DATREND Systems Inc.

venTest™

Ventilator Tester

Operating Manual

MN-108

venTest™

Ventilator Tester

Operating Manual

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DATREND Systems Inc.

To order this manual, use Part Number 6100-200

Revision	Revision History Description	Date
A	Initial Release	2016-Mar-08
B	General update	2018-Jun-28

Unpacking and Inspection

Follow standard receiving practices upon receipt of the instrument. Check the shipping carton for damage. If damage is found, stop unpacking the instrument. Notify the freight carrier and ask for an agent to be present while the instrument is unpacked. There are no special unpacking instructions, but be careful not to damage the instrument when unpacking it. Inspect the instrument for physical damage such as bent or broken parts, dents, or scratches.

Claims

Our routine method of shipment is via common carrier. Upon delivery, if physical damage is found, retain all packing materials in their original condition and contact the carrier immediately to file a claim.

If the instrument is delivered in good physical condition but does not operate within specifications, or if there are any other problems not caused by shipping damage, please contact your local sales representative or DSI immediately.

Standard Terms and Conditions

Refunds & Credits

Please note only serialized products (products labelled with a distinct serial number) and accessories are eligible for partial refund and/or credit. Non-serialized parts and accessory items (cables, carrying cases, auxiliary modules, etc.) are not eligible for return or refund. In order to receive a partial refund/credit, the product must not have been damaged, and must be returned complete (meaning all manuals, cables, accessories, etc.) within 90 days of original purchase and in "as new" and resalable condition. The *Return Procedure* must be followed.

Return Procedure

Every product returned for refund/credit must be accompanied by a Return Material Authorization (RMA) number, obtained from Datrend Customer Service. All items being returned must be sent *prepaid* (freight, duty, brokerage, and taxes) to our factory location.

Restocking Charges

Products returned within 30 days of original purchase are subject to a minimum restocking fee of 15%. Products returned in excess of 30 days after purchase, but prior to 90 days, are subject to a minimum restocking fee of 20%. Additional charges for damage and/or missing parts and accessories will be applied to all returns. Products which are not in "as new" and resalable condition, are not eligible for credit return and will be returned to the customer at their expense.

Certification

This instrument was thoroughly tested and inspected and found to meet DSI's manufacturing specifications when it was shipped from the factory. Calibration measurements are traceable to the National Research Council of Canada (NRC) and/or the National Institute of Standards and Technology (NIST). Devices for which there are no NRC/NIST calibration standards are measured against in-house performance standards using accepted test procedures.

Warranty and Product Support

Datrend Systems Inc. ("DSI") warrants the venTest Unit (the "Datrend product") to be free from defects in materials and workmanship under normal use and service for one (1) year from the date of original purchase. During the warranty period DSI will, at our option, either repair or replace defects in materials and workmanship at no charge; provided the Datrend product is returned (shipping, duty, brokerage and taxes prepaid) to DSI. Any and all transportation charges incurred are the responsibility of the purchaser and are not included within this warranty. This warranty extends only to the original purchaser and does not cover damage from abuse, neglect, accident or misuse or as the result of service or modification by other than DSI. IN NO EVENT SHALL DATREND SYSTEMS INC. BE LIABLE FOR CONSEQUENTIAL DAMAGES.

This warranty is subject to the following limitations:
- Standard Accessories: 90 day limited warranty
- Re-calibration of the instrument, which has a recommended annual calibration frequency, is not covered under the warranty.

No warranty shall apply when damage is caused by any of the following:
- Power failure, surges, or spikes,
- Damage in transit, when moving the instrument, or if the unit is dropped,
- Improper power supply such as low voltage, incorrect voltage, defective wiring or inadequate fuses,
- Accident, alteration, abuse or misuse of the instrument,
- Fire, water damage, theft, war, riot, hostility, acts of God, such as hurricanes, floods, etc.

Only serialized products (those items bearing a distinct serial number tag) and their accessory items are covered under this warranty. PHYSICAL DAMAGE CAUSED BY MISUSE OR PHYSICAL ABUSE IS NOT COVERED UNDER THE WARRANTY. Items such as cables and non-serialized modules are not covered under this warranty.

This warranty gives you specific legal rights and you may have other rights, which vary from province to province, state to state, or country to country. This warranty is limited to repairing the instrument to DSI's specifications.

When you return an instrument to DSI for service, repair or calibration, we recommend shipment using the original shipping foam and container. If the original packing materials are not available, we recommend the following guide for repackaging:
- Use a double-walled carton of sufficient strength for the weight being shipped.
- Use heavy paper or cardboard to protect all instrument surfaces. Use non-abrasive material around all projecting parts.
- Use at least four inches of tightly packed, industrial-approved, shock-absorbent material all around the instrument.

DSI will not be responsible for lost shipments or instruments received in damaged condition due to improper packaging or handling. All warranty claim shipments must be made on a prepaid basis (freight, duty, brokerage, and taxes). No returns will be accepted without a Return Materials Authorization ("RMA") number. Please contact to obtain an RMA number and receive help with shipping/customs documentation.

Warranty Disclaimer

Should you elect to have your instrument serviced and/or calibrated by someone other than Datrend Systems or an Authorized Service Centre, please be advised that the original warranty covering your product becomes void when the tamper-resistant Quality Seal is removed or broken without proper factory authorization. We strongly recommend, therefore, that you send your instrument to Datrend Systems or an Authorized Service Centre for service and calibration, especially during the original warranty period.

In all cases, breaking the tamper-resistant Quality Seal should be avoided at all cost, as this seal is the key to your original instrument warranty. In the event that the seal must be broken to gain internal access to the instrument (e.g., in the case of a customer-installed firmware upgrade), you must first contact Datrend Systems at 1-604-291-7747. You will be required to provide us with the serial number for your instrument as well as a valid reason for breaking the Quality Seal. You should break this seal only after you have received factory authorization. Do not break the Quality Seal before you have contacted us! Following these steps will help ensure that you will retain the original warranty on your instrument without interruption.

WARNING

Unauthorized user modifications or application beyond the published specifications may result in electrical shock hazards or improper operation. Datrend Systems will not be responsible for any injuries sustained due to unauthorized equipment modifications.

DSI DISCLAIMS ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR APPLICATION.

THIS PRODUCT CONTAINS NO USER-SERVICEABLE COMPONENTS. UNAUTHORIZED REMOVAL OF THE INSTRUMENT COVER SHALL VOID THIS AND ALL OTHER EXPRESSED OR IMPLIED WARRANTIES.

Note: Calibration of Datrend products typically involves adjustment of parameters stored in firmware by proprietary software. Parties other than Datrend and its Authorized Service Centers are limited to verification of the status of the accuracy of the instrument. Do not confuse verification with calibration.

Table of Contents

Abbreviations and Definitions

The following abbreviations, terms and acronyms are used throughout this manual:

ENF	enflurane
DES	desflurane
HAL	halothane
ISO	isoflurane
SEV	sevoflurane
l	liter
ml	milliliter
l/min	liters per minute
ml/min	milliliters per minute
l/s	liters per second
cfm	cubic feet per minute
s, sec	second
ms, msec	millisecond
kPa	kilopascal
hPa	hectopascal
MPa	megapascal
cmH_2O	centimeters of water
psi	pounds-force per square inch
bar	bar
mbar	millibar
%	percent
mmHg	millimeters of mercury
Torr	Torr
inH_2O	inches of water
inHg	inches of mercury
°F	degrees Fahrenheit
°C	degrees Celcius

Hz	Hertz
1/min	1 per minute
% Vol	Volume percent
% r.f.	Percent relative humidity
% h	Percent per hour
mAh	milliamp-hours

Symbol Definitions

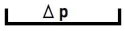
The following symbols may be found on venTest:

CONSULT MANUAL FOR PROPER OPERATION

The operating manual provides valuable information on the proper use of venTest. It is highly recommended the operator read the instructions thoroughly before operating the device. It is possible to damage the Equipment and/or cause harm to the operator if venTest is used incorrectly.

The following symbols may appear on the device or in the manual.

Symbol	Description
I / O	ON/OFF Button
	SD Memory Card
USB-A	USB Type A, Host port
USB-B	USB Type B, Device Port
	Ethernet Port
RS-232	DB9 Female, serial port (*special purpose)

Symbol	Description
	Read Instruction Manual
	Warning
	Differential Pressure
	Attention/Information
	Note on waste disposal

Chapter 1

1 Specifications

Performance Specifications

1.1 Instrument Specifications

1.1.1 FlowSense 300 (Hi Flow) Sensor Measurement

Physical Data		
Dimensions	150 mm x 41 mm x 58 mm (L x W x H)	
Connector 1	Cone ID 22 mm	
Connector 2	Cone OD 22 mm, ID 15 mm	
Weight	Approx. 290 g	
Environmental Conditions		
Parameter	Operation	Storage
Temperature	10 to 40 °C	-20 to 50 °C
Ambient Humidity	5 to 95% RH (non-condensing)	5 to 95% RH (non-condensing)
Gas Temperature	10 to 40 °C	
Gas Humidity	0 to 95% RH (non-condensing)	
Ambient Pressure	60 - 110 kPa	60 - 110 kPa

Range and Accuracy			
Parameter	**Units**	**Range**	**Accuracy (whichever is greater)**
Flow: Air		± 300 l/min	± 2% or 0.1 l/min (STPD)
Flow: O_2		± 200 l/min	± 4% or 0.2 l/min (STPD)
Flow: Air/O_2		± 200 l/min	± 4% or 0.2 l/min (STPD)
Vti	l; ml	0 - 10 L	± 2% of m.v. or 0.2 l (AIR) ** ± 4% of m.v. or 0.4 l (O_2, AIR/O_2) **
Vte	l; ml	0 - 10 L	± 2% of m.v. or 0.2 l (AIR) ** ± 4% of m.v. or 0.4 l (O_2, AIR/O_2) **
MVi	l/min; ml/min	0.5 - 50 L/min (AIR) 0.5 - 50 L/min (O_2, AIR/O_2)	± 2% of m.v. or 0.2 l/min (AIR) ** ± 4% of m.v. or 0.4 l/min (O_2, AIR/O_2) **
MVe	l/min; ml/min	0.5 - 50 L/min (AIR) 0.5 - 50 L/min (O_2, AIR/O_2)	± 2% of m.v. or 0.2 l/min (AIR) ** ± 4% of m.v. or 0.4 l/min (O_2, AIR/O_2) **
Breath Rate (Freq)	BrPM	1 - 100 BrPM 101 - 200 BrPM	± 0.1 BrPM ‡ ± 0.2 BrPM ‡
Ventilation Pressure	kpa; mbar; cmH_2O; mmHg; psi; hpa	0 - 10 kPa	± 1% of m.v. or 0.2 hPa
PEEP	kpa; mbar; cmH_2O; mmHg; psi; hpa	0 - 10 kPa	± 1% or 0.02 kPa* **
Peak	kpa; mbar; cmH_2O; mmHg; psi; hpa	0 - 10 kPa	± 1% or 0.02 kPa* **

Range and Accuracy			
Parameter	**Units**	**Range**	**Accuracy (whichever is greater)**
Plateau	kpa; mbar; cmH_2O; mmHg; psi; hpa	0 - 10 kPa	± 1% or 0.02 kPa* **
Mean	kpa; mbar; cmH_2O; mmHg; psi; hpa	0 - 10 kPa	± 1% or 0.02 kPa* **
I/E		300/1 - 1/300	± 0.1 **
Ti	s; ms	0 - 60 sec	± 1% ± 0.02sec **
Te	s; ms	0 - 60 sec	± 1% ± 0.02sec **
Tip	s; ms	0 - 60 sec	± 1% ± 0.02sec **
Tep	s; ms	0 - 60 sec	± 1% ± 0.02sec **
Humidity	% rh	5 - 95%	5 - 80 % rh: ± 3% 80 - 95 % rh: ± 4%
Insp. Peak Flow	l/min; ml/min	0 - 300 L/min (AIR) 0 - 200 L/min (O_2, AIR/O_2	± 2% of m.v. or 0.1 l/min (AIR) ** ± 4% of m.v. or 0.2 l/min (O_2, AIR/O_2) **
Exp. Peak Flow	l/min; ml/min	0 - 300 L/min (AIR) 0 - 200 L/min (O_2, AIR/O_2	± 2% of m.v. or 0.1 l/min (AIR) ** ± 4% of m.v. or 0.2 l/min (O_2, AIR/O_2) **
HFO Pmean	kpa; mbar; cmH_2O; mmHg; psi; hpa	0 - 10 kPa	± 2% of m.v. or 0.04 kPa* **
HFO PMax	kpa; mbar; cmH_2O; mmHg; psi; hpa	0 - 10 kPa	± 2% of m.v. or 0.04 kPa* **
HFO PMin	kpa; mbar; cmH_2O; mmHg; psi; hpa	0 - 10 kPa	± 2% of m.v. or 0.04 kPa* **
HFO amplitude	kpa; mbar; cmH_2O; mmHg; psi; hpa	0 - 10 kPa	± 2% of m.v. or 0.04 kPa* **
HFO frequency	Hz	0 - 20	± 1 Hz
HFO I/E		3/1 - 1/3	± 0.3

(*) Please note that due to the pneumatic resistance of the Flowsense 300 Sensor the measured pressure from the ventilation pressure sensor may differ from values measured at other places in breathing system, especially at high flows .
(**) Subject to trigger settings

1.1.2 FlowSense 012 (Low Flow) Sensor Measurement

Physical Data			
Dimensions	125 mm x 41 mm x 58 mm (L x W x H)		
Connector 1	6 mm tube connection		
Connector 2	6 mm tube connection		
Weight	Approx. 290 g		
Environmental Conditions			
Parameter	Operation	Storage	
Temperature	10 to 40 °C	-20 to 50 °C	
Ambient Humidity	5 to 95% RH (non-condensing)	5 to 95% RH (non-condensing)	
Gas Temperature	10 to 40 °C		
Gas Humidity	0 to 95% RH (non-condensing)		
Ambient Pressure	60 - 110 kPa	60 - 110 kPa	
Range and Accuracy			
Parameter	**Units**	**Range**	**Accuracy (whichever is greater)**
Flow: Air		± 12 l/min	± 2% or 0.01 l/min (STPD)
Flow: O_2		± 12 l/min	± 4% or 0.02 l/min (STPD)
Flow: Air/O_2		± 12 l/min	± 4% or 0.02 l/min (STPD)
Vti	l; ml	0 - 7.5 L	± 2% of m.v. or 20 ml (AIR) ‡
Vte	l; ml	0 - 7.5 L	± 2% of m.v. or 20 ml (AIR) ‡

Range and Accuracy			
Parameter	**Units**	**Range**	**Accuracy (whichever is greater)**
MVi	l/min; ml/min	0.5 - 12 L/min (AIR) 0.5 - 12 L/min (O_2, AIR/O_2)	± 2% of m.v. or 20 ml/min (AIR) ‡ ± 4% of m.v. or 40 ml/min (O_2, AIR/O_2) ‡
MVe	l/min; ml/min	0.5 - 12 L/min (AIR) 0.5 - 12 L/min (O_2, AIR/O_2)	± 2% of m.v. or 0.2 l/min (AIR) ‡ ± 4% of m.v. or 0.4 l/min (O_2, AIR/O_2) ‡
Breath Rate (Freq)	BrPM	1 - 100 BrPM 101 - 200 BrPM	± 0.1 BrPM ‡ ± 0.2 BrPM ‡
Ventilation Pressure	kpa; Mpa; bar; mbar; cmH_2O; mmHg; psi; hpa; Torr; inH_2O; inHg	0 - 10 kPa	± 1% of m.v. or 0.2 hPa
PEEP	kpa; mbar; cmH_2O; mmHg; psi; hpa	0 - 10 kPa	± 1% or 0.02 kPa † ‡
Peak	kpa; mbar; cmH_2O; mmHg; psi; hpa	0 - 10 kPa	± 1% or 0.02 kPa † ‡
Plateau	kpa; mbar; cmH_2O; mmHg; psi; hpa	0 - 10 kPa	± 1% or 0.02 kPa † ‡
Mean	kpa; mbar; cmH_2O; mmHg; psi; hpa	0 - 10 kPa	± 1% or 0.02 kPa † ‡
I/E		300/1 - 1/300	± 0.1 ‡
Ti	s; ms	0 - 60 sec	± 1% ± 0.02sec ‡
Te	s; ms	0 - 60 sec	± 1% ± 0.02sec ‡
Tip	s; ms	0 - 60 sec	± 1% ± 0.02sec ‡
Tep	s; ms	0 - 60 sec	± 1% ± 0.02sec ‡
Humidity	% rh	5 - 95%	5 - 80 % rh: ± 3% 80 - 95 % rh: ± 4%

Range and Accuracy			
Parameter	**Units**	**Range**	**Accuracy (whichever is greater)**
Insp. Peak Flow	l/min; ml/min	0 - 300 L/min (AIR) 0 - 200 L/min (O_2, AIR/O_2	± 2% of m.v. or 0.1 l/min (AIR) ‡ ± 4% of m.v. or 0.2 l/min (O_2, AIR/O_2) ‡
Exp. Peak Flow	l/min; ml/min	0 - 300 L/min (AIR) 0 - 200 L/min (O_2, AIR/O_2	± 2% of m.v. or 0.1 l/min (AIR) ‡ ± 4% of m.v. or 0.2 l/min (O_2, AIR/O_2) ‡
HFO Pmean	kpa; mbar; cmH_2O; mmHg; psi; hpa	0 - 10 kPa	± 2% of m.v. or 0.04 kPa † ‡
HFO PMax	kpa; mbar; cmH_2O; mmHg; psi; hpa	0 - 10 kPa	± 2% of m.v. or 0.04 kPa † ‡
HFO PMin	kpa; mbar; cmH_2O; mmHg; psi; hpa	0 - 10 kPa	± 2% of m.v. or 0.04 kPa † ‡
HFO amplitude	kpa; mbar; cmH_2O; mmHg; psi; hpa	0 - 10 kPa	± 2% of m.v. or 0.04 kPa † ‡
HFO frequency	Hz	0 - 20	± 1 Hz
HFO I/E		3/1 - 1/3	± 0.3

(†) Please note that due to the pneumatic resistance of the Flowsense 012 Sensor the measured pressure from the ventilation pressure sensor may differ from values measured at other places in breathing system, especially at high flows .

(‡) Subject to trigger settings

1.1.3 Oxygen (O_2) Sensor Measurement

Physical Data			
Dimensions	73 mm x 31 mm x 31 mm (L x W x H)		
Weight	Approx. 75 g		
Environmental Conditions			
Parameter	Operation	Storage	
Temperature	5 to 40 °C	-20 to 60 °C	
Ambient Humidity	10 to 90% RH (non-condensing)	0 to 100% RH (non-condensing)	
Gas Temperature	10 to 40 °C		
Gas Humidity	0 to 95% RH (non-condensing)		
Ambient Pressure	80 - 121 kPa	51 - 152 kPa	
Range and Accuracy			
Parameter	**Units**	**Range**	**Accuracy**
O_2 concentration	%Vol	0 - 100 %	± 1% of m.v.

