 3
Bit 3: 1 => corr. of cross-interference valid for range 2
Bit 2: 1 => corr. of cross-interference valid for range 1

Bit 1	Bit 0	Analog input of ext. interfering gas
1	0 =>	4 - 20 mA
0	1 =>	2 - 20 mA
0	0 =>	0 - 20 mA

Bit 7: 1
Bit 6, 5, 4, 3, 2: 0

Bit 1	Bit 0
1	1 => residual gas influence via ELAN
1	0 => residual gas infl. with analog current
0	1 => constant residual gas interference
0	0 => no residual gas influence

Read/set alarm status (SIPAN 34) **'s'/'S', 17, crc.**

Bit 7: 1
Bit 6, 5, 4: 0
Bit 3: 1 => alarm enabling in parameter set 4
Bit 2: 1 => " 3
Bit 1: 1 => " 2
Bit 0: 1 => " 1

Read/set controller status (SIPAN 34) **'s'/'S', 18, crc.**

Bit 7: 1
Bit 6, 5, 4: 0
Bit 1: 1 => frequency controller (0 => pulse length controller)
Bit 0: 1 => controller on (0 => controller off)

Read/set measured-value saving

's'/'S', 19, crc.

Bit 5	Bit 4	with error:
1	1 =>	highest value (20 mA)
1	0 =>	lowest value (0/2/4 mA)
0	1 =>	save measured value
0	0 =>	save function off (update)
Bit 1	Bit 0	with function check:
1	1 =>	highest value (20 mA)
1	0 =>	lowest value (0/2/4 mA)
0	1 =>	save measured value
0	0 =>	save function off (update)

Bit 7: 1
Bit 6, 3, 2: 0

With the ULTRAMAT 6 and OXYMAT 6 there is no difference between an error and a function check. The input for a function check thus also applies to an error.

Read/set valves

's'/'S', 20, crc.

Bit 7: 1
Bit 6: 0
Bit 5: 1 => valve for calibration gas 4 open (0 => close)
Bit 4: 1 => " calibration gas 3 " "
Bit 3: 1 => " calibration gas 2 " "
Bit 2: 1 => " calibration gas 1 " "
Bit 1: 1 => " zero gas " "
Bit 0: 1 => " sample gas " "

Read/set AK parameters

's'/'S', 21, crc. 1, crc. 2, crc. 3, crc. 4, crc. 5

'Don't care' character
End character
Start character
AK[1] format (see table)
Baud rate (see table)

This command is only permissible with the AK optional board fitted.
The start character, end character and 'Don't care' character must not be 0.

Control character 1	Baud rate
1	300
2	600
3	1200
4	2400
5	4800
6	9600

[1] AK: Arbeitskreis der deutschen Automobilindustrie (Working Party of the German Automotive Industry)

Control character 2	AK format			
	No. of data bits	Parity	No. of stop bits	No. of bits per sign
1	7	None	2	10
2	7	Even	1	10
3	7	Odd	1	10
4	8	None	1	10
5	7	Even	2	11
6	7	Odd	2	11
7	8	Even	1	11
8	8	Odd	1	11
9	8	None	2	11

Sync input/pump (ULTRAMAT 23)

's'/'S', 22, crc.

Bit 7: 1
Bit 6, 5, 4, 3: 0
Bit 2: 1 => pump on with *Zero calibration* (0 => off)
Bit 1: 1 => pump on with *Measure* (0 => off)
Bit 0: 1 => Sync input starts *Zero calibration*
(0 => no *Zero calibration;* only set Cal contact)

Read/set external interference component

's'/'S', 23, crc. 1, crc. 2

Component address for correction of cross-interference 2
Bit 7, 6, 5, 4: channel address (1 - 12)
Bit 3, 2, 1, 0: component address (0 - 4)

Component address for correction of cross-interference 1
Bit 7, 6, 5, 4: channel address (1 - 12)
Bit 3, 2, 1, 0: component address (0 - 4)

With the ULTRAMAT 6 and OXYMAT 6, only the component address for correction of cross-interference 1 is valid.

Read/set dimension of measured value (ULTRAMAT 23)

's'/'S', 24, crc.

Control character	Dimension	Comment
1	Not used	
2	vpm	
3	%	Not currently used
4	mg/m^3	
5	ppm	

This command is not valid for the O_2 sensor.

Read/set internal interference component

's'/'S', 25, crc. 1, crc. 2

| | | Component address for correction of internal cross-interference 2
| | | Bit 7: 1
| | | Bit 6, 5, 4: 0
| | | Bit 3, 2, 1, 0: component address (0 - 4)
| | |
| |_____ | Component address for correction of internal cross-interference 1
| | Bit 7: 1
| | Bit 6, 5, 4: 0
| | Bit 3, 2, 1, 0: component address (0 - 4)

Read relay inputs / binary outputs

"s"/, 26, crc. 1, crc. 2, crc. 3, crc. 4

				binary inputs 8 - 14
				Bit 7 : 1
				Bit 0 - 6 : state of binary inputs 8 - 14
				binary inputs 1 - 7
				Bit 7 : 1
				Bit 0 - 6 : state of binary inputs 1 - 7
				relay outputs 8 - 14
				Bit 7 : 1
				Bit 0 - 6 : state of relay outputs 8 - 14
				relay outputs 1 - 7
				Bit 7 : 1
				Bit 0 - 6 : state of relay outputs 1 - 7

Relay outputs 8 – 14 and binary inputs 8 – 14 on supplementary electronics board (optional).

read/set language selection

"s"/"S", 27, crc.

