

# Technicals for CITREX

## CITREX RS-232 Interface

<b>Version</b>	2.1
<b>Document-Tag</b>	CITREX
<b>Content</b>	This document describes the RS-232 Protocol Specification for the CITREX Firmware.

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## 1 INTRODUCTION

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This documentation provides information about the communication protocol of the CITREX H5 and CITREX H4. There are two different protocols available. The commands are the same, whereas the communication speed is different.

The «IMT protocol» delivers 3 data values whereas the «IMT fast Protocol» 12 data values transfers. The CITREX H5 supports the «IMT protocol» and the «IMT fast Protocol». The CITREX H4 supports the «IMT protocol» only.

## 2 COMMUNICATION PARAMETERS

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

### IMT protocol

Port	RS-232
Bits per second (baud rate)	19200
Data Bits	8
Parity	None
Stop Bits	1
Flow control	None

### IMT fast protocol

Port	RS-232
Bits per second (baud rate)	115200
Data Bits	8
Parity	None
Stop Bits	1
Flow control	None

### 3 RS-232 INTERFACE OPERATIONS OVERVIEW

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

Id: Operation Identifier  
 (CR): Carriage return  
 {\$Value}: 0, 1 or 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 an 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 device answers with a '?'.  
 ?

#### Example:

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

## 4 EXECUTE COMMAND

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

## 4.1 CALIBRATION

<b>Id</b>	<b>Operation</b>	<b>Action</b>
<b>1</b>	<i>Command</i>	Start Pressure / Flow Offset Adjust
<b>2</b>	<i>Command</i>	Start Oxygen Calibration
<b>3</b>	<i>Command</i>	Proceed to next Calibration Step (see also Chapter 8); must be sent when CITREX is waiting for user acknowledge, otherwise ignored
<b>4</b>	<i>Command</i>	Stop running calibration; if no calibration running, this command is ignored; to find out if a calibration is running, see chapter 8

**Note:** A calibration (command 1 and 2) can only be started, when the calibration state (see Chapter 8) is idle, otherwise, the command is ignored.

**Example:**

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

## 4.2 ECHO

Id	Operation	Action
5	<i>Command</i>	Switch echo of RS-232 port on/off Parameter 1:    0 = switch echo off 1 = switch echo on

**Example:**

```
Switch echo of RS-232 port on          %CM#5$1(CR)
Answer of CITREX:                      %CM#5(CR)
```

## 4.3 RS-232 FAST DATA

Id	Operation	Action
64	Command	Start RS-232 Fast Data transmission
65	Command	Stop RS-232 Fast Data transmission

### IMT protocol

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<sup>1</sup> resolution since the start of RS-232 Fast Data transmission  
 Value1..Value3: Values as configured within Settings → see chapter **Error! Reference source not found.**  
 Checksum: If the sum (8 Bit) of Byte 1 to Byte 9 is zero, the packet is valid.

### Example:

Start RS-232 Fast Data %CM#64(CR)  
 Answer of CITREX: %CM#64(CR)  
 After this  
 Bytes 1..9 every 5ms<sup>1</sup>

### IMT fast protocol

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8	..	Byte 27
Time Stamp		Value 1		Value 2		Value 3		..	Checksum

Time Stamp: Time in 5ms<sup>2</sup> resolution since start of RS232 Fast Data transmission  
 Value1..Value12: Values as configured within Settings  
 Checksum: If the sum (8 Bit) of Byte 1 to Byte 27 is zero, the packet is valid.

### Note:

- For all values above – 32767 means value not defined.

### Example:

Start RS232 Fast Data %CM#64(CR)  
 Answer of CITREX: %CM#64(CR)  
 After this  
 Bytes 1..27 every 5ms<sup>1</sup>

## 4.4 AUTOMATED ZERO CALIBRATION

A single command to perform an automatic zero calibration of all pressure/flow sensors (see **Error! Reference source not found.** for manual offset adjustment).