1.1.4 IRMA™ AX+ Multigas Sensor†

Physical Data			
Dimensions	38 mm x 37 mm x 34 mm (L x W x H)		
Weight	Approx. 25 g		
Dead Space: Adult Infant	6ml 1ml		
Warm-up Time	10 sec, full specification within 60 sec		
Interface	RS-232 at 9600 bps		
Environmental Conditions			
Parameter	Operation	Storage	
Temperature	5 to 40 °C	-20 to 50 °C	
Ambient Humidity	10 to 95% RH (non-condensing)	0 to 100% RH (non-condensing)	
Gas Temperature	10 to 40 °C		
Gas Humidity	0 to 95% RH (non-condensing)		
Ambient Pressure	53 - 120 kPa		
Range and Accuracy			
Parameter	**Units**	**Range**	**Accuracy**
CO_2	Vol %	0 - 10 10 - 15	± 0.2vol% + 2% of reading ± 0.3vol% + 2% of reading
N_2O	Vol %	0 - 100	± 2vol% + 2% of reading
HAL, ISO, ENF	Vol %	0 - 8	± 0.15vol% + 5% of reading
SEV	Vol %	0 - 10	± 0.15vol% + 5% of reading
DES	Vol %	0 - 22	± 0.15vol% + 5% of reading

† For further information refer to the Masimo Sweden Website (www.masimosweden.com)

1.2 User Interface

Display.	7" widescreen colour LCD
User Controls.	Capacitive touchscreen
Wired Connectivity.	USB 2.0 Type B USB 2.0 Type A Ethernet
Wireless Connectivity.	802.11 b/g/n Bluetooth 2.1+ EDR
Memory, Internal..	16GB Maximum

Equipment Technical Specifications

1.3 Electrical Ratings

External Adapter:
100 - 240 VAC ± 10%, 50/60 Hz, 900mA, 12V DC, 3A

Internal Battery:
LiPo 7.4V / 5.2 Ah, approx. 6 hours operation

1.4 Environment for Use

10 to 40 °C operation
-20 to 50 °C storage
5 to 95% RH (non-condensing)
10 to 40 °C gas temperature
5 to 95% RH (non-condensing) gas humidity
60 - 110 kPa Ambient Pressure
Altitude: 2000m max.
Indoor use only
Pollution Degree 2

1.5 Dimensions

Base unit. . . . . 8.3 x 5.5 x 3.14 in. (21 x 14 x 8 cm)

1.6 Weight

3.1 lb (1.4kg)

1.7 Standard Accessories

T-piece	22M x 22M x 22F
Coupler	22F x 22F
Coupler	22M x 22M
Adapter	22F to 9-11mm ID Tubing
Adapter	22M to 9-11 mm ID Tubing

1.8 Optional Accessories

High Pressure 10bar pressure option
High Pressure Tubing, 2m with locking fitting, for 10bar pressure option
IRMA AX+ Multigas Sensor option
IRMA Airway Adapter, Infant
IRMA Airway Adapter, Adult
IRMA RS232 M-M adapter
Oxygen Sensor option
O2/Air gas mix option
Test Lung, 1Liter

For a complete list of available accessories, visit www.datrend.com or contact Datrend Customer Service

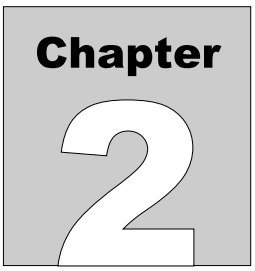
1.9 Compliance With Standards

venTest has been designed to meet the following safety standards:

CAN/CSA-C22.2 No. 61010-1-(2nd Edition) - Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use, Part 1: General Requirements

UL Std. No. 61010-1 (2nd Edition) - Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use - Part 1: General Requirements

Following manufacture, all units are subjected to, and have passed the requirements of the 'Routine Tests' defined in Annex F of the above Standard(s).



2 Overview

Datrend venTest is a compact, mobile and easy to handle measuring device for ventilation parameters, which is able to be adapted to nearly every ventilator measuring task. It is appropriate for testing ventilators of virtually any type, as well as other measuring tasks in which you have to measure gas flow and pressure.

To successfully manage your measuring tasks, it is of prime importance to read this manual entirely and follow the instructions accurately.

You can configure the venTest exactly to your preferred measuring conditions. This may require a high level of parameter adjustment, which is accessed via a clearly arranged, menu driven user interface. Handle the venTest with care. The flow and oxygen sensor have the benefit of not being integrated into the device, and therefore may be placed in areas that a larger system may not normally fit. However, it is necessary to handle the sensors with care. The same applies to the corresponding sensor cables.

Exposure to direct sunlight on the venTest, as well as on all connected sensors should be avoided because this may cause a rise in measured values. It is not recommended to use the device outside.

ATTENTION!

The venTest is **not** a monitor to be connected to a patient. It is a testing and measuring device.

During patient care via a ventilator, connection to the venTest is prohibited.

2.1 Features

2.1.1 Analyzer Base Unit

The Datrend venTest is comprised of a Base Unit which provides the control and displays, and connection to either a high or low flow sensor. Referring to Figure 1 , controls, interfaces and features of the Analyzer Base Unit are:

Figure 1 - venTest Base Unit Back Panel

Item	Description/Function
1. 'ON/OFF' button	Turn base unit ON/OFF, illuminated
2. SD Card	Removable SD memory card
3. USB connector	Type B, connection to USB-Host
4. USB connector	2 x Type A, connection to USB Devices
5. Ethernet connector	connection to network
6. DB-9F	RS-232 connection to IRMA AX+ multigas sensor (option)
7. O2 Sensor	3 pin connection to oxygen sensor (option)
8. Label	"Refer to instruction manual"
9. Flow Sensor connector	Connection to FlowSense air flow sensor, Hi or Lo flow
10. Hi Pressure connector	0-1 Mpa / 10 bar (option)
11. Differential Pressure connector A	± 100 kPa / ± 1 bar
12. Differential Pressure connector B	± 20 kPa / ± 200 mbar
13. Differential Pressure connector C	± 2 kPa / ± 20 mbar
14. Power Input	+12 Vdc
15. Reset button	Press to reset Base Unit

2.1.2 Pressure Connections

The differential pressure connections (± 20 mbar, ± 200 mbar, ± 1 bar) are each marked with the designations ‘IN’ and ‘REF’.

If the pressure ‘IN’ is higher in reference to ‘REF’, a positive differential pressure is displayed. Conversely, if the pressure ‘IN’ is lower in reference to ‘REF’, a negative differential pressure is displayed.

WARNING:

Note that the differential pressure inputs should not exceed the rated pressure by more than 10%, or permanent damage may occur to the inputs.

Silicone hoses with an inner diameter of 2mm and outer diameter of 4mm are recommended.

Information on the adjustment of the pressure sensors can be found in section 4.12.1 “Zeroing of Pressure Sensors”

The optional high pressure connection (10 bar) has a quick release fastener. When inserting the hose, hold behind the connector and push, allowing the connector to lock in place. To remove the hose, pull back on the connector sleeve to release the lock. Note that the High Pressure sensor option must be activated before it can be identified by venTest. For further information contact Datrend.

WARNING:

Do not force the hose on or off, or permanent damage to the hose connector may occur.

2.1.3 Flow Sensor Connection

The flow sensor(s) are equipped with an eight pin push-pull-interlocking connector. When inserted, the connector locks in place. The connector may be removed easily by sliding the plug cover (4) toward the sensor cable.

To insert, line up the arrow marking (3) to be visible from above, per Figure 2.

Figure 2

(1) Nut
(2) White mark on socket
(3) Arrow mark
(4) Plug Cover

WARNING:

Do not force the connector on or off, or pull on the sensor cable. Permanent damage to the cable and connector may occur.

IMPORTANT:

When first received, some zero flow variation may be observed. It is recommended that a zero point adjustment be performed before first use. See Section 4.12.1.

2.1.4 Oxygen Sensor Connection (option)

To connect the optional Oxygen Sensor, line up the pins to the cable connector and then hand tighten the knurled nut. When disconnecting, ensure the knurled nut is fully disengaged before pulling gently on the connector.

Note: The Oxygen sensor option must be activated before it can be identified by venTest. For pricing and activation information please contact Datrend (see section 4.17.4)

WARNING:

Do not force the connector on or off, or pull on the sensor cable. Permanent damage to the cable and connector may occur.

2.1.5 IRMA™ Sensor Connection (option)

To connect the optional IRMA AX+ Multi-gas Sensor for measuring anesthesia gases, connect the sensor to the DB9/RS232 connector using the cable adapter (7200-241), as shown in Figure 3.

Note: The IRMA sensor option must be activated before it can be identified by venTest. For pricing and activation information please contact Datrend (see section 4.17.4)

WARNING:

Do not force the connector on or off, or pull on the sensor cable. Permanent damage to the cable and connector may occur.

The **IRMA™** sensor must be turned on in the Sensor->IRMA screen before use, and is ready for use if the green LED on the sensor is illuminated. A corresponding symbol will be shown on the status bar of the LCD display when the sensor is connected correctly. For correct readings, an airway adapter (7050-070 adults/ped, or 7050-071 infant) must be used. It may be necessary to do a zero adjustment before use.

Figure 3

2.1.6 Ethernet

venTest may be connected to a local network for transferring logged data, display sets and test protocols directly to/from other network devices. The network connection may be set up in the network setup menu.

2.1.7 USB

The USB connections can be used for data logging, and to transfer display sets, test protocols and screenshots to/from the storage media. The USB port is also used for software updating.

A detected USB stick is displayed as a symbol on the status bar.

2.1.8 SD Card slot

An SD card can also be used for data logging, transfer of display sets, test protocols and screenshots to/from the storage media. An SD card is also used for software updating.

A detected SD card is displayed as a symbol on the status bar. If there is no SD card installed or detected, then the status bar will not show the symbol.

Note: If an external memory device shows “??” instead of a name then no name has been assigned to the device. Under Windows, the name can be assigned after formatting or later using the "general\properties" of the device (limited to 11 characters).

2.1.9 Reset

In the event venTest is not responding, you can reset the unit by pressing the Reset button (see section 2.1.1). Settings will not be affected by a reset.

Chapter 3

3 General Instructions

3.1 Safety

3.1.1 Responsibility of Operating Staff

Proper function of this test device is only ensured if the device is operated and maintained according to the manufacturer's notes and instructions. The manufacturer cannot be held responsible for damages which result from failure to observe these instructions.

The device should only be operated by qualified and properly trained personnel. This requires strict observation of these operating instructions and any additional accompanying documents and manufacturer's information, as well as the observance of the following 'general precautions'.

Only shielded cables shall be used for all external connections and the peripheral devices must comply with valid regulations. This does not apply for connections which are used for service purposes only.

The measurement of flow with the venTest can be calibrated to the following gases: AIR, 100 % O_2, O_2/Air-Mix, and additionally with the small sensor 100 % N_2O. As the venTest itself cannot detect which type of gas is being measured, the user must set the correct type of gas on the device, otherwise errors may occur.

WARNING:

Please read these operating instructions before using the device and observe all notes in these instructions with the headline ATTENTION or WARNING. These instructions describe how to operate the device. Please refer to the service instructions for notes on maintenance and repair by qualified experts approved by the manufacturer.

WARNING:

Any faults that may occur during operation are indicated by the corresponding error symbol. Find information on further action in the error list.

WARNING:

Under no circumstances should this device or its sensors be used in the presence of flammable gases.

3.2 Maintenance

It is recommended that the venTest, and the FlowSense-Sensors be calibrated annually by the manufacturer or its authorized agent. Only original spare parts should be used. The operating staff assumes the responsibility for damages and regulatory violation resulting from improper handling or service activities carried out by a non-authorized personnel.

3.3 Manufacturer Liability

The manufacturer is liable for the safety, reliability and proper function of the device only if:

- The device is used according to the description in the manual
- Regular maintenance and calibration is carried out.
- Modifications of any kind (upgrading, new settings, changes or repair work) are carried out only by experts qualified by the manufacturer.

3.4 Precautions

- The device is only designed for the intended use described in section 3.5 of this manual.
- Operation of the device must only be undertaken by qualified personnel. Detailed knowledge of the contents of this manual is required.
- Handle the device with care to avoid damage or disruption.
- Before use, the device must be properly calibrated and/or the corresponding routine device tests, as described in this manual, must have been carried out.
- Before turning on the device make sure that the operating voltage of the power supply corresponds with the local mains voltage. Only the original power supply unit is to be used.
- Please use and store the device only within the defined environmental conditions.
- Do not use any power supply or plug that has visible damage.
- For safety reasons, do not use any power extension cables.

3.5 Intended Use

venTest is an electronic testing and measuring device for determination of ventilation parameters for performance checking and verification of ventilators consisting of:

- venTest desktop/base unit
- FlowSense Airflow Sensor
- venTest power supply unit

venTest is not intended to be used on patients, or be used on devices that are connected, in any way, to patients.

The unit is designed for use by qualified, trained service technicians, familiar with the use and operation of ventilatory equipment. The device is intended to be used in a laboratory/service environment, and should generally only be used in rooms protected from environmental influences (heat, cold, humidity, electrically safe, etc.).

Selection of test parameters of the venTest will be made via the integrated touch screen, in combination with a wide range of accessories.

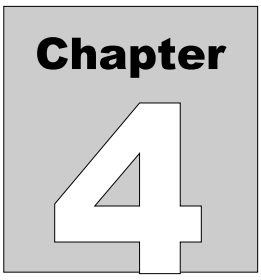
venTest is designed to carry out tests independent from the mains power supply, using an integrated battery. The internal battery is on charge whenever the external 12 V power adapter unit is connected.

WARNING:

Although venTest is designed according to the latest safety standards, and is built to a high quality and tested on the latest state-of-the-art equipment, improper use or abuse may cause damages with serious consequences.

IMPORTANT:

When first received, some zero flow variation may be observed. It is recommended that a zero point adjustment be performed on the flow sensors before first use. See section 4.12.1.



4 Operation

This chapter contains general information about the operation of the Datrend venTest.

WARNING:

Operate in a location where air inlets are not obstructed, otherwise overheating may occur.

4.1 Power

venTest is powered by an internal, rechargeable battery, which enables mobile operation. When running on battery, a battery (power source) icon is displayed on the main display, in the upper left of the status bar.

When operating from the mains supply through the power adapter, the battery icon will be replaced with a power plug icon.

Battery charging begins as soon as the power adapter is connected, whether the venTest is turned ON or OFF. When venTest is OFF, all power is applied to charging the battery.

A battery charge level icon (bar graph) is displayed next to the power icon, indicating the approximate capacity level of the battery. A low battery is indicated by: a) a warning message on the display screen; b) the battery status bar will blink; and, c) the ON/OFF power button will flash.

Operating time of the venTest on batteries depends on several criteria such as configuration, external sensors, operating conditions and age of the rechargeable battery. Battery capacity should be maintained above 70% to maintain good battery life.

WARNING:

Failure to maintain the battery charge level or allowing the battery to fully discharge may result in permanent damage to the battery.

4.1.1 Power ON

venTest is switched ON using the green ON/OFF button on the rear panel of the display base unit. The Datrend logo is displayed, internal sensors are initialized and sensor calibration data is checked. On successful completion, the main window is displayed and the device is ready for use. External sensors, such as the gas flow sensor, have their own internal memory and maintain their calibration data independently.

4.1.2 Power OFF/Power Button Menu

To switch the unit OFF, the ON/OFF button is pressed momentarily, causing the Power Menu screen to be displayed as in Figure 4. To complete the power OFF process, select Shutdown (1).

To cancel, select the Back icon (4).

Figure 4

WARNING:

If the device fails to respond to the request to turn OFF, the venTest may be switched OFF by pressing and holding the ON/OFF switch for more than 6 seconds.

This function should only be used in an emergency situation, as it may result in data loss.

4.1.3 Energy Saving Mode

Select Standby (2) to enter the energy saving mode. In this mode, the screen will be turned off and the ON/OFF button will blink. To return to normal mode, press the ON/OFF button again.

During Energy Saving mode, the FlowSense airflow sensor is still active, and no additional setup time is required.

To cancel the power OFF process, press the Back button (4), as shown in Figure 4.

4.1.4 Screenshots

To save a screen shot from a display, press the ON/OFF switch to show in Figure 4. Select the appropriate storage medium from the pop down list and then press the Screenshot icon (3).

After saving the display image, the filename of the image will be displayed for reference.

To cancel the power OFF process, press the Back button (4), as shown in Figure 4.

4.2 User Interface

venTest has a capacitive touch screen LCD display. The operating interface reacts to the 'press and release' of the touch screen at the position pressed. If a field is pressed by mistake, the selection can be cancelled by moving the finger sideways, off the icon, while the finger is still on the display surface.

The display may not react to the use of gloves, pens, prosthesis or other objects. Repeated fast touching on the same position may trigger a touch electronics re-calibration, and may delay response for several seconds.

Some buttons may respond to a 'press and hold' action to enable faster selection of function values, making frequent touching superfluous.

Figure 5 displays the possible states a button may display:

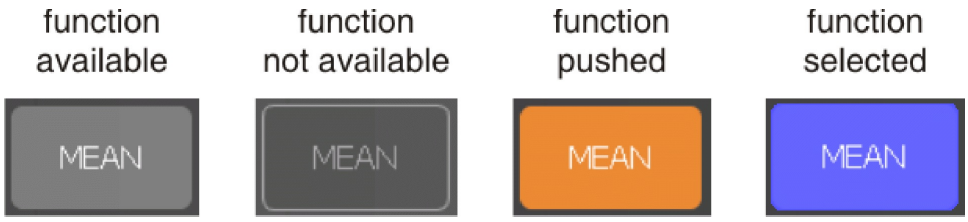
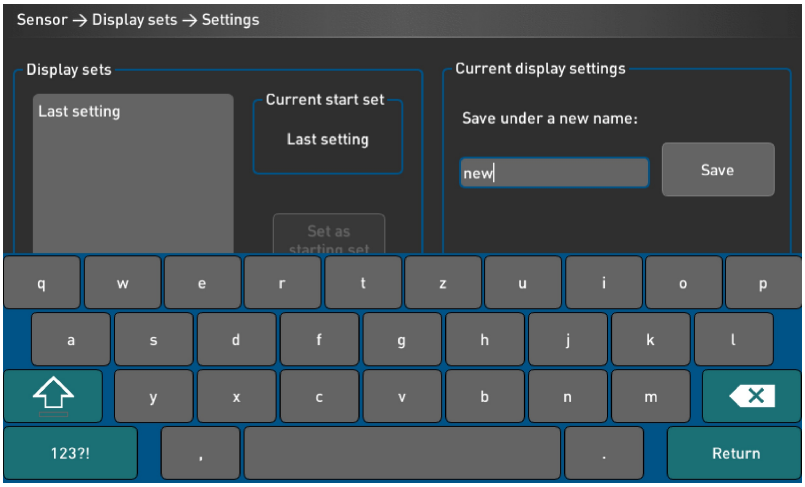


Figure 5

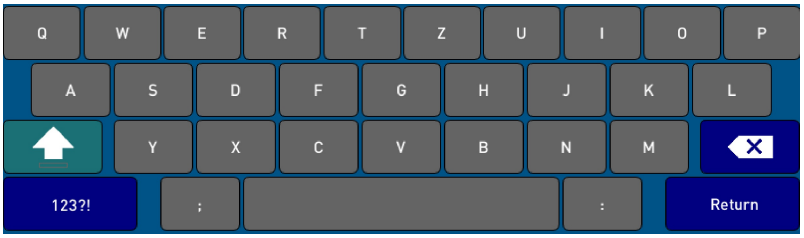
Option fields that are transparent are not available in the current mode, and may need to be activated before access is permitted.

4.2.1 Keyboard

If input of text and/or numbers is required, double tap in the text field and a software keyboard will appear in the lower part of the screen.

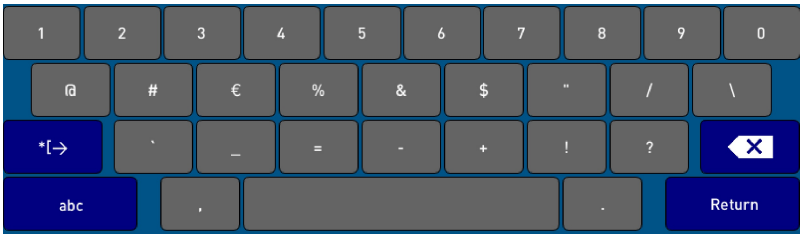


Additional characters are available by pressing the Shift key  to expose (: and ;)

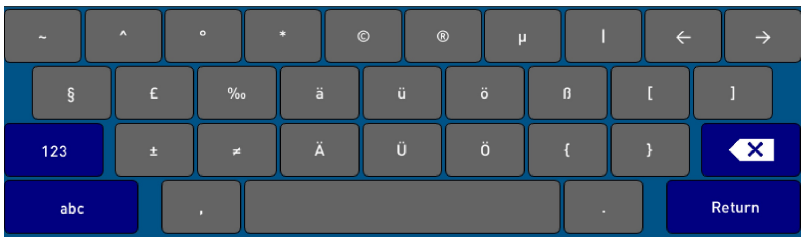


or, the Numeric key 

:



or the Symbols key *[→ :



The connection of a standard USB keyboard for large editing operations or stationary device use is supported.

4.2.2 Swipe screens

The main screen of the venTest utilizes three windows, selectable via a ‘swipe’ or ‘wipe’ motion. At the bottom middle of the display, there are 3 small rectangles representing the windows - Traces; Measured Values; and Main Display.

Figure 6

4.2.3 Trace Display

This window displays up to 2 graphical traces of selectable waveforms, in a large screen format (no numerical data).

Figure 7

Various parameters can be displayed as traces or graphs. To configure the graph, touch inside the graphical area. Refer to section 4.9 for more details.

During operation the display can be paused by touching the gray 'Pause' button in the lower right corner of the graph. When in Pause mode, the cursor can be moved to the right or left to get more precise values at specific points in time. The values are displayed in the lower graph display area.

When paused, the Pause symbol changes to a Play symbol. To resume normal display press the Play icon.

ATTENTION:

If the display is Paused, the wipe function has limited operation. Window selection is only possible by using controls outside of the graphical display area.

The configuration window is also not available when in the Pause mode.

4.2.4 Measured Value Display

This window displays up to 4 parameters in a large text format. These parameters are the first four values displayed on the main window.