	1 => German
	2 => English
	3 => Spanish
	4 => French
	5 => Italian

4.7 Read/Write Values

Command structure

Read values:

Control command:	'w', number
Answer:	'w', number, val. 1 ... val. n

Example: read integration times

Control command: 'w', 11

Answer: 'w', 11, '10.0', 0, 9, 0,
'1.0', 0, 25, 0,
'3.0', 0, 25, 0,
'5.0', 0, 25, 0

- Separator
- Units (Table 4-1)
- Separator
- Values
- Integration times

Write values:

Control command:	'W', number, val. 1 ... val. n
Answer:	'W', number,

Example: write slope gas concentrations

Control command: 'W', 3, '10.0', 0, '50', 0, '100.0', 0, '3000', 0

Answer: 'W', 3

Read/write start-of-scale values

'w'/'W', 1, val. 1, val. 2... val. n

- Start-of-scale value of highest range
- " measuring range 2
- " measuring range 1

Condition: value 1 < value 2 <... < value n
With the ULTRAMAT 6, value 1 is valid for all measuring ranges

Read/write full-scale values

'w'/'W', 2, val. 1, val. 2... val. n

- Full-scale value of highest range
- " measuring range 2
- " measuring range 1

Condition: value 1 < value 2 <... < value n

Read/write slope gas concentrations

'w'/'W', 3, val. 1, val. 2... val. n

- Calibration gas concentration:
- Highest measuring range
- Measuring range 2
- Measuring range 1

The slope gas concentrations must be smaller than the full-scale value of the associated measuring range.

Read/write linearization gas concentrations

'w'/'W', 4, val. 1, val. 2

|	
|	Concentration of sensitivity gas
|	" of curve dip gas

This command is only valid for IR components.
The concentration of the curve dip gas must be between 30 % and 70 % of the full-scale value, and the concentration of the sensitivity gas between 70 % and 105 % of the full-scale value.

Read/write zero gas concentration

'w'/'W', 5, value

Read/write *Autocal* cycle parameters

'w'/'W', 6, val. 1, val. 2, val. 3

|	
|	Carry out slope calibration following each 'Value 3' cycle
|	Cycle time (in hours)
|	Time up to next *Autocal* (in minutes)

With the ULTRAMAT 6 and OXYMAT 6, commands for *Autocal* are only valid with the optional board fitted.
With the ULTRAMAT 23, value 3 cannot be written.

Read/write purge times for *Autocal* steps 1 to 6

'w'/'W', 7, val. 1, val. 2, val. 3, ... val. 6

|	|	|	|_____ Purge time step 6 (in min)
|	|	|_____	" 3 "
|	|_____		" 2 "
|_____			" 1 "

Purge time inputs for step 'Signalling contact' are ignored.
With the ULTRAMAT 6 and OXYMAT 6, commands for *Autocal* are only valid with the optional board fitted.
ULTRAMAT 23 only has the *Autocal* steps for zero gas and sample gas purging with the same purge time. This purge time is entered using value 1. Further values are ignored.
If an O_2 probe is connected, times less than 1 min can be entered for the ULTRAMAT 23.

Read/write purge times for *Autocal* steps 7 to 12

'w'/'W', 8, val. 7, val. 8, val. 9... val. 12

|	|	|	|_____ Purge time step 12 (in min)
|	|	|_____	" 9 "
|	|_____		" 8 "
|_____			" 7 "

Purge time inputs for step 'Signalling contact' are ignored.
With the ULTRAMAT 6 and OXYMAT 6, commands for *Autocal* are only valid with the optional board fitted.

Read/write limit 1

'w'/'W', 9, val. 1, val. 2

|	|
|	|_____ Hysteresis
|_____	Limit

The hysteresis can only be entered for SIPAN 34.

Read/write limit 2

'w'/'W', 10, val. 1, val. 2

|	|
|	|_____ Hysteresis
|_____	Limit

The hysteresis can only be entered for SIPAN 34.

Read/write integration times

'w'/'W', 11, val. 1, val. 2, val. 3, val. 4

			_____ Dead time (in s)
		_____	T90 outside threshold value (in s)
	_____		T90 within threshold value (in s)
_____			Threshold value (in % of smallest measuring range)

A dead time cannot be entered for the ULTRAMAT 6, OXYMAT 6 and ULTRAMAT 23.

Read/write autorange hysteresis thresholds

'w'/'W', 12, val. 1, val. 2

	__ Lower threshold (in % of lower measuring range)
_____	Upper threshold (in % of current measuring range)

The upper threshold must be higher than the lower threshold.

Read/write pump capacity

'w'/'W', 13, val.

_____ Capacity (0 - 100)

Read/write date of O_2 sensor installation

'w'/'W', 14, val. 1, val. 2, val. 3

		_____	Year (0 - 99)
	_____		Month (1 - 12)
_____			Day (1 - 31)

This command is only permissible with an O_2 sensor connected.
A zero calibration (”Z”, 5) must have been executed prior to input of date.

