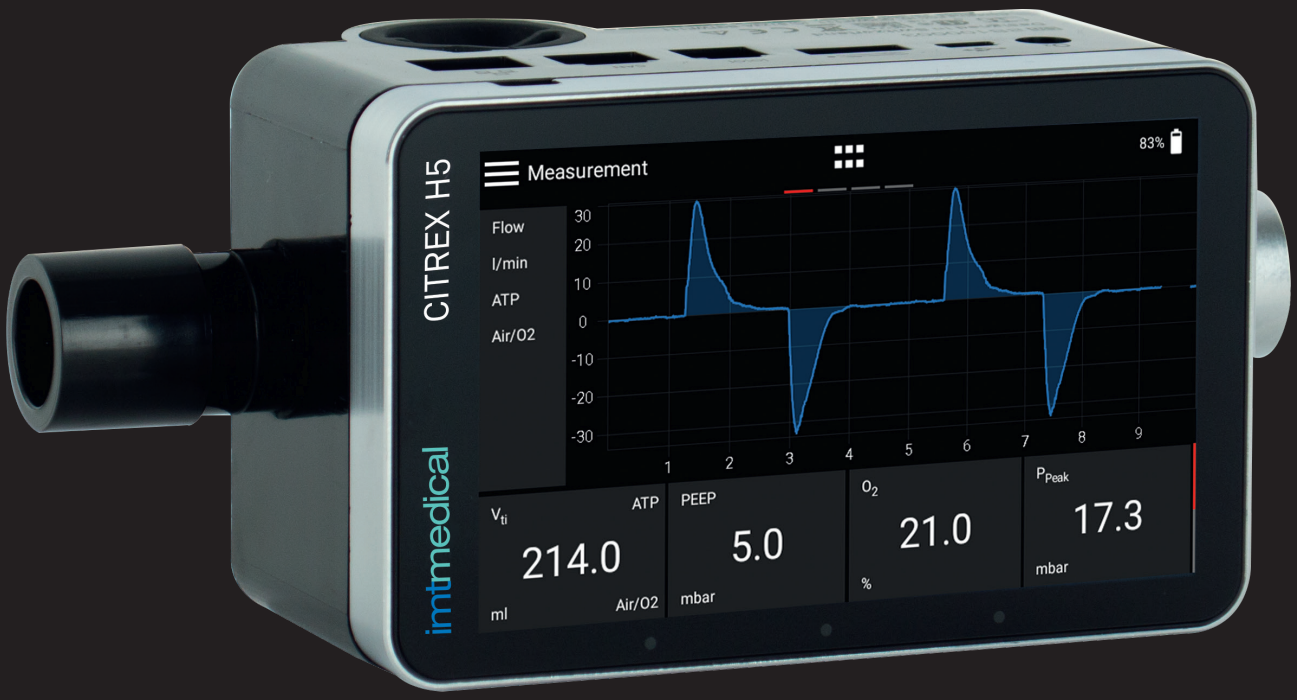
analyser

the art of measuring



User Manual
CITREX H5

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Table of Contents

1 Introduction

CITREX H5 was developed in order to measure flow and various pressures and thus calculate a large number of ventilation parameters. CITREX H5 is a compact, mobile and easy-to-operate measuring instrument. The integrated oxygen sensor makes it possible for users to determine the oxygen concentration. The instrument is controlled on a 4.3" multi-touch display and it has a large number of different interfaces for data analysis.

The descriptions and instructions in this manual refer to the product CITREX H5. In this User Manual the unit "sL/min" is based on ambient conditions of 0°C and 1013.25 mbar in accordance with DIN 1343.

This documentation applies to the following versions:

CITREX H5 firmware:	4.0.000
CITREX H5 Flow App software:	4.0.000
CITREX H5 hardware:	4.0

In the case of older or newer versions there may be discrepancies in relation to this User Manual.

Subject to technical modifications without notice.

To avoid possible injuries, please read all the safety instructions before you use the product.

The device is not intended for use outside a building.

2 Intended use

This product is intended for testing and calibration purposes on medical devices or systems that generate gas flows or gas pressures. That includes medical ventilators and anaesthetic equipment. The user of the device has received training on how to use medical equipment and can perform repairs, maintenance and servicing on medical devices. The device can be used in hospitals, in clinics, at device manufacturers or at independent service companies that perform repairs or servicing on medical devices.

CITREX H5 is intended for use in a laboratory environment. It may only be used outside the nursing sector. It must not be used directly on patients or devices that are connected to patients. The measuring instrument CITREX H5 is intended for over-the-counter sale.

With CITREX H5 you have the solution for measurements in the following areas:

- Flow
- Volume
- Differential pressure
- High pressure
- Ambient pressure
- Oxygen
- Temperature

In addition, various ventilation parameters can be measured:

- Ventilation rate
- Time
- Ratio
- T_i/T_{cyc}
- Tidal volume
- Minute volume
- Peak flow
- Pressure
- Compliance
- Trigger

CITREX H5 is a measuring instrument for checking and calibrating ventilators and anaesthetic equipment. It must not be used for patient monitoring. During patient treatment by the ventilator it is not allowed to connect to the CITREX H5.

3 Safety instructions

Please read all the safety instructions carefully before you use CITREX H5.

3.1 Representation of hazards, cautions and notes

This User Manual uses the representation below to specifically draw attention to residual risks during intended use and emphasise important technical requirements.

Information and/or instructions and prohibitions to prevent damage of any kind, as well as useful tips and information for handling the device.

3.2 Personnel

Work on and with CITREX H5 may only be performed by persons who have undergone appropriate technical training and have the necessary experience.

3.3 Responsibility and guarantee

The manufacturer accepts no responsibility or guarantee and will exempt itself from liability claims accordingly if the operator or any third parties:

- Fail to use the device in accordance with its intended use.
- Disregard the specifications.
- Tamper with the device in any way (conversions, modifications or the like).
- Operate the device with accessories that are not listed in the associated sets of product documentation.

Although the device meets high quality and safety standards and it has been constructed and tested according to the current state of the art, it is not possible to rule out the risk of injuries with serious consequences if the device is used in non-compliance with the intended use (improperly) or is misused.

Therefore please read through this User Manual carefully and keep this documentation in a readily accessible place close to your device.

3.4 Service life

The maximum service life of the device has been specified as 10 (ten) years, provided it is handled properly in accordance with this User Manual.

4 Symbol explanation

The symbols listed below may appear on the packaging material, the device rating plate and in the User Manual of the CITREX H5 measuring instrument.

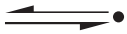
IOIOI	RS-232 interface
	USB interface
SN BBXXXX	Serial number
	Analog interface
CAN	CAN interface
	Ethernet interface
	On/Off button
	SD card
	Fragile contents
	Keep dry
	Read the User Manual
	The device must not be disposed of in household waste
	The device is CE approved
	Caution: observe the safety instructions in the User Manual
	Reusable packaging
	Manufacturer's specification and date of manufacture
	Keep away from heat
	Temperature range for storage and transport
	CSA monogram with C/US indicator
	Not dangerous goods

Table 1: Symbol explanation

5 Start-up

	CITREX H5
	Power supply plug with country-specific adapters
	USB cable
	MicroSD card
	Dust filter
	Inlet pipe
	USB adapter cable
	CITREX carrying case
	Network cable
	Car adapter

Table 2: Scope of delivery

5.1 Power supply

CITREX H5 can be operated from the mains or from the integrated battery.

