RS232 Interface Description for FlowAnalyser and CITREX

Revision History

Version	Date	Summary of Changes
0.0	29.Sep.2003	Creation (Jehle)
1.0	29.Oct.2003	Release as imtmedical document (Hofstetter)
1.1	05.Nov.2003	Setting Oxygen Concentration added (Jehle)
1.2	12.Mar.2004	Bugs in the examples fixed (Jehle)
1.3	09.Sep.2004	New command for switching echo of RS232 port on/off added, measurement value Ti/TCycle added (Jehle)
1.4	13.Apr.2005	Limits of start/stop trigger for trigger source flow changed Limits of trigger delay changed New measurement values Peak Flow Insp. and Peak Flow Exp. added (Jehle)
1.5	17.Oct.2005	P low added (only available with optional board) (Jehle)
1.6	30.Mai 2006	RS232 Fast Data added Additional Gas Types Additional Gas Standards P Vac added (only available with optional board) (Hanselmann)
1.7	25.Sept.2006	Plateau Pressure and Compliance added (Hanselmann)
1.8	22.Feb.2007	Additional gas type 'Custom' Settings density and dynamic viscosity for custom gas type (Jehle)
1.9	03.Apr.2007	Increased resolution for "Breath Rate" (now 0.1 Breaths/min) (Wirth)
1.10	05.Sep 2007	Additional settings No. 16 -18 for custom gas
1.11	26. Mar. 2011	Current breath phase added
1.12	17. Feb 2012	Modifications for Citrex added
1.13	7. Dec 2012	New settings command for Citrex: Set Gas Humidity

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1 Communication Parameters

To establish a connection to the FlowAnalyser, the settings for the serial port have to be set as follows:

Port	RS232
Bits per second (baud rate)	19200
Data bits	8
Parity	None
Stop bits	1
Flow control	None

2 RS232 Interface Operations Overview

Operation	Send to FlowAnalyser	Answer of FlowAnalyser
Execute a Command on the FlowAnalyser	%CM#*id{$Value}(CR)*	%CM#*id(CR)*
Write a setting to the FlowAnalyser	%WS#*id*$*Value(CR)*	%WS#*id*$*Value*(CR)*
Read a setting from the FlowAnalyser	%RS#*id(CR)*	%RS#*id*$*Value(CR)*
Read a measurement value from the FlowAnalyser	%RM#*id(CR)*	%RM#*id*$*Value(CR)*
Read a system information from the FlowAnalyser	%RI#id(CR)	%RI#id$Value(CR)
Read the State of the FlowAnalyser	%ST#*id(CR)*	%ST#*id*$*State(CR)*

Id: Operation Identifier
(CR): Carriage return
{$Value}: 0, 1or several Values can be given (max. 10)

* Note: The value sent in the answer of a write operation is the value that has been read from the hardware after executing the write operation. If the value of the write operation and the value of the answer are not identical the write operation failed.

Errors:
When a invalid string (invalid command ID, invalid parameter ID, not enough arguments, …) is sent or the time between receiving the characters of a command is too long (10 seconds), the FlowAnalyser answers with a '?'.

Example:
Send Command with invalid command ID to FlowAnalyser: %CM#12*(CR)*
Answer of FlowAnalyser: ?

3 Execute Command

This chapter describes all the commands that can be executed on the FlowAnalyser.

3.1 Calibration

Id	Operation	Action
1	*Command*	Start Pressure / Flow Offset Adjust
2	*Command*	Start Oxygen Calibration
3	*Command*	Proceed to next Calibration Step (see also Chapter 7); must be sent when FlowAnalyser is waiting for user acknowledge, otherwise ignored
4	*Command*	Stop running calibration; if no calibration running, this command is ignored; to find out if a calibration is running, see chapter 7

Note: A calibration (command 1 and 2) can only be started, when the calibration state (see Chapter 7) is idle, otherwise the command is ignored.