Read/write time

'w'/'W', 16, val. 1, val. 2, val. 3, val. 4, val. 5

				_____ Year (0 - 99)
			_____	Month (1 - 12)
		_____		Day (1 - 31)
	_____			Hour (0 - 23)
_____				Minute (0 - 59)

Read/write barometric pressure **'w'/'W', 18, val.**

|____ Read value of pressure sensor, or adjust pressure sensor to entered value (in hPa).

Read/write analog output **'w'/'W', 19, val.**

By writing the measured value (in µA) at the analog output in mode *Adjust analog output*, the current output is set to the defined setpoint, and the next current value is output.
'Read analog output' shows the actual analog output current.

Read/write LCD contrast **'w'/'W', 20, val.**

|____ Contrast (1 - 100)

Read/write frequency **'w'/'W', 21, val.**

|____ Read or set the chopper frequency for the ULTRAMAT 6 or the magnetic field frequency for the OXYMAT 6.

Read/write reduction value **'w'/'W', 22, val.**

|____ Read reduction value for gain or set reduction value to entered value.

Read/write phase **'w'/'W', 23, val.**

|____ Read phase value or set phase to entered value.

Read/write noise signal suppression **'w'/'W', 24, val.**

|____ Suppress noise signals with a duration of up to 'val.' (in s).

Read/write calibration tolerances **'w'/'W', 25, val. 1, val. 2, val. 3**

|	|	|____	Number of calibrations for determination of tolerance
|	|		
|	|_____		Calibration tolerance at zero (in % of smallest measuring range)
|			
|_____			Calibration tolerance of sensitivity (in % of current measuring range)

The calibration tolerance of the sensitivity is not used with the ULTRAMAT 23. The number of calibrations is not used with the ULTRAMAT 6 and OXYMAT 6.

Read/write shock compensation

'w'/'W', 26, val.

|__ Attenuation coefficient in the compensation circuit (in % of the measuring circuit attenuation).

Read/write parameters of external pressure sensor

'w'/'W', 27, val. 1, val. 2

| |	
| |___	Full-scale value of external pressure sensor (in kPa)
|_____	Start-of-scale value

Read/write parameters of external interfering gas 1

'w'/'W', 28, val. 1, val. 2, val. 3

| | |	
| | |_____	Full-scale value of interfering gas
| |_____	Start-of-scale value
|_____	Interfering gas equivalent

With the ULTRAMAT 23, only the interfering gas equivalent applies.

Read/write sample point times

'w'/'W', 29, val. 1, val. 2, val. 3, ... val. 6

| | | |	
| | | |___	6th sample point time (in min)
| | |_____	3rd " " "
| |_____	2nd " " "
|_____	1st " " '

Inputs for sample points which are not enabled (relay set) are ignored.

Note

The assignment of the sample point number to the sample point time results from the number of the relay which is assigned to the sample point. The sample point with the lowest relay number is assigned the first sample point time, etc.

Read/write relay delay times (SIPAN 34)

'w'/'W', 30, val. 1, val. 2, val. 3

| | |	
| | |_____	Warning delay time
| |_____	Failure delay time
|_____	Limit delay time

Read/write reference temperature for temperature compensation (SIPAN 34)

'w'/'W', 31, val.

|_____ Reference temperature for temperature compensation

Read/write basic controller parameters (SIPAN 34)

'w'/'W', 32, val. 1, val. 2

| |_____	Switch-on time/duration (depending on chosen controller)
|_____	Period/frequency (depending on chosen controller)

Read/write controller setpoint (SIPAN 34)

'w'/'W', 33, val. 1, val. 2

| |_____	Neutral range
|_____	Setpoint

Read/write controller start-of-scale and full-scale values (SIPAN 34)

'w'/'W', 34, val. 1, val. 2

| |_____	Full-scale value
|_____	Start-of-scale value

Read/write controller characteristic point 1 (SIPAN 34)

'w'/'W', 35, val. 1, val. 2, val. 3

| | |_____	Reset time 1
| |_____	% of manipulated variable for point 1
|_____	Controlled variable for point 1

Read/write controller characteristic point 2 (SIPAN 34)

'w'/'W', 36, val. 1, val. 2, val. 3

| | |_____	Reset time 2
| |_____	% of manipulated variable for point 2
|_____	Controlled variable for point 2

Read/write alarm limits (SIPAN 34)

'w'/'W', 37, val. 1, val. 2, val. 3, val. 4

| | | |_____	Upper limit for triggering the warning relay
| | |_____	Lower limit "
| |_____	Upper limit for triggering the failure relay
|_____	Lower limit "

Read/write cleaning times (SIPAN 34)

'w'/'W', 38, val. 1, val. 2, val. 3, val. 4, val. 5

				|_____ Run-in time
			|_____	Waiting time
		|_____		Cleaning time
	|_____			Rinsing time
|_____				Cycle time

Read/write center value of analog output (SIPAN 34)

'w'/'W', 39, val.

|_____ Measured value when the analog output is 10 mA (range 0 - 20 mA) or 12 mA (range 4 - 20 mA).

Read/write autorange lower limits

'w'/'W', 40, val. 1, val. 2, val. 3

		|_____ Lower limit for measuring range 4
	|_____	" " " 3
|_____		" " " 2

If the measured value falls below the lower limit for measuring range x, measuring range x-1 will be selected if autorange is on. The limit for measuring range x must be greater than or equal to the limit of measuring range x-1.