Power can be supplied via the USB port (Mini B), the Analog interface or the CAN interface on the top of CITREX H5. Use the power supply unit included to charge the battery or operate the device via the USB port. You will find more information about power supply and how to configure the plugs in section 5.3.

During the charging operation the right-hand status LED is lit orange. As soon as the battery is fully charged the right-hand status LED lights up green.

Please connect the power supply unit included to a voltage of 100 VAC to 240 VAC with a frequency of 50 Hz to 60 Hz.

Figure 1: Power supply

Before switching on, make sure the operating voltage of the power supply unit agrees with the local mains voltage. You will find this information on the rating plate on the back of the power supply unit. When operating CITREX H5 via the USB port only use the original power supply unit included!

The device indicates visually and audibly when the battery has to be charged. Please do not store the battery in the depleted state.

Caution: depletion can damage the battery beyond repair!

5.2 Mechanical connectors

5.2.1 Flow channel

The flow channel can be used bidirectionally. The positive flow direction is from left to right, viewed from the front of the device. The measurement of volume, flow, gas temperature, oxygen and channel pressure takes place in the flow channel. The values, and the ventilation parameters calculated from them, can be displayed on the screen. You will find the relevant setting options in section 6: Operation.

Flow (air)	Measuring range	±300 sL/min
	Accuracy	±1.9% of reading or ±0.1 sL/min
Volume	Measuring range	±10 L
	Accuracy	±2% or ±0.20 mL (>6 sL/min)
Temperature	Measuring range	0…50°C
	Accuracy	±1.75% of reading or 0.5°C
Oxygen	Measuring range	0…100%
	Accuracy	±1% O_2
Pressure in flow channel	Measuring range	-50… +150 mbar
	Accuracy	±0.75% of reading or ±0.1 mbar

Figure 2: Flow channel

5.2.2 Differential pressure

This pressure connector measures the difference in pressure between the two connectors. If only one connector is used for a measurement, pressure measurement takes place at ambient pressure. The measuring range is ±200 mbar. Please comply with the maximum permissible pressure at the connector.

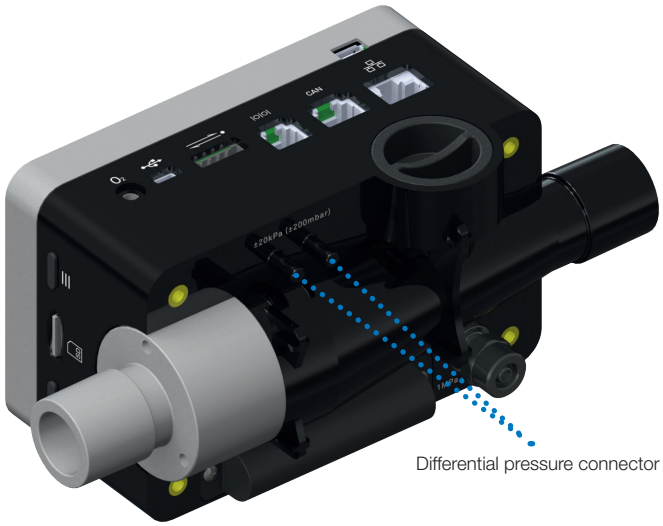


Figure 3: Differential pressure connector

Measuring range	±200 mbar
Accuracy	±0.75% of reading or ±0.1 mbar

Pressures above 1 bar damage the differential pressure sensor beyond repair!

5.2.3 High pressure

The high-pressure connector measures the applied pressure up to 10 bar. It is recommended that the differential pressure connector be used for measurements up to 200 mbar. It is up to 100 times more accurate.

The high-pressure connector can be fitted with a DISS adapter for air and oxygen. You will find the ordering code in section 13 "Accessories and spare parts".

Figure 4: High-pressure connector

Measuring range	0 … 10 bar
Accuracy	± 1% of reading or 10 mbar

Pressures above 15 bar damage the high-pressure sensor beyond repair!

5.2.4 Oxygen sensor

CITREX H5 can measure the oxygen concentration in the gas flow channel. To do so, an oxygen sensor is screwed into the appropriate port. The oxygen sensor has to be connected to the measuring instrument using the cable included. The following steps explain how to install and replace the oxygen sensor.

Figure 5: Oxygen sensor holder

Measuring range	0 … 100%
Accuracy	± 1% O_2 (absolute)

5.2.5 Installing the oxygen sensor

1. Remove the protective cap from the sensor port on the device.

Figure 6: Protective cap

2. Screw the oxygen sensor clockwise into the appropriate port. Make sure the sensor seals off the port and there is no leak.

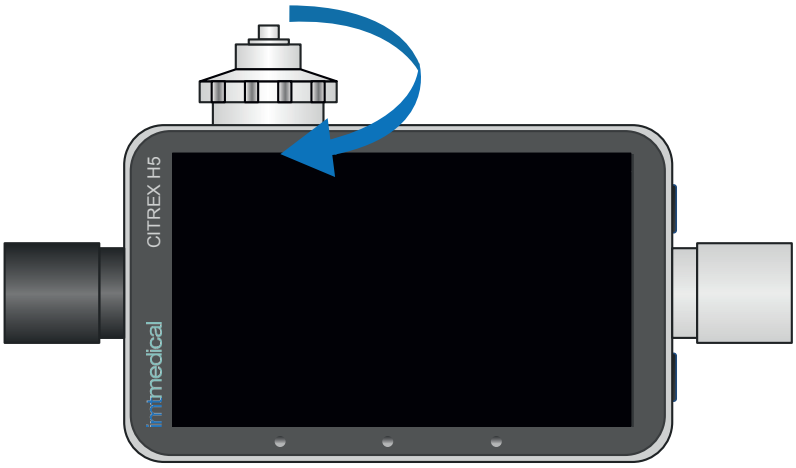


Figure 7: Screwing in the oxygen sensor

3. Connect the cable included to the oxygen sensor by pushing the cable into the hole at the top of the sensor until the cable locks into place. Connect the other end of the cable to CITREX H5 by inserting it into the hole provided, which is labelled "O_2"

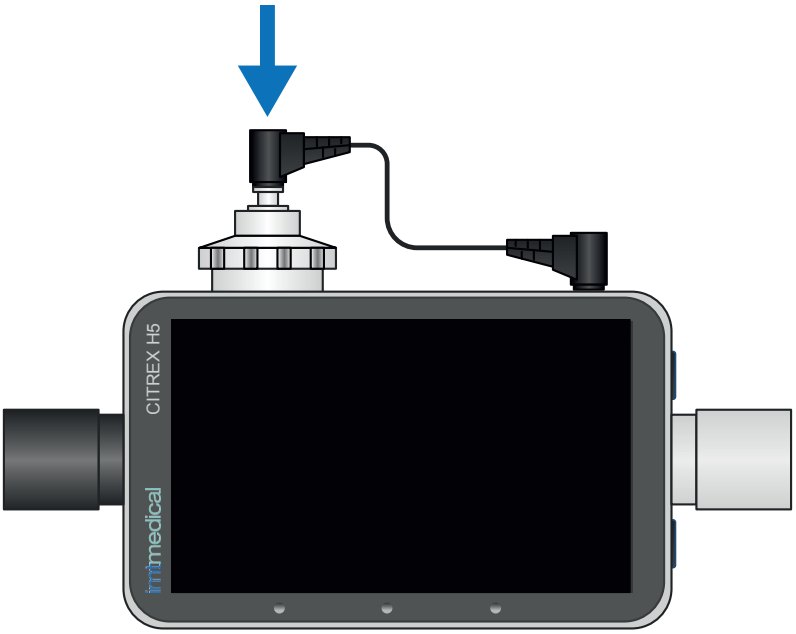


Figure 8: Oxygen sensor cable

4. Perform an oxygen calibration. The calibration procedure is described in section 7. Calibration ensures that the measured values of the new sensor are correct.

