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## **FLUKE Biomedical VT900A/VT650 User Communication Interface**

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### **INTRODUCTION**

This document specifies the communications interface for products in the Ventilator Tester (VT) family including models VT900A, VT900, and VT650.

The VT can be controlled remotely by sending it commands and receiving responses, including test data.

The VT has a USB Device Port (peripheral) that can be connected to a computer (PC). This port can be configured to look like a COM port to the PC or to look like a regular USB Device.

## USB INTERFACE

### USB CABLE CONNECTION

The VT USB Device Port (peripheral) has a Micro Type B connector. It connects to a PC USB Controller Port that has a Type A rectangular connector.

Connect the VT to your PC with the USB Type A to Micro Type B cable supplied.

### OPERATING SYSTEM REQUIREMENT

Fluke supports connecting the VT to a PC running Windows XP, Vista, Windows7, or a later version.

### WINDOWS SOFTWARE DRIVER

The VT USB port is built from an integrated circuit (IC) device that is commonly used inside adapter cables that convert USB to RS232. When this device is connected to a PC it looks like a COM port to the PC. When Windows enumerates the device it assigns a COM port number to it. It is called a virtual COM port (VCP).

The IC is an FT232R from the FTDI company. It is compatible with the USB Version 2.0 Full Speed specification.

Versions of Windows XP, Vista, 7, 10, and later, include a software driver for FTDI USB Serial Converters, including the FT232R. The USB ID numbers are: VID 0403 and PID 6001.

When you connect the VT to your PC for the first time, Windows should recognize and register your VT as a USB Serial Converter and USB Serial Port (COMx).

The VT can be controlled as a virtual COM port or from the FTDI D2XX Direct Interface API. Typically, single users typing commands in a terminal emulation program would use the COM interface. Users writing their own programs might prefer D2XX.

### VIRTUAL COM PORT

When using the virtual COM port, the USB port resides inside the VT, but the PC acts like it now has an additional COM port and that COM port is connected to an RS232 serially controlled instrument.

### DEVICE MANAGER

The VT is configured to enable COM port enumeration unless turned off in device manager.

Run Device Manager to check the status of the VT COM port. When viewing by Type, your VT shows up in two places:

- Universal Serial Bus controllers / USB Serial Converter.
- Ports (COM & LPT) / USB Serial Port (COMx).

If you view by Connection, the VT will be under one of the USB Root Hubs as:

- USB Serial Converter / USB Serial Port (COMx).

If Device Manager only lists the USB Serial Converter but not the COM port it could be that the Virtual COM Port driver is not enabled. Open USB Serial Converter Properties and go to Advanced. Check the Load VCP box if it is not already checked and press OK. Then the COM port should show up.

You can change the COM port number assigned by Windows in Device Manager. Open the Properties for the USB Serial Port (COMx), go to Port Settings and press Advanced. Select the desired COM Port Number from the drop down list box and press OK. To get the device list to show the new COM port number perform a Scan for hardware changes.

If Device Manager says that a COM port number is in use, it may be from another USB device that is no longer being used. You can click through the error message and force it to the number you want.

If you unplug your VT, you can still see it in Device Manager by selecting View / Show hidden devices. It will be shown grayed out.

## ADVANCED USERS

Advanced users can get more information about the FT232R from the FTDI web site: [www.ftdichip.com](http://www.ftdichip.com). You can get new software drivers, application notes, and USB utilities. You can learn how to view your USB connections and load and/or delete all FTDI drivers from your PC. You can get drivers for other operating systems. You can learn how to use the D2XX direct interface API to include in your own custom interface programs if you don't want to use a COM port.

## COM PORT SETTINGS

Settings for the COM port should be made by the program that opens and uses the COM port such as a terminal emulation program (HyperTerminal, Tera Term or other). The settings in Device Manager are usually irrelevant because they are overridden by the controlling program.

The COM port should be set to:

- 115,200 baud
- No parity
- 8 data bits
- 1 stop bit
- Hardware handshaking should be turned on.