Read/write autorange upper limits

'w'/'W', 41, val. 1, val. 2, val. 3

		|_____ Upper limit for measuring range 3
	|_____	" " " 2
|_____		" " " 1

If the measured value exceeds the upper limit for measuring range x, measuring range x+1 will be selected if autorange is on. The limit for measuring range x must be greater than or equal to the limit of measuring range x-1. The upper limit must be greater than the lower limit of the same measuring range.

Read/write full-scale value of linearization curve

'w'/'W', 42, val.

|_____ Full-scale value of linearization curve

Read deviation in zero and slope calibration

'w'/'W', 43, val. 1, val. 2

	|__ Deviation in slope calibration (not ULTRAMAT 23)
|_____	Deviation in zero

Read deviations for last *Zero calibration* ('Z', 5), *Adjust component slope* ('Z', 6) or *Autocal* ('Z', 14).

Read/write parameters of external interfering gas 2

'w'/'W', 44, val. 1, val. 2, val. 3

With the ULTRAMAT 23, only the interfering gas equivalent applies.

Read/write parameters of internal interfering gas 1

'w'/'W', 45, val. 1, val. 2, val. 3

With the ULTRAMAT 23, only the interfering gas equivalent applies.

Read/write parameters of internal interfering gas 2

'w'/'W', 46, val. 1, val. 2, val. 3

With the ULTRAMAT 23, only the interfering gas equivalent applies.

4.8 Read Diagnostic Values

Command structure

Read values:

Control command:	'h', number
Answer:	'h', number, value

Example: read temperature of measuring head (OXYMAT 6)

Control command:	'h', 2
Answer:	'h', 2, '75.8', 0, 40, 0

Separator	
Unit (Table 4-1)	
Separator	
Value	
Diagnostic number	

See Section 7.1 for table of diagnostic values.

4.9 Other Commands

Read measured value of one component

'k', 1, val., crc.

| |	
| |_____	Measured variable (see Tabelle 4-2)
|_____	Measured value of component

Tabelle 4-2 Measured variable

1. no component	26. C_6H_6
(only used with command "k", 2)	27. SF_6
2. CO	28. CH_3OH
3. CO_2	29. C_2H_5
4. CH_4	30. CH_2Cl_2
5. C_6H_{14}	31. $C_2H_4Cl_2$
6. SO_2	32. CH_3Cl
7. NO	33. C_2H_4O
8. NO_2	34. H_2O (water vapor)
9. $CHClF_2$ (R22)	35. G/l (conductivity)
10. C_3H_8	36. C
11. C_4H_{10}	37. S
12. O_2	38. N
13. C_5H_{12}	39. CF_4
14. Σ HC	40. $COCl_2$ (phosgene)
15. P (process pressure)	41.
16. pH	42.
17. T (temperature)	43.
18. C_2H_4	44.
19. C_2H_2	45.
20. C_3H_6	
21. C_4H_6	100. Help variable process pressure
22. C_4H_8	(only used at command 'k',2)
23. C_2H_6	101.
24. NH_3	102.
25. N_2O	103.

Read measured value(s) of the channel

'k', 2, val. 1, crc. 1, ...
val. x, crc. x

| |	
| |_____	Measured variable (see Tabelle 4-2)
|_____	Measured value of component

This command can be used to determine the assignment between component and measured variable.

Read channel functions

'k', 3, crc. 1, crc. 2, crc. 3, ...

```
|       |       |
|       |       |__     Bit 7: 1
|       |               Bit 2, 3, 4, 5, 6: 0
|       |               Bit 1: 1 => solenoid valve for calibration gas on
|       |               Bit 0: 1 => cleaning on
|       |
|       |_________      Bit 7: 1
|                       Bit 6: 1 => measured-value store on
|                       Bit 5: 1 => sample point switching on
|                       Bit 4: 1 => logbook locked
|                       Bit 3: 1 => Autocal calibration cycles on
|                       Bit 2: 1 => radiator voltage on
|                       Bit 1: 1 => pump on
|                       Bit 0: 1 => solenoid valve for zero gas on
|
|_________________      Bit 7: 1
                        Bit 6: 1 => measuring head heating on
                        Bit 5: 1 => magnetic field on
                        Bit 4: 1 => pressure monitor for reference gas on
                        Bit 3: 1 => pressure monitor for sample gas on
                        Bit 2: 1 => broadcast on
                        Bit 1: 1 => remote on
                        Bit 0: 1 => maintenance switch on
```

Read component functions

'k', 4, crc. , ...

```
|
|_______________  Bit 7: 1
                  Bit 6: 0
                  Bit 5: 1 => calibrate zero before slope
                  Bit 4: 1 => signal violation of calibration tolerance
                  Bit 3: 1 => suppress negative measured values
                  Bit 2: 1 => total calibration
                  Bit 1: 1 => limit monitoring on
                  Bit 0: 1 => autorange on
```

Read error status

'k', 5, crc. 1, ... crc. x

```
|
|_______________  Current errors (see Instruction Manual)
```

Read channel version

'k', 6, crc., val. 1, val. 2, val. 3, val. 4, val. 5, val. 6

```
|       |       |     |     |       |       |
|       |       |     |     |       |       |__________  Meas. range list
|       |       |     |     |       |__________________  Firmware number
|       |       |     |     |__________________________  Order No.
|       |       |     |________________________________  Revision
|       |       |_____________________________________  Software version
|       |_____________________________________________  Serial No.
|_____________________________________________________  Channel type
                                                         (Table 4-3)
```

Values 1 to 6 may contain ASCII letters and characters (+, -, ., /, etc.) in addition to ASCII numbers.