5.3 Electrical interfaces

Figure 9 shows the available electrical interfaces of CITREX H5.

Figure 9: Electrical interfaces

1	**MicroSD card slot**	The firmware of CITREX H5 is stored on the microSD card. It also contains customized configurations and test reports can be saved on the memory card. You will find more information in section 11 Reading measurement data.
2	**O_2 interface**	The oxygen sensor is connected to CITREX H5 via the O_2 interface. You will find further information on this in section 5.2.4.
3	**USB port**	The USB port is used to operate the device from the mains power supply and to charge the device battery but it can also be used as a data interface. It is a "USB Mini-B port". You will find more information in section 11 Reading measurement data.
4	**Analog OUT**	The Analog Out port is used for reading analog signals. It is also possible to connect an external trigger. Two ports are reserved for mains operation and charging the device battery. You will find the ordering code for the matching connector in section 13. You will find additional technical information about the port in section 16.2.
5	**RS-232**	The RS-232 port is used as a data interface. In section 16.2 you will find further information about the interface.
6	**CAN**	The CAN interface is prepared in the device but at present it is not yet supported by the firmware. The CAN interface can be used for charging the device battery. You will find information about the port in section 16.2.
7	**Ethernet**	The Ethernet interface is used to configure the device and it is used as a data interface. You will find more information in section 11 Reading measurement data.
8	**USB-Host**	This port is used for updating the CITREX H5 software. It is a "USB Micro-B port".

Table 3: Description of electrical interfaces

6 Operation

This section describes how to use the device and what possibilities there are.

6.1 Switching the device on/off

The device is switched on and off at the On/Off button. Figure 12 shows where this button is located on the device. To switch CITREX H5 on you must press the On/Off button briefly. You will hear an audible signal. To switch the device off you must press the On/Off button for about 1 second. A shutdown menu appears in which the process has to be acknowledged with a gesture. If the device can no longer be controlled, you have the option of pressing the On/Off button for about 6 seconds. The device is then forced to shut down.

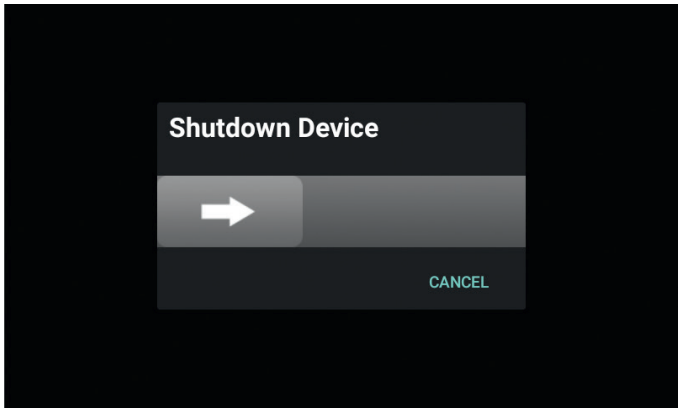


Figure 10: Shutdown menu

6.2 Start screen

The start screen appears as soon as the device is switched on. The screen indicates that the device is powering up. After the power-up process the home screen is displayed. The start screen can be seen in figure 11: Start screen.

Figure 11: Start screen

6.3 User controls

Figure 12: User controls

1	On/Off button
2	Context button; long press: key lock on/off
3	LED 1: Indicates error
4	LED 2: Lit when the device is switched on
5	LED 3: Charging process indicator. Lit orange during the charging process and green when the battery is fully charged.

6.4 User control gestures

To be able to operate the multi-touch screen optimally and easily you have various gestures at your disposal.

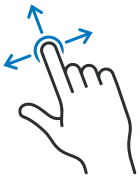
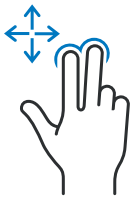
Gesture	Designation	Action	Function
	Tap	Tap an element once	• Increase in readings and measurement curves • Selection of menu items • Perform measurement on the graphical measurement curves
	Hold down	Press and keep pressed for one second.	• Editing readings and curves
	Swipe	Drag your finger across the screen.	• Change views on the measurement screen • Unlock screen • Shut down device
	Move by swiping	Tap an element, drag it to the position required and let go there	Move a reading.
	Pinch close or pinch open	Move thumb and index finger together or move them apart	Zoom in or out on measurement curves.
	Two finger swipe	Place index finger and middle finger on object and drag	Moving of measurement curves when the measurement curve is paused.

Table 4: Gestures

6.5 Start screen

The start screen is the starting point for operation of CITREX H5. The software version described in this User Manual displays the menu items listed below.

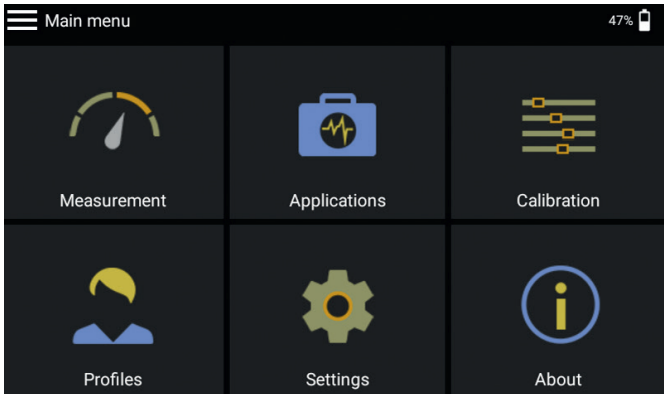


Figure 13: Start screen

Measurement	This is where the measured pressures, flows and ventilation parameters are displayed. There are graphical and numerical methods of representation available. They can be freely configured by the user. You will find more information on this in sections 6.7 and 6.8.
Settings	All device-specific representations are configured in this menu item. The options available are explained in section 6.6.
Calibration	Zero-point calibration and oxygen sensor calibration can be called up with this menu item. You will find details of how to perform calibration in section 7.
Profiles	With CITREX H5 you have the option of creating profiles to suit your particular requirements. You will find information on how to load, edit and create functions in this menu item. For further information refer to section 9.
Applications	With the menu item Applications you are offered custom applications. If you are in need of such a solution, please contact imtmedical at: sales@imtmedical.com
About	This menu item saves user information and device information.

Table 5: Menu items

6.6 Settings

Under the menu item "Settings" it is possible to define settings for measurements and for CITREX H5.

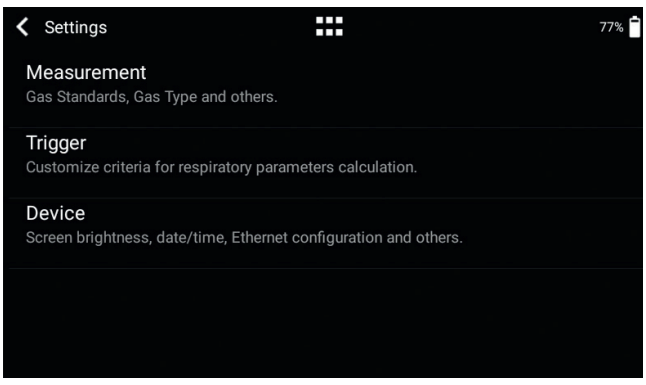


Figure 14: Configuration

In the menu sub-item "Measurement" the settings are made for gas type, gas standard, gas humidity and pressure compensation source. CITREX H5 provides three different trigger settings. The associated settings can be found in the sub-item "Trigger". You will find the settings concerning the device in the sub-menu "Device". That contains various adjustment options for the screen, device settings and the various interfaces. In the menu "Other" you can save your personal information.