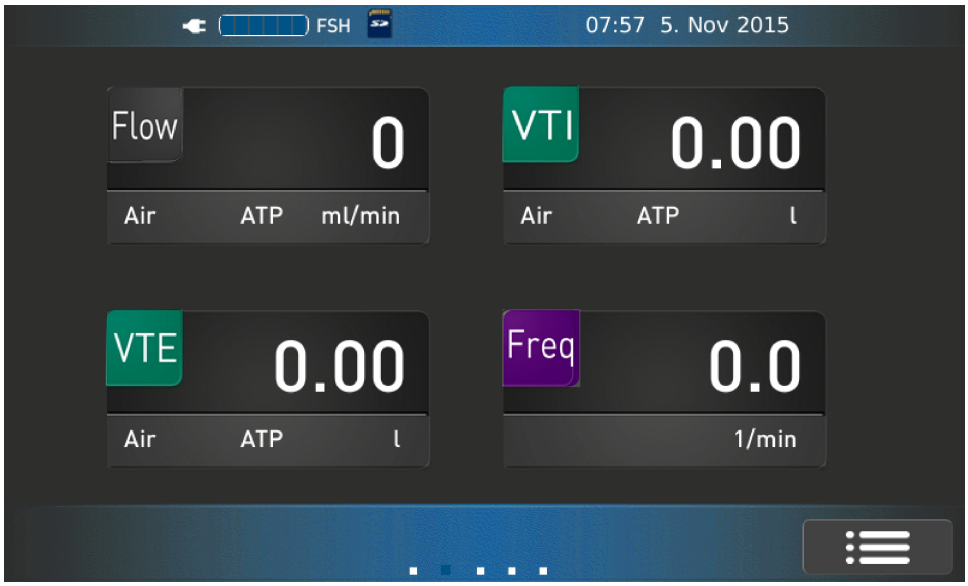


Figure 8

Touch on a value to adjust the configuration. Refer to the section 4.4 for more details.

4.2.5 Main Display

The main window display is the central display for all measuring tasks. It contains a graphical display for 2 values as well as eleven numerical values, plus data logging control.

For more information about data logging, refer to SubMenu: Logging.

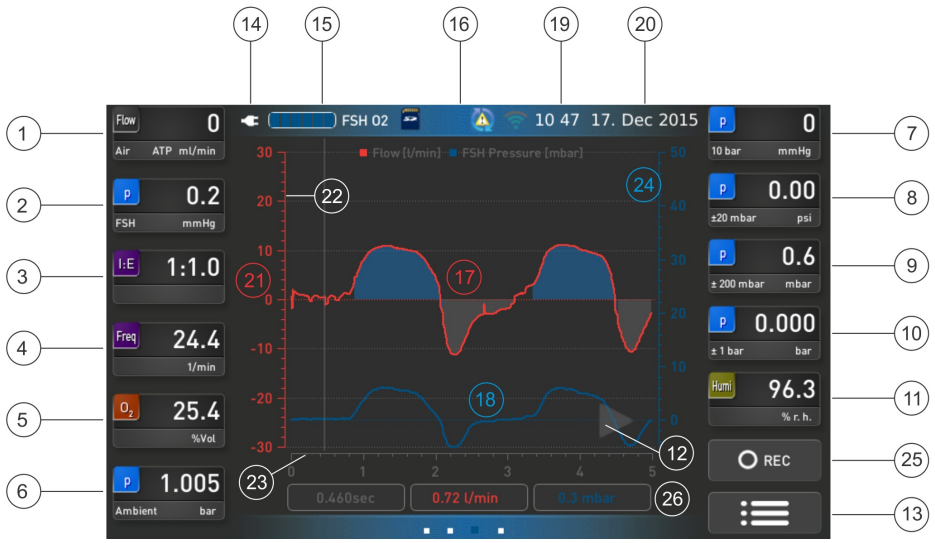


Figure 9

(1 - 11)	Measured Value numeric display	19	Time (hh:mm)
12	Start/Stop (Pause)	20	Date (dd:mm:yyyy)
13	Menu	21	Y-axis red (trace 1)*
14	-> Battery mode	22	Cursor (Pause mode)
	-> Mains mode	23	X-axis (sec)
15	Battery Charge status	24	Y-axis blue (trace 2)*
16	Status Bar	25	Record (data logging)
17	Trace 1 (red)	26	Cursor values (Pause mode)
18	Trace 2 (blue)		

* axis units at top line in graphical area

Various parameters can be displayed as traces or graphs. To configure the graph, touch inside the graphical area. Refer to the Configuration Menu: Graph for more details.

During operation the display can be frozen by touching the gray 'Pause' button (12) in the lower right corner of the graph area. When in Pause mode, the cursor (26) can be moved to the right or left to get more precise values at specific points in time. The values are displayed below the graph display area.

When paused, the Pause symbol changes to a Play symbol. To resume normal display press the Play icon.

ATTENTION:

If the display is Paused, the wipe function has limited operation. Window selection is only possible by using controls outside of the graphical display area.

The configuration window is also not available when in the Pause mode.

4.3 Status Bar

In the status bar, the following information is displayed as symbols:

Mains operation	
Battery operation	
FlowSense Hi Sensor connected	
FlowSense Lo Sensor connected	
SD card connected	
USB memory stick connected	
Update available	
IRMA™ Sensor connected	

Printer connected	
Network connected	
WiFi stick connected	
WiFi connected	

4.4 Structure of Measured Values Display

It is possible to configure 11 different measurement values for display on the screen.

Figure 10

The information displayed is:

(1) Name of measured parameter

(2) Gas Type

Standard conditions for volume related values;
Gas type for IRMA™ sensor unit (CO_2, N_2O, HAL, ENF, ISO, SEV, DES)

(3) Measured values or messages like:
- ➟ **n.c.**: Sensor not connected
- ➟ **Err.**: Error occurred
- ➟ **ov**: Value overflow
- ➟ **uv**: Value underflow

4.4.1 Measured Value Configuration Menu

Touching on one of the measured value segments on the display enters the respective configuration menu for this value:

Note: There are 3 pages of parameter button selections, with parameters on the top and bottom of the display. If you do not see the parameter you think should be available, check all three pages. See section 4.5 fro a list of all the available parameters that can be displayed.

Figure 11

1	Sensor	6	FlowSense setting (if connected)
2	Measuring Units	7	**'Apply'**
3	Standard Conditions	8	**'Cancel'**
4	Filter	9	Parameter(s)
5	**'Prev page / Next page'**		

Configuration is done in the following manner:

- Click on the desired parameter. The selected button is indicated by the colored background. If the field is transparent, the respective sensor must be connected or the respective function has to be released.
- In the configuration area all available sensors for this parameter are displayed (ie. FSH, FSL, O_2, Irma AX+).
- Select a sensor.
- More selectable items are displayed in columns like: Units; Standard Conditions; and Filter.

- The Units and Standard Conditions may be displayed on several ‘pages’ and can be selected using the browse button at the lower end of the column.
- An additional button: 'FlowSense settings' may be visible depending on the sensor type connected.
- Press the 'Apply' button ✔ to accept the selection(s) and return the display to the previous screen.

ATTENTION:

⚠ The **'Apply'** button ✔ is only active if a selection is made in each column, otherwise the button is disabled (transparent) and cannot be selected.

- Press the **‘Cancel’** button X to cancel the selection(s) and return the display to the previous screen.
- If, during configuration or selection of the configuration menu no sensor was detected, a message will appear, prompting that the sensor should be connected.

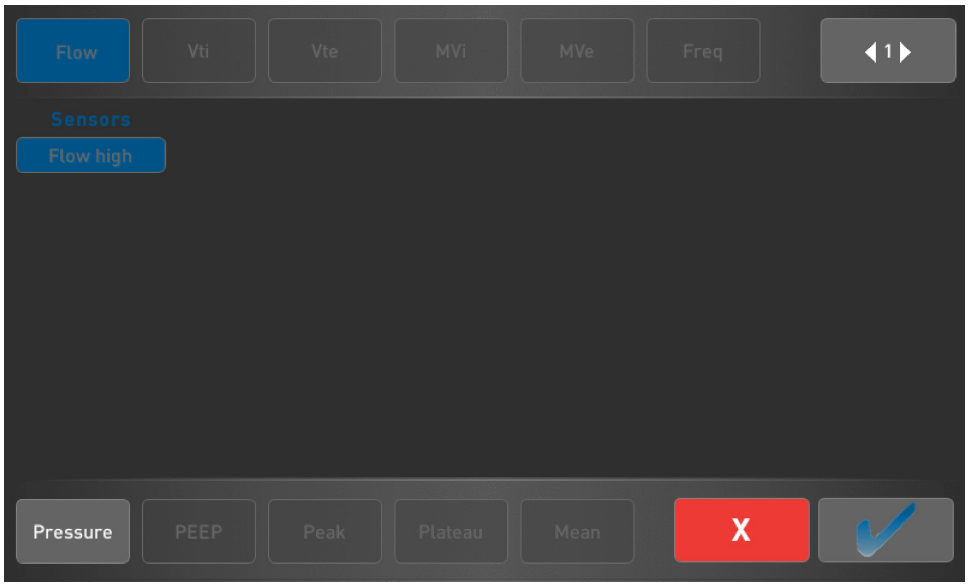


Figure 12

4.5 Overview: Measured Value

4.5.1 Flow Measured Values

Sign	Abbreviation	Measured Value
	Flow	Flow
	Exp. Peak Flow	Peak expiratory flow
	Insp. Peak Flow	Peak inspiratory flow

4.5.2 Ventilation Values

Sign	Abbreviation	Measured Value
	Vti	Inspiratory tidal volume
	Vte	Expiratory tidal volume
	MVi	Minute volume inspiration
	MVe	Minute volume expiration
	Freq	Frequency
	I/E	Breathing time relation
	Ti	Inspiration time (include Tip)
	Te	Expiration time (include Tep)
	Tip	Pause phase inspiration time

Sign	Abbreviation	Measured Value
	Tep	Pause phase expiration time
	Humi	Relative humidity

4.5.3 Pressure Measured Values

Sign	Abbreviation	Measured Value
	P	Pressure
	PEEP	Positive end-expiratory pressure
	Peak	Peak pressure
	Plateau	Plateau pressure
	MEAN	Average pressure

4.5.4 Gas Concentration Values

Sign	Abbreviation	Measured Value
	O_2	O_2-Concentration
	CO_2	CO_2-Concentration
	AGAS	Anesthesia gas concentration
	N_2O	N_2O-Concentration

4.5.5 Other

Sign	Abbreviation	Measured Value
	No Parameter	Value not used

4.6 Overview: Standard Conditions

Display Value	Temperature	Atmosph. pressure	Humidity
	Value referred to		
ATP	Actual	Actual	Actual
ATPD	Actual	Actual	0% rel.
ATPS	Actual	Actual	100% rel.
STP	20° C	1013.25 hPa	Actual
STPD	20° C	1013.25 hPa	0 % rel.
STPS	20° C	1013.25 hPa	100 % rel.
BTPS	Body temperature (= 37° = 310 K)	Actual	100 % rel.
STP 21/1013	21.1° C	1013.25 hPa	Actual
STPH (USA)	21.1° C	1013.25 hPa	Actual
STP 0/1013	0° C	1013.25 hPa	Actual
STPD 21/1013	21.1° C	1013.25 hPa	0 % rel.
STPD (USA)	21.1° C	1013.25 hPa	0 % rel.
STPD 0/1013	0° C	1013.25 hPa	0 % rel.
20/981	20° C	981.0 hPa	0 % rel.
15/1013D	15° C	1013.25 hPa	0 % rel.
25/991D	25° C	991.0 hPa	0 % rel.
AP21	21° C	Actual	Actual

4.7 Filter

With this setting only a software filter is applied.

without Filter	Measured values are displayed unfiltered.
with Filter	Measured values are displayed filtered, therefore measured values are more constant.

For the numeric values, an IIR-filter with a cutoff frequency of 1 Hz is used. Unfiltered this data is brought to the display approximately every 320 ms for the numeric values.

4.8 FlowSense Settings Button

Pressing the FlowSense icon leads directly to the menu of connected FlowSense Sensors in sub menu 'Sensors'. On this screen, a number of additional settings, such as invert flow, # samples to average, Insp. and Exp. Trigger levels can be selected. In addition, the ability to reset the flow and pressure zero point is available under the ‘Adjustment’ selection.

IMPORTANT:

When first received, some zero flow variation may be observed. It is recommended that a zero point adjustment be performed before first use. See section 4.12.1.

4.9 Graph Configuration Menu

Traces can be displayed in the graph area of the main window, or in the large traces display. To start configuration of the graph area please touch inside the graph.

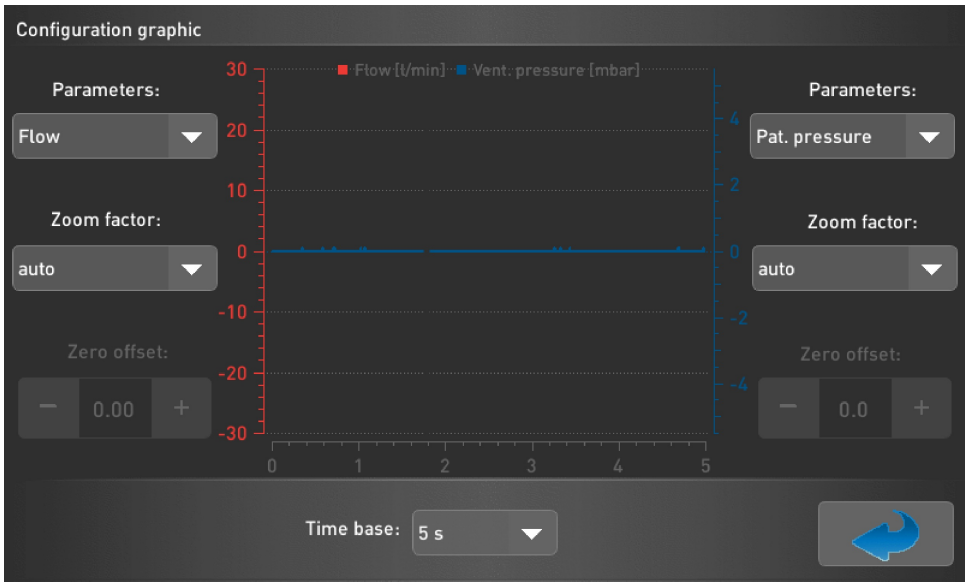


Figure 13

Parameters for trace 1 (red) are on the left side of the screen, for trace 2 (blue) are on the right. The zero offset can not be changed when the zoom factor is ‘auto’.

The time base for both channels can also be selected .

4.10 Main Menu

Pressing the 'Menu' button  on the Main (default) display leads to the main menu (Fig.14).

Figure 14

1	Back to main Display	4	Sub menu Display sets
2	Back to Main Menu	5	Sub menu Logging
3	Sub menu Setup	6	Sub menu Sensors

In the center area the available ‘swipe’ windows are displayed. Here the desired window can be selected directly, to be able to quickly change the display.

Return to the previous window by touching the 'Back to main Display' button (1).

The main window provides access to the following sub menus:

4.10.1 Setup Sub Menu

Pressing the 'Setup' button (3 - Figure 14) leads to the general settings functions of the device, as shown below.

Figure 15

- Info & Update
- Date, Sound & Language
- Network
- Service

Detailed descriptions of the settings follow.

4.10.1.1 Info and Update

Select the **'Info and Update'** symbol in the setup screen.

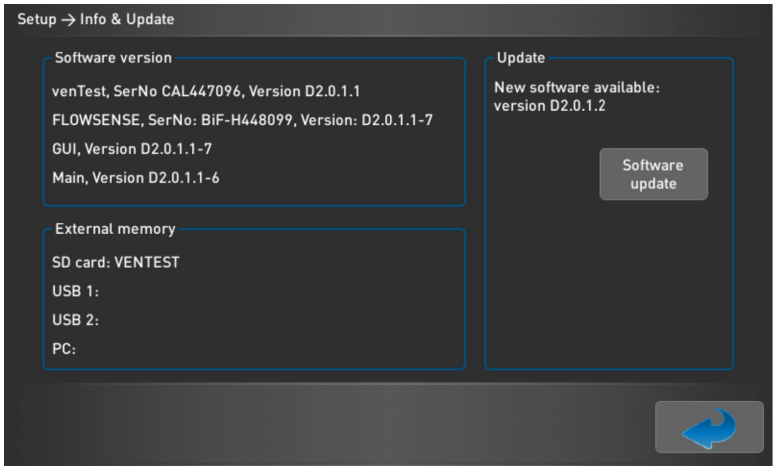


Figure 16

This screen provides information about actual installed software and serial numbers. If external memory devices are connected, they are listed here with their device names.

If a software update is available it will be displayed in the ‘Update’ window and can be started from this screen.

Note that a software update can only be done while powered from the mains electrical supply, not when running from battery power.

4.10.1.2 Date, Sound and Language

Select the **'Date, Sound and Language'** symbol.

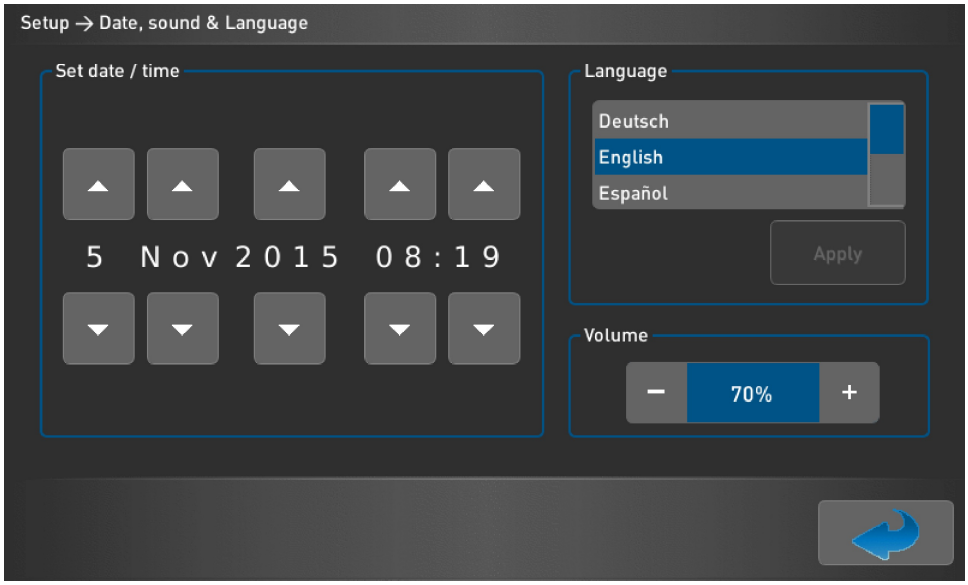


Figure 17

Date and time can be set by using the up and down arrows for each digit.

The available languages are displayed and can be selected. By pressing the **'Apply'** button the language is set after a restart of the device.

Speaker volume can be set by the **'-'** and **'+'** buttons

The **'Back'** button returns to the previous menu.

4.10.1.3 Network

Select the **'Network'** symbol in the setup menu.

If the venTest is connected to a network via cable, or via a WiFi module*, the actual network configuration is displayed.

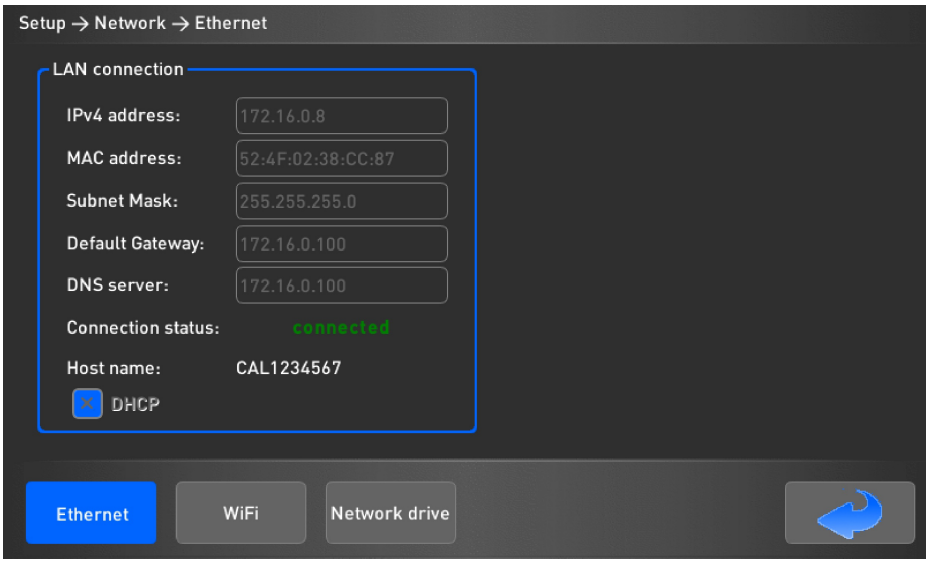


Figure 18

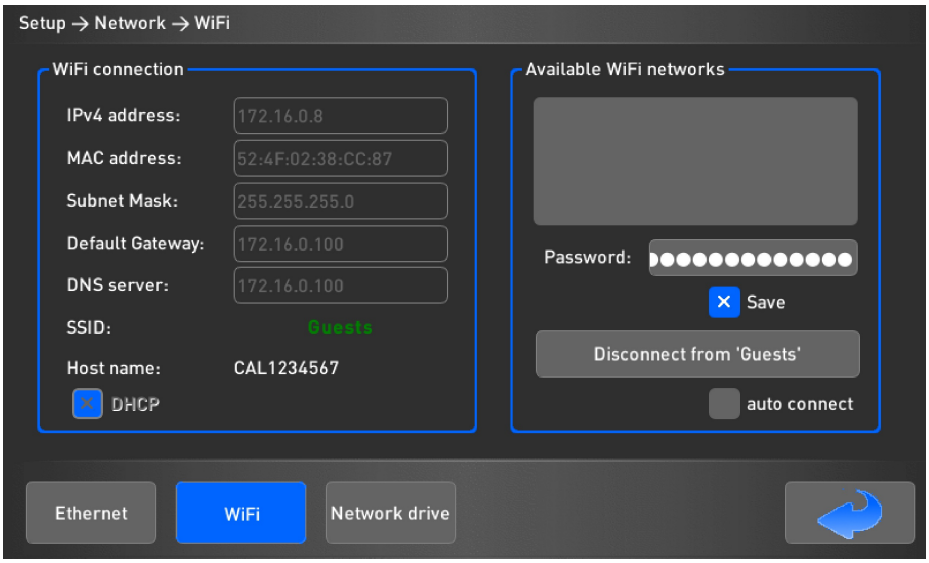


Figure 19

* EDIMax AC450 Wi-Fi USB Adapter-11ac EW-7711ULC, or equivalent

It is possible to connect a specific network drive.