Table 4-3 Channel type

1	ULTRAMAT 6
2	OXYMAT 6
3	FIDAMAT 6
4	ULTRAMAT 23
5	SIPAN 34
6	---
7	CALOMAT 6

Reset linearization coefficients

'K', 7

Only valid with *maintenance switch on*.

Read remaining time

'k', 8, val.

| Remaining time for statuses with automatic change upon expiry (e.g. *Warm-up phase, Temperature compensation, Zero calibration, Slope calibration...).*

Read time to next *zero calibration*

'k', 9, val.

Read logbook entry

Control command:

'k', 10, crc.

| Entry number (last entry => number 1; last but one entry => number 2; etc.)

Answer:

'k', 10, crc. 1, crc. 2, crc. 3, val. 1, val. 2, val. 3, val. 4, val. 5

| Year
| Month
| Day
| Hour
| Minute
| Status (Table 4-4)
| Error No.
| Entry No.

Table 4-4 Status of logbook entries

Bit 0:	1 => error appeared 0 => error disappeared
Bit 1:	1 => entry acknowledged 0 => entry not acknowledged
Bit 2, 3, 4, 5, 6:	0
Bit 7:	1

Acknowledge logbook entry

'K', 10, crc.

|_____ Entry number (last entry => number 1; last but one entry => number 2; etc.)

Read measured values of channel and lambda

'k', 11, val. 1, ... val. x, val. y

| |
| |_____ Calculated lambda value (according to Brettschneider formula)
|_____ Measured value of the components 1... x

Read maintenance request status

'k', 12, crc. 1... crc. x

|_____ Current maintenance requests (see Instruction Manual)

Transfer data sectors

'K', 14, crc.

Control character	Function
1	Load user data into current working data
2	Save current working data in user data
3	Load factory settings into current working data
4	Save current working data in factory settings
5	Load basic factory data into current working data

No communication is possible while these commands are being executed.
A *Reset* is executed automatically following the load commands.
With ULTRAMAT 23 the commands for the user data (control characters 1, 2) are not possible.

Read/enter channel name

'k'/'K', 16, val.

A name can be assigned to the channel to permit easy identification.
The value may contain ASCII letters and characters (+, -, ., /, etc.) in addition to ASCII numbers. The maximum length of the value is 10 characters (SIPAN34: 8 characters).

Read/enter input/output parameter set (SIPAN 34)

'k'/'K', 17, crc.

|_____ Number of parameter set to be processed (1 - 4)

Read message status

'k', 18, crc. 1... crc. x

|_____ Current messages (see Instruction Manual)

Read current *Autocal* step

'k', 19, crc.

Control character	Step	Comment
1	No *Autocal*	
2	Zero gas 1	
3	Zero gas 2	
4	Calibration gas 1	
5	Calibration gas 2	
6	Calibration gas 3	
7	Calibration gas 4	
8	Sample gas purging	
9	Intermediate sample gas mode	
10	Signalling contact	

With ULTRAMAT 6 and OXYMAT 6, commands for *Autocal* are only permissible with the optional board fitted.

Scan boot program errors

"k", 20, Stz.

| _____ Bit 7: 1
Bit 6, 5, 4, 3 : 0
Bit 2: 1 => transmission error
Bit 1: 1 => data error
Bit 0: 1 => flashprom-error

Error scan only possible aftger termination of boot program.

Start boot program

'K', 20, crc. (without separator 00H)

Control character	Step	Comment
1	Start boot program without checking of target address	Only meaningful with single analyzer.
2	Start boot program with checking of target addresses (bus mode).	The channel must first be set to *Reset* using a *Reset* command.

This command is only accepted within one second of the *Reset.*

Run firmware update

'K', 21, crc. 1, ... crc. x (without separator 00H)

This command is only accepted within the boot program.
Refer to Appendix for description of control characters and sequence.