6.7 Numerical readings

You can display all the readings in CITREX H5 numerically or graphically. In Appendix B "Measurement parameters and units" you will find an overview of the available readings and parameters. To access edit mode, tap a measurement tile once. In edit mode you can edit parameters, gas type, gas standard and unit of measurement.

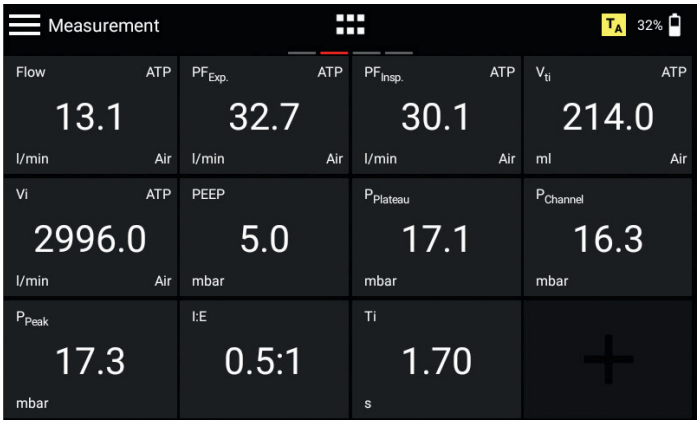


Figure 15: Numerical readings

6.8 Graphical readings

Each reading or parameter can be represented by a measurement curve. To edit the value, tap the name of the reading. In the full-screen view you have the option of changing the parameter, the unit of measurement, the gas standard and the gas type. With the pause button you can also freeze the curve and perform measurements on it.

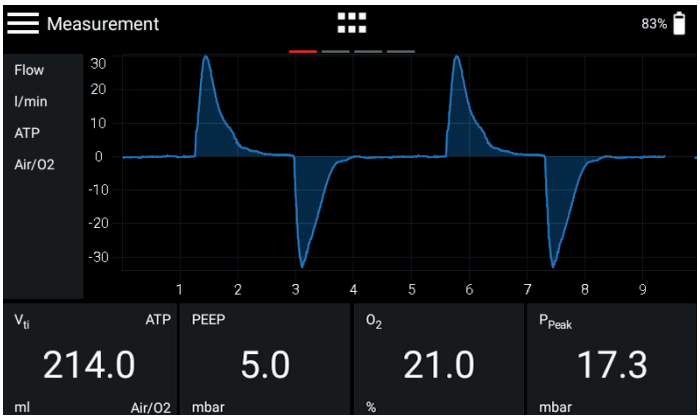


Figure 16: Graphical readings

6.9 Screen lock

Press the context button on the side of the device for 2 seconds. The screen shows a message indicating that the screen is locked. To unlock the screen, tap the screen and follow the instructions.

6.10 Software update

To perform a software update, format a USB memory stick with the FAT32 format. Copy the installation file to the storage medium and connect the latter to the device with the USB adapter included. Plug the other end of the adapter into the "USB-Host" port.

Start the device and in the sub-menu "About" go to "Software Update". Follow the instructions on the screen.

7 Calibration

The various calibrations of CITREX H5 are described in this section. To avoid incorrect measurements you must adhere to the procedures described here.

7.1 Zero point

Zero calibration must be performed as soon as CITREX H5 has warmed up. To perform zero calibration you must remove all connected tubes from the device.

In the main menu, tap the "Calibration" icon.

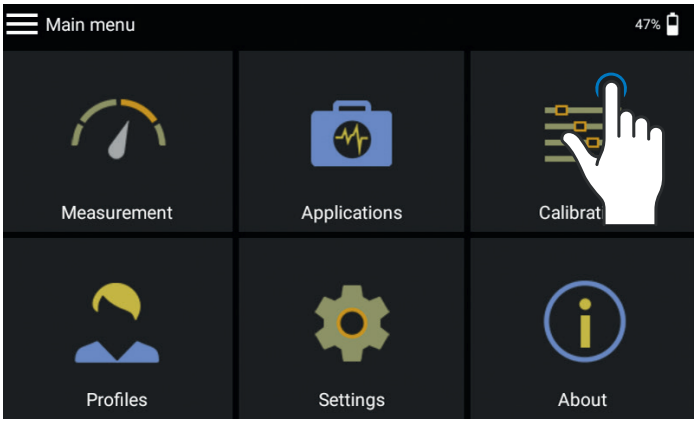


Figure 17: Calibration

In the Calibration sub-menu tap the "Zero Offset" icon. Follow the instructions on the screen and tap Start. After successful calibration a message appears confirming that calibration was successful. The device is now ready for use.

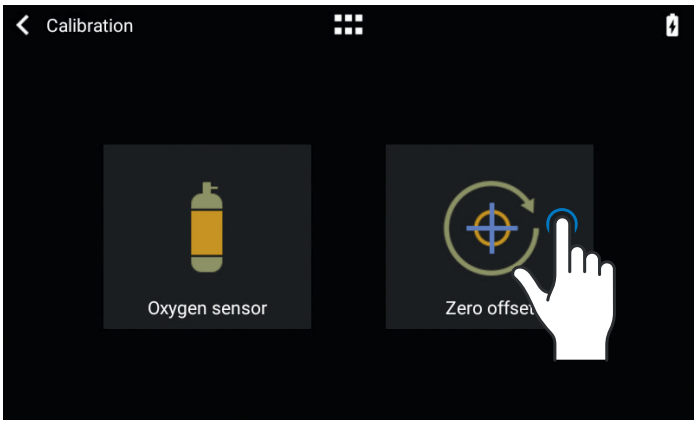


Figure 18: Zero offset

7.2 Oxygen (O_2) calibration

There are two different methods of calibrating the oxygen cell. The variant in which the oxygen cell is calibrated with air only takes about two minutes. The second variant calibrates the oxygen cell with air and 100 % oxygen. This so-called two-point calibration adjusts the oxygen sensor more accurately. Calibration can be called up under Calibration and then Oxygen Sensor. See figure 18.

7.2.1 Calibration with air only

Make sure air is flowing through the flow channel at a rate of at least 30 L/min. Then press "Start Air Calibration" and follow the instructions on the screen. The entire process takes about two minutes. At the end of the process a message appears confirming that calibration was successful, or an error message appears.

7.2.2 Calibration with oxygen and air

In this calibration, the requirement is oxygen (100 %) and air at a flow of 30 L/min. In the first step, the sensor is subjected to oxygen calibration. For this purpose connect the device to a gas flow source with an oxygen flow of 30 L/min and press "Start Oxygen Calibration". Follow the instructions on the screen. In the second step you must connect air with a gas flow of 30 L/min. The entire process takes about four minutes.