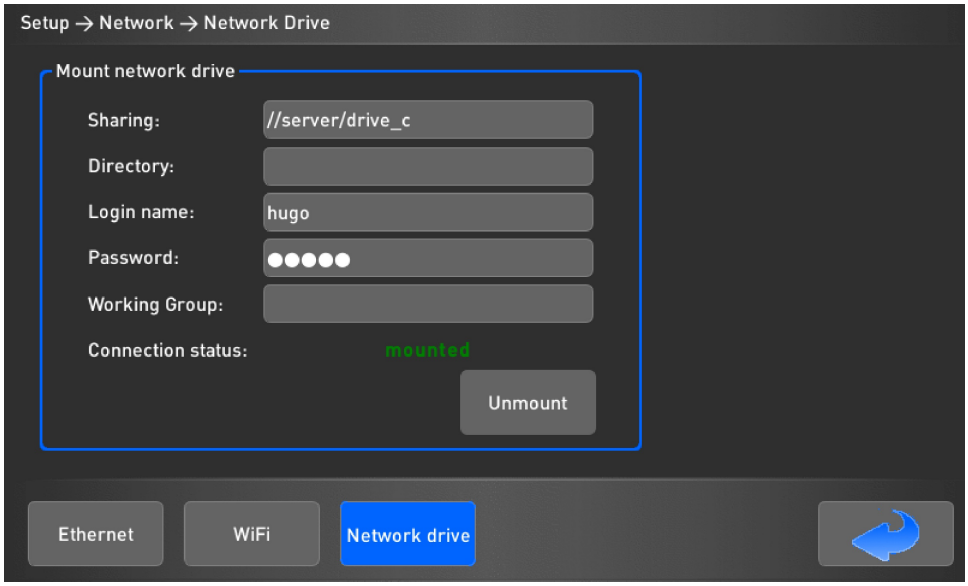


Figure 20

Click on the **'Network drive'** button, complete the required fields and press the **'Mount'** button.

A message displays the actual connection status, and the **'Mount'** button changed to **'Unmount'** as shown in Figure 20.

4.10.1.4 Service

This sub menu is for service purposes and the activation of additional sensors/options, and is password protected. Contact Datrend for instructions when activating features.

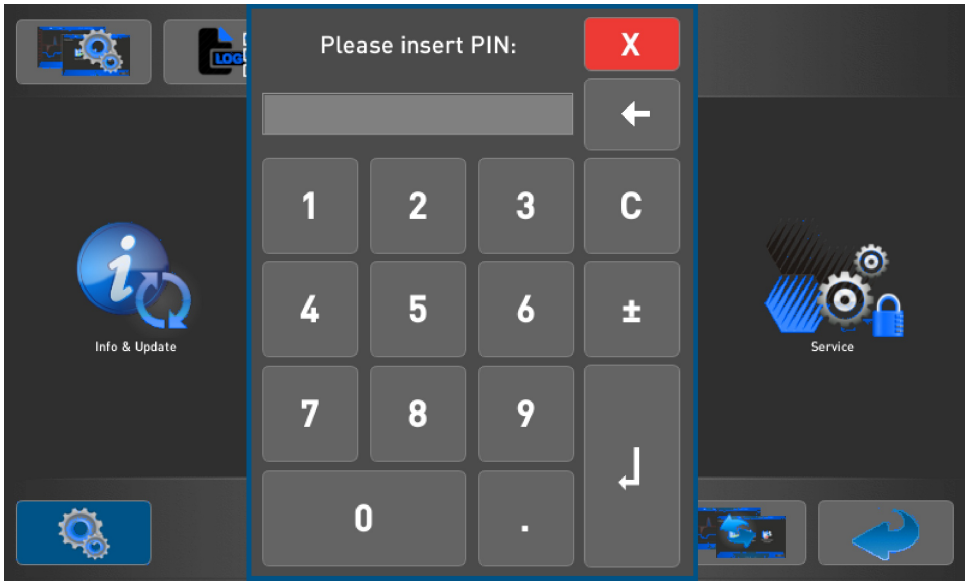


Figure 21

4.10.2 Display Sets Sub Menu

Creating display sets allows storage of the measurement settings for different devices and applications, which can be reloaded at any time without setting up the individual parameters again.

In a display set, all settings like configuration of measured values display, corresponding graph settings and general FlowSense settings are saved.

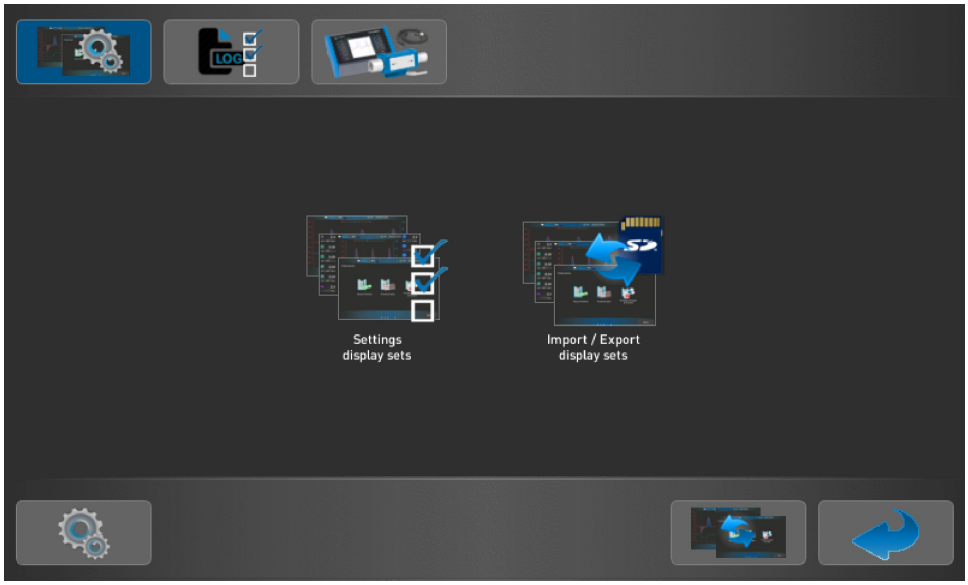


Figure 22

4.10.3 Selection of Display Sets

Clicking on the **'Settings display sets'** icon opens a window to control the stored display sets.

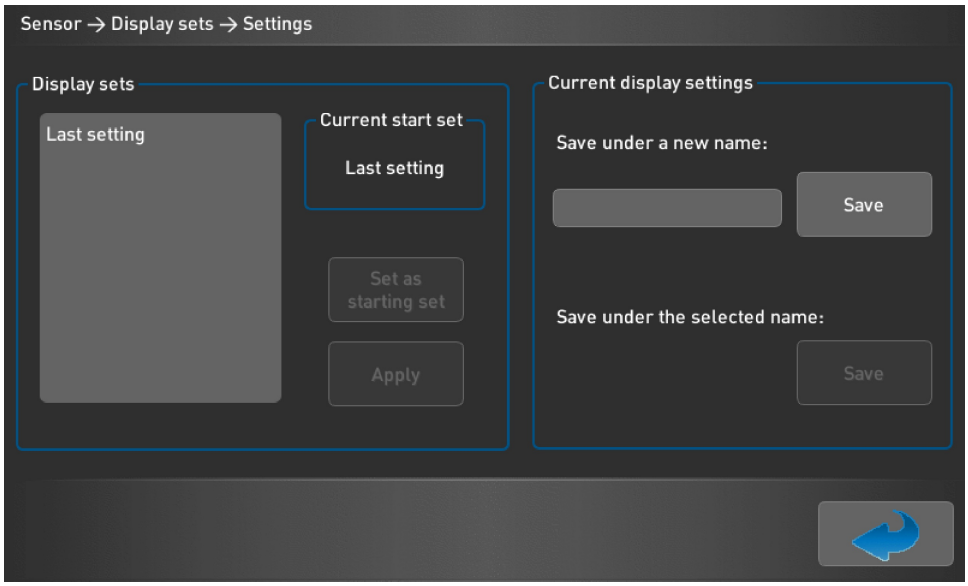


Figure 23

Select one of the available display sets and press the **'Apply'** button. The main window will be displayed using the selected settings.

Any number of display sets can be saved. The number of possible settings is only limited by storage capacity in the internal memory.

Any display set can be defined as the start set by using the **'Set as start set'** button to have this set selected after device start.

The **'Last setting'** entry contains the actual setting at power down and is always available, and cannot be deleted or modified.

4.10.4 Creation of New Display Sets

To create a new display set, all parameters must first be set in the main window, as desired.

In the menu **'Display sets'** enter a name for the actual set. To enter the name, tap twice in the 'new name' field to cause the keyboard to appear. Once the name has been entered, press the **'Save'** button. Note that there are certain character restrictions in the display set name. The following characters should not be used in Display sets names: ? : " * | / \ < > If an 'illegal' character is detected, it will be replaced with the '_' character.

All display sets on internal memory can be exported to an external memory device.

4.10.5 Modifying Existing Display Sets

To modify an existing display set, first load (apply) the set of interest.

In the main window make the desired modifications to the display, trigger or global settings, and then save the setting under the same or a new name. Note that to activate the keyboard, the text box must be tapped twice.

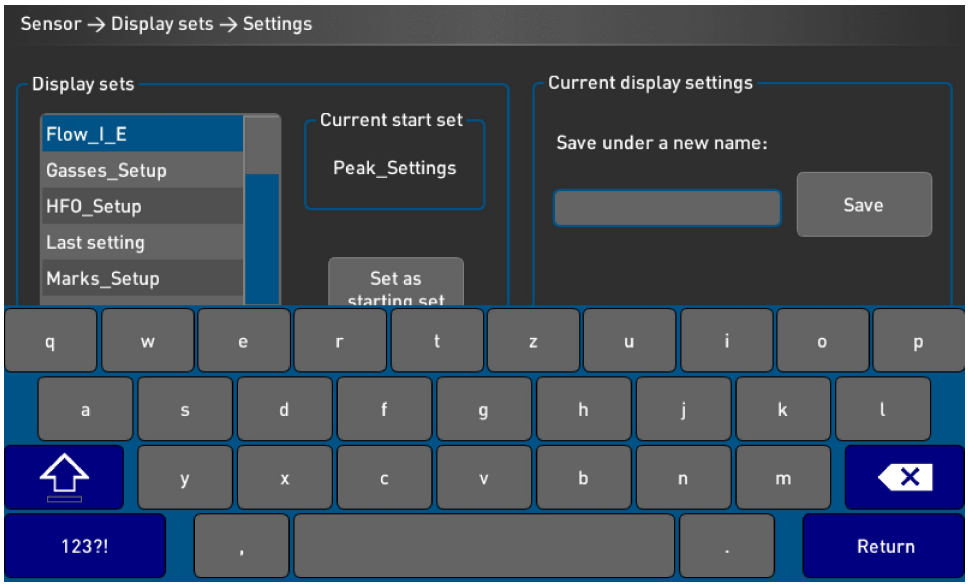


Figure 24

4.10.6 Import / Export of Display Sets

Select **'Import / Export'** to copy display sets between internal memory and connected external memory devices.

The display sets to be copied can be selected (single, multiple selection or all), and the transfer activated using the direction keys.

In this window it is also possible to delete display sets.

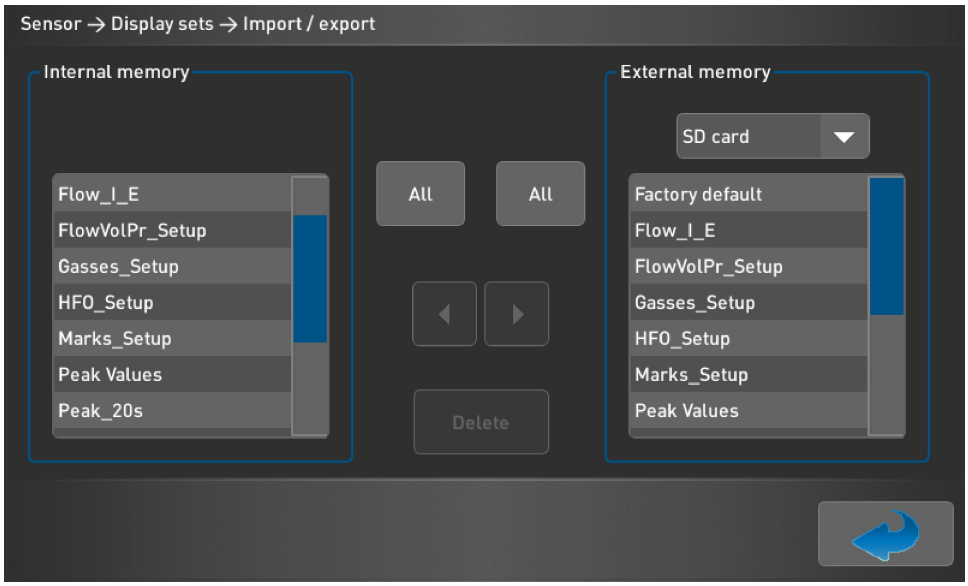


Figure 25

4.10.7 Deleting Display Sets

Select a display set(s) to be deleted from any memory device (internal or external) and using the **'Delete'** button. Multiple sets, or the **'All'** selection is also supported.

The **'Delete'** process must be confirmed with **'Yes'**.

4.11 'Logging' Sub Menu

The venTest allows measured data to be logged. All values and graphs can be recorded over a specified time and stored.

For storage, any connected external storage device can be used.

By pressing the **'Log'** button you get to the configuration menu for the data logging.

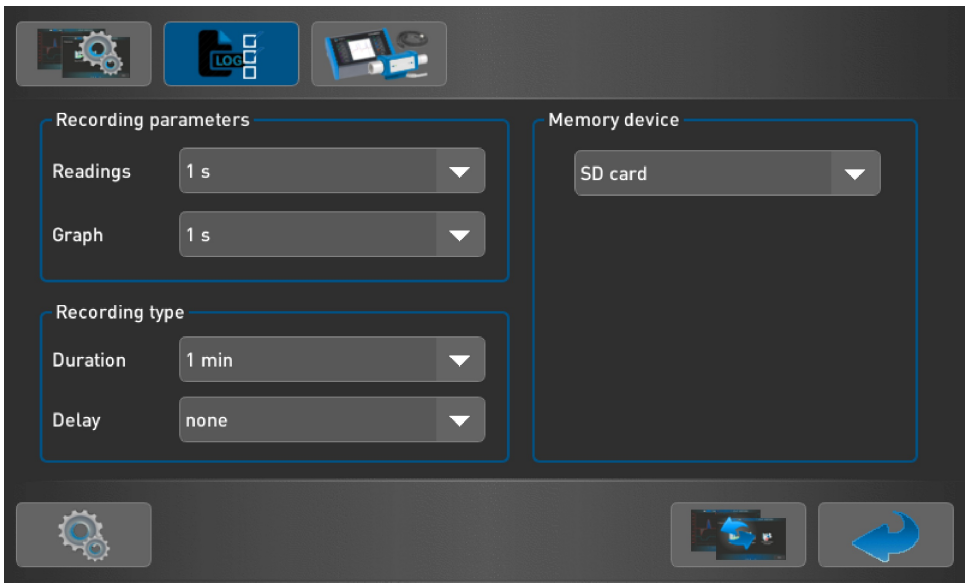


Figure 26

Available recording parameters:

Readings : 250 ms, 500 ms, 1 s, 2 s, 5 s, 10 s, 20 s, 30 s, 1 min
Graph: 10 ms, 20 ms, 50 ms, 100 ms, 250 ms, 500 ms, 1 s, 2 s, 5 s

Available recording types (modes):

Duration: 1 min, 30 min, 1 h, 2 h, 5 h, 12 h, 25 h, unlimited
Start delay: none, 5min, 30min, 1 h, 2 h, 5 h, 12 h

Logging is started by pressing the **'Rec'** button on the main window. The following dialog will be displayed to confirm the start of recording.

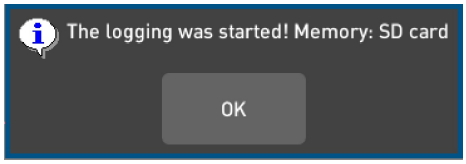


Figure 27

Logging can be stopped by pressing the button again, or allowing the set recording time to elapse. The following dialog will be displayed to confirm the end of recording.

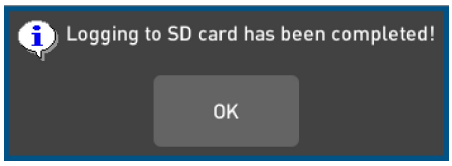


Figure 28

Example:

- Readings: 1 s
- Graph: off
- Duration: 1 h
- Delay: 5min

With these settings the device starts logging 5 min after pressing the 'Rec' button. All 11 values are logged each second for 1 hour and stored on selected media.

The actual status of the data logging process is displayed on the 'Rec' button of main window.

	Recording not active, ready
	Recording active
	Recording automatically starts after selected delay time

ATTENTION:

At least one parameter has to be selected and one external storage medium must be connected and selected to enable the logging function.

Logged data is stored on selected external storage media under the venTest/ Logging directory. The file format is .csv (can be read by many spreadsheet programs like Excel, etc.) For more information on the contents of the file, see Appendix B.

4.12 Sensors Sub Menu

In this sub menu all internal and external sensors are listed. Clicking on an individual symbol leads to sensor sub menus for sensor configuration and calibration.

ATTENTION:

External sensors can only be selected if they are connected and detected by the device. Otherwise the symbol is displayed transparently.

If a sensor is an option, and has not been activated, a 'locked' icon will be visible over the sensor icon. Contact your Distributor or Datrend to purchase the option and unlock the sensor function.

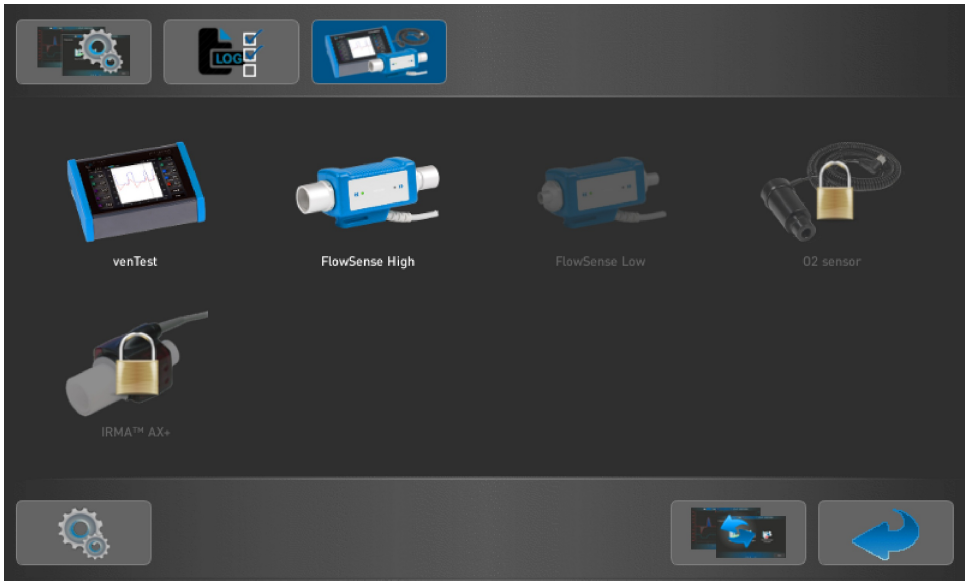


Figure 29

4.12.1 Zeroing of Pressure Sensors

This sub menu is used to set zero points for all internal pressure sensors of the base unit.