Clear logbook

'K', 22

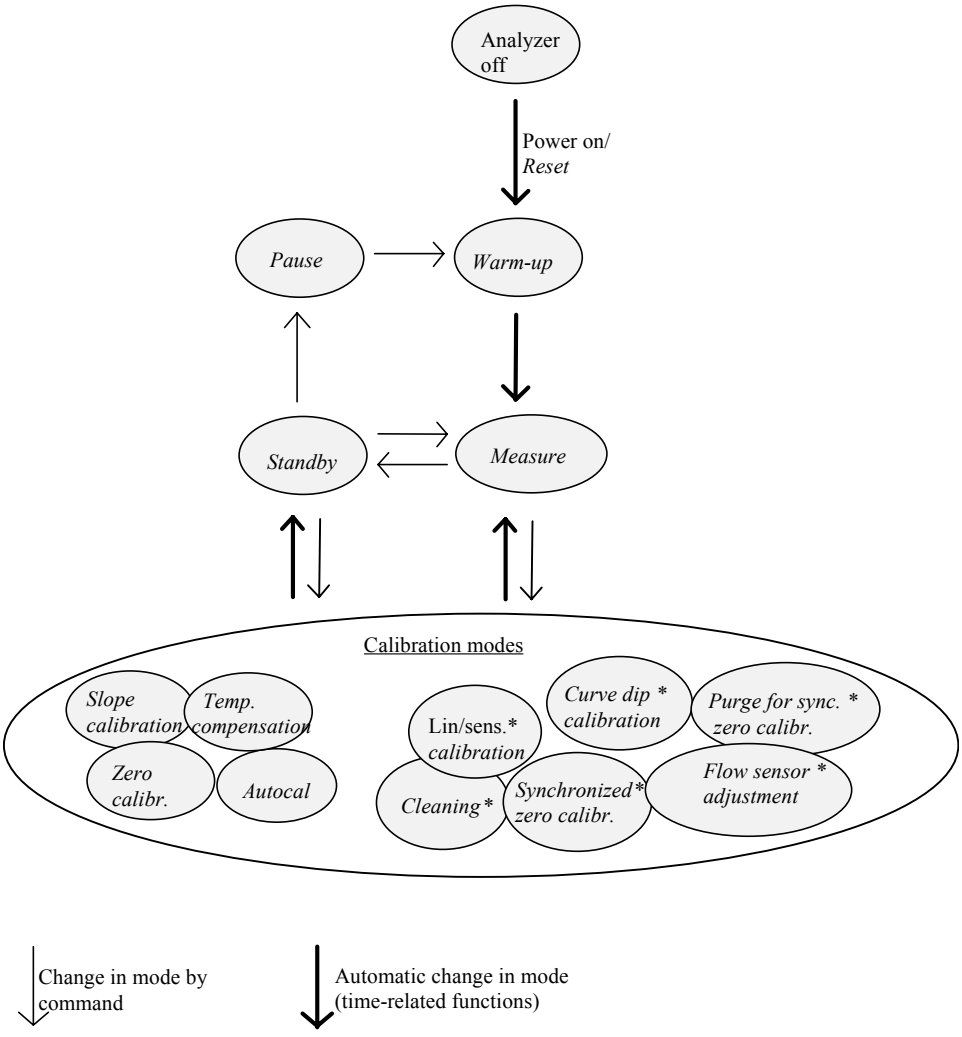
All current logbook entries are cleared.

5 Channel Modes

5.1 General

Following power-up the channels are in W*arm-up* mode.
When this is finished, the channels are automatically switched to *Measure* mode.

5.2 Graphic Overview



* Only if channel includes this mode

6 Examples

Read measured value of channel 3, component 1

Control system/PC	Analyzer	Comment
10H, 01H,		DLE, SOH
30H,		Component address
D0H,		Control system address
6BH, 01H,		Command ('k', 1)
10H, 03H,		DLE, ETX
95H, C0H		Checksum
	10H, 06H	DLE, ACK
	10H, 01H,	DLE, SOH
	D0H, 30H,	Control system address, component address
	00H,	Collective status: ready to measure (Table 03-1)
	04H,	Mode: *Measure* (Table 3-2)
	6BH, 01H,	Command ('k', 1)
	33H, 2EH, 35H, 00H,	3.5
	0BH, 00H,	% v/v
	02H, 00H,	CO
	10H, 03H,	DLE, ETX
	XXH, YYH	Checksum
10H, 06H		DLE, ACK

Read error status

Control system/PC	Analyzer	Comment
10H, 01H, 12H, D0H,		DLE, SOH, addresses
6BH, 05H,		Command ('k', 5)
10H, 03H, D2H, 83H		DLE, ETX, checksum
	10H, 06H	DLE, ACK
	10H, 01H, D0H, 12H,	DLE, SOH, addresses
	05H,	Collective status: not ready to measure, error (Table 03-1)
	01H,	Mode: *Warm-up* (Table 3-2)
	6BH, 05H,	Command ('k', 5)
	07H, 00H,	Error 7 and
	1BH, 00H,	error 27 are set
	10H, 03H, XXH, YYH	DLE, ETX, checksum
10H, 06H		DLE, ACK

Write slope concentration for channel 1, component 4

Control system/PC	Analyzer	Comment
10H, 01H, 13H, D0H,		DLE, SOH, addresses
57H, 03H,		Command ('W', 3)
32H, 30H, 30H, 2EH, 30H, 00H		200.0
10H, 03H, 6EH, FAH		DLE, ETX, checksum
	10H, 06H	DLE, ACK
	10H, 01H, D0H, 14H,	DLE, SOH, addresses
	00H,	Collective status: ready to measure (Table 03-1)
	04H,	Mode: *Measuring* (Table 3-2)
	57H, 03H,	Command ('W', 3)
	10H, 03H, XXH, YYH	DLE, ETX, checksum
10H, 06H		DLE, ACK

Send unknown command

Control system/PC	Analyzer	Comment
10H, 01H, 13H, D0H,		DLE, SOH, addresses
57H, 51H,		Unknown command ('W', 81)
01H, 30H, 48H, 68H,		Any data
10H, 03H, 53H, 29H		DLE, ETX, checksum
	10H, 06H	DLE, ACK
	10H, 01H, D0H, 13H,	DLE, SOH, addresses
	24H,	Collective status, not ready to measure, command not accepted (Table 03-1)
	03H,	Mode: *Standby* (Table 3-2)
	3FH, 3FH,	'??'
	10H, 03H, XXH, YYH	DLE, ETX, checksum
10H, 06H		DLE, ACK

Send wrong checksum

Control system/PC	Analyzer	Comment
10H, 01H, 13H, D0H,		DLE, SOH, addresses
5AH, 04H,		Command ('Z', 4)
10H, 03H, XXH, YYH		DLE, ETX, checksum (wrong)
	10H, 15H	DLE, NAK

Broadcasting of measured values

Channel starts automatic transmission of measured values every 500 ms.