Example:

Start Pressure / Flow Adjust:	%CM#*1(CR)*
Answer of FlowAnalyser:	%CM#*1(CR)*

3.2 RS232 Port

Id	Operation	Action
5	*Command*	Switch echo of RS232 port on/off Parameter 1: 0 = switch echo off 1 = switch echo on

Example:

Switch echo of RS232 port on	*%CM#5$1(CR)*
Answer of FlowAnalyser:	*%CM#5(CR)*

3.3 RS232 Fast Data

Id	Operation	Action
64	*Command*	**Start** RS232 Fast Data transmission
65	*Command*	**Stop** RS232 Fast Data transmission

RS232 Fast Data Format

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8	Byte 9
Time Stamp		Value 1		Value 2		Value 3		Checksum

Time Stamp: Time in 5ms resolution since start of RS232 Fast Data transmission
Value1..Value3: Values as configured within Settings → see chapter 4.7
Checksum: If the sum (8 Bit) of Byte 1 to Byte 9 is zero, the packet is valid.

Example:

Start RS232 Fast Data *%CM#64(CR)*
Answer of FlowAnalyser: *%CM#64(CR)*
After this
Bytes 1..9 every 5ms

4 Read/Write Settings

4.1 Gas Type

Id	Operation	Value
1	*R / W*	0 = Air 1 = Air/O2-Man. 2 = Air/O2-Aut. 3 = N2O/O2-Man. 4 = N2O/O2-Aut. 5 = Heliox 6 = He/O2-Man. 7 = He/O2-Aut. 8 = N2 9 = CO2 10 = Custom (Custom gas, defined by density and dyn. Viscosity)

Example:

Read Gas Type from FlowAnalyser:	%RS*#1(CR)*
Answer of FlowAnalyser (Gas type = Oxygen):	%RS*#1$1(CR)*

4.2 Manual Oxygen Concentration

The manual oxygen concentration is used when the gas type “O2-Man” is selected.

Id	Operation	Value
2	*R / W*	21 .. 100 ([%])

Example:

Write manual oxygen concentration = 30% to FlowAnalyser:	%WS*#2$30(CR)*
Answer of FlowAnalyser:	%WS*#2$30(CR)*

4.3 Gas Standards

Id	Operation	Value
3	*R / W*	0 = Ambient Temperature and Pressure and Humidity 1 = Standard Temperature and Pressure (21.1° C, 1013.25mbar) 2 = Body Temperature and Pressure, Saturated 3 = Body Temperature and Pressure, Dry 4 = 0°C, 1013.25mbar, Dry 5 = 20°C, 981mbar, Dry 6 = 15°C, 1013mbar, Dry 7 = 20°C, 1013mbar, Dry 8 = 25°C, 991mbar, Dry 9 = Ambient Pressure 21°, Dry 10 = Standard Temperature and Pressure, Humid (21.1° C, 1013.25mbar) 11 = Ambient Temperature and Pressure, Dry

		12 = Ambient Temperature and Pressure, Saturated

Example:

Write Gas Standard = 15°C, 1013mbar, Dry to FlowAnalyser: %WS#3$6*(CR)*
Answer of FlowAnalyser: %WS#3$6*(CR)*

4.4 Volume Trigger

4.4.1 Resp. Mode

Id	Operation	Value
4	*R / W*	0 = Adult 1 = Pediatric 2 = High Frequency

Example:

Read Resp. Mode from FlowAnalyser: %RS#4*(CR)*
Answer of FlowAnalyser (Resp. Mode = High Frequency): %RS#4$2*(CR)*

4.4.2 Trigger Source

Id	Operation	Value
5	*R / W*	1 = internal High Flow Channel 2 = internal Low Flow Channel **(FlowAnalyser only)** 3 = external High Flow Channel 4 = external Low Flow Channel **(FlowAnalyser only)**

Example:

Read Trigger Source from FlowAnalyser: %RS#5*(CR)*
Answer of FlowAnalyser (Trigger Source = internal Low Flow Channel): %RS#5$2*(CR)*

4.4.3 Start Trigger Signal

Id	Operation	Value
6	*R / W*	0 = Flow 1 = Pressure

Example:

Write Start Trigger Signal = Pressure to FlowAnalyser: %WS#6$1*(CR)*
Answer of FlowAnalyser: %WS#6$1*(CR)*