Setting zero points of single sensors is supported as well as setting the zero point of all existing sensors together.

During this process no pressure must be applied to any of the sensors. All pressure connections of the venTest shall be left open (no hoses shall be connected).

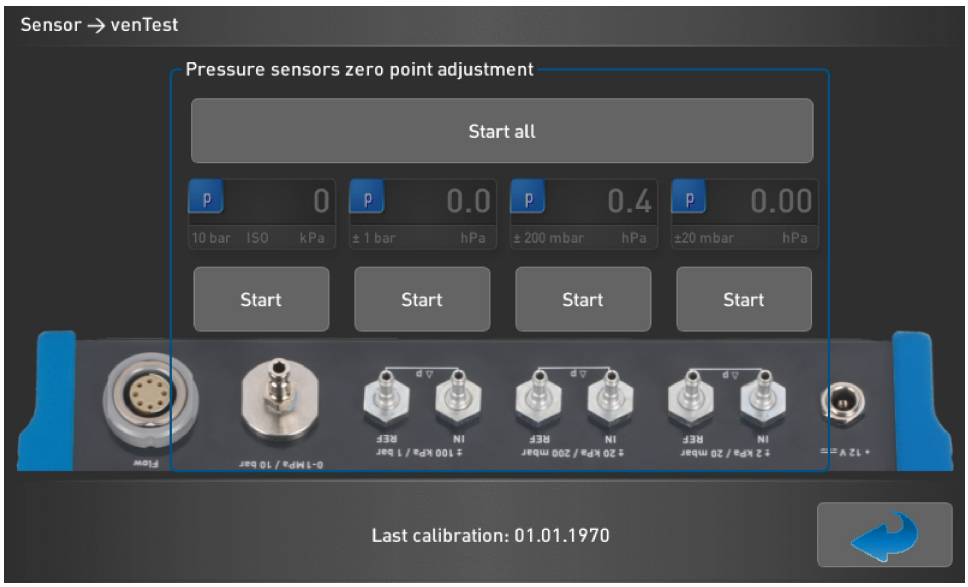


Figure 30

After confirming that no pressure is applied to the sensors, press the **'Start'** button to enter the zero adjustment process. Start has to be confirmed by pressing **'Yes'** or **'No'**.

If **'Yes'** is selected, a message appears after successful zero adjustment. This message must be confirmed.

In the lower part of the screen the last factory calibration date of the sensors is displayed.

4.12.2 FlowSense Hi and Lo Sensors

This sub menu shows all settings for a connected FlowSense sensor.

The following description applies to FlowSense Hi, as well as to FlowSense Lo.

ATTENTION:

These are global settings of all measuring parameter of the connected sensor like gas type or trigger conditions. All settings in this menu may influence all measured parameters of the display.

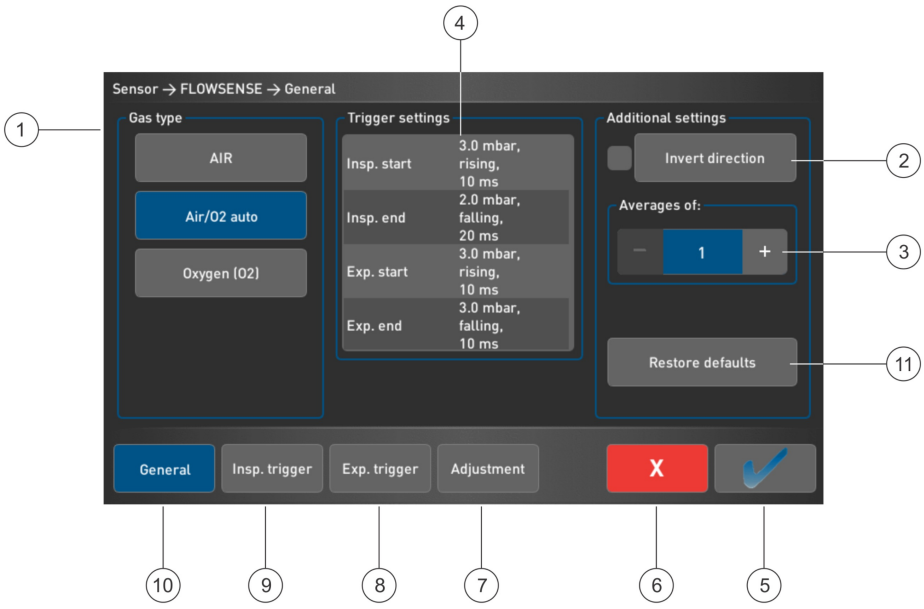


Figure 31

1	Gas type Selection	7	Adjustment screen
2	Invert direction of flow	8	Expiration trigger screen
3	Average values	9	Inspiration trigger screen
4	Trigger status	10	General screen
5	Apply	11	Restore defaults of Additional Settings
6	Cancel		

Activate the selection by pressing the **'Apply'** button(5 - Figure 31). Pressing the **'Cancel'** button (6 - Figure 31) discards the settings and the previous configuration remains valid, while the display returns to the main menu.

4.12.2.1 'General' Button

Gas Type (1 - Figure 31)

The gas types (displayed) depend on the FlowSense sensor connected. Select the gas type used.

For gas types other than Air, a Flow Sensor with special calibration is required.

For AIR/Oxygen mixtures with the Oxygen % greater than 21%, a Hi or Low flow sensor with an Oxygen calibration is required, along with an Oxygen sensor. For option availability please visit the Datrend Website (www.datrend.com) or contact Datrend (see section 4.17.4).

For N_2O mixtures a Low flow sensor with an N_2O calibration is required. For option availability please visit the Datrend Website (www.datrend.com) or contact Datrend (see section 4.17.4).

Invert Direction (2 - Figure 31)

The flow measurement direction is swapped. This leads to a sign change for the flow for displayed values and graphs. Also, remember that ventilation related parameters **insp.** and **exp.** are swapped; (sample: I/E changes from 1:0.5 to 1:2.0).

Averages values (3 - Figure 31)

This parameter defines how many values will be used to calculate an average value of :
Vti, Vte, Mvi, Mve, Freq, Ti, Te, Tip, Tep, I/E

If, as example, the value is set to 5, the average value is calculated from last 5 breaths.

Summary Trigger Settings (4 - Figure 31)

All actual trigger settings are displayed in this area. Trigger settings like value (pressure or flow), slope and delay are shown for the start and end of inspiration and expiration.

Restore Defaults (11 - Figure 31)

This button restores trigger default values of the sensor.

Default trigger conditions are:

Start inspiration: 3.0 l/min Flow rising with 40 ms delay
End inspiration: 1.0 l/min Flow falling with 40 ms delay
Start expiration: -3.0 l/min Flow falling with 40 ms delay
End expiration: -1.0 l/min Flow rising with 40 ms delay

Trigger setting for volume (measurement of TI and TE) is very important for measurement accuracy. See Appendix A for detailed information and examples of flow and pressure curves with various trigger settings.

4.12.2.2 Inspiration & Expiration Trigger Button

Detection of inspiration and expiration phases of ventilation depend on the start and end trigger conditions. These conditions can be set in this window. It is possible to trigger on flow or pressure values.

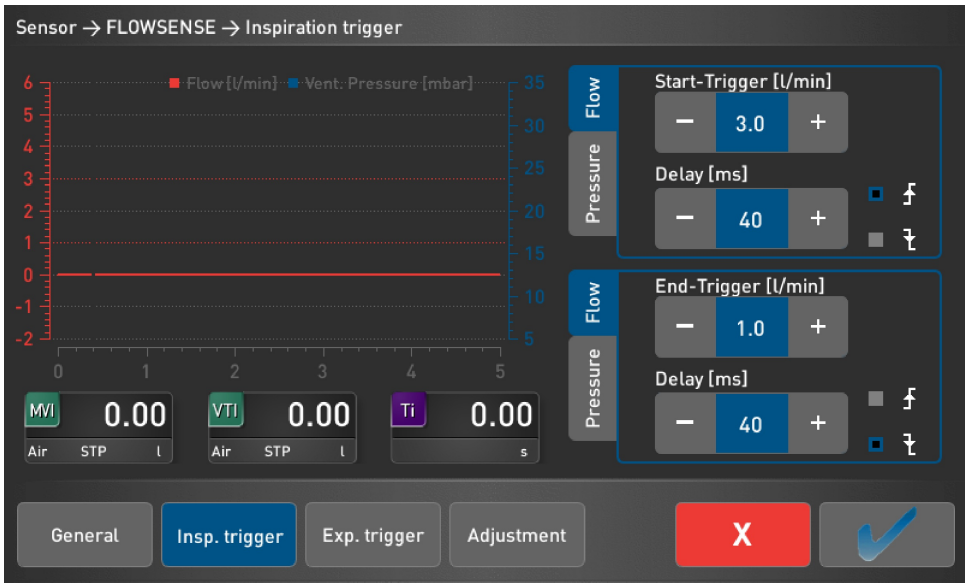


Figure 32

With **'Start-Trigger'**, the beginning of inspiration or expiration is determined, the end trigger value detects the end of the phase.

Selection of trigger slope is also a trigger condition.

If a rising edge is selected, the trigger condition is true if the flow / pressure rises above the set trigger value. If a falling edge is selected, the trigger condition is true if the flow / pressure has dropped below the trigger value that is set.

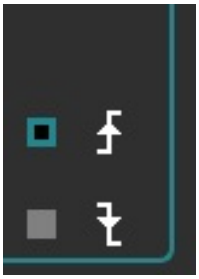


Figure 33

Delay values define how long the trigger condition must be true (eg. start-flow above 3.0 l/min) before the trigger becomes active.

If the measured value falls below this value during the delay time, the measurement is not started. This is how disturbances of measurement, such as those from fluttering values can be suppressed.

Start and end triggers for flow and pressure can be set in steps of 0.1 l/min or mbar using the **'+'** and **'-'** buttons. Start and end delay can be modified in steps of 10 ms.

The buttons have an auto repeat function, so that a quick change of values is very convenient. A click on the value itself opens a numerical keyboard for direct value input.

The actual trigger levels are displayed in the graph. As in the main display, it is possible to stop the graph. The graph may be paused by touching on the graph and resumed by touching the graph again.

The numeric values resulting from trigger settings can be observed for up to three parameters. For average calculation refer to the **'General'** page.

Measurements with default values after power on:

Default values for trigger conditions have been chosen to minimize effects caused by switching values.

The default values may not be valid in all cases because some parts of the flow are not measured or the trigger may fail. It is recommended to use the graphical display to evaluate the quality of triggering and adjust the thresholds and delays depending on application.

Incorrect triggering may not be immediately obvious in a volume measurement whereas time measurements (TI, TE, I/E and Frequency) may lead to significant deviations. The basic default settings are a good starting point from which the optimum settings can be determined.

In general, once a setting has been defined for an application (test setup, ventilator, modes) it will normally be used in the future.

Using the display set function, these optimum settings can be stored.

Optimization of trigger conditions:

It is not easy to define general rules for trigger conditions due to the wide variety of possibilities.

- In a closed loop system (circle system) it may be useful to switch from flow to pressure triggering
- In open loop systems only flow triggering is possible, because there is no pressure to be detected.
- Unexpected peak values of flow caused by switching values should be suppressed by selecting a trigger delay instead of a higher flow trigger value.
- Similar effects from exhaust values can be suppressed by an end trigger delay.
- Set the trigger levels no higher than necessary, so as much flow as possible can be detected for the volume calculation.

Over time, optimum trigger conditions for the different measuring tasks emerge.

High Frequency Ventilators:

When in High Frequency mode, the trigger levels are preset for optimal detection, and are not user adjustable.

4.12.2.3 'Adjustment' Button

This menu item is used for setting the zero level of the connected flow sensor.

Flow and pressure zero values can be set independently.

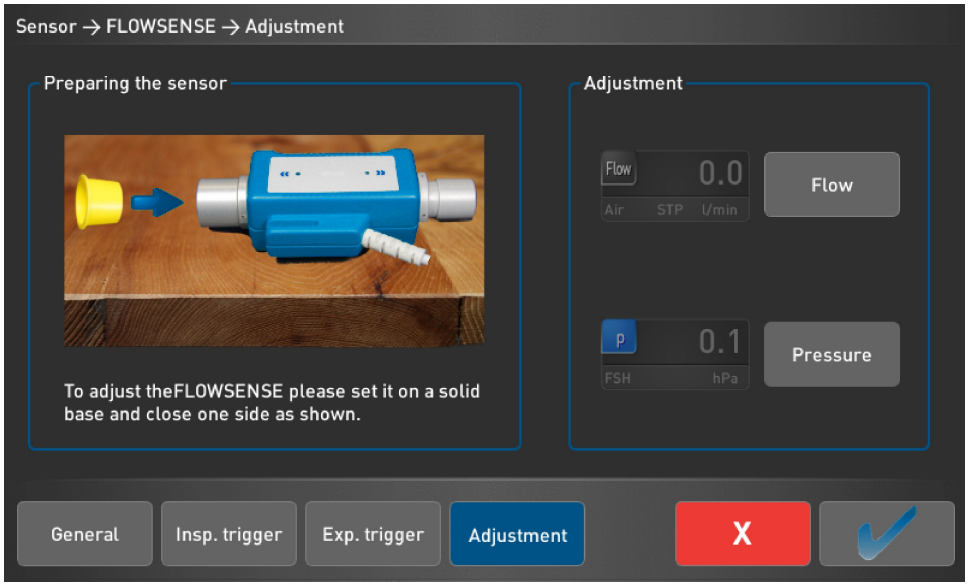


Figure 34

If the zero level needs to be set, ensure that there is no flow or pressure applied to the sensor.

The FlowSense Sensor shall be located on a solid surface and one side shall be closed by the cap delivered with the sensor.

'Adjustment' expects the sensor being exposed to ambient air. In case of any doubts, the sensor should be flushed with ambient air for a few seconds.

After confirming the above conditions, the adjustment process can be started by pressing the desired button (**'Flow'** or **'Pressure'**).

Simultaneous illumination of both direction indicators of the FlowSense sensor indicates an active adjustment is achieved.

If no FlowSense sensor is connected, an error message appears. After re-connection of the sensor, the process must be restarted.

During adjustment process the following symbol is shown on screen 

After successful adjustment, the message **'Adjustment OK'** appears. If the adjustment results in values exceeding defined limits, an error message occurs and adjustment must be carried out again.

Any adjustments made with this menu are the responsibility of the user. Since the measurement accuracy of the venTest also depends on the quality of these adjustments, these have to be carried out very carefully.

IMPORTANT:

When first received, some zero flow variation may be observed. It is recommended that a zero point adjustment be performed before first use. See section 4.12.1.

4.12.3 O_2-Sensor (optional)

This section describes the adjustment of the optional oxygen sensor.

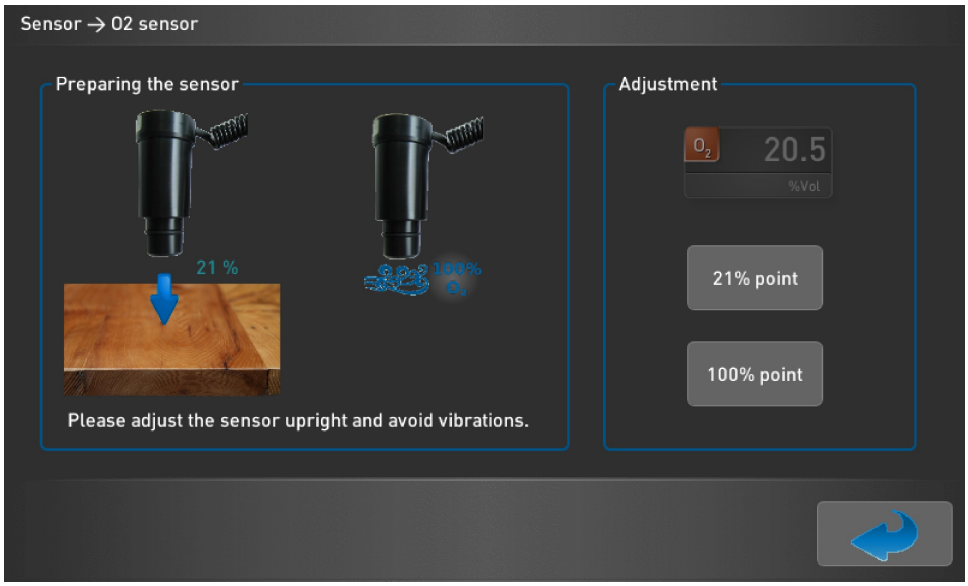


Figure 35

The calibration of the O_2-Sensor is based on the concentration points 21% and 100% oxygen.

After selection of the desired concentration point a confirmation message is displayed to confirm the accepted value.

Adjustments must be made after providing the correct oxygen concentration (21% ambient air or 100% oxygen) to the sensor.

The actual value measured by the sensor appears at the top right and can be used as an indicator of whether the measuring value has stabilized at each selected concentration. It should be noted here that the absolute oxygen value in the calibration is not important, but whether the measuring value is stabilized.

During calibration the sensor should not be exposed to pressure and the sensor must be held firmly, in a vertical position, with the sensor opening directed downwards.

Failure to observe these instructions can result in misalignment of the sensor.

Figure 36

After successful adjustment, an **'Adjustment OK'** message will appear and must be confirmed.

In case of adjustment failure an error message as shown below appears and the adjustment must be repeated.

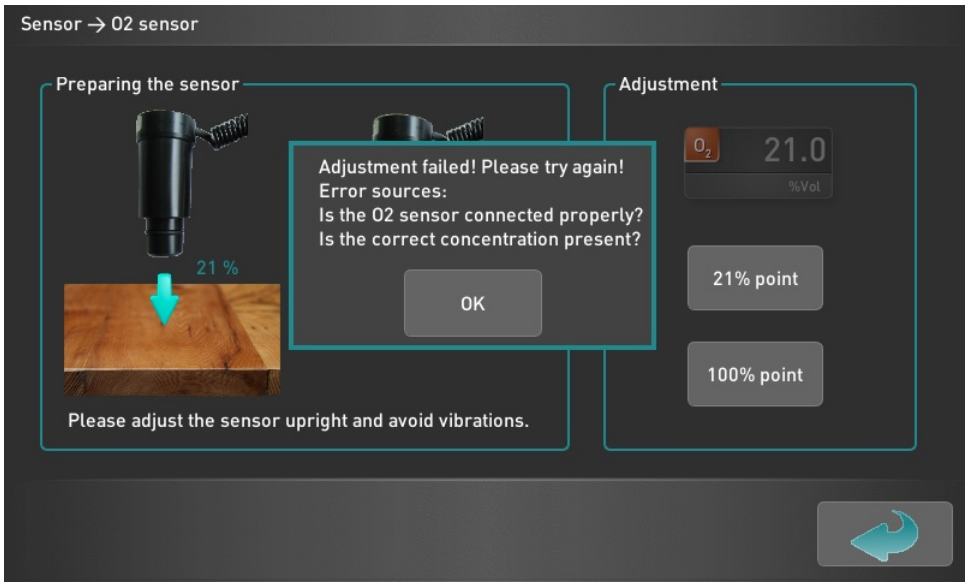


Figure 37

Additional hints :

- Do not apply shock to the sensor at any time. If it occurs as an accident, the sensor must be left standing for a minimum of 2 to 3 hours.
- The built-in sensor temperature compensation is very slow, rapid temperature changes should be avoided.

4.12.4 IRMA™ AX+ (optional)

This menu item is used to power on the IRMA™ and perform adjustments. Note that the sensor is connected to the RS232 connector on the back panel of the venTest, using a DB9M to DB9M adapter cable (7200-241).

