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FLUKE Biomedical VT900A/VT650 User Communication Interface

Version 8.0 01/21/2022

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. 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	CR	0D
Line Feed	LF	0A
Space	SP	20
Backspace	BS	08
Escape	ESC	1B

- 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
LOCAL	Local	Local control
RMAIN	Main	Main Remote control mode

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

COMMAND SPECIFICATIONS

Unless specified otherwise:

- Commands return *.

GENERAL COMMANDS

IDENT	Get the instrument identification and firmware version.
Legal modes:	All modes
Returns:	A string including model number VERSION and version number, including build number, separated by spaces without commas: ex. "VT900 VERSION 1.00.06"

SN	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.

LOCAL	Go to Local control mode.
Legal modes:	All modes
Returns:	LOCAL

REMOTE	Go to Remote control RMAIN mode.
Legal modes:	All modes
Returns:	RMAIN

QMODE	Query the mode.
Legal modes:	All modes
Returns:	The Remote mode mnemonic per table above.

RESET	Resets the product as it was turned off and back on.
Legal modes:	Remote mode

CALINFO	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

DATE= <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

TIME= <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

DF= <i>dateformat</i>	Set the Date Format, stored in non-volatile memory.
<i>dateformat</i>	MDY MM/DD/YYYY DMY DD/MM/YYYY

QDF	Query the Date Format.
Returns:	The Date Format as above in DF .

TF= <i>timeformat</i>	Set the Time Format, stored in non-volatile memory.
<i>timeformat</i>	24 24 hour format 12 12 hour format with AM/PM

QTF	Query the Time Format.
Returns:	The Time Format as above in TF .

QDT	Query the Date and Time.
Returns:	Date,Time formatted per the user selected formats

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

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

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

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

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

QBDM	Query the Breath Detection type.
Returns:	Breath Detection

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

QBDS	Query the Breath Detection Trigger Source.
Returns:	Trigger Source

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

QBDP	Query the Breath Detection Patient.
Returns:	Patient

BDTH= <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: IN or EX .
<i>threshold</i>	Detection Threshold in lpm: float

QBDTH= <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

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

QGAS	Query the Gas.
Returns:	Gas

MEASUREMENT COMMANDS

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

QMEAS	Query the measurement mode
Returns:	The measurement mode, per above.

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

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

OXY	Get the Oxygen measurement in airway.
Returns:	float in percent

OXYMIN	Get the Oxygen Minimum measurement in airway.
Returns:	float in percent

OXYMAX	Get the Oxygen Maximum measurement in airway.
Returns:	float in percent

OXYAVG	Get the Oxygen Average measurement in airway.
Returns:	float in percent

TEMP	Get the Temperature measurement in airway.
Returns:	float in user units

HUM	Get the Humidity measurement in airway.
Returns:	float in percent

BRP	Get all Breath Parameter measurements.
Returns:	Breath parameters, comma separated, in 4 lines, in the following order: 1 st line: times and rate: Ti, Te, TiH, TeH, I:E, BPM 2 nd line: flows and volumes: PIF, PEF, Vti, Vte, MV 3 rd line: pressures: PIP, IPP, MAP, PEEP 4 th 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.

ANQCONN	Query Vapor connection.
Returns:	TRUE if connected, else FALSE .

ANPWR=power	Set Vapor power.
power	TRUE for On, FALSE for Off.

ANQPWR	Query Vapor power.
Returns:	TRUE if on, else FALSE .

ANQST	Query Vapor status.
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Returns status, one of:	OFF	Powered off
	STST	Self-Test
	STBY	Standby
	STUP	Startup
	WARMACC	Warmup Accuracy
	FULLACC	Full Accuracy
	SLEEP	Sleeping

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

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

ANWK	Wake up Vapor.
Legality:	Only legal when Status = SLEEP .

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

ANQER	Query Vapor error.
Returns:	Vapor error number, or 0 if no error.

STREAMING COMMANDS

These commands can be used to select parameters to stream and to set the streaming frequency. These must be sent while in the valid measurement mode ("MEAS=xxx") as listed above in the "MEASUREMENT COMMANDS" section.

All 3 main airway parameters may be streamed together (flow, pressure, and volume). Setting "**TRUE**" turns on streaming for the parameter, "**FALSE**" turns it off. Note that the VT device will stream parameters in the order in which the **TRUE/FALSE** streaming command was sent.