4.4.4 Start Trigger Edge

Id	Operation	Value
7	*R / W*	0 = Rising Edge 1 = Falling Edge

Example:

Read Start Trigger Edge from FlowAnalyser: %RS#7*(CR)*
Answer of FlowAnalyser (Start Trigger Edge = Rising Edge): %RS#7$*0(CR)*

4.4.5 Start Trigger Signal Value

Id	Operation	Value Start Trigger Signal = High Flow	Start Trigger Signal = Low Flow	Start Trigger Signal = Pressure
8	*R / W*	-2500..2500 [-250 .. 250 l/min]	-150..150 [-15 .. 15 l/min]	0 .. 200 [0.. 20 mbar]

Example:

Write Start Trigger Signal Value = 3 mbar to FlowAnalyser: %WS#8$30*(CR)*
Answer of FlowAnalyser: %WS#8$*30(CR)*

4.4.6 End Trigger Signal

Id	Operation	Value
9	*R / W*	0 = Flow 1 = Pressure

Example:

Read End Trigger Signal from FlowAnalyser: %RS#9*(CR)*
Answer of FlowAnalyser (Eng Trigger Signal = Flow): %RS#9$*0(CR)*

4.4.7 End Trigger Edge

Id	Operation	Value
10	*R / W*	0 = Rising Edge 1 = Falling Edge

Example:

Write End Trigger Edge = Falling Edge to FlowAnalyser: %WS#10$1*(CR)*
Answer of FlowAnalyser: %WS#10$*1(CR)*

4.4.8 End Trigger Signal Value

Id	Operation	Value Start Trigger Signal = High Flow	Start Trigger Signal = Low Flow	Start Trigger Signal = Pressure
11	*R / W*	-2500..2500 [-250 .. 250 l/min]	-150..150 [-15 .. 15 l/min]	0 .. 200 [0.. 20 mbar]

Example:

Read End Trigger Signal Value from FlowAnalyser: %RS#11*(CR)*
Answer of FlowAnalyser (End Trigger Signal Value = 5 l/min): %RS#11$5*0(CR)*

4.4.9 Trigger Delay (FlowAnalyser only)

Id	Operation	Value
12	*R / W*	10 .. 120 [ms]

Example:

Write Trigger Delay = 60 ms to FlowAnalyser: %WS#12$60*(CR)*
Answer of FlowAnalyser: %WS#12$60*(CR)*

4.5 Baseflow

This setting is the baseflow of the flow channel selected with the trigger source.

Id	Operation	Value
13	*R / W*	0 = Baseflow disabled 1 = Baseflow enabled
14	*R / W*	Vol. Trigger Flow Channel = High Flow:-3000 .. 3000 [-300 .. 300 l/min] Vol. Trigger Flow Channel = Low Flow: -40 .. 40 [-4 .. 4 l/min]

Example:

Write Baseflow = Disabled to FlowAnalyser: %WS#13$0*(CR)*
Answer of F FlowAnalyser: %WS#13$0*(CR)*

4.6 Filter Type

Id	Operation	Value
15	*R / W*	0 = None 1 = Filter Low 2 = Filter Medium 3 = Filter High

Example:

Read Filter Type from FlowAnalyser: %RS#15*(CR)*
Answer of FlowAnalyser (Filter Type = Filter Medium): %RS#15$2*(CR)*

4.7 Density for Gas Type 'Custom'

Id	Operation	Value
16	*R / W*	100 .. 10000 [0.1 .. 10 kg/m^3]

Example:

Write Custom Density (1.290 kg/m^3) to FlowAnalyser: %WS#16$1290*(CR)*
Answer of FlowAnalyser: %WS#16$1290*(CR)*

4.8 Dynamic Viscosity for Gas Type 'Custom'

Id	Operation	Value
17	*R / W*	100 .. 5000 [0.000001 .. 0.00005 Pa s]

Example:

Read custom dynamic viscosity from FlowAnalyser: %RS#17*(CR)*
Answer of FlowAnalyser (dynamic viscosity = 0.00001809 Pa s): %RS#17$1809*(CR)*

4.9 Dynamic Viscosity Coefficient for Gas Type 'Custom'

Id	Operation	Value
18	*R / W*	-10000 .. 10000 [-0.0000000001 .. 0.0000000001 Pa s / °C]