## HANDSHAKING

VT uses hardware handshaking.

VT does not use XON/XOFF software handshaking.

## COMMAND PROTOCOL

### COMMANDS

Commands are made up of alphanumeric characters. The first character must be alphabetic. Alphabetic characters may be sent in upper or lower case.

Special characters are:

Name	Abbreviation	Hex Value
Carriage Return	<b>CR</b>	<b>0D</b>
Line Feed	<b>LF</b>	<b>0A</b>
Space	<b>SP</b>	<b>20</b>
Backspace	<b>BS</b>	<b>08</b>
Escape	<b>ESC</b>	<b>1B</b>

- Commands must be terminated by **CR** or **LF** or both.
- **BS** erases the last character from the command.
- **ESC** erases all characters from the command.
- Some commands require one or more parameters to be sent with them. Where a command needs parameters, the command is followed by an equal sign and the parameters. Multiple parameters are separated by commas.
- In the command specification, parameters are given names in *lower case italics* which are place holders for the actual parameter to be sent with the command.
- For numeric parameters, the format is flexible.
- Boolean parameters are **TRUE** or **FALSE** or can be shortened to **T** or **F**.

## COMMAND RESPONSES

After receiving a command, the VT will not store or respond to additional received characters until it has executed the command and responded to it.

The VT always responds to a command after it has executed it, by returning a response, terminated by **CR** and **LF**. Some commands return a multiple line message, with each line terminated by **CR** and **LF**.

The standard command response is "\*", unless other data is to be returned. "\*" indicates that the command was understood and executed.

Incorrect commands return the following error coded messages.

Error Coded Message	Description
!	Command empty, no characters
!01 Unknown command	Command not recognized
!02 Illegal command	Command not legal for current mode or state
!03 Illegal parameter	Parameter not legal for command
!04 Buffer overflow	Command too long for buffer

## CONTROL STATES AND MODES

### LOCAL CONTROL MODE

VT powers up initially under Local control by user keys.

### REMOTE CONTROL MODE(S)

In Remote control, VT accepts commands and executes them. The user interface is disabled except for a single touch that can return to Local Control Mode. Unless otherwise specified, commands are legal only in the **RMAIN** mode. The modes are listed in the table:

Mode Mnemonic	Type	Description
<b>LOCAL</b>	Local	Local control
<b>RMAIN</b>	Main	Main Remote control mode

The **LOCAL** command brings the VT back to local control.

## COMMAND SPECIFICATIONS

Unless specified otherwise:

- Commands return \*.

### GENERAL COMMANDS

<b>IDENT</b>	Get the instrument identification and firmware version.
Legal modes:	All modes
Returns:	A string including model number <b>VERSION</b> and version number, including build number, separated by spaces without commas: ex. "VT900 <b>VERSION</b> 1.00.06"
<b>SN</b>	Get the serial number.
Legal modes:	All modes
Returns:	The serial number: up to 10 characters possible, normal production Fluke serial numbers are 7 decimal digits.

<b>LOCAL</b>	Go to Local control mode.
Legal modes:	All modes
Returns:	<b>LOCAL</b>
<b>REMOTE</b>	Go to Remote control <b>RMAIN</b> mode.
Legal modes:	All modes
Returns:	<b>RMAIN</b>
<b>QMODE</b>	Query the mode.
Legal modes:	All modes
Returns:	The Remote mode mnemonic per table above.
<b>RESET</b>	Resets the product as it was turned off and back on.
Legal modes:	Remote mode
<b>CALINFO</b>	Returns the device calibration information.
Legal modes:	Remote Mode
Returns:	CAL version (x2), CAL Date and the CAL technician ID Ex. "001,001,06/01/2018,TEST_TECH"