**Note:** Do not perform any other commands while the automatic zero calibration is running (takes about 7 seconds).

<sup>1</sup> For CITREX the time resolution of 5ms can only be guaranteed if the screen is locked for RS-232 communication

<sup>2</sup> time resolution of 5ms can only be guaranteed if the screen is locked for RS-232 communication

Id	Operation	Action
66	Command	<b>Start</b> automated Zero calibration Return value: - 0: Zero calibration failed - 1: Zero calibration succeeded

**Remarks:** CITREX Firmware Version has to be  $\geq 3.5.000$

**Example:**

Start automated Zero calibration	%CM#66(CR)
Answer of the device (success):	%CM#66\$1(CR)

## 4.5 LOCK SCREEN

Id	Operation	Action
67	Command	Lock screen for RS-232 communication Parameter 1: 0 = Screen unlocked 1 = Screen locked for RS-232 communication

**Remarks:** CITREX Firmware Version has to be  $\geq 3.5.000$

**Example:**

Lock screen	%CM#67\$1(CR)
Answer of the device:	%CM#67(CR)

## 4.6 LOCK TOUCH

Id	Operation	Action
68	Command	Lock touch for RS-232 communication Parameter 1: 0 = Touch unlocked 1 = Touch locked for RS-232 communication

**Remarks:** Firmware Version has to be  $\geq 3.6.000$

**Example:**

Lock screen	%CM#68\$1(CR)
Answer of the device:	%CM#68(CR)



## 5 READ/WRITE SETTINGS

### 5.1 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 CITREX: %RS#1(CR)  
Answer of CITREX (Gas type = Oxygen): %RS#1\$1(CR)

### 5.2 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 %WS#2\$30(CR)  
CITREX:  
Answer of CITREX: %WS#2\$30(CR)

### 5.3 GAS STANDARDS

Id	Operation	Value
3	R / W	0 = ATP
		1 = STP
		2 = BTPS
		3 = BTPD
		4 = 0 / 1013
		5 = 20 / 981
		6 = 15 / 1013
		7 = 20 / 1013
		8 = 25 / 991
		9 = AP21
		10 = STPH
		11 = ATPD
		12 = ATPS
		13 = BTPS-A
		14 = BTPD-A
		15 = NTPD
		16 = NTPS

#### Example:

Write Gas Standard = 15 / 1013 to CITREX:

%WS#3\$6(CR)

Answer of CITREX:

%WS#3\$6(CR)

### 5.4 VOLUME TRIGGER

#### 5.4.1 RESP. MODE

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

#### Example:

Read Resp. Mode from CITREX:

%RS#4(CR)

Answer of CITREX (Resp. Mode = High Frequency):

%RS#4\$2(CR)

#### 5.4.2 TRIGGER SOURCE

Id	Operation	Value
5	R / W	1 = internal High Flow Channel
		3 = external High Flow Channel

#### Example:

Read Trigger Source from CITREX

%RS#5(CR)

Answer of CITREX

%RS#5\$3(CR)

## 5.4.3 START TRIGGER SIGNAL

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

### Example:

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

## 5.4.4 START TRIGGER EDGE

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

### Example:

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

## 5.4.5 START TRIGGER SIGNAL VALUE

Id	Operation	Value	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 CITREX: %WS#8\$30(CR)  
 Answer of CITREX: %WS#8\$30(CR)

## 5.4.6 END TRIGGER SIGNAL

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

### Example:

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

## 5.4.7 END TRIGGER EDGE

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

### Example:

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

## 5.4.8 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 CITREX: %RS#11(CR)  
 Answer of CITREX (End Trigger Signal Value = 5 l/min): %RS#11\$50(CR)

## 5.4.9 TRIGGER DELAY

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

### Example:

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

## 5.5 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 CITREX: %WS#13\$0(CR)  
 Answer of F CITREX: %WS#13\$0(CR)

## 5.6 FILTER TYPE

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

### Example:

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

## 5.7 RS-232 FAST DATA

Id	Operation	Action
64	R / W	Id of Value 1 → see chapter 6 for Id
65	R / W	Id of Value 2 → see chapter 6 for Id
66	R / W	Id of Value 3 → see chapter 6 for Id
160	R / W	Id of Value 4 → see chapter 6 for Id
161	R / W	Id of Value 5 → see chapter 6 for Id
162	R / W	Id of Value 6 → see chapter 6 for Id
163	R / W	Id of Value 7 → see chapter 6 for Id
164	R / W	Id of Value 8 → see chapter 6 for Id
165	R / W	Id of Value 9 → see chapter 6 for Id
166	R / W	Id of Value 10 → see chapter 6 for Id
167	R / W	Id of Value 11 → see chapter 6 for Id
168	R / W	Id of Value 12 → see chapter 6 for Id

### Example:

Set Oxygen as second value on CITREX:

%WS#65\$9(CR)

Answer of CITREX:

%WS#65\$9(CR)

## 5.8 USB MASS STORAGE

Disable / enable the USB mass storage functionality.