Example:

Read custom dynamic viscosity coefficient from FlowAnalyser:	%RS#18*(CR)*
Answer of FlowAnalyser (dynamic viscosity coefficient = 0.000000017 Pa s / °C	%RS#18$170*(CR)*

4.10 Start Trigger Delay (Citrex only)

Id	Operation	Value
19	*R / W*	10 .. 120 [ms]

Example:

Write Trigger Delay = 65 ms to Citrex:	%WS#19$65*(CR)*
Answer of Citrex:	%WS#19$65*(CR)*

4.11 End Trigger Delay (Citrex only)

Id	Operation	Value
20	*R / W*	10 .. 120 [ms]

Example:

Write Trigger Delay = 81 ms to Citrex:	%WS#20$81*(CR)*
Answer of Citrex:	%WS#20$81*(CR)*

4.12 Gas Humidity (Citrex only)

Id	Operation	Value
21	*R / W*	0 .. 100 [%]

Remarks: Citrex Firmware Version has to be >= 3.1.000
Example:

Write Gas Humidity = 76 % to Citrex:	%WS#21$76*(CR)*
Answer of Citrex:	%WS#21$76*(CR)*

4.13 RS232 Fast Data

Id	Operation	Action
64	*R / W*	Id of Value 1 → see chapter 5 for Id
65	*R / W*	Id of Value 2 → see chapter 5 for Id
66	*R / W*	Id of Value 3 → see chapter 5 for Id

Example:

Set Oxygen as second value on FlowAnalyser:	%WS#65$9*(CR)*
Answer of FlowAnalyser:	%WS#65$9*(CR)*

5 Read Measurement Values

Id	Operation	Value	Range	Unit	Resolution
0	*R*	High Flow	-300 .. 300	l/min	0.1 l/min
1	*R*	*Low Flow*	*-20 .. 20*	*l/min*	*0.01 l/min*
2	*R*	*Pressure low (optional)*	*0 .. 5*	*mbar*	*0.001 mbar*
3	*R*	Differential Pressure	-150.. 150	mbar	0.01 mbar
4	*R*	Pressure HF	0 .. 150	mbar	0.01 mbar
5	*R*	*Pressure Vac (optional)*	*-1000 .. 1000*	*mbar*	*0.1 mbar*
6	*R*	Volume HF	0 .. 10000	ml	0.1 ml
7	*R*	*Volume LF*	*0 ..10000*	*ml*	*0.01ml (?)*
8	*R*	Bit 0: Current breath phase	1: Inspiration 0 : Expiration	-	-
9	*R*	Oxygen	0 .. 110	%	0.1 %
10	*R*	*Humidity*	*0 .. 100*	*%*	*1 %*
11	*R*	Temperature	0 .. 100	°C	0.1 °C
12	*R*	*Dew Point*	*0 .. 100*	*°C*	*0.1 °C*
13	*R*	High Pressure	0 .. 10000	mbar	1 mbar
14	*R*	Ambient Pressure	0 .. 1150	mbar	1 mbar
15	*R*	Not impl.	-	-	-
16	*R*	Not impl.	-	-	-
17	*R*	Not impl.	-	-	-
18	*R*	Not impl.	-	-	-
19	*R*	Inspiration Time	0.2 .. 60	sec	0.01 sec
20	*R*	Expiration Time	0.2 .. 60	sec	0.01 sec
21	*R*	I : E	300:1 .. 1:300*	-	0.1
22	*R*	Breath Rate	0 .. 150	Breath/min	0.1 Breath/min
23	*R*	Vti	0 .. 10000	ml	1 / 0.1 ml
24	*R*	Vte	0 .. 10000	ml	1 / 0.1 ml
25	*R*	Vi	0 .. 300 / 0 .. 20 (HF / LF)	l/min	0.1 / 0.01 l/min (HF / LF)
26	*R*	Ve	0 .. 300 / 0 ..20 (HF / LF)	l/min	0.1 / 0.01 l/min (HF / LF)
27	*R*	Peak Pressure	0 .. 150	mbar	0.1 mbar
28	*R*	Mean Pressure	0 .. 150	mbar	0.1 mbar
29	*R*	Peep	0 .. 150	mbar	0.1 mbar
30	*R*	Ti/TCycle	0 .. 100	%	0.1 %
31	*R*	Peak Flow Insp.	-300 .. 300 / -20 .. 20 (HF / LF)	l/min	0.1 / 0.01 l/min (HF / LF)
32	*R*	Peak Flow Exp.	-300 .. 300 / -20 .. 20 (HF / LF)	l/min	0.1 / 0.01 l/min (HF / LF)
41	*R*	Plateau Pressure	0 .. 150	mbar	0.1 mbar
42	*R*	Compliance	0 .. 100000	ml/mbar	0.1 ml/mbar

