



Vates Colorimeter Operating Manual.





All rights reserved. No part of this document may be reproduced, stored in a database or retrieval system, or published in any form or way, electronically, mechanically, by print, photo print, microfilm or any other means without prior written permission from the publisher.

All correspondence regarding copyrights :

Admesy B.V.

Beneluxstraat 7

6014CC Ittervoort

The Netherlands

Tel : +31 (0) 475 600232

Fax : +31 (0) 475 600316

URL : [Http://www.admesy.nl](http://www.admesy.nl)

Contents



1	About this manual	4
2	General introduction	5
	2.1 Colorimeter highlights	5
	2.2 Standards	5
3	Electrical interfaces	6
	3.1 USB interface	6
	3.2 Ethernet 10/100 BASE-T	6
	3.3 RS232 interface	6
	3.3.1 Triggering	7
	3.4 Power connections	8
4	Communications protocol	9
	4.1 USB	9
	4.2 Ethernet / RS232	9
5	Device drivers	10
	5.1 USB	10
	5.2 Ethernet	10
	5.3 RS232	10
6	Command set description	11
	6.1 Command structure	12
	6.2 System commands	13
	6.3 Configuration commands	14
	6.4 Measurement commands	16
	6.5 User EEPROM commands	17
	6.6 Returned results	19
7	Measurement example	20
8	Vates formulas.	21
	8.1 XYZ to Yxy conversion	21
	8.2 XYZ to Lab conversion	21
	8.3 Delta E calculation	21
9	Operating modes	22
10	Typical spectral sensitivity	23
11	Mechanical drawing (mounting holes)	24

1 About this manual

The material in this manual is subject to change. No rights can be derived from the content of this manual.

The content of this manual is valid for firmware version higher or equal than 1.0.0.

In this manual, the following symbols are used to draw your attention.

-  : Practical tip
-  : Note



2 General introduction

The Vates colorimeter offers a unique combination of high speed, accurate colour and gloss measurement. Our products are developed with the highest care for usability and robustness of both hardware and software.

2.1 Colorimeter highlights

45°/0° Colour measurement (specular excluded) in XYZ, xy, Luv, LCH and CIE L*a*b*, dE.

20°, 45° and 60° gloss measurements (Can also measure colour).

Other colour spaces available via a supplied colour library.

Stabilised light source.

High speed colour and gloss measurements at 4K samples per second.

Non contact measurement.

USB/RS232 and Ethernet communication interfaces.

2.2 Standards

The colorimeter is compliant to the USBTMC standard and can be used in combination with external provided USBTMC compliant drivers.

Currently it has been tested on Windows, Linux and Apple OSX using NI VISA (<http://www.ni.com/visa>)

On Linux our USBTMC devices work now directly with a kernel $\geq 2.6.28$. This is Admesy's preferred driver structure for Linux. Alternatively there's an open-source driver provided by Agilent (http://www.home.agilent.com/upload/cmc_upload/All/usbtmc.html) on Linux (i686, x86_64 and ARM).

For installation instructions on the Agilent USBTMC driver, refer to the Linux Brontes how-to on the Admesy web site (http://www.admesy.nl/products/docs/Admesy_Brontes_Linux_howto.pdf).

3 Electrical interfaces



3.1 USB interface

The USB B connector is used to connect the Vates Colorimeter to a PC/Laptop.

The Vates Colorimeter complies to the USBTMC class protocol and can therefore be used directly with third party provided VISA compliant libraries like NI-VISA .

3.2 Ethernet 10/100 BASE-T

The Ethernet connector is used to connect the Vates Colorimeter to any device that supports Ethernet.

The Vates Colorimeter complies to the IEEE 802.3 standard and can therefore be used directly with third party provided VISA compliant libraries like NI-VISA.

Default IP: 192.168.0.50

Default GW: 192.168.0.1

Default MASK: 255.255.255.0

3.3 RS232 interface

RS232 is provided to connect the Vates Colorimeter to any host that doesn't provide USB/Ethernet or for which no drivers exist. Using RS232 the high speed options of the Colorimeter are still available, only transfer of data to the host is reduced in speed. It is recommended to use USB in case the high speed sampling options are needed.

The following table shows the RS232 port configuration.