**SETUP COMMANDS**

<b>DATE=</b> <i>year,month,day</i>	Set the Date.
<i>year</i>	2017 to 2099
<i>month</i>	1 to 12
<i>day</i>	1 to 31
<b>TIME=</b> <i>time</i>	Set the Time in 24-hour format. Seconds will be zeroed.
<i>hour</i>	0 to 23
<i>minute</i>	0 to 59
<b>DF=</b> <i>dateformat</i>	Set the Date Format, stored in non-volatile memory.
<i>dateformat</i>	<b>MDY</b> MM/DD/YYYY <b>DMY</b> DD/MM/YYYY
<b>QDF</b>	Query the Date Format.
Returns:	The Date Format as above in <b>DF</b> .
<b>TF=</b> <i>timeformat</i>	Set the Time Format, stored in non-volatile memory.
<i>timeformat</i>	<b>24</b> 24 hour format <b>12</b> 12 hour format with AM/PM
<b>QTF</b>	Query the Time Format.
Returns:	The Time Format as above in <b>TF</b> .
<b>QDT</b>	Query the Date and Time.
Returns:	Date,Time formatted per the user selected formats

<b>UFLAW=unit</b>	Set the Airway Flow user unit.
<i>unit</i>	<b>LM</b> liters per minute <b>LS</b> liters per second <b>MLM</b> milliliters per minute <b>MLS</b> milliliters per second <b>CFM</b> cubic feet per minute
<b>QUFLAW</b>	Query the Airway Flow user unit.
Returns:	unit
<b>UFLULO=unit</b>	Set the UltraLow Flow user unit. (VT900 only)
<i>unit</i>	same as for <b>UFLAW</b>
<b>QUFLULO</b>	Query the UltraLow Flow user unit. (VT900 only)
Returns:	unit
<b>UVOL=unit</b>	Set the Volume user unit.
<i>unit</i>	<b>L</b> liters <b>ML</b> milliliters <b>CF</b> cubic feet
<b>QUVOL</b>	Query the Volume user unit.
Returns:	unit
<b>UPRAW=unit</b>	Set the Airway Pressure user unit.
<i>unit</i>	<b>MBAR</b> millibars <b>BAR</b> bars <b>MMHG</b> millimeters of mercury <b>INHG</b> inches of mercury <b>CMH2O</b> centimeters of water <b>INH2O</b> inches of water <b>PSI</b> pounds per square inch <b>ATM</b> atmospheres <b>KPA</b> kilopascals
<b>QUPRAW</b>	Query the Airway Pressure user unit.
Returns:	unit
<b>UPRLO=unit</b>	Set the Low Pressure user unit.
<i>unit</i>	same as <b>UPRAW</b>
<b>QUPRLO</b>	Query the Low Pressure user unit.
Returns:	unit

<b>UPRULO=unit</b>	Set the UltraLow Pressure user unit. (VT900 only)
<i>unit</i>	same as <b>UPRAW</b>
<b>QUPRULO</b>	Query the UltraLow Pressure user unit. (VT900 only)
Returns:	unit
<b>UPRHI=unit</b>	Set the High Pressure user unit.
<i>unit</i>	same as <b>UPRAW</b>
<b>QUPRHI</b>	Query the High Pressure user unit.
Returns:	unit
<b>UPRBA=unit</b>	Set the Barometric Pressure user unit.
<i>unit</i>	same as <b>UPRAW</b>
<b>QUPRBA</b>	Query the Barometric Pressure user unit.
Returns:	unit
<b>UTMP=unit</b>	Set the Temperature user unit.
<i>unit</i>	<b>C</b> Celsius <b>F</b> Fahrenheit
<b>QUTMP</b>	Query the Temperature user unit.
Returns:	unit
<b>FLCM=correctmode</b>	Set the Airway Flow Correction Mode.
<i>correctmode</i>	<b>ATP</b> Ambient temp & pressure, actual humidity <b>ATPD</b> Ambient temp & pressure, dry <b>ATPS</b> Ambient temp & pressure, saturated <b>STP20</b> Std temp 20 C, std press 760 mmHg, actual humidity <b>STP21</b> Std temp 21 C, std press 760 mmHg, actual humidity <b>STPD0</b> Std temp 0 C, std press 760 mmHg, dry <b>STPD20</b> Std temp 20 C, std press 760 mmHg, dry <b>STPD21</b> Std temp 21 C, std press 760 mmHg, dry <b>BTPS</b> Body temp 37 C, ambient pressure, saturated <b>BTPD</b> Body temp 37 C, ambient pressure, dry <b>CUST</b> Custom user defined
<b>QFLCM</b>	Query the Airway Flow Correction Mode.
Returns:	Correction Mode