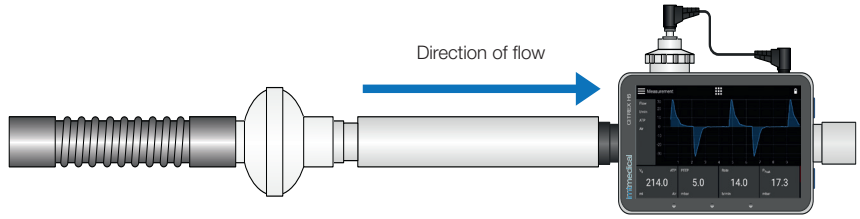
8 Connecting the device

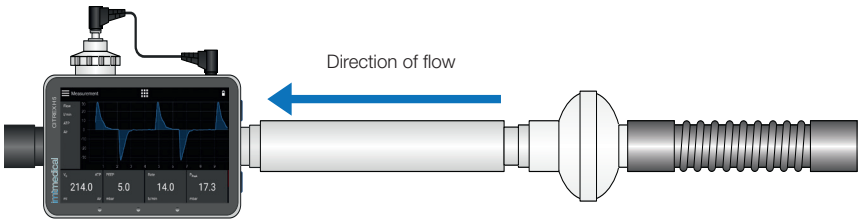
The measurement setup for CITREX H5 has an impact on flow measurement. To obtain results that are as accurate as possible, comply with the instructions in this section. It is important to ensure that the tubing in the measurement setup does not have any radii, kinks or dents. You are also recommended to always use the inlet pipe and the dust filter.

The measured gases must be free of oil, grease and dust.

8.1 General measurement setup

The general measurement setup applies to gas flow measurement. A filter and the inlet pipe must be used. This ensures laminar flow to the flow sensor unit. The filter also prevents dust, oil and grease from contaminating the CITREX H5 measuring instrument and thus prevents discrepancies in measurement results. The measurement setups shown below are dependent on the direction of gas flow being measured.

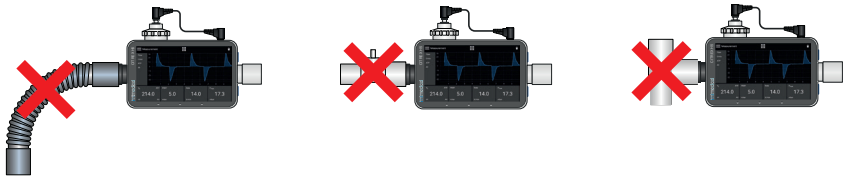




The measured gases must be free of oil, grease and dust. The best measurement results for flow measurements are achieved with the "Adult" trigger setting.

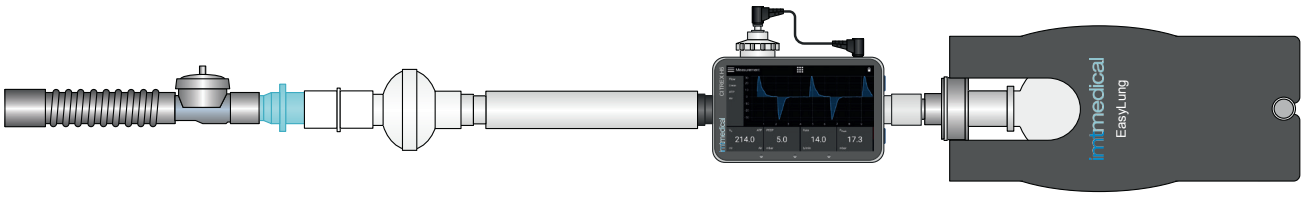
The measurement setups listed below are bad and produce bad measurement results. Kinks, tees and angle pieces must be avoided in the flow channel. They cause turbulence in the gas being measured and hence bad or incorrect measurement results.

Bad setup: Kink, tees, angle pieces at the device inlet



8.2 Measurement setup for checking ventilators

CITREX H5 is ideal for checking ventilators. The best measurement results are achieved with the measurement setup shown below. Make sure the test lung is connected to the grey aluminium port of CITREX H5.

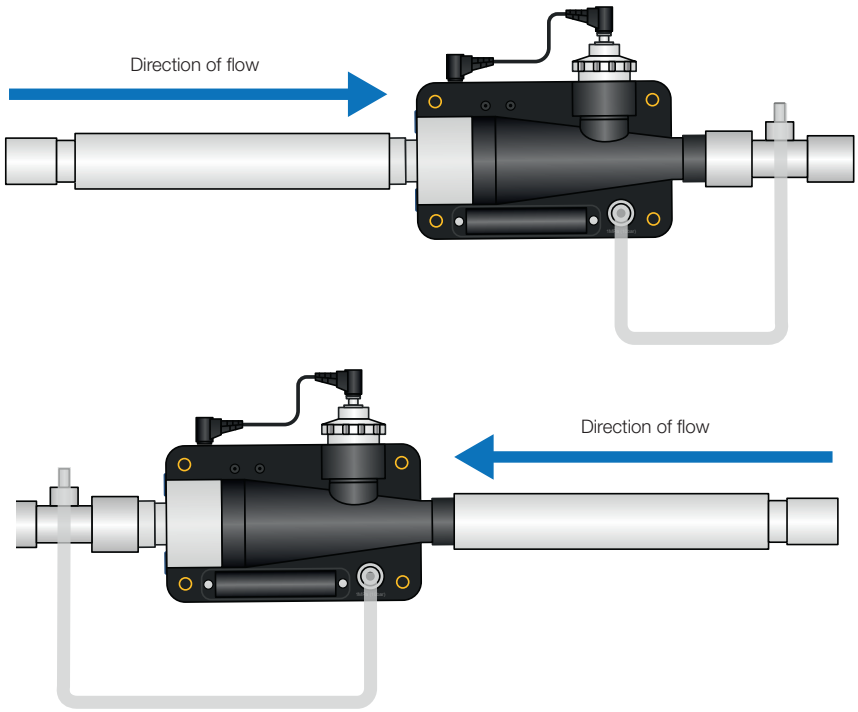


Breathing circuit | Filter | Inlet pipe | CITREX H5 | Test lung

8.3 Measurement setup for gases at high pressure

CITREX H5 compensates for the gas pressure during flow measurement. In the flow channel, gas pressures up to 150 mbar are compensated. For gases at higher pressures the high-pressure sensor can be used. For this purpose connect the device outlet to the high-pressure sensor. In the menu "Settings", "Measurement" you must also switch the "Pressure Compensation" setting to "Pressure High".

> In the flow channel, pressures up to 150 mbar can be compensated. In conjunction with the high-pressure sensor, pressures up to 300 mbar can be compensated. Pressures in the flow channel above 800 mbar can damage the device.



9 Profiles

The user has the option of saving different profiles to suit particular requirements.

Profiles can be edited, imported, exported or deleted. In the main menu there is a menu item called "Profiles". This is where all stored profiles are managed.