Id	Operation	Value
70	R / W	0 = Disabled 1 = Enabled

**Remarks:** CITREX Firmware Version has to be  $\geq 3.5.000$

**Example:**

Disable USB Mass Storage: %WS#70\$0(CR)  
 Answer of the device (Mass storage disabled): %WS#70\$0(CR)

## 5.9 START TRIGGER DELAY

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)

## 5.10 END TRIGGER DELAY

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)

## 5.11 GAS HUMIDITY

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

**Remarks:** CITREX Firmware Version has to be  $\geq 3.1.000$

**Example:**

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

## 5.12 RESPIRATORY PARAMETER PRESSURE SOURCE

This command allows changing the pressure source for the ventilation parameters.

Id	Operation	Value
22	<i>R / W</i>	0 = Pressure Channel 1 = Differential Pressure 2 = High Pressure

**Remarks:** CITREX Firmware Version has to be  $\geq 4.0.000$

**Example:**

Write the respiratory pressure source "Differential pressure" to CITREX:	%WS#22\$1(CR)
Answer of CITREX:	%WS#22\$1(CR)
Read respiratory pressure source from CITREX:	%RS#22(CR)
Answer of CITREX "Differential pressure":	%RS#22\$1(CR)

## 6 READ MEASUREMENT VALUES

Id	Operation	Value	Range	Unit	Resolution
0	R	High Flow	-300 .. 300	l/min	0.1 l/min
1	R	<i>Low Flow</i>	<i>-20 .. 20</i>	<i>l/min</i>	<i>0.01 l/min</i>
2	R	<i>Pressure low (optional)</i>	<i>0 .. 5</i>	<i>mbar</i>	<i>0.001 mbar</i>
3	R	Differential Pressure	-150.. 150	mbar	0.01 mbar
4	R	Pressure HF	0 .. 150	mbar	0.01 mbar
5	R	<i>Pressure Vac (optional)</i>	<i>-1000 .. 1000</i>	<i>mbar</i>	<i>0.1 mbar</i>
6	R	Volume HF	0 .. 10000	ml	0.1 ml
7	R	<i>Volume LF</i>	<i>0 ..10000</i>	<i>ml</i>	<i>0.01ml</i>
8	R	Bit 0: Current breath phase	1: Inspiration 0 : Expiration	-	-
9	R	Oxygen	0 .. 110	%	0.1 %
10	R	<i>Humidity</i>	<i>0 .. 100</i>	<i>%</i>	<i>1 %</i>
11	R	Temperature	0 .. 100	°C	0.1 °C
12	R	<i>Dew Point</i>	<i>0 .. 100</i>	<i>°C</i>	<i>0.1 °C</i>
13	R	High Pressure	0 .. 10000	mbar	1 mbar
14	R	Ambient Pressure	0 .. 1150	mbar	1 mbar
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
43	R	IPAP	0 .. 150	mbar	0.1 mbar

### Note:

- For all values above -2147483648 means value not defined (sensor not working properly, sensor not calibrated).

- All lines in the above table which are *italic* indicate an Id which is only available on CITREX.

\*: 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 CITREX:

%RM#3(CR)

Answer of CITREX (Differential Pressure = 12.73 mbar):

%RM#3\$1273(CR)

## 7 READ SYSTEM INFORMATION

### 7.1 HARDWARE VERSION

Id	Operation	Value
1	R	Hardware Version

**Example:**

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

### 7.2 SOFTWARE VERSION

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

**Example:**

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

### 7.3 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 CITREX: %RI#6(CR)  
 Answer of CITREX (Month of Year of Last Calibration = 12 = December): %RI#6\$12(CR)

### 7.4 DATE OF NEXT CALIBRATION

Id	Operation	Value
9	R	Day of Month of next calibration 1 .. 31
10	R	Month of Year of next calibration 1 .. 12
11	R	Year of next calibration

**Remarks:** CITREX Firmware Version has to be  $\geq 3.5.000$

**Example:**

Read Month of Year of next Calibration: %RI#10(CR)  
 Answer (Month of Year of next Calibration = 12 = December): %RI#10\$12(CR)

### 7.5 SERIAL NUMBER

Id	Operation	Value
8	R	Serial Number

**Example:**

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

## 8 READ STATES

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

### Example:

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