<b>CFLCM=</b> <i>temperature, t_entry, pressure, p_entry, humidity</i>	Set the Custom Airway Flow Correction Mode settings.
<i>temperature</i>	<b>AMB</b> Ambient temperature <b>T0</b> 0° C <b>T20</b> 20° C <b>T21</b> 21° C <b>T37</b> 37° C <b>ENT</b> Numeric entry in °C
<i>t_entry</i>	The temperature numeric entry 0 to 99, only used when <i>temperature</i> is <b>ENT</b> , otherwise enter zero here, do not leave blank
<i>pressure</i>	<b>AMB</b> Ambient pressure (barometer) <b>ABS</b> Total absolute pressure (barometer + airway) <b>1AT</b> 1 atm (760 mmHg) <b>ENT</b> Numeric entry in mbar
<i>p_entry</i>	The pressure numeric entry 0 to 9999, only used when <i>pressure</i> is <b>ENT</b> , otherwise enter zero here, do not leave blank
<i>humidity</i>	<b>ACT</b> Actual humidity <b>DRY</b> Dry humidity <b>SAT</b> Saturated humidity

<b>QCFLCM</b>	Query the Custom Airway Flow Correction Mode settings.
Returns:	Temperature, t_entry, pressure, p_entry, humidity settings as defined above in <b>CFLCM</b>

<b>BDM=mode</b> <i>mode</i>	Set the Breath Detection Mode.
<i>mode</i>	<b>BI</b> Bi-directional <b>IN</b> Inspiratory <b>EX</b> Expiratory <b>OFF</b> Off

<b>QBDM</b>	Query the Breath Detection type.
Returns:	Breath Detection

<b>BDTS=trigsource</b> <i>trigsource</i>	Set the Breath Detection Trigger Source.
<i>trigsource</i>	<b>FL</b> Flow <b>PR</b> Pressure <b>EXT</b> External

<b>QBDS</b>	Query the Breath Detection Trigger Source.
Returns:	Trigger Source

<b>BDP=patient</b> <i>patient</i>	Set the Breath Detection Patient.
<i>patient</i>	<b>AD</b> Adult <b>PED</b> Pediatric



<b>QBDP</b>	Query the Breath Detection Patient.
Returns:	Patient

<b>BDTH=</b> <i>trigsource,</i> <i>patient,</i> <i>phase,</i> <i>threshold</i>	Set a Breath Detection Threshold for the specified condition of Trigger Source, Patient, and Phase.
<i>trigsource</i>	Detection Trigger Source as above.
<i>patient</i>	Detection Patient as above.
<i>phase</i>	Detection Phase: <b>IN</b> or <b>EX</b> .
<i>threshold</i>	Detection Threshold in lpm: float

<b>QBDTH=</b> <i>trigsource,</i> <i>patient,</i> <i>phase</i>	Query the Breath Detection Threshold for the specified condition of Trigger Source and Patient.
<i>trigsource</i>	Detection Trigger Source as above.
<i>patient</i>	Detection Patient as above.
<i>phase</i>	Detection Phase as above.
Returns:	float in lpm

<b>GAS=</b> <i>gas</i>	Set the Gas type.
<i>gas</i>	<b>AIR</b> Air <b>N2</b> Nitrogen <b>O2</b> Oxygen <b>AR</b> Argon <b>CO2</b> Carbon dioxide <b>N2O</b> Nitrous oxide <b>HELIOX</b> Helium and oxygen <b>O2BALN2O</b> Measured oxygen measured w/ balance nitrous oxide <b>O2BALHE</b> Measured oxygen w/ balance helium <b>O2BALN2</b> Measured oxygen w/ balance nitrogen