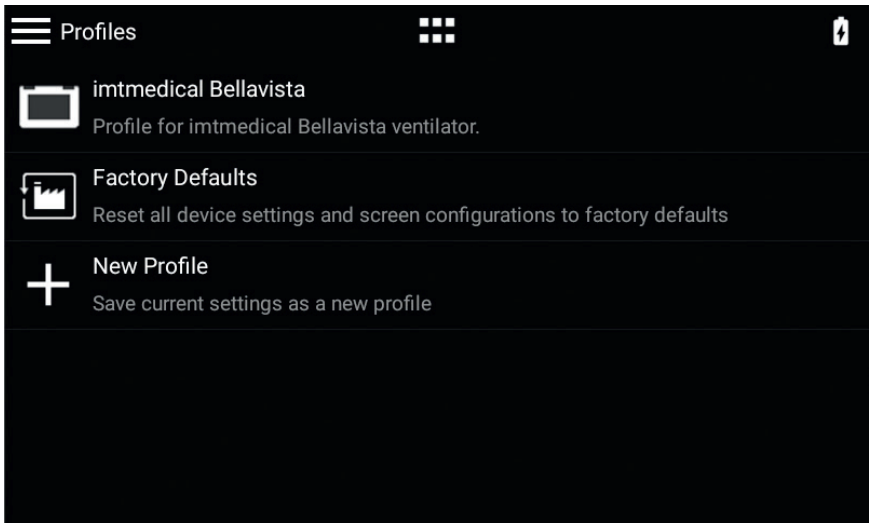


Figure 19: Profile overview

With the current software version you can access edit mode by tapping a certain profile. There you can delete the profile, change the description and the name, and export the profile.

To save the current settings as a profile, tap the context menu icon and then Save current settings as Profile. There you also have the option of exporting all the profiles or individual ones.

10 Configuration tool

10.1 PC minimum requirements

Microsoft® Silverlight 5 or higher

Windows x86 or x64 (64-bit mode only supports IE) 1.6 GHz or higher with 512 MB RAM

Macintosh (Intel based) Intel Core Duo 1.83 GHz or higher with 512 RAM

Microsoft® Windows® 10, 8.1, 8, Windows Server 2012, 7, 7 SP1, Windows Server 2008 SP2, Windows Server 2008 R2 SP1, Vista

Macintosh OS 10.6 (Intel based), MacOS 10.7 – 10.11 (Intel based)

Ethernet network connection

Screen resolution 1024 × 768 (1280 × 1024 recommended)

11 Reading measurement data

The files on the microSD card must not be renamed or deleted under any circumstances.

Measurement data can be read via the microSD card, via the Analog OUT interface or via the RS-232 interface. For information about using the Analog OUT interface please contact your dealer or imtmedical directly.

For information about using the RS-232 interface please contact your dealer or imtmedical directly.

11.1 Reading the data

The data can be read directly from the SD card. For this purpose you must disconnect the SD card from CITREX H5 by pressing the SD card once. It is possible to connect the card to your computer directly using an SD card reader.

If you do not have a reader, you can connect CITREX H5 using the USB cable included. On the screen a query appears asking you whether CITREX should be used as a USB drive. Tap Yes. Then you can read the data on your computer.

The memory card of CITREX H5 contains the following data and folders.

Folder or file	Description
DATA	In this directory you will find the readings that have been saved.
LOGS	CITREX H5 continuously records information about its functions and saves it in the form of log files. This data is only used for remedying malfunctions and resolving issues.
*.CFG, *.SCR, *.TRG files	CFG, SCR and TRG files are required by CITREX to activate internal processes.
Formatter\SetupReportFormatter.bat	This batch file is required to format saved data in an Excel file.
Formatter\AboutReportFormatter.txt	This TXT file describes the procedure for formatting saved data in an Excel file.
Formatter\ReportFormatter.xlsb	This is the actual Excel file template in in which the saved data is formatted.
ClientBin\ConfigurationWeb.xap	This directory is required for the configuration tool.
Clientaccesspolicy.xml	This file is required for the configuration tool.
index.html	This file is required for the configuration tool.
USB-Driver\usb_cdc_ser.inf	Driver for USB device recognition.

Table 6: Folder structure of CITREX H5

12 Servicing and care

Careful servicing in compliance with the instructions is essential for ensuring that CITREX H5 operates safely and efficiently. Only components recommended by the manufacturer may be used.

It is absolutely essential to comply with the guidelines and servicing instructions issued by the various manufacturers.

The servicing operations listed below may only be performed by persons who are familiar with CITREX H5. All further repair work may only be performed by authorised trained professionals. Please also observe the information issued by the various manufacturers.

12.1 Preventive cleaning and servicing operations

To ensure that your device operates with precision and reliability for as long as possible, it is essential to perform the following servicing routines regularly.

12.1.1 During operation

Use of the filter included and the inlet pipe. Make sure the device is only used inside a building.

12.1.2 Every 4 weeks

Check the bacterial filter for soiling. For this purpose the inlet and outlet of the filter must be connected to the differential pressure port using two tees. In this way the pressure drop above the filter can be measured. The pressure drop must not exceed a value of 2 mbar at a flow of 60 L/min. Otherwise the filter must be replaced.

12.1.3 Every 12 months

Factory calibration and servicing to ensure reliable measurement; it may only be performed by imtmedical or an authorised partner.

To have CITREX H5 calibrated at the manufacturer's, imtmedical, visit the website www.imtmedical.com/easycal.

The EasyCal service makes it possible for users to have CITREX H5 calibrated and adjusted quickly and easily. The annual servicing procedure is also performed.

13 Accessories and spare parts

On the website www.imtmedical.com you will find the spare parts and other products from imtmedical.

Ordering address:

imtmedical ag
Gewerbestrasse 8
CH-9470 Buchs, Switzerland

Tel: +41 (0) 81 750 66 99
Email: sales@imtmedical.com

13.1 Accessories table

Options	
304.587.000	Warranty extension (plus 2 years) for CITREX H5
Service	
000.000.015	Recalibration and servicing of CITREX H5
000.000.016	Receiving inspection of CITREX H5
304.592.000	Triple recalibration and servicing package for CITREX H5

Accessories and consumables	
300.548.000	Adapter set
301.997.000	Car adapter for CITREX
302.077.000	Laminar inlet pipe
304.161.000	Black protective pouch for CITREX
304.161.001	Red protective pouch for CITREX
304.161.002	Blue protective pouch for CITREX
500.030.000	High-pressure adapter DISS O_2
500.030.002	High-pressure adapter DISS Air
301.851.000	MicroSD memory card
302.075.000	RS-232 interface cable
301.672.000	Analog output terminal connector
301.655.000	Blind plug for oxygen port (rubber)
302.178.000	Blind plug for oxygen port (solid)
301.624.000	Oxygen sensor with mono jack
302.531.000	Bacterial filter RT019

Spare parts	
304.593.000	Carrying case for CITREX H4
301.625.000	Battery for CITREX
301.563.000	Network cable
304.582.000	USB adapter for CITREX H5
301.673.000	USB cable for CITREX
301.653.000	Oxygen sensor cable
304.578.000	Power supply plug for CITREX H5
302.780.000	Flow channel protective cap

14 Disposal

Disposal of the device is the operator's responsibility. The device can …

- be delivered, carriage free and duty paid, to the manufacturer for disposal.
- be handed over to a licensed private or public collection company.
- be professionally broken down into its constituent parts by the operator and be recycled or disposed of in accordance with regulations.

In the case of self-disposal the disposal regulations are country-specific and are contained in relevant laws and ordinances. These codes of conduct must be obtained from the authorities responsible.

In this context, wastes must be recycled or destroyed …

- without endangering human health.
- without using processes or methods that harm the environment, especially water, air, soil, animals and plants.
- without causing noise or odour nuisances.
- without having a detrimental effect on the surroundings or landscape.