Baud rate	Data bits	Parity	Stop bits	Flow control	Termination character
115200	8	None	1	None	LF = '\n'

Table 1: RS232 port configuration

3.3.1 Triggering

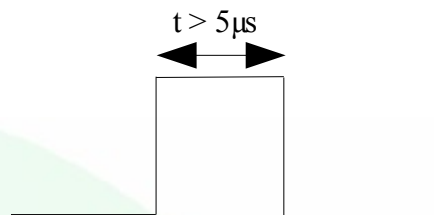
The Vates Colorimeter can be triggered when it's operating in USB, Ethernet and RS232. When triggering is enabled, the trigger output line will be set to a high level once the measurement has finished and the measurement result is available.

The trigger output will stay at a high value for a minimum of 50µs in stand alone mode. In USB and RS232 it will stay at a high level until the next command is carried out.

In USB, a trigger will carry out the previously send command and send the result to the host via an interrupt endpoint on the USB bus. The Colorimeter main application allows external triggering in the data logging tab. Supplied code examples show how to use this feature in an application.

In RS232 mode, the trigger output line is used to indicate that the measurement is ready.

The trigger input signal responds to a rising edge and should comply to the following diagram.



Trigger pulses arriving faster than the Vates Colorimeter can measure will be ignored, but it may slowdown overall performance. Trigger pulses should not arrive faster than the measurement takes to complete.

Triggering via USB currently only supports the :MEASure/:SAMPlE commands.

The output trigger is made zero before a command starts and made high after the command finishes. The minimum pulse time is 50µs for the trigger output.

Manufacturer: Tyco electronics part number:

solder

Straight Cable Plug, crimp: 1051638-1
Right-Angle Cable Plug, crimp: 1052063-1

clamp

Straight Cable Plug, Crimp: 1050721-1
Right-Angle Cable Plug, Crimp: 1051140-1



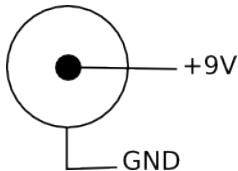
3.4 Power connections

The Vates Colorimeter should be connected to either powered USB, PoE (Power-over-Ethernet) or using a 9V DC power supply.

PoE module is designed conforming the IEEE 802.3af PoE standard. The signature and control circuit provides the PoE compatibility signature and power classification required by the Power Sourcing Equipment (PSE) before applying power to the port (Class 0: 0.44W – 12.95W).

When using RS232 the Colorimeter needs to be powered via the external adapter.

In case a 9V adapter is used, Admesy can only guarantee stable measurement results and CE compliance when using the supplied adapter.



The unit shall be powered by a 9Vdc voltage or via a standard USB PC-port , reinforced separated from Mains, with a limited energy of < 150VA and < 8A.

For power ratings, please refer to the power supply table.

	Min voltage	Typical voltage	Max voltage	Consumption
USB powered	4.75V	5.00V	5.25V	Typical 450mA (LED on)
DC-adapter powered	8.50V	9.00V	9.50V	Typical 450mA (LED on)
POE	36V	48V	57V	Typical 450mA (LED on)

Table 2: Power supply table

4 Communications protocol

4.1 USB

The Vates Colorimeter can be connected to any USB host that runs Windows, Linux or Apple OSX. The Colorimeter is a USBTMC compliant device. This makes the Vates Colorimeter directly usable in programming languages like NI's Labview and Labwindows or any other language that supports USBTMC.

The Vates Colorimeter has two interfaces build in, which require a different device driver to be used.

Vates Colorimeter (USBTMC device driver , Vendor ID : 0x23CF, Product ID 0x0E99)

When the Vates Colorimeter is connected to the host, it will start the Vates Colorimeter firmware, Green LED lights up. As soon as the firmware is idle to receive commands, the Red LED lights up and the Green LED turns off. The Vates Colorimeter is a USB 2.0 High and Full speed device.

4.2 Ethernet / RS232

Vates Colorimeter commands are equal for all interfaces.

5 Device drivers

5.1 USB

Since the Vates is an USBTMC device, drivers exists for many platforms and processor architectures.

The following table provides an overview of these platforms.