<b>QGAS</b>	Query the Gas.
Returns:	Gas

**MEASUREMENT COMMANDS**

<b>MEAS=</b> <i>mode</i>	Set the measurement mode. Must be set prior to obtaining the desired measurement.
<i>mode</i>	<b>NONE</b> No measurements being performed <b>AW</b> Airway: for all measurements in the High Flow Airway channel including: Airway Flow, Volume, Airway Pressure, Oxygen, Temperature, Humidity, and Barometric Pressure. <b>FLULO</b> UltraLow Flow <b>PRLO</b> Low Pressure <b>PRULO</b> UltraLow Pressure <b>PRHI</b> High Pressure <b>AN</b> Anesthesia (VT900A with Vapor)

<b>QMEAS</b>	Query the measurement mode
Returns:	The measurement mode, per above.

<b>MCLEAR</b>	Clear the active measurements per mode above: Sets all active Min, Max, and Avg values to the current reading.
<b>ZFLAW</b>	Zero the Airway Flow measurement.
<b>ZFLULO</b>	Zero the UltraLow Flow measurement.
<b>ZVOL</b>	Zero the Volume measurement.
<b>ZPRAW</b>	Zero the Airway Pressure measurement.
<b>ZPRLO</b>	Zero the Low Pressure measurement.
<b>ZPRULO</b>	Zero the UltraLow Pressure measurement.
<b>ZPRHI</b>	Zero the High Pressure measurement.
<b>ZZS</b>	Clear all the user zeroes.
<b>FLAW</b>	Get the Airway Flow measurement.
Returns:	float in user units
<b>FLAWMIN</b>	Get the Airway Flow Minimum measurement.
Returns:	float in user units
<b>FLAWMAX</b>	Get the Airway Flow Maximum measurement.
Returns:	float in user units
<b>FLAWAVG</b>	Get the Airway Flow Average measurement.
Returns:	float in user units
<b>FLULO</b>	Get the UltraLow Flow measurement. (VT900 only)
Returns:	float in user units
<b>FLULOMIN</b>	Get the UltraLow Flow Minimum measurement. (VT900 only)
Returns:	float in user units
<b>FLULOMAX</b>	Get the UltraLow Flow Maximum measurement. (VT900 only)
Returns:	float in user units
<b>FLULOAVG</b>	Get the UltraLow Flow Average measurement. (VT900 only)
Returns:	float in user units
<b>VOL</b>	Get the Volume measurement.
Returns:	float in user units
<b>PRAW</b>	Get the Airway Pressure measurement.

	Returns: float in user units
<b>PRAWMIN</b>	Get the Airway Pressure Minimum measurement.
	Returns: float in user units
<b>PRAWMAX</b>	Get the Airway Pressure Maximum measurement.
	Returns: float in user units
<b>PRAWAVG</b>	Get the Airway Pressure Average measurement.
	Returns: float in user units
<b>PRLO</b>	Get the Low Pressure measurement.
	Returns: float in user units
<b>PRLOMIN</b>	Get the Low Pressure Minimum measurement.
	Returns: float in user units
<b>PRLOMAX</b>	Get the Low Pressure Maximum measurement.
	Returns: float in user units
<b>PRLOAVG</b>	Get the Low Pressure Average measurement.
	Returns: float in user units
<b>PRULO</b>	Get the UltraLow Pressure measurement. (VT900 only)
	Returns: float in user units
<b>PRULOMIN</b>	Get the UltraLow Pressure Minimum measurement. (VT900 only)
	Returns: float in user units
<b>PRULOMAX</b>	Get the UltraLow Pressure Maximum measurement. (VT900 only)
	Returns: float in user units
<b>PRULOAVG</b>	Get the UltraLow Pressure Average measurement. (VT900 only)
	Returns: float in user units
<b>PRHI</b>	Get the High Pressure measurement.
	Returns: float in user units
<b>PRHIMIN</b>	Get the High Pressure Minimum measurement.
	Returns: float in user units
<b>PRHIMAX</b>	Get the High Pressure Maximum measurement.
	Returns: float in user units
<b>PRHIAVG</b>	Get the High Pressure Average measurement.
	Returns: float in user units
<b>PRBA</b>	Get the Barometric Pressure measurement.
	Returns: float in user units