15 Directives and approvals

- CE
- CAN/CSA-C22.2 No. 61010-1-12
- UL Std. No. 61010-1 (3rd Edition)
- IEC 61010-1 2010
- IEC 61326-1 2012
- ETSI EN 301 489-17 V3.1.0
- FCC part 15, subpart B, Digital Devices, emission Class B

CE Declaration of Conformity

2014/35/EU (LVD)
DIRECTIVE 2014/35/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 26 February 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of electrical equipment designed for use within certain voltage limits tested according to EN61010-1:2010

2014/30/EU (EMC)
DIRECTIVE 2014/30/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 26 February 2014 on the harmonisation of the laws of the Member States relating to electromagnetic compatibility tested according to EN61326-1:2013

2014/53/EU (RED)
DIRECTIVE 2014/53/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 16 April 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and tested according to ETSI EN 301 489-17 V3.1.0

16 Specifications

16.1 Measurement parameters

Flow and pressure measurement	Measuring range	Accuracy
Air and N_2		
Flow measurement	±300 sL/min ***	±1.9% * or ±0.1 sL/min **
Temperature compensated	Yes	
Ambient pressure compensated	Yes	
Channel pressure compensated	Yes	-50 … +600 mbar
O_2 / air mixtures		
Flow measurement	±300 sL/min ***	±1.9% * or ±0.1 sL/min **
Temperature compensated	Yes	
Ambient pressure compensated	Yes	
Channel pressure compensated	Yes	-50 … +600 mbar
CO_2		
Flow measurement	±140 sL/min ***	3% * or ±0.1 sL/min **
Temperature compensated	Yes	25 … 30°C
Ambient pressure compensated	Yes	
Channel pressure compensated	Yes	-50 … +600 mbar
Heliox (21% O_2/79% He)		
Flow measurement	±300 sL/min ***	±4% * or ±0.3 sL/min **
Temperature compensated	Yes	25 … 30°C
Ambient pressure compensated	Yes	
Channel pressure compensated	Yes	-50 … +600 mbar
N_2O / O_2 mixtures		
Flow measurement	±80 sL/min ***	±4% * or ±0.3 sL/min **
Temperature compensated	Yes	25 … 30°C
Ambient pressure compensated	Yes	
Channel pressure compensated	Yes	-50 … +600 mbar
Pressure		
High	0 … 10 bar	±1% * or ±10 mbar **
Difference	±200 mbar	±0.75% * or ±0.1 mbar **
In flow channel	-50 ... 150 mbar	±0.75% * or ±0.1 mbar **
Barometer	500 ... 1150 mbar	±1% * or ±5 mbar **

Additional readings	Measuring range	Accuracy
Oxygen concentration (pressure compensated ≤ 150 mbar)	0 … 100%	± 1% O_2**
Gas temperature****	0 … 50°C	± 1.75% * or ± 0.5 °C **
Gas type	Air, Air/O_2, N_2O/O_2, Heliox (21% O_2), N_2, CO_2	
Gas standard	ATP, ATPD, ATPS, AP21, STP, STPH, BTPS, BTPS-A, BTPD, BTPD-A, 0/1013, 20/981, 15/1013, 25/991, 20/1013, NTPD, NTPS	

Units of measurement		
Flow	L/min, L/s, cfm, mL/min, mL/s	
Pressure	bar, mbar, cmH_2O, inH_2O, Torr, inHg, hPa, kPa, mmHg, PSI	

It is the larger tolerance that applies: * Tolerance in relation to the reading ** Absolute tolerance

*** In this User Manual the unit sL/min is based on ambient conditions of 0°C and 1013.25 mbar (DIN1343)

**** CITREX H5 measures gas temperature inside the measurement channel. While CITREX H5 is warming up, the temperature of the measurement channel, and hence also the temperature of the gas inside the measurement channel, rises at the same time. The measurement channel volume is relatively small, even for relatively high volumetric flows (e.g. PIF @ 60 L/min). If the temperature of the gas on entering CITREX H5 is compared with gas temperature in the measurement channel, it becomes evident that the temperature in the measurement channel is higher. Therefore the temperature of the gas entering the CITREX H5 measurement channel should not be expected to equal the temperature displayed on the screen because the temperature displayed is measured inside the CITREX H5 measurement channel.

Ventilation parameters		Measuring range	Accuracy
Rate	Breaths/min	1 ... 1000 breaths/min	± 1 breath or ± 2.5% **
Time	T_i, T_e	0.05 ... 60 s	± 0.02 s
Ratio	I:E	1:300 ... 300:1	± 2.5% *
	T_i/T_{cyc}	0 ... 100%	± 5% *
Tidal volume	V_{ti}, V_{te}	± 10 sL	± 2% * or ± 0.20 mL (> 6 sL/min)** ***
Peak flow	PF_{Insp}/PF_{Exp}	± 300 sL/min	± 1.9% * or ± 0.1 sL/min **
Pressure	P_{Peak}, P_{Mean} PEEP, $P_{Plateau}$, IPAP	0 ... 150 mbar	± 0.75% * or ± 0.1 mbar **
Compliance	C_{Stat}	0 ... 1000 mL/mbar	± 3% * or ± 1 mL/mbar **
Trigger	Adult, Paediatric, HFO flow and volume		

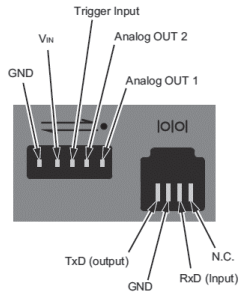
General information	
Screen	4.3 " multi-touch screen with 800 × 480 pixels
Real-time curves	Flow, pressure, volume, temperature, oxygen, ventilation parameters
Interfaces	RS-232, USB, Ethernet, CAN, Analog Out, TTL, WLAN
AC input	100 ... 240 VAC (50/60 Hz)
Battery operation	5 hours
Dimensions (W x D x H)	11.4 × 7 × 7.3 cm
Weight	0.52 kg
Calibration interval	Once a year
Memory card	Yes

Operating data	
Ambient temperature	15 ... 40 °C (59 ... 104 °F)
Air humidity	10 ... 90% RH
Ambient pressure	783 ... 1150 mbar
Storage and transport conditions	-10 ... 60 °C (14 ... 140 °F) at 5 ... 95% RH

It is the larger tolerance that applies: * Tolerance in relation to the reading ** Absolute tolerance

*** In this User Manual the unit sL/min is based on ambient conditions of 0°C and 1013.25 mbar (DIN1343)

16.2 Interface definition



Interface	Pin assignment	Range
Analog OUT	Pin 1: Analog OUT 1 Pin 2: Analog OUT 2 Pin 3: Trigger Input Pin 4: V_{IN} Pin 5: GND	0…5 VDC ±1.8%, load ≥5 kΩ 0…5 VDC ±1.8%, load ≥5 kΩ 5…24 VDC 12 VDC ±20%…24 VDC ±20%
RS-232	Pin 1: NC Pin 2: RxD (Input) Pin 3: TxD (Output) Pin 4: GND	
CAN	Pin 1: VIN Pin 2: CAN_H Pin 3: CAN_L Pin 4: Pin 5: Pin 6: GND 120 Ω Connectable terminating resistor	12 VDC ±20%…24 VDC ±20%

16.3 Gas type

The type of gas measured must agree with the setting on CITREX H5. Please select the correct gas type in the settings.

The following gas types are available for selection:

- Air 100%
- Air/O_2-Man. Air/oxygen mixture according to manual input; the default is 100% O_2
- Air/O_2-Auto. Air/oxygen mixture according to sensor measurement of internal oxygen cell
- N_2O/O_2-Man. Nitrous oxide / oxygen mixture according to manual input; the default is 100% O_2
- Heliox 21% O_2/79% He
- N_2 100%
- CO_2 100%

Standard conditions are understood to mean defined conditions for pressure, temperature and, in some cases, humidity, which constitute the basis for converting the flow actually measured. Therefore it is essential to check which standard condition the value displayed will relate to.