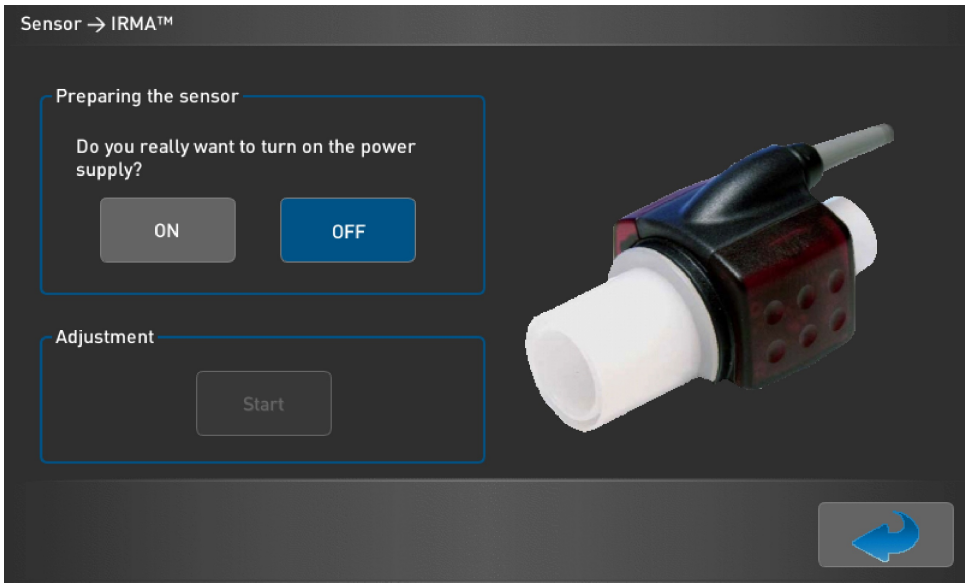


Figure 38

WARNING:

A voltage is applied to a pin of the RS232 socket by turning on the IRMA™-supply voltage. Be sure that no other device is connected to the RS232 port, otherwise the device could be damaged.

A zero adjustment is required if the sensor deviates from its zero point. The zero adjustment is completed when the IRMA™ sensor stops flashing and the green light is on steadily. The sensor must be attached to a Masimo multigas tubing adapter (7050-070 Adult/ped, or 7050-071 Infant) to get any reading on the venTest.

4.13 Creating Test Procedures and Test Reports (optional)

Testing can be automated through the use of test Procedures or Checklists, using the facilities provided in the (optional) vPad-Check system available from your Datrend Systems dealer. Vpad-Check provides a variety of procedural task steps which are fully configurable by the user. Procedures can be written which include: prompts, report headers, inspection tasks, limit tests for data input, interfaces to other test devices (both Datrend and other company devices), branching to skip test sections that are not applicable, loops to repeat sections that may apply to more than one accessory part (eg. Ultrasound probe(s)), and show pictures/instructions/videos as part of a test step.

A vPad-venTest plugin has been developed for vPad-Check that allows control of the venTest during testing, and retrieval of test data as the test progresses. Test reports may be printed, saved, and/or transmitted to a PC or to a CMMS system.

For additional information on the vPad-VT and/or vPad-Check system and its applicability to automating your testing on venTest, contact your dealer or visit www.datrend.com; and ask about the MN-122 6100-128 vPad-VT Plugin Operators Manual; and, MN-084 6100-049 vPad-Check Operators Manual, to get complete details on how the system can improve efficiency and productivity in preventive maintenance and performance assurance testing.

4.14 Sensor Startup

This section covers the startup of the various sensors.

4.14.1 FlowSense Airflow Sensor

This section is valid for all FlowSense Sensors independent from measurement range and gas types.

Connect the sensor to the flow sensor connector to the back of the venTest base unit. As soon as the sensor is detected, the sensor symbol appears in the Status. For the FlowSense Sensor High-Flow 'FSH' is displayed and for the FlowSense Sensor Low-Flow 'FSL'.

After connecting, the sensor shows its initialization by alternately flashing the flow direction LEDs on the sensor. When initialization is completed, both LEDs go off and the sensor has reached its specified accuracy after a setup time of 15 minutes.

Figure 39

In subsequent operation of the sensor, the flow direction is indicated by the corresponding LED as shown above.

WARNING!

Tubing connected to the sensor should be as straight as possible to prevent incorrect measurements.

4.14.2 O_2-Sensor (optional)

Once the sensor is connected correctly to the base unit, it is automatically recognized by the device and is ready for use. In the status bar, the sensor is not displayed.

4.14.3 IRMA™ AX+ (optional)

Connect the IRMA™ sensor to the rear DB-9/RS-232 connector on the rear of the base unit.

To set IRMA™ in operation, the supply voltage must be switched on. Once the power has been turned on, IRMA™ connects to the device and indicates this by flashing LED's. Once a green LED lights up steadily, the IRMA™ is connected.

4.15 Troubleshooting & Error Handling

4.15.1 BiFlow-Sensor Error Messages

DISPLAY MESSAGE	ERROR DESCRIPTION / TROUBLE SHOOTING
Flow sensor defective	BiFlow-Sensor was detected as defective. Disconnect sensor and re-connect again. Check sensor for contamination. If the error still occurs, send sensor in for repair
Please return BiFlow for calibration	BiFlow-Sensor has exceeded its recommended calibration interval. Send BiFlow-Sensor in for calibration

4.15.2 IRMA™ AX+ Sensor Error Messages

DISPLAY MESSAGE	ERROR DESCRIPTION / TROUBLE SHOOTING
IRMA™ Adapter error	Check correct installation of adapter. Adapter may be replaced if error still occurs.
O_2 value of IRMA™ is out of measurement range!	Please check concentration
N_2O value of IRMA™ is out of measurement range!	Please check concentration
PA value of IRMA™ is out of measurement range!	Please check concentration
Pressure value of IRMA™ is out of measurement range!	Please check applied pressure
Following error occurred on IRMA™: Error 1!	A software error occurred. Please restart sensor.
Following error occurred on IRMA™: Error 2!	A hardware error occurred. Please restart sensor. If the error still occurs, the sensor has to be replaced.
Following error occurred on IRMA™: Error 4!	A motor error occurred. Please restart sensor. If the error still occurs, the sensor has to be replaced.
Following error occurred on IRMA™: Error 8!	The motor speed exceeds limits Please restart sensor. If the error still occurs, the sensor has to be replaced.

4.16 Cleaning

Before cleaning, turn off the device and disconnect the electrical power / mains plug.

The following care instructions will be explained in the subsequent paragraphs.

- Case
- Display
- FlowSense Sensor

4.16.1 Housing

The case can be cleaned with a soft cloth and a mild soap solution.
Never allow fluids to penetrate the device or the connections.

4.16.2 Display

The display should be cleaned with a soft cloth and pure water only. The use of microfiber cloths and chemical cleaning agents is not recommended.

4.16.3 FlowSense Sensor

The flow sensors have a measuring wire per direction that can be damaged by improper cleaning. Therefore, the following information is essential:

- The case can be cleaned with a soft cloth and a mild soap solution.
- Never allow fluids to penetrate the device or the connections.
- Never clean the sensor with high pressure or under running water.
- Never clean the sensor in an automated disinfection device or ultrasonic bath.
- Never autoclave the sensor.

To prevent contamination of the sensor we strongly advise you to cover the ends of the sensor with the provided protection caps when not in use.

4.17 Maintenance and Calibration

4.17.1 venTest and FlowSense Sensors

The basic unit and the FlowSense Sensors should be returned annually to Datrend Systems Inc. or its authorized service center for maintenance and calibration.

4.17.2 Oxygen sensor

The (optional) oxygen sensor will become less sensitive as it is used. Therefore it must be calibrated regularly by the user. This calibration will be carried out with 21 % O_2 (normal ambient air) and 100 % O_2 (pure oxygen).

The operating life of the sensor basically depends on 2 factors:

1. Ambient temperature in which the sensor is stored and operated.
2. Oxygen concentration to which the sensor is exposed.

The operating life of the sensor is defined as 900000%h by the manufacturer. Whereas the end of operating life is defined as a drop under 70% of the original output signal.

This definition is based on an ambient temperature of 20°C and an oxygen concentration of 21% which means that under these circumstances the sensor has an operating life of 5 years. However, an ambient temperature of 30°C shortens the operating life to 75%, an ambient temperature of 40°C to 50% of the specification.

The impact of a higher oxygen concentration is even more significant. With a constant supply of 40% O_2 the operating life drops to 50% of the specification. At 70% O_2 it is only approx. 30% and at 100% O_2 it is only 25% of the initial operating life. If measurement is always made at 100% O_2 and 20°C, the sensor will be consumed after a little more than one year.

The impact of the ambient temperature and the measured oxygen concentration have a simultaneous effect and influence on the operating life of the sensor.

These effects require a regular calibration of the sensor. As the decrease in sensitivity of the sensor over the operating life is typically linear you can set up the following table for the calibration intervals:

Average O_2-Concentration	Time until accuracy is decreased by approx. 0.5% (adjustment interval)
100%	approx. 1 Week
40%	approx. 2 Weeks
20%	approx. 4 Weeks

ATTENTION:

The average O_2 concentration is the median oxygen concentration which is given to the sensor in the course of a day or a week .

Example: You measure 100% O_2 for 4 hours per day, 21% O_2 for 20 hours. That implies an average concentration of (4 * 100 % + 20 * 21%)/24 = 34 %

The stated accuracy of the oxygen measurements only apply if calibrations have been carried out properly.

Please note that the sensor reacts on overpressure (related to the ambient pressure during calibration adjustment) with a relative error of +0.1% per mbar (Attention: not Vol %!!). At a measuring value of 50 Vol % and an overpressure of 10 mbar, an error of +0.5 Vol % is generated, this means that 50.5 Vol% is displayed.

This effect is also present as far as calibration is concerned. Therefore an additional calibration beyond calibration intervals is necessary if the ambient pressure differs considerably from the pressure which had existed at the time of calibration.

4.17.3 Waste Management

The European Union has issued legal regulations to prevent waste and other forms of exploitation of electrical and electronic equipment, and to promote reuse and recycling to improve the environmental protection of the economic parties involved in management of this waste.

Also an initiative has been adopted to the recovery and disposal of electrical and electronic equipment, and to protect human health by restricting the use of hazardous substances in such equipment.

The device contains components (batteries, sensors) that must be disposed of in accordance with the legal regulations.

Directive 2002/96/EC of the European Parliament requires that electrical and electronic equipment, according to this directive, has to be disposed of in an environmentally friendly way in a separate collection.

Please contact an authorized waste management company in your country. Disposal with household waste (unsorted waste) or similar facilities for the collection of municipal waste is not allowed!

4.17.4 Technical Support

If you have any queries or problems, do not hesitate to contact our technical support:

Datrend Systems Inc.
#130 - 4020 Viking Way
Richmond BC Canada V6V 2L4
Phone.: 1-604-291-7747
Fax: 1-604-294-2355
E-Mail: customerservice@datrend.com

Appendix A: Triggering Options

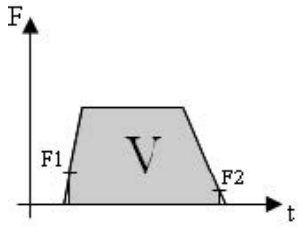
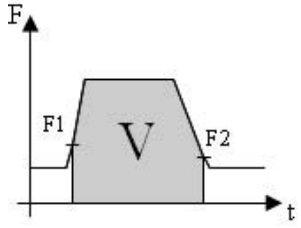
1 Trigger Options of venTest

Examples of triggering options for the venTest are illustrated in this appendix.

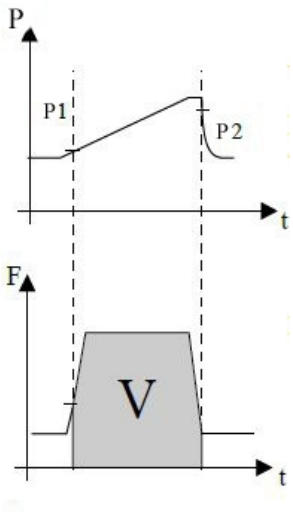
Only volume measurement will be discussed, but frequency and I/E measurement (TI and TE) are also influenced by trigger conditions.

The flow and pressure diagrams shown are to be regarded as examples as they can take many other forms in practice (according to the measuring application and instrument under test).

1.1 Volume Measuring with Flow Triggering

	Volume measurement with 2 flow trigger thresholds, F_1 and F2. The volume measurement is going to start with flow exceeding F1, ending with flow being below F2.
	Volume measurement with a continuous-flow-base and two flow trigger thresholds F1 and F2. Volume measurement is going to start with flow exceeding F1, ending with flow being below F2.

1.2 Volume Measuring with Pressure Triggering

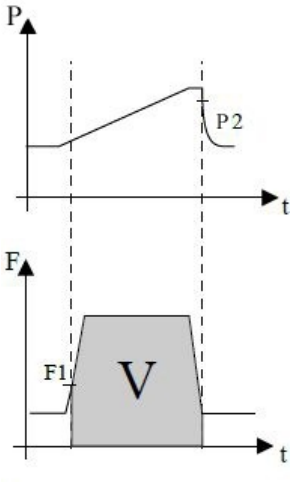


Volume measurement with 2 pressure trigger thresholds, P1 and P2.

Volume measurement is going to start with pressure exceeding P1, ending with pressure being below P2.

In volume calculation an existing flow-base will be added.

1.3 Volume Measuring with Pressure/Flow Triggering

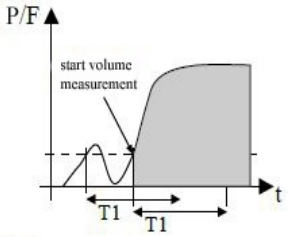


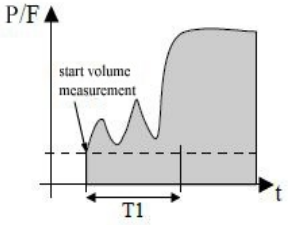
Volume measurement with a flow trigger threshold F1 and a pressure trigger threshold P2.

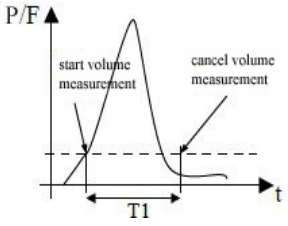
Volume measurement is going to start with flow exceeding F1, ending with flow being below P2.

In volume calculation an existing flow-base will be added.

1.4 Trigger Delay with Flow/Pressure Triggering

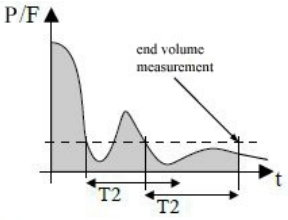
<table>
<tr>
<td>


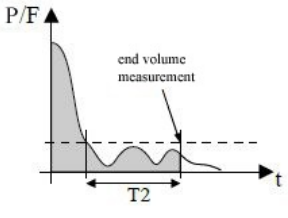




</td>
<td>If the flow/pressure after start falls again below trigger threshold 1 (F1/P1) within T1 time frame, the volume measurement will be aborted.

If the flow/pressure after start falls below trigger threshold 1 (F1/P1) within T1 time frame, the volume measurement will be terminated. Otherwise the volume measurement will be terminated if trigger threshold 2 (F2/P2) becomes true.

Flow/pressure must be above trigger threshold (F1/P1) for time T1 minimum to accept volume measurement.</td>
</tr>
<tr>
<td>




</td>
<td>If within time T2 flow/pressure exceeds trigger threshold 2 (F2/P2) volume measurement will not be terminated.

Volume measurement will be terminated if flow/pressure is below trigger threshold 2 (F2/P2) for time T2 minimum.</td>
</tr>
</table>

2 Volume measuring of Gases

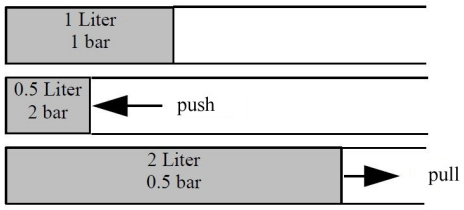
Measuring of air volume is not easy because gases are unlike liquids, being compressible, and expand when being warmed up.

If you state a gas volume, you also have to state the respective ambient conditions of pressure (e.g. 1013 mbar) and temperature (e.g. 20°C). With the gas law below described it is possible to convert into different ambient conditions.

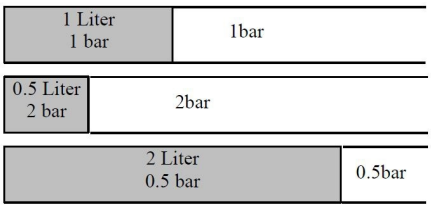
2.1 Physical Basics (Ideal Gas)

- Gases do not have a fixed volume, but a fixed mass which is dependent on the amount of gas molecules and their mass.
- An amount of gas always takes up the volume at their disposal and in doing so a pressure is created.

Example: Assume a closed receptacle filled with air, showing a volume of 1 l and a pressure of 1 bar. If volume is reduced to 0.5 l, pressure in the recipient will increase to 2 bar. If the original volume is increased to 2 l, pressure will decrease to 0.5 bar.



Example: Assume a closed recipient filled with air with a flexible wall; volume 1 l, ambient pressure 1bar. If ambient pressure is increased to 2 bar, volume will decrease to 0.5 l. If ambient pressure is reduced to 0.5 bar volume will increase to 2 l.



- Another important factor is the temperature of the respective gas. If a gas contained in a closed container is heated, pressure will increase. On cooling down pressure will decrease.

With a flexible container being able to expand, i.e. where pressure inside can adapt itself to ambient pressure, the container will expand (volume will increase) with temperature rising. On cooling down the container will contract (volume will decrease).

The ratio between pressure (P), volume (V) and temperature (T) are shown in the gas law:

$$\frac{P1 \times V1}{T1} = \frac{P2 \times V2}{T2}$$

The gas law therefore says that the ratio between pressure, volume and temperature has to be the same, both before and after modification of ambient conditions.

Example: At a temperature of 20°C and a pressure of 1 bar a gas takes up a volume of 1 l. The gas is now heated up from T1 = 20°C (293.2K) to T2=30°C (303.2 K)

a) The container's walls are flexible (as stated in the example above):

Volume can expand (V1 to V2), pressure remains the same (P1=P2=P). The gas law can now be adapted as follows:

$$\frac{P1 \times V1}{T1} = \frac{P2 \times V2}{T2} \quad \text{leads to} \rightarrow \quad \frac{V1}{T1} = \frac{V2}{T2}$$

Result: $V2 = \frac{V1 \times T2}{T1}$

In our example: V2 = 1 litre * 303.2/293.2 = 1.034 litre

b) The container's walls are rigid:

Volume cannot expand (V1=V2=V), pressure changes (P1 to P2). The gas law can now be transformed:

$$\frac{P1 \times V1}{T1} = \frac{P2 \times V2}{T2} \quad \text{leads to} \rightarrow \quad \frac{P1}{T1} = \frac{P2}{T2}$$

$$\text{Result: } P2 = P1 \times \frac{T2}{T1}$$

In our case: P2 = 1 bar * 303.2/293.2 = 1.034 bar

Example: At a temperature of 20°C and a pressure of 1 bar a gas takes up a volume of 1 l. Now ambient pressure is going to be increased from 1bar to 1.1.bar.

a) The container's walls are flexible:

Volume can expand (V1 to V2), temperature remains the same (T1=T2=T). The gas law can now be adapted as follows:

$$\frac{P1 \times V1}{T1} = \frac{P2 \times V2}{T2} \quad \text{leads to} \rightarrow \quad P1 \times V1 = P2 \times V2$$

$$\text{Result: } V2 = \frac{V1 \times P1}{P2}$$

In our case V2 = 1 Liter * 1/1.1 = 0.909 Liter

b) The container's walls are rigid: A modification of ambient pressure therefore cannot affect gas pressure.

3 Consequences of Physical Characteristics Of a Gas

- A gas does not have a fixed volume but takes up the volume that is defined by pressure and temperature.
- Volume values for gases must always be named with temperature and pressure indications.
- There are different standard conditions to which volume indications are converted. You will always have to check which one of said standard conditions has been applied.

3.1 Standard Conditions

Volume is often stated as standard volume. This means that the respective volume is the result of measuring having been done at both a standard temperature and a standard pressure. Unfortunately there is a great variety of standard conditions with different standard temperatures and pressures:

DIN 1343	Tn = 0°C and Pn = 1013 mbar	(= 1 atm, physical Atmosphere)
DIN 02 (ISO 1-1975)	Tn = 20°C and Pn = 981 mbar	(= 1 at, tech. Atmosphere)
STPD	Tn = 21.1 °C (=70°F) and Pn = 1013 mbar	(= 760 mmHg)

It is important to check to which standard condition the value is referring to.

The volume can also be shown in ATP (geometric volume). This is the volume that the gas takes up at both present pressure and temperature.

For measuring devices it is important to verify to which standard condition the information is presented.

If the standard condition indication is missing for the measuring device, you can normally consider that the geometric volume is shown.

3.2 Temperature Compensation

Temperature compensation makes measuring independent of the current gas temperature by measuring it and then, based on this temperature, volume changes are automatically corrected.

This must not be confused with the conversion at different standard conditions (as described above).

If this is not done by the measuring device, the correction has to be done manually. Therefore it is necessary to know the current gas temperature and the temperature of the gas with which the measuring device had been calibrated.

3.3 Pressure Compensation

The same requirements apply for pressure as for the temperature compensation above.

Pressure compensation makes measurement independent of the current ambient pressure. This happens by measuring pressure and automatically adjusting the volume.

If it is not being carried out by the measuring device the correction must be done manually, therefore it is necessary to know the current pressure and the pressure during which the measuring device had been calibrated.