<b>OXY</b>	Get the Oxygen measurement in airway.
Returns:	float in percent
<b>OXYMIN</b>	Get the Oxygen Minimum measurement in airway.
Returns:	float in percent
<b>OXYMAX</b>	Get the Oxygen Maximum measurement in airway.
Returns:	float in percent
<b>OXYAVG</b>	Get the Oxygen Average measurement in airway.
Returns:	float in percent
<b>TEMP</b>	Get the Temperature measurement in airway.
Returns:	float in user units
<b>HUM</b>	Get the Humidity measurement in airway.
Returns:	float in percent
<b>BRP</b>	Get all Breath Parameter measurements.
Returns:	Breath parameters, comma separated, in 4 lines, in the following order: 1 <sup>st</sup> line: times and rate: Ti, Te, TiH, TeH, I:E, BPM 2 <sup>nd</sup> line: flows and volumes: PIF, PEF, Vti, Vte, MV 3 <sup>rd</sup> line: pressures: PIP, IPP, MAP, PEEP 4 <sup>th</sup> line: other: O2, CMPL

## ANESTHESIA COMMANDS

These commands should be sent to the VT900A to interface with Vapor for Anesthesia measurement. These commands are only legal for VT900A model when Measurement Mode is set to Anesthesia with: **MEAS=AN**.

Commands beyond **ANQCONN** only legal if Vapor connected.

<b>ANQCONN</b>	Query Vapor connection.
Returns:	<b>TRUE</b> if connected, else <b>FALSE</b> .
<b>ANPWR=<i>power</i></b>	Set Vapor power.
<i>power</i>	<b>TRUE</b> for On, <b>FALSE</b> for Off.
<b>ANQPWR</b>	Query Vapor power.
Returns:	<b>TRUE</b> if on, else <b>FALSE</b> .
<b>ANQST</b>	Query Vapor status.

Returns status, one of:	<b>OFF</b>	Powered off
	<b>STST</b>	Self-Test
	<b>STBY</b>	Standby
	<b>STUP</b>	Startup
	<b>WARMACC</b>	Warmup Accuracy
	<b>FULLACC</b>	Full Accuracy
	<b>SLEEP</b>	Sleeping

<b>ANM</b>	Get the measurement data.
Legality:	Only legal when Status = <b>LOWACC</b> or <b>FULLACC</b> .
Returns:	All data separated by commas, values are in percent with % sign: Primary Agent Name [ <b>NONE</b> , <b>HAL</b> , <b>ENF</b> , <b>ISO</b> , <b>SEV</b> , <b>DES</b> ], Primary Agent Value , Secondary Agent Name [ <b>NONE</b> , <b>HAL</b> , <b>ENF</b> , <b>ISO</b> , <b>SEV</b> , <b>DES</b> ], Secondary Agent Value , <b>N2O</b> , Nitrous Oxide Value , <b>CO2</b> , Carbon Dioxide Value example: " <b>HAL</b> ,12.3 % , <b>ENF</b> ,21.6 % , <b>N2O</b> ,45.6 % , <b>CO2</b> ,3.2 %"

<b>ANSL</b>	Put Vapor to sleep.
Legality:	Only legal when Status = <b>LOWACC</b> or <b>FULLACC</b> .

<b>ANWK</b>	Wake up Vapor.
Legality:	Only legal when Status = <b>SLEEP</b> .

<b>ANLOOP</b>	Perform a loop test on the VT Vapor interface circuit with a loopback plug.
Returns:	<b>TRUE</b> if test succeeds, Vapor power must be on, else <b>FALSE</b> .

<b>ANQER</b>	Query Vapor error.
Returns:	Vapor error number, or 0 if no error.