The standard currently set is indicated on the numerical and graphical display.

A gas type that has not been selected properly and a gas standard that has not been selected properly can lead to measuring errors of up to 20%.

16.4 Power supply

Input voltage of the power supply unit	100 ... 240 VAC, 50 ... 60 Hz
Supply voltage	5 VDC
Power input	2.5 ... 6 W

16.5 Battery operation

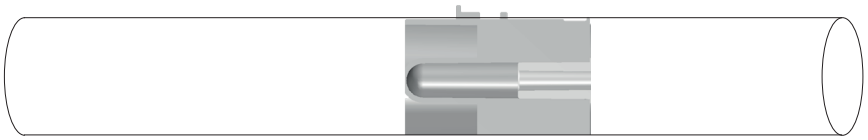
Operating time in battery operation	5 hours*
Charging the battery	A complete charging process takes 5 to 8 h, depending on which connection port is used for charging. The service life of the battery is extended if the battery is charged completely only after a prompt by the device

* This operating time is reached in non-networked operation (i.e. the interfaces are not in use or they are switched off)

17 Appendix

17.1 Principle of flow measurement

Flow in the flow channel is determined by differential pressure measurement. To build up differential pressure a linear flow element is used to provide flow resistance.



$$\Delta p = c_1 \times \eta \times Q + c_2 \times \rho \times Q^2$$

η: dynamic viscosity of the gas [Pa s]

ρ: gas density [kg/m^3]

c_1, c_2: device-specific constants (channel geometry)

Dynamic viscosity

- The viscosity of the medium is its resistance to flow and shear.
- Viscosity is extremely dependent on temperature.
- The viscosity of a medium is slightly dependent on the pressure and moisture content of the medium.

Density

- Density is the unit for the mass per unit volume of the medium.
- Viscosity is extremely dependent on temperature.
- The viscosity of a medium is slightly dependent on the pressure and moisture content of the medium.

17.2 Measurement parameters and units

Pressure readings	Measurement parameter	Designation	Units of measurement
	Ambient pressure	P_{Atmo}	mbar, bar, inH_2O, cmH_2O, psi, Torr, inHg, mmHg, hPa, kPa
	Pressure high	P_{High}	
	Pressure in flow channel high	$P_{Channel}$	
	Differential pressure	P_{Diff}	
Flow readings	**Measurement parameter**	**Designation**	**Units of measurement**
	Flow	Flow	L/min, mL/min, cfm, L/s, mL/s
Meteorological readings	**Measurement parameter**	**Designation**	**Units of measurement**
	Temperature	Temp.	°C, K, °F
	Oxygen content	O_2	%
	Volume	Volume	mL, L, cf
Gas concentrations	**Measurement parameter**	**Designation**	**Units of measurement**
	Gas concentration	Gas concentration	%
	Partial pressure	Partial pressure	mbar, bar, inH_2O, cmH_2O, psi, Torr, inHg, mmHg, hPa, kPa
Ventilation parameters	**Measurement parameter**	**Designation**	**Units of measurement**
	Positive end-expiratory pressure	PEEP	mbar, bar, inH_2O, cmH_2O, psi, Torr, inHg, mmHg, hPa, kPa
	Mean pressure	P_{Mean}	
	Inspiratory positive airway pressure	IPAP	
	Maximum pressure	P_{Peak}	
	Plateau pressure	$P_{Plateau}$	
	Expiratory minute volume	V_e	L/min, mL/min, cfm, L/s, mL/s
	Inspiratory minute volume	V_i	
	Inspiratory peak flow	PF_{Insp}	
	Expiratory peak flow	PF_{Exp}	
	Expiratory volume	Vte	mL, L, cf
	Inspiratory volume	Vti	mL, L, cf
	Ventilation rate	Rate	Breaths/min
	Inspiratory/expiratory ratio	I:E	
	Expiratory time	T_e	s
	Inspiratory time	T_i	s
	Compliance	C_{Stat}	mL/mbar, L/mbar, mL/cmH_2O, mL/cmH_2O

17.3 Gas standards for flow and volume readings

CITREX H5 converts the flow and volume readings measured in the device to match the conditions of the standard selected. The following gas standards are supported by CITREX H5.

Gas standard		Pressure	Temperature	Relative humidity
Ambient Temperature and Pressure	ATP	Current ambient pressure	Current gas temperature	Current gas humidity
Ambient Temperature and Pressure Dry	ATPD	Current ambient pressure	Current gas temperature	0%
Ambient Temperature and Pressure Saturated	ATPS	Current ambient pressure	Current gas temperature	100%
Ambient Pressure at 21 °C	AP21	Current ambient pressure	21.0 °C (70 °F)	Current gas humidity
Standard Conditions USA	STP	1013.25 mbar (760 mmHg)	21.0 °C (70 °F)	0%
Standard Conditions USA Humid	STPH	1013.25 mbar (760 mmHg)	21.0 °C (70 °F)	Current gas humidity
Body Temperature and Pressure, Saturated	BTPS	Current ambient pressure + channel pressure	37.0 °C (99 °F)	100%
Body Temperature and (Ambient) Pressure Saturated according to ISO 80601-2-12:2011	BTPS-A	Current ambient pressure	37.0 °C (99 °F)	100%
Body Temperature and Pressure Dry	BTPD	Current ambient pressure + channel pressure	37.0 °C (99 °F)	0%
Body Temperature And (Ambient) Pressure Dry	BTPD-A	Current ambient pressure	37.0 °C (99 °F)	0%
Standard Conditions to DIN1343	0/1013	1013.25 mbar (760 mmHg)	0.0 °C (32 °F)	0%
Standard Conditions to ISO 1-1975 (DIN 102)	20/981	981 mbar (736 mmHg)	20.0 °C (68 °F)	0%
API Standard Conditions	15/1013	1013.25 mbar (14.7 psia)	15.0 °C (60 °F)	0%
Cummings Standard	25/991	991 mbar (500 ft altitude)	25.0 °C (77 °F)	0%
20 °C/1013 mbar	20/1013	1013.25 mbar (760 mmHg)	20.0 °C (68 °F)	0%
Normal Temperature and Pressure	NTPD	1013.25 mbar (760 mmHg)	20.0 °C (68 °F)	0%
Normal Temperature and Pressure, Saturated	NTPS	1013.25 mbar (760 mmHg)	20.0 °C (68 °F)	100%

17.4 Conversion factors

Value	Equivalent		
1 mbar	0.001	bar	
	100	Pa	
	1	hPa	
	0.1	kPa	
	0.75006	torr	(760 torr = 1 atm.)
	0.75006	mmHg	(at 0 °C)
	0.02953	inHg	(at 0 °C)
	1.01974	cmH_2O	(at 4 °C)
	0.40147	inH_2O	(at 4 °C)
	0.01450	psi, psia	
1 bar	1000	mbar	
	0.1	Pa	
	1000	hPa	
	100	kPa	
	750.06	torr	(760 torr = 1 atm.)
	750.06	mmHg	(at 0 °C)
	29.53	inHg	(at 0 °C)
	1019.74	cmH_2O	(at 4 °C)
	401.47	inH_2O	(at 4 °C)
	14.50	psi, psia	

17.5 List of tables

17.6 List of figures

17.7 Index

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Z

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