3.4 Air Humidity

Air humidity can also have a significant influence on the measurements. The compensation of this determining factor is not easy and can only be carried out by very expensive measuring devices. In general, it is recommended that the gas have a relative humidity of 30 % to 70 % without being able to cause a significant measuring error.

3.5 Gas type

The gas type has a major influence on the measurement. Because of the different physical parameters of gases (density, viscosity, thermal conductivity etc.) the measuring device must be set to the correct gas type it is to measure, otherwise this can lead to major measuring errors.

3.6 (Tidal-) Volume Measuring

All comments so far have been related to accuracy of volume measurements, which are influenced by the physical characteristics of the gas.

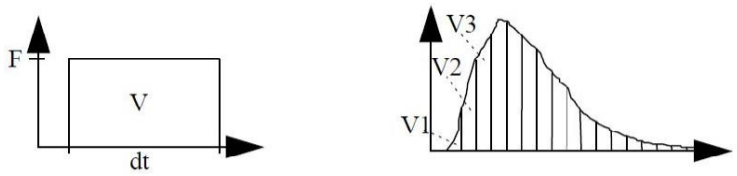
Another important point as far as volume measurement is concerned is the way in which this volume is calculated from the measured flow, the main measured value.

Two aspects must be taken into consideration:

- Volume V is calculated, with a short fraction of time dt in which you measure the flow F and multiply by the fraction of time dt V= F*dt. Then you have calculated the volume which has flowed through the sensor. A precondition for an exact measurement of the volume is that flow in the time 'dt' stays constant.

However this can not be ensured as a rule. Therefore the period of time 'dt' has to be set as small as possible to be able to 'scan' the flow curve as accurately as possible. The total volume then is the sum of these partial volumes:

V = V1 + V2 + V3 + ...(this can be described as discrete integration)

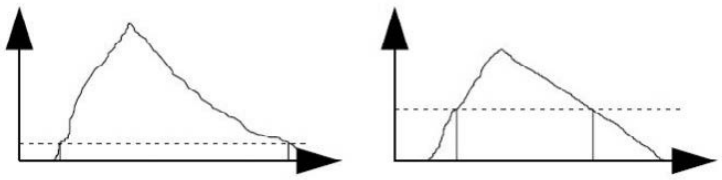


You have to be aware that this method always contains an error factor because you cannot choose the time period 'dt' small enough that the flow is really constant within this time segment.

A major criteria is the time resolution dt. The smaller this time interval is the more exact the flow curve will be scanned. The user generally has no control of this value. You have to count on the manufacturer of the measuring device to have chosen an adequate time resolution for use and accuracy.

The other point of view is the criteria when the volume measurement (integration) should begin and when it ends.

As a rule you use a flow trigger threshold for this. If this trigger is exceeded, the volume measuring begins. It will be terminated if the flow has dropped below this threshold. The trigger threshold is generally adjustable. There are other trigger conditions conceivable such as pressure rise via a pressure trigger threshold or end of pressure rise.



This measurement though will also cause a measuring error because the volume that flows through the sensor before the trigger threshold has been reached is not being measured. The same happens to the volume which is still flowing while the flow is dropping under the trigger threshold.

This means that with a trigger threshold set too high, the volume measurement displayed may be much too low if you have error triggering or fluctuating measuring values from measurement to measurement when the trigger threshold is set too low. So the trigger threshold can only be a compromise between accuracy and error triggering.

Often one can set certain time criteria and/or time delays which suppresses error triggering by unwanted flow peaks caused, for instance, by switching values.

Appendix B

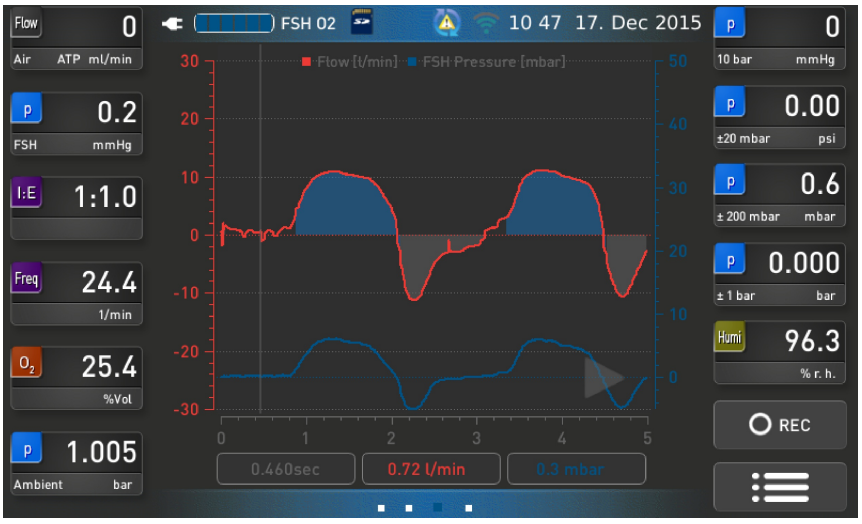
Appendix B: Understanding Data Records

Test records and graphical data can be recorded to internal memory, an attached/ removable memory device (SD card, USB memory stick) or to a network PC location defined by your network connections. Data can only be recorded from the combined parameter data and dual trace graphic screen. Data recording is configured on the Logging menu screen (see section 4.11), and the frequency of data capture can differ for the parameters and the graphical data.

1 Recording Data from a Test

1.1 Test Records

Test records, whether it is parameter data or graphical data, can only be recorded from the combined parameter data and dual trace graphic screen shown below.



Pressing the record button, 

, will begin the recording of both parameter va
and graphical data. The parameter values will be stored in an Excel compatible CSV file named yyyy-mm-dd_hh-mm-ss_values.csv, while the graphical data will be stored in a file named yyyy-mm-dd_hh-mm-ss_graph.csv . Note that the separator is actually a semi-colon (;) , not a comma (,).

The structure of the values file is:

S: 1st column: Start time in seconds starting at 1970
2nd column: Start time date and time

R: Remark (not used at this time)

T: Time resolution (value; unit)

C: Number of channels (based on how many of the 11 available slots are in use)

D: Channel description (number of D-lines correspond to value from C:)
- Name of channel
- Unit
- minimum value
- maximum value
- resolution

Resolution value:
Value 1000 -> 1000 (resolution = 0)
Value 1000 -> 100.0 (resolution = 1)
Value 1000 -> 10.00 (resolution = 2)

Followed by data starting with timestamp, and followed by the parameter values for each of the D channels, separated by a semi-colon (;).

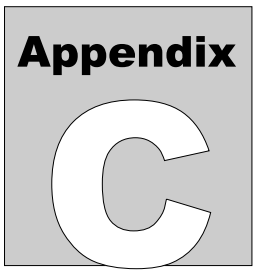
An example of a values file is:

```
S;1450852775260;23.12.2015 07:39:35.260
R;
T;1000;ms
C;11
D;Flow;ml/min;0;0;0;
D;Pressure;mmHg;0.0;0.0;1;
D;I/E;;0.0;0.0;1;
D;Frequency;1/min;0.0;0.0;1;
D;O2;%Vol;0.0;0.0;1;
D;Pressure;bar;0.000;0.000;3;
D;Pressure;mmHg;0;0;0;
D;Pressure;psi;0.00;0.00;2;
D;Pressure;mbar;0.0;0.0;1;
D;Pressure;bar;0.000;0.000;3;
D;Humidity;% r. h.;0.0;0.0;1;
07:39:35.000;-253;0.0;0.0;0.0;20.6;0.993;0;0.00;0.3;0.000;17.3;
07:39:36.000;-253;0.0;0.0;0.0;20.6;0.993;0;0.00;0.3;0.000;17.3;
07:39:37.000;-259;0.1;0.0;0.0;20.6;0.993;0;0.00;0.3;0.000;17.3;
07:39:38.000;-260;0.1;0.0;0.0;20.6;0.993;0;0.00;0.3;0.000;17.3;
07:39:39.000;-1330;0.1;0.0;0.0;20.6;0.993;0;0.00;0.3;0.000;17.3;
07:39:40.000;-272;0.1;0.0;0.0;20.6;0.993;0;0.00;0.3;0.000;20.1;
07:39:41.000;8954;2.8;0.0;0.0;20.6;0.993;0;0.00;0.3;0.000;20.4;
07:39:42.000;-6676;-1.4;0.0;0.0;20.6;0.993;0;0.00;0.4;0.000;54.1;
07:39:43.000;-2583;0.1;0.0;0.0;20.6;0.993;0;0.00;0.4;0.000;56.2;
07:39:44.000;6633;0.9;0.0;0.0;20.6;0.993;0;0.00;0.4;0.000;56.6;
07:39:45.000;-7057;-1.3;0.0;46.9;20.6;0.993;0;0.00;0.4;0.000;56.4;
07:39:46.000;7212;2.2;0.0;44.8;20.6;0.993;0;0.00;0.4;0.000;62.3;
07:39:47.000;8061;1.4;0.0;44.8;20.6;0.993;0;0.00;0.3;0.000;61.7;
07:39:48.000;-5858;-1.1;0.0;44.8;20.6;0.993;0;0.00;0.4;0.000;71.9;
07:39:49.000;-5871;-1.3;0.0;44.8;20.6;0.993;0;0.00;0.3;0.000;72.4;
07:39:50.000;8411;2.3;1.6;17.0;20.6;0.993;0;0.00;0.3;0.000;50.8;
07:39:51.000;8549;2.3;1.6;17.0;20.6;0.993;0;0.00;0.4;0.000;50.3;
07:39:52.000;7509;-0.2;1.6;17.0;20.6;0.993;0;0.00;0.4;0.000;77.9;
07:39:53.000;-5419;-1.7;1.6;17.0;20.6;0.993;0;0.00;0.4;0.000;78.7;
07:39:54.000;2442;1.7;0.6;12.9;20.6;0.993;0;0.00;0.3;0.000;70.7;
07:39:55.000;10382;2.9;0.6;12.9;20.6;0.993;0;0.00;0.4;0.000;69.9;
07:39:56.000;8999;3.5;1.4;33.0;20.6;0.993;0;0.00;0.4;0.000;65.8;
07:39:57.000;-1183;-2.7;1.4;33.0;20.6;0.993;0;0.00;0.4;0.000;65.8;
07:39:58.000;-6796;-1.7;1.4;33.0;20.6;0.993;0;0.00;0.4;0.000;70.1;
07:39:59.000;-4251;1.0;1.4;33.0;20.6;0.993;0;0.00;0.4;0.000;70.0;
07:40:00.000;10409;2.9;2.1;18.8;20.6;0.993;0;0.00;0.4;0.000;55.4;
```

1.2 Graphical records

The graphical record may have a different sample rate than the values record, but will be recorded for the same time period/duration, as defined in the Logging screen. As can be seen from the graph record below, it has a similar structure to the values file, but is limited to the 2 columns of data which are on the graphical display.

```
S;1450852775260;23.12.2015 07:39:35.260
R;
T;1000;ms
C;2
D;Flow high      ; l/min  ;-300.00;300.00;2;
D;Beatm. Druck   ; mbar   ;-10.0;100.0;1;
07:39:35.000;-0.22;0.1;
07:39:36.000;-0.22;0.1;
07:39:37.000;-0.22;0.1;
07:39:38.000;-0.87;0.1;
07:39:39.000;-0.30;0.1;
07:39:40.000;7.62;3.0;
07:39:41.000;5.18;1.3;
07:39:42.000;-3.92;-0.6;
07:39:43.000;6.99;2.5;
07:39:44.000;-6.61;-2.2;
07:39:45.000;-1.05;0.0;
07:39:46.000;6.02;1.8;
```



Appendix C: Connecting to a Windows Data Share

1 General

Before attempting to connect venTest to a Windows Share, it is important to know how that Share is Managed.

Domains, Workgroups, and Homegroups represent different methods for organizing computers in networks. The main difference among them is how the computers and other resources on the networks are managed.

Computers running Windows on a network must be part of a Workgroup or a Domain. Computers running Windows on home networks can also be part of a Homegroup, although it's not required.

In a Domain:

One or more computers are Servers. Network administrators use Servers to control the security and permissions for all computers on the Domain. This makes it easy to make changes because the changes are automatically made to all computers. Domain users must provide a password or other credentials each time they access the Domain.

If you have a user account on the Domain, you can log on to any computer on the domain without needing an account on that computer.

You probably can make only limited changes to a computer's settings because network administrators often want to ensure consistency among computers.

There can be thousands of computers in a domain.

The computers can be on different local networks.

In a Workgroup:

All computers are peers; no computer has control over another computer.

Each computer has a set of user accounts. To log on to any computer in the workgroup, you must have an account on that computer.

There are typically no more than twenty computers.

A workgroup is not protected by a password.

All computers must be on the same local network or subnet.

In a Homegroup:

Computers on a home network must belong to a workgroup, but they can also belong to a homegroup. A homegroup makes it easy to share pictures, music, videos, documents, and printers with other people on a home network.

A homegroup is protected with a password, but you only need to type the password once, when adding your computer to the homegroup.

It should also be noted that “Home” versions of Windows cannot join a Domain. In order to join a Domain, the computer must be running at least the “Pro” or “Enterprise” version of Windows.

Windows Homegroups are not supported with venTest.

While computers in a Windows Domain can be on different local networks and sub-nets, venTest should connect to a computer on the same logical sub-net and physical local network.

This appendix deals with connecting to the “Pro” versions of Windows, specifically Windows 10 Pro.

2 Workgroup or Domain?

venTest can connect to a Windows Data Share as long as the venTest and the target computer are on the same LAN and subnet. You need to know where the Data Share is located on the network (which computer / device), and then is that computer part of a Workgroup or a Domain.

If the Data Share is on a computer which is part of a Domain, then it is most likely you will have to involve your Network System Administrator to set the required permissions to allow you access to your target Data Share.

The examples in this Appendix deal with the Data Share named “SharedTestData” which exists on a computer named “Spare”.

Examples are provided for both Workgroup and Domain shares.

3 Connecting to a Workgroup Share

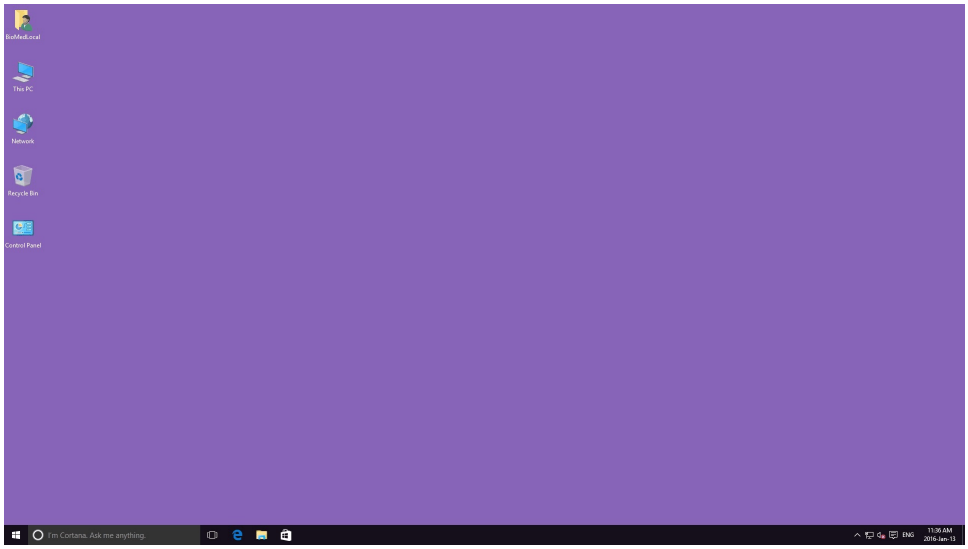


Figure 43 - Windows 10 Desktop

Right-click on “This Computer”, and select “Properties”

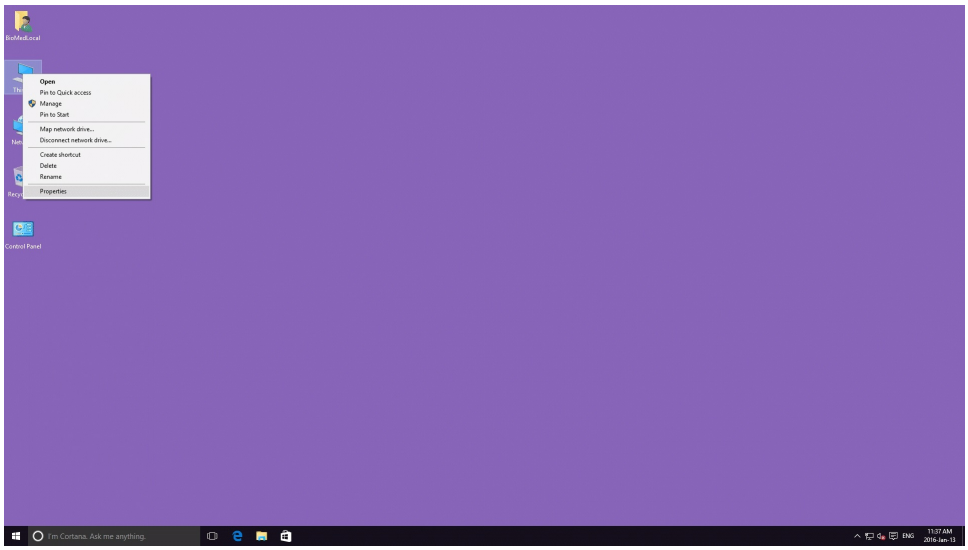


Figure 44 - Select “Properties”

In the panel that opens, review the section titled “Computer name, domain, and workgroup settings”

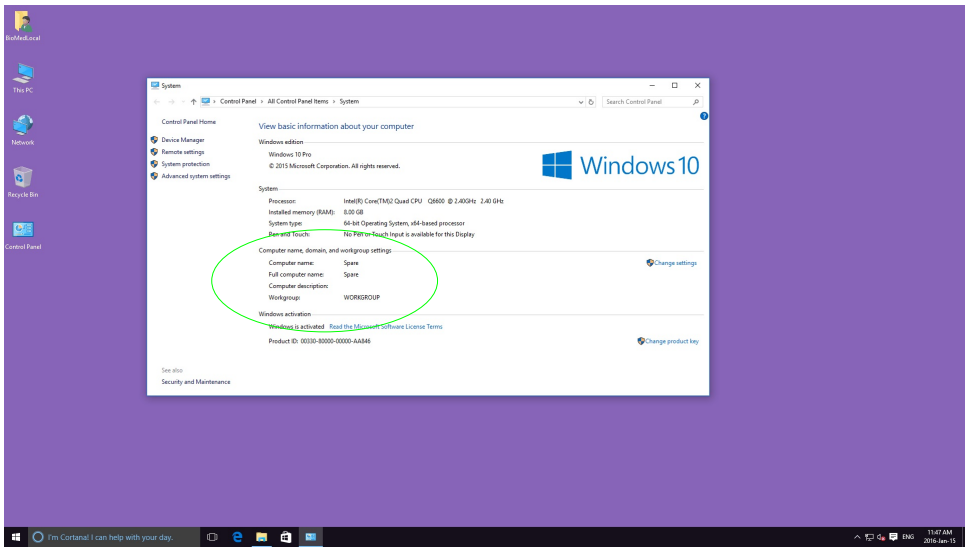


Figure 45 - Computer Properties (Workgroup)

In this example the name of the computer is “Spare”, and it is part of the Workgroup “WORKGROUP”. This means that the computer is not part of a Domain, and the Data Share can be created and administered on the “Spare” computer.

3.1 LAN / Network Address

You need to know the network address of the “Share” computer. The reason for this is that venTest is not capable of resolving computer names via DNS (Domain Name Services). Proceed as follows:

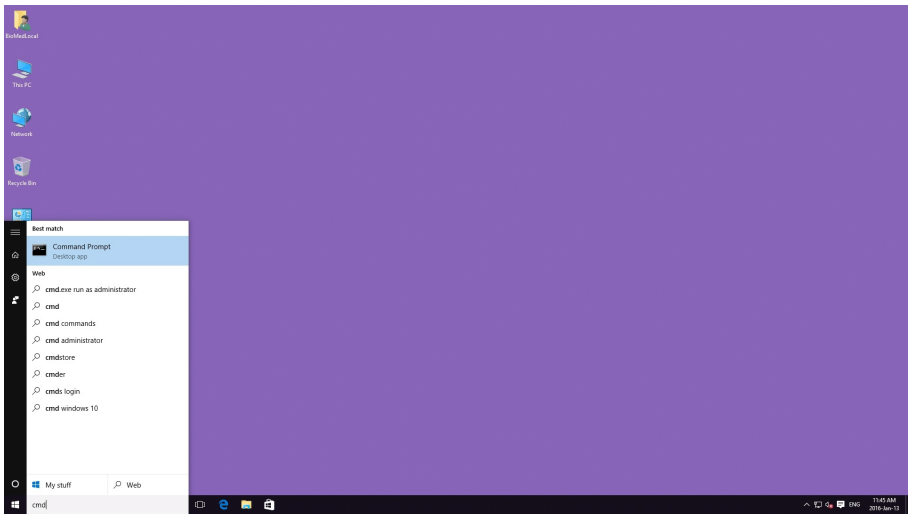


Figure 46 - Finding the Command Prompt

In the search box located to the right of the start window icon (lower left corner of the Desktop) type “cmd” and then click on “Command Prompt”. This will cause a command line interface window to open. At the prompt type “ipconfig”. The results should be similar to Figure 47.