Control system/PC	Analyzer	Comment
	10H, 01H,	DLE, SOH
	F0H, 30H,	Broadcast, channel address
	00H,	Collective status: ready to measure (Table 03-1)
	04H,	Mode: *Measuring* (Table 3-2)
	6BH, 02H,	Command ('k', 2)
	33H, 2EH, 35H, 00H, 0BH, 00H, 02H, 00H,	Component 1: 3.5 % v/v CO
	32H, 30H, 2EH, 39H, 00H, 0AH, 00H, 0CH, 00H,	Component 2: 20.9 % O_2
	33H, 2EH, 35H, 00H, 0BH, 00H, 03H, 00H,	Component 3: 3.5 % v/v CO_2
	10H, 03H,	DLE, ETX
	XXH, YYH	Checksum
	0BH, 00H,	% v/v
	02H, 00H,	CO
	10H, 03H,	DLE, ETX
	XXH, YYH	Checksum

There will be neither a confirmation nor an answer.

7 Appendix

7.1 Tables of Diagnostic Values

OXYMAT 6	Command type *
1. Temperature of physical section	b
2. Temperature of measuring head	b
3. Detector raw signal	k
4. Magnetic field	b
5. Temperature of display	b
6. Calibration reserve	k
7. Analog input	k
8. Signal vector	k
9. Disturbance vector	k

ULTRAMAT 6	Command type *
1. Temperature of chopper	b
2. Temperature of receiver chamber	b
3. Detector raw signal	k
4. Chopper deviation	b
5. Temperature of display	b
6. Calibration reserve	k
7. Analog input	k
8. Signal vector	k
9. Disturbance vector	k

ULTRAMAT 23	Command type *
1. Temperature of detectors	k
2. Temperature of radiator	b
3. Detector raw value	k
4. Supply raw voltage	b
5. Temperature of display	b
6. Calibration reserve	k
7. O_2 sensor voltage	b

*: b = channel-related command
k = component-related command

7.2 Boot Program

The channel's program memory contains a non-erasable boot program. Using this program it is possible to download new channel firmware by means of ELAN commands.
The boot program can be started with the boot command when sent within one second after switching on the unit or resetting the channel.
In order to allow booting even with faulty firmware there are two versions of the command "Start boot program" ('K', 20, 1 or 2)

1. **Boot without checking of channel address:**
   The boot command is accepted by all channels.
   This mode is not possible in bus operation since command answers are necessary to control the transmission.
   This command version is specifically made for firmware updates of a channel when the firmware is missing or faulty.
2. **Boot with checking of channel address:**
   The boot program is only accepted by the addressed channel.
   In order to avoid loss of the channel address during the reset which is required prior to booting, the reset must be executed using the ELAN *Reset* command.
   Booting with this command is possible during bus operation. However, it is advisable to reduce other bus communication (e.g. broadcast, scanning of other channels) at this time for faster, more reliable downloading.

The command "Run firmware update" ('K', 21) is used for downloading. The channel address is checked or not depending on the boot command (see above).
After execution of the boot program it should be checked for an error-free download using command ”Scan boot program errors (”k”, 20). In case of errors restart boot program.
The firmware is stored in the PC as a file in Intel hex format (extended). To speed up the transmission, the individual strings (records) of this file are shortened of the start character, checksum and end character, and converted from ASCII to binary format.
The characters thus obtained are the data in the command.

Example of data transformation (write bytes 12H, A0H, 5CH, BFH starting at address 4A80H)

	Intel hex format	Binary format	ELAN command ('K', 21)
Start character:	3AH,	-	10H, 01H,
ELAN addresses:	-	-	20H, D0H,
ELAN command:	-	-	4BH, 15H,
Data number:	30H, 34H,	04H,	04H,
Address:	34H, 41H, 38H, 30H,	4AH, 80H,	4AH, 80H,
Record type:	30H, 30H,	00H,	00H,
Data:	31H, 32H, 41H, 30H,	12H, A0H,	12H, A0H,
	35H, 43H, 42H, 46H,	5CH, BFH	5CH, BFH,
Checksum:	xxH, yyH,	-	-
End character:	0DH, 0AH	-	10H, 03H,
ELAN-CRC:	-	-	XXH, YYH

Boot procedure without checking of channel address

1. Switch off the analyzer, disconnect it from the bus system and connect it to the controller (PC).
2. Switch on the analyzer and send the command 'K', 20, 1 from the PC to the analyzer within the first second.

Note

The target address used is insignificant but should be within the acceptable range
(1-12) and must be retained throughout the boot process.