Note:
- For all values above –2147483648 means value not defined (sensor not working properly, sensor not calibrated).
- All lines of the above table which are *italic* indicate a Id which is only available on FlowAnalyser.
*: If inspiration time > expiration time, inspiration time divided by expiration time is returned, otherwise – expiration time divided by inspiration time

Example:

Read Differential Pressure from FlowAnalyser:	%RM#3*(CR)*
Answer of FlowAnalyser (Differential Pressure = 12.73 mbar):	%RM#3$1273*(CR)*

6 Read System Information

6.1 Hardware Version

Id	Operation	Value
1	*R*	Hardware Version

Example:

Read Hardware Version from FlowAnalyser: %RI#1*(CR)*
Answer of FlowAnalyser (Hardware Version= 2): %RI#1$2*(CR)*

6.2 Software Version

Id	Operation	Value
2	*R*	Major Version
3	*R*	Minor Version
4	*R*	Release

Example:

Read Minor Version from FlowAnalyser: %RI#3*(CR)*
Answer of FlowAnalyser (Minor Version= 4): %RI#3$4*(CR)*

6.3 Date of Last Calibration

Id	Operation	Value
5	*R*	Day of Month of last calibration 1 .. 31
6	*R*	Month of Year of last calibration 1 .. 12
7	*R*	Year of last calibration

Example:

Read Month of Year of last Calibration from FlowAnalyser: %RI#6*(CR)*
Answer of FlowAnalyser (Month of Year of Last Calibration = 12 = December): %RI#6$12*(CR)*

6.4 Serial Number

Id	Operation	Value
8	*R*	Serial Number

Example:

Read Serial Number from FlowAnalyser: %RI#8*(CR)*
Answer of FlowAnalyser (Serial Number = 247): %RI#8$247*(CR)*

7 Read States

Id	Operation	Value
1	*R*	Calibration State 0 : Idle 1: Error during calibration Oxygen calibration: 2: Oxygen calibration, waiting for 100% oxygen 3: Reading 100% Oxygen 4: Oxygen calibration, waiting for 21% oxygen 5: Reading 21% Oxygen 6: Oxygen calibration finished, waiting for user acknowledge 7: Oxygen calibration finished Pressure / Flow offset adjust: 8: Wait for user acknowledge 9: Reading offset 10: Offset adjust finished, waiting for user acknowledge 11: Offset adjust finished Pressure Sensor Gain Adjust: 12: Read Offset, waiting for user acknowledge 13: Reading Offset 14: Read High adjustment pressure 1, waiting for user acknowledge 15: Read High adjustment pressure 1 16: Read High adjustment pressure 2, waiting for user acknowledge 17: Read High adjustment pressure 2 18: Pressure Gain Adjustment finished, waiting for user acknowledge 19: Pressure Gain Adjustment finished Flow Calibration: 20: Next Flow, waiting for user acknowledge 21: Read next Flow 22: Flow Calibration finished, waiting for user acknowledge 23: Flow Calibration finished Drift Compensation: 24: Drift Compensation started 25: Drift Compensation, read reference 26: Drift Compensation, waiting for next temperature 27: Drift Compensation, read temperature and offset

Example:

Read Calibration State from FlowAnalyser:	%ST#1*(CR)*
Answer of FlowAnalyser (Calibration State = Oxygen calibration, waiting for 21% oxygen):	%ST#1$4*(CR)*