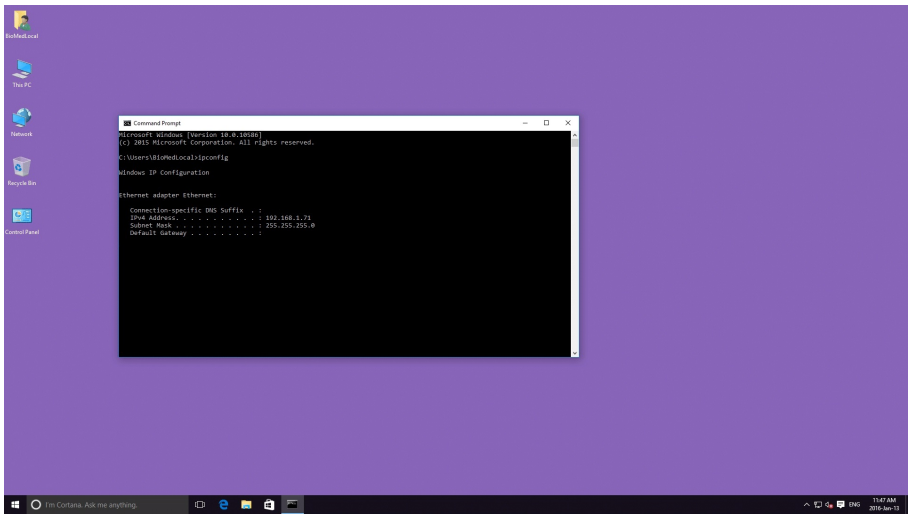


Figure 47 - IPv4 Address

Make note of the “IPv4 Address”.

3.2 Windows Data Share

By default folders on computers are not shared. A Windows Data Share is simply a folder which has been specifically identified as “Shared”. For this example there is a folder named “SharedTestData” located in “C:\” on the “Spare” computer.

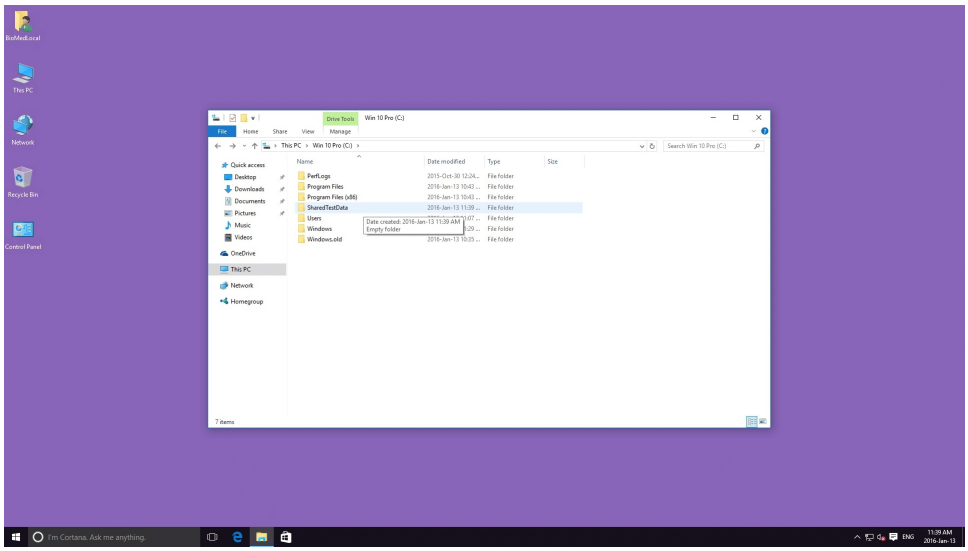


Figure 48 - “SharedTestData” *folder*

To Share the “SharedTestData” folder, right-click on the “SharedTestData” folder and select Properties.

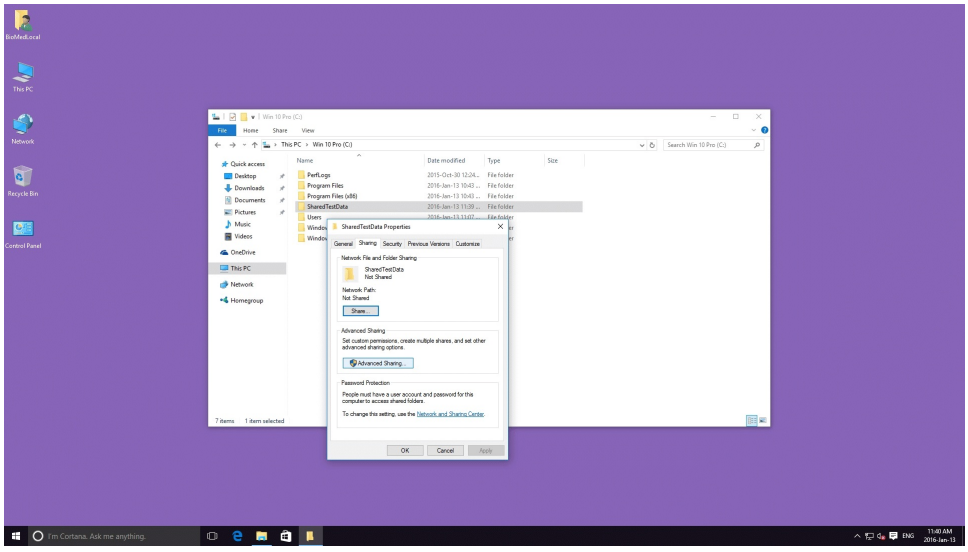


Figure 49 - “SharedTestData” *folder properties*

Click on the “Sharing” tab, and then click on “Advanced Sharing”

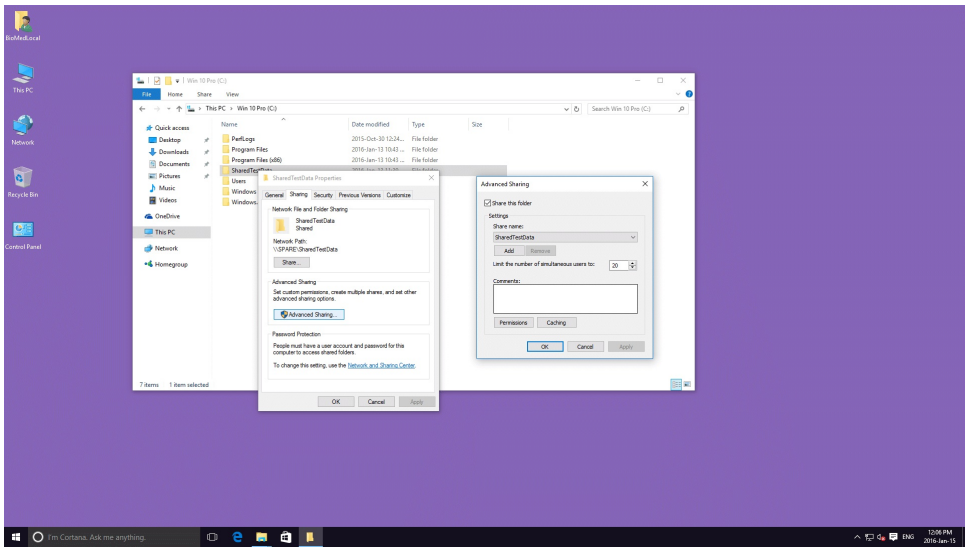


Figure 50 - “SharedTestData” *Advanced Sharing Properties*

Now click on “Permissions”.

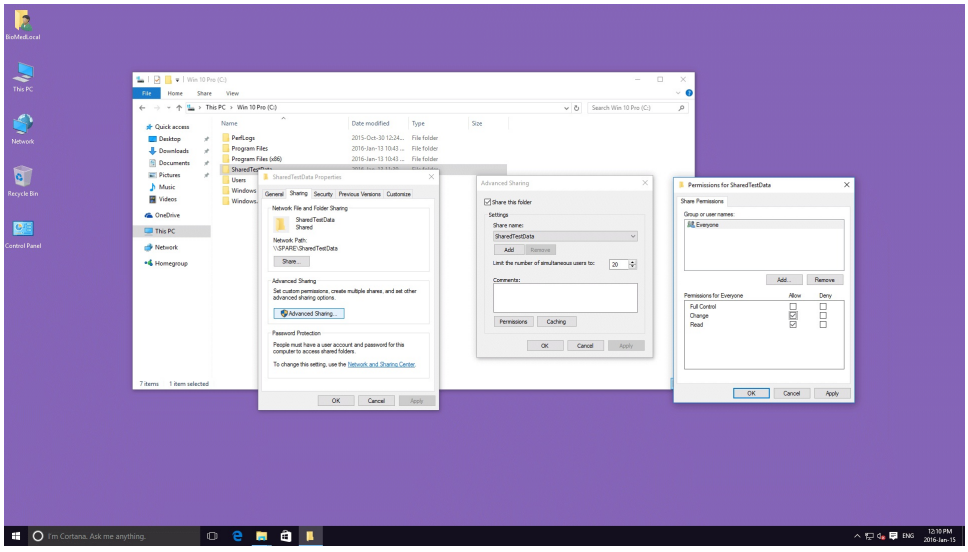


Figure 51 - Sharing Permissions

When the “Permissions” dialog opens, the “Everyone” group should show with only the “Read” permission checked off. Put a checkmark in the box for “Change”, and then click “OK” to close the 3 dialog boxes.

The “SharedTestData” share is now ready for the venTest to connect to.

3.3 Connecting venTest to the Windows Data Share

With the venTest connected to the network, select the Network Drive settings. Enter the "IPv4 Address" previously recorded (Appendix C3.1) along with the Windows Data Share Name as shown in Figure 52.

Windows requires Authentication (login) to access the computer, so in this example the user BioMedLocal is a user account that exists on the "Spare" computer with Administrator permissions. Enter the username and associated password as shown as shown in Figure 52, then select the "Mount" soft-button on the venTest screen.

The venTest will take approximately a minute or so and then the message "Mounting the remote folder was successful!" should appear. Press "OK" and the "Mount" button will change to "Unmount".

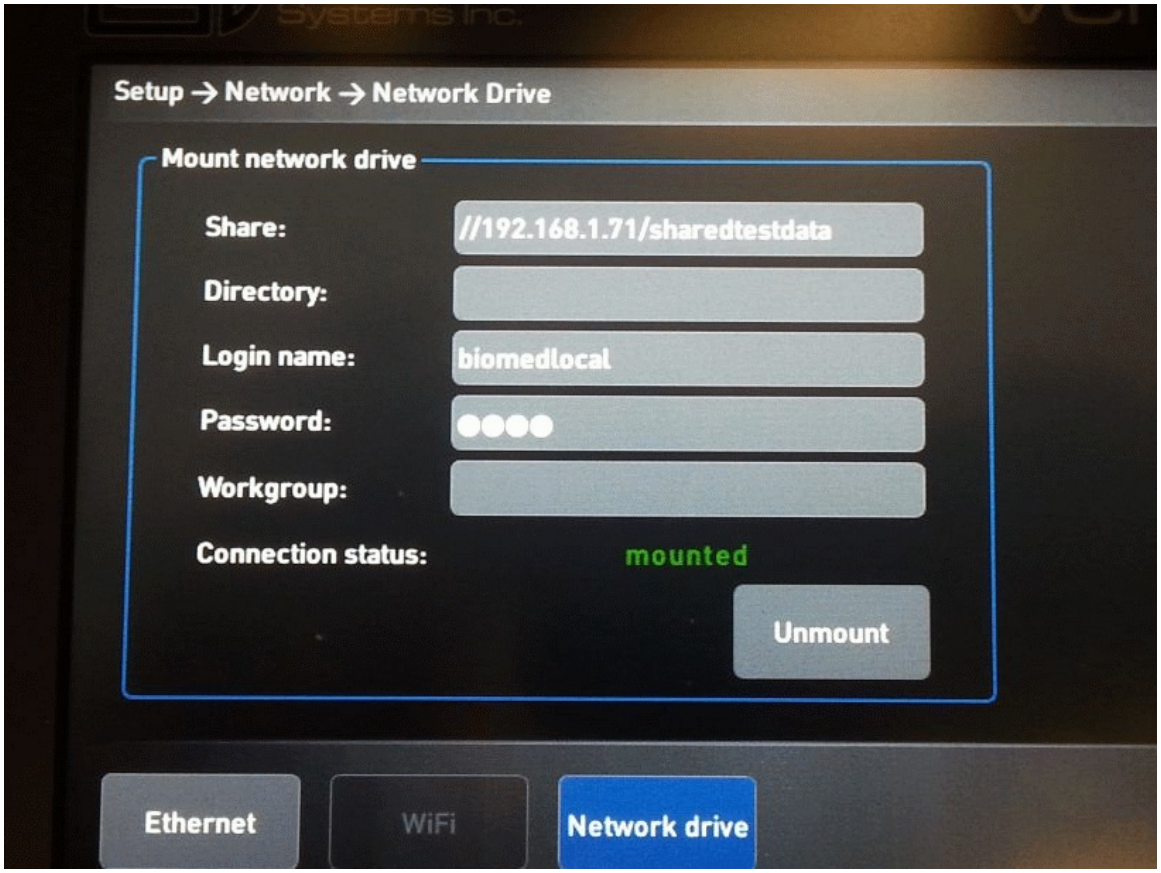


Figure 52 - venTest Connected (Workgroup)

4 Connecting to a Domain Share

Connection to a Domain Data Share is almost identical to connecting to a Workgroup Share. The difference is the target computer which contains the Data Share is part of a Domain. When the Data Share is on a computer which is part of a Domain, a Domain User Account - controlled by the Domain Server - must be used to successfully connect to the Domain computer which contains the Windows Data Share.

Additionally, the Domain User Account should also be identified as an “Administrator” of the computer which has the Data Share on it.

Domain Accounts are added to the Domain via “Active Directory Users and Computers” by your Network System Administrator. Your Network System Administrator should also be able to assign “administrator” status to the account on the domain computer which contains the Windows Data Share.

Note: Do NOT use the “Administrator” account when trying to connect to a Data Share! There is no practical way to differentiate between the “Administrator” account on the local machine (“spare\administrator” in this example) and the “Administrator” on the Domain (“DSI2\administrator” in this example); because of this, any attempt to use the “Administrator” account to connect to the Data Share will fail.

For this example the “Spare” computer has been joined to the DSI2.LOCAL domain, as shown in the computer properties window (Figure 53):

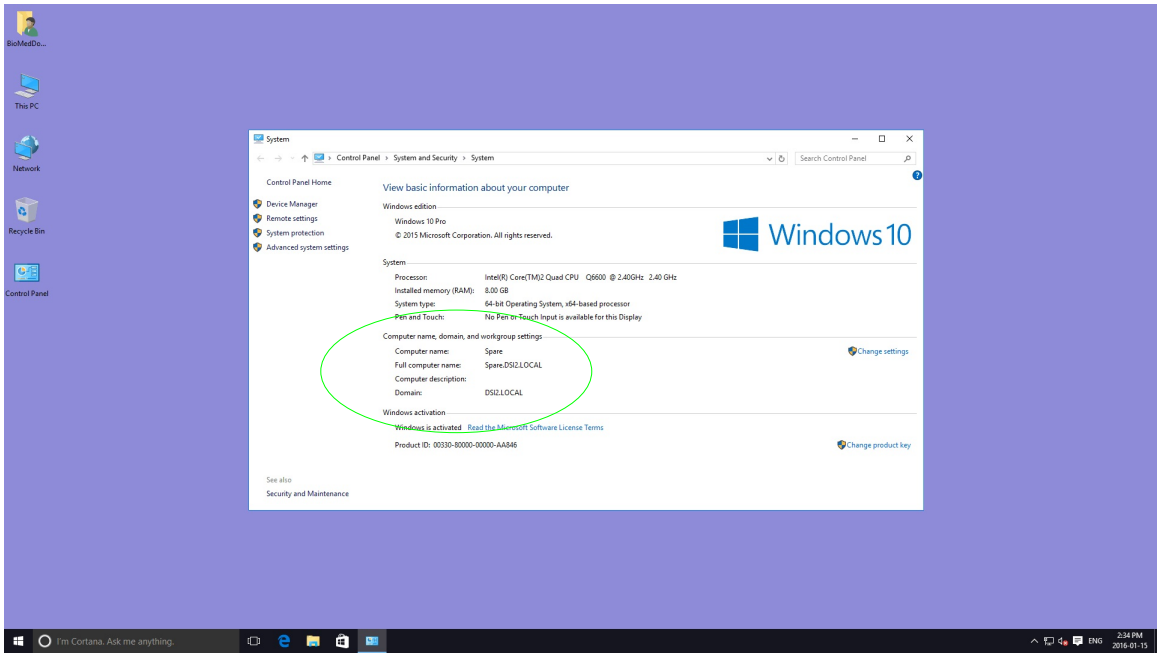


Figure 53 - Computer Properties (Domain)

The Domain User “BioMedDomain” can then connect to “SharedTestData” on “Spare”:

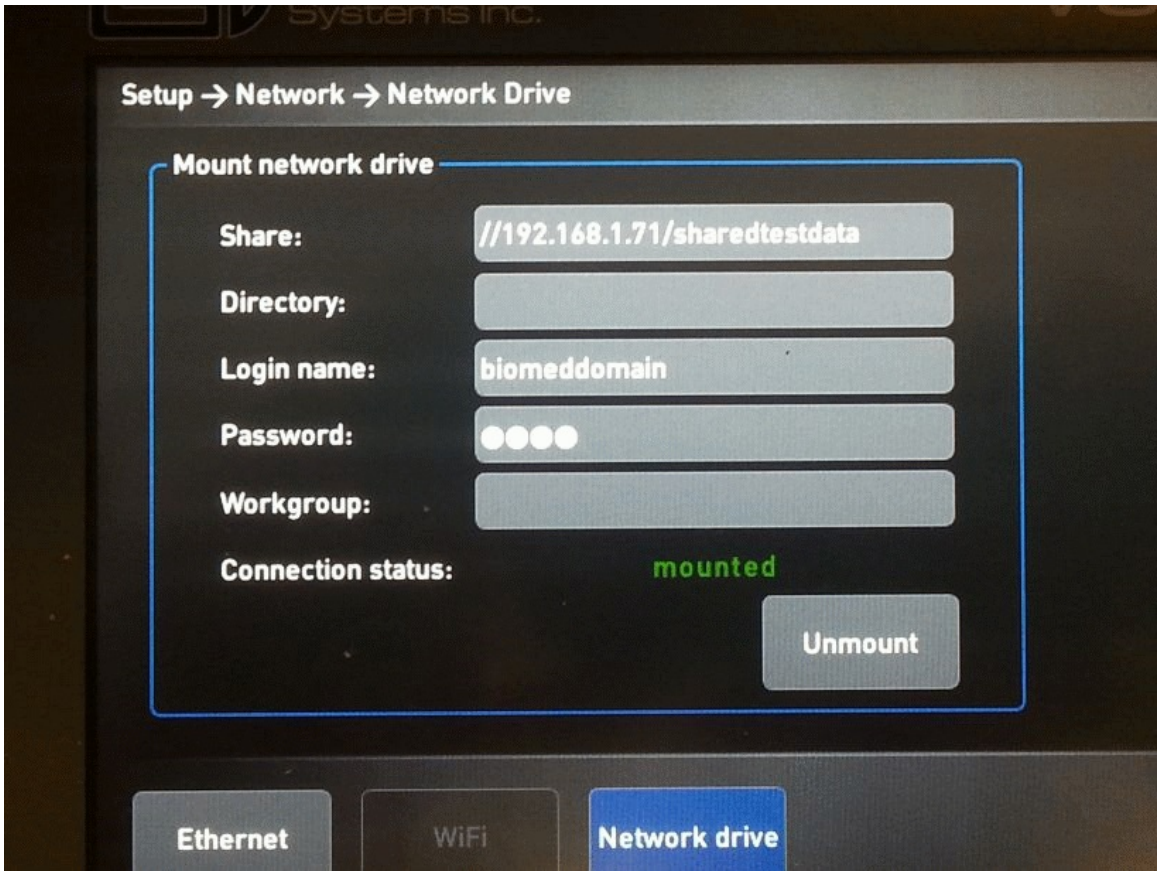


Figure 54 - venTest connected (Domain)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