At 115200 baud rate, 1 parameter may be streamed at a rate between 20 and 200 Hz. As many as 3 airway parameters may be streamed at a rate between 20 and 100 Hz. To stream >1 parameter between 100 and 200 Hz, the UARTFAST command must be used (outlined below).

UARTFAST=rate	Used to change the baud rate from 115.2K to 921.6K to stream more than one parameter at frequencies greater than 100 Hz.
<i>rate</i>	<p>TRUE for 921.6K baud rate, FALSE for 115.2K baud rate</p> <p>Requests the product speed up the serial/UART interface to 921.6k baud if TRUE. The setting is unchanged until the unit is reset or restarted.</p> <p>When this command is set to TRUE, the VT device will send the character "A" at 5Hz over the USB connection. In the communication terminal, change the baud rate setting from 115200 to 921600 and verify "A" is being received repeatedly. Send "A" back to confirm the PC and product are in sync. The device will return with "*" to acknowledge the faster rate has been set.</p> <p>The "A" sync will run for ~22 seconds before timing out. If timeout is reached, the VT device will resume normal communication at 115.2k baud rate.</p> <p>Note: No CR or LF is required for the "A" sync.</p>

MFLAW=flow	Turn Airway Flow streaming on and off.
<i>flow</i>	TRUE for On, FALSE for Off.
Legality:	Only legal after MEAS=AW has successfully been sent.

MPRAW=pressure	Turn Airway Pressure streaming on and off.
<i>pressure</i>	TRUE for On, FALSE for Off.
Legality:	Only legal after MEAS=AW has successfully been sent.

MVOL=volume	Turn Airway Volume streaming on and off.
<i>volume</i>	TRUE for On, FALSE for Off.
Legality:	Only legal after MEAS=AW has successfully been sent.

MFLULO=ulflow	Turn Ultra Low Flow streaming on and off.
<i>ulflow</i>	TRUE for On, FALSE for Off.
Legality:	Only legal on VT900A after MEAS=FLULO has successfully been sent.

MPRLO= <i>lowpress</i>	Turn Low Pressure streaming on and off.
<i>lowpress</i>	TRUE for On, FALSE for Off.
Legality:	Only legal after MEAS=PRLO has successfully been sent.

MPRULO= <i>ulpress</i>	Turn Ultra Low Pressure streaming on and off.
<i>ulpress</i>	TRUE for On, FALSE for Off.
Legality:	Only legal on VT900A after MEAS=PRULO has successfully been sent.

MPRHI= <i>highpress</i>	Turn High Pressure streaming on and off.
<i>highpress</i>	TRUE for On, FALSE for Off.
Legality:	Only legal after MEAS=PRHI has successfully been sent.

MFREQ= <i>frequency</i>	Set the streaming frequency for parameter(s) set to stream using the above commands. The default setting is 50 Hz.
<i>frequency</i>	20 to 200 Note: Streaming multiple parameters above 100 Hz streaming rate requires the baud rate to be adjusted, see “ UARTFAST ” command above.
Legality:	Only in a legal measurement mode after a parameter has been set to “ TRUE ” for streaming.

STREAM	Initiates streaming as defined with above commands
Legality:	Only legal in valid measurement mode after parameter is set to stream and streaming frequency has been set.
Returns:	Measurements of parameter selected at the set frequency. Example (with 3 airway parameters selected): >STREAM <*< 0.01, 0.26, 0.1, < 0.01, 0.25, 0.1, < 0.03, 0.25, 0.1, Returns “!02 ILLEGAL COMMAND” if not in a valid measurement mode or no parameters have been selected to stream.

STREAMIDX	Initiates streaming with incrementing index appended, as defined with above commands
Legality:	Only legal in valid measurement mode after parameter is set to stream and streaming frequency has been set.
Returns:	Measurements of parameter selected at the set frequency, with an incrementing index appended to each line. The index is a 32-bit unsigned integer. The VT product does not reset the index between repeated streams, only upon power cycle. Example (with 3 airway parameters selected): >STREAMIDX <*<-0.01, 0.10,-1.9,428 < 0.01, 0.10,-1.9,429 Returns “!02 ILLEGAL COMMAND” if not in a valid measurement mode or no parameters have been selected to stream.