3. The analyzer is now in boot mode. The old firmware is deleted first (takes about 20 s) and then the analyzer expects the data transmission.
4. Each individual firmware record must be converted in the PC (as shown in the example) and sent to the analyzer with the ELAN command 'K', 21.
   The successful transmission and the correct programming of the record is acknowledged with DLE (10H), ACK (06H).
   If the analyzer answers with DLE (10H), NAK (15H), the record must be transmitted again.
5. After transmission of all records it must be checked for an error-free boot process using ELAN command ”k”, 20.
6. When all records have been transmitted correctly the analyzer pauses for about 10 s to determine the checksum. After that the new firmware can be started by switching the analyzer off and on again or alternatively by using the ELAN *Reset* command ('Z', 1).

Note

To speed up the transmission during the download and the subsequent *Reset* command, there are no answering telegrams.

Boot procedure with checking of channel address

1. Restart analyzer using the ELAN *Reset* command ('Z', 1).
2. Send the command 'K', 20, 2 from the PC to the analyzer within the first second.
3. The analyzer is now in boot mode. The old firmware is deleted first (takes about 20 s) and then the analyzer expects the data transmission.
4. Each individual firmware record must be converted in the PC (as shown in the example) and sent to the analyzer with the ELAN command 'K', 21.
   The successful transmission and the correct programming of the record is acknowledged with DLE (10H), ACK (06H).
   If the analyzer answers with DLE (10H), NAK (15H), the record must be transmitted again.
5. After transmission of all records it must be checked for an error-free boot process using ELAN command ”k”, 20.
6. When all records have been transmitted correctly the analyzer pauses for about 10 s to determine the checksum. After that the new firmware can be started using the ELAN *Reset* command ('Z', 1).

Note

To speed up the transmission during the download and the subsequent *Reset* command, there are no answering telegrams.

Example of boot program without checking of channel address

Control system/PC	Analyzer	Comment
		1. Switch off the analyzer
10H, 01H, 20H, D0H, 4BH, 14H, 01H, 10H, 03H, 89H, 51H		2. Switch on the analyzer and send boot request Start, addresses, command ('K', 20, 1), end, CRC
	10H, 06H	3. Analyzer accepts the request and enters boot mode (wait about 20 s)
10H, 01H, 20H, D0H, 4BH, 15H, 04H, 4AH, 80H, 00H, 12H, A0H, 5CH, BFH, 10H, 03H, 26H, 6DH	10H, 06H 10H, 15H	4. Send data strings Start, addresses, command ('K', 21), data (example of data conversion), end, CRC Analyzer has received data string correctly and stored it => send next string or Error occurred => send string again
10H, 01H, 20H, D0H, 6BH, 14H, 10H, 03H, 86H, 94H	10H, 06H 10H, 01H, D0H, 20H, 04H, 01H, 6BH, 14H, 80H, 00H, 10H, 03H, 71H, 83H	5. Send error scan after transmission of all data strings Start, addresses, command (‘k’, 20), end, CRC Analyzer has received command correctly Start, addresses, State : not ready, State : warm-up, command (‘k’, 20), error state : no errors, end, CRC
10H, 01H, 20H, D0H, 5AH, 01H, 10H, 03H, 99H, ACH	10H, 06H	6. wait approx. 10 s , switch on and off or send command *Reset* Start, addresses, command (‘Z’, 1), end, CRC Analyzer Reset
		Analyzer starts with new firmware

Example of boot program with checking of channel address

Control system/PC	Analyzer	Comment
10H, 01H, 60H, D0H, 5AH, 01H, 10H, 03H, 97H, 6CH		1. Restart analyzer using *Reset* command Start, addresses, command ('Z', 1), end, CRC
	10H, 06H	Command received
	10H, 01H, D0H, 60H, 5AH, 01H, 10H, 03H, XXH, YYH	Command answer Analyzer carrying out a *Reset*
10H, 01H, 60H, D0H, 4BH, 14H, 02H, 10H, 03H, 38H, 95H		2. Send boot request Start, addresses, command ('K', 20, 2), end, CRC
	10H, 06H	3. Analyzer accepts the request and enters boot mode (wait about 20 s)
10H, 01H, 60H, D0H, 4BH, 15H, 04H, 4AH, 80H, 00H, 12H, A0H, 5CH, BFH, 10H, 03H, 67H, EDH		4. Send data strings Start, addresses, command ('K', 21), data (example of data conversion), end, CRC
	10H, 06H	Analyzer has received the data string correctly and stored it => send next string
		or
	10H, 15H	Error occurred => send string again
10H, 01H, 20H, D0H, 6BH, 14H, 10H, 03H, 86H, 94H		5. Send error scan after transmission of all data strings Start, addresses, command (‘k’, 20), end, CRC
	10H, 06H	Analyzer has received command correctly
	10H, 01H, D0H, 20H, 04H, 01H, 6BH, 14H, 80H, 00H, 10H, 03H, 71H, 83H	Start, addresses, State : not ready, State : warm-up, command (‘k’, 20), error state : no errors, end, CRC

to be continued on next page

Control system/PC	Analyzer	Comment
10H, 01H, 20H, D0H, 5AH, 01H, 10H, 03H, 99H, ACH	10H, 06H	6. wait approx. 10 s , switch on and off or send command *Reset* Start, addresses, command (‘Z’, 1), end, CRC Analyzer Reset
		Analyzer starts with new firmware