Driver name →	NI-VISA	Libusb	Native kernel driver	Agilent USBTMC
Windows XP	☑	☑	not available	untested
Windows VISTA	☑	☑	not available	untested
Windows 7	☑	untested	not available	untested
Windows CE	☑	untested	not available	unknown
Apple OSX PPC	☑	untested	not available	unknown
Apple OSX Intel	☑	☑	Kernel >= 2.6.28	☑
Linux i386 (32bit)	32bit mode	☑	Kernel >= 2.6.28	☑
Linux i386 (64bit)	untested	☑	Kernel >= 2.6.28	☑
Linux ARM	not available	☑	Kernel >= 2.6.28	☑
Linux other	system dependent	☑	Kernel >= 2.6.28	☑

Untested : Available, but not tested by Admesy.

Native kernel driver : Driver included with the operating system

Admesy supports all tested platforms but does not provide standard applications on all platforms. The above matrix is provided to show the possible platforms for software development.

5.2 Ethernet

Driver name →	NI-VISA	Native		
Windows XP	☑	☑		
Windows VISTA	☑	☑		
Windows 7	☑	☑		
Windows CE	☑	☑		
Apple OSX PPC	☑	☑		
Apple OSX Intel	☑	☑		
Linux i386 (32bit)	☑	☑		
Linux i386 (64bit)	not available	☑		
Linux ARM	not available	☑		
Linux other	☑	☑		

Untested : Available, but not tested by Admesy.

5.3 RS232

When no USB driver is available or the host system does not provide USB/Ethernet, RS232 can be used as it does not require additional drivers for the Vates Colorimeter.

6 Command set description

The functions of the Colorimeter can be best described via the following categories :

- System commands
- Configuration commands
- Measurement commands
- Trigger programming commands

The Vates Colorimeter uses SCPI like commands for control and measurement. These are ASCII based commands and follow specific rules regarding syntax. Although the Vates Colorimeter uses SCPI like commands, they deviate from the SCPI standard.



6.1 Command structure

Every command starts with a colon “:”, which identifies the root of the command tree. Each further keyword is also separated a colon. In case parameters need to be specified, the last keyword and parameters are separated by a single space character. In case more than one parameter needs to be specified, the parameters need to be separated by a comma.

The command tables show commands in long and short format. The short format is specified by upper case characters. It is allowed to use long and short format or a mixed format. Optional keywords are shown between brackets [...]. Commands are case insensitive, so it is allowed to use both or a mix of upper and lower case.

The command structure is valid for all communication interfaces of the Vates Colorimeter.

Example commands :

Command table syntax	Valid command syntax examples	Notes
:SENSe:GAIN auto	:sens:gain auto :sense:gain auto :SENS:gain auto :SENSE:GAIN auto	Sets the GAIN function of the Vates Colorimeter.
:MEASure:XYZ	:measure:XYZ :measure:xyz :meas:XYZ :MEASure:XYZ	The measure commands uses the averaging and gain options.
:SAMPlE:XYZ	:sample:XYZ :sample:xyz :samp:XYZ :SAMPlE:XYZ	With the SAMPLE command, the Vates Colorimeter will perform fast sampling to internal memory. Results are read back from memory after the measurement has been performed.

6.2 System commands

The following command can be used to control the Vates Colorimeter or read information about the system.


Table 3: System commands

Command syntax	Parameters	Purpose
.*CLS	none	Clear status
.*IDN?	none	Identification Query
.*RST	none	Reset Command
.*STB?	none	Read Status Byte Query (only USB)
.*TST	none	Self-Test Query
.*FWD?	none	Firmware date Query
.*FWT?	none	Firmware time Query
.*SYSTem:VERSion?	none	Get system version information
.*SYSTem:ERRor?	none	Retrieve the last occurred error
.*SYSTem:ERRor:NEXT?	none	Retrieve previous errors.

Table 4: System commands

The Status byte can be used to retrieve information about the status of a command or the system
Return values of the status command can be seen in the table below :

Code	description
0	System is idle
1	Data is available
2	Command processed
4	Data in buffer (should not occur)
8	An error occurred. Use “.*SYSTem:ERRor?” to get the exact error that occurred.

 The *STB? Command is only available on USB.

6.3 Configuration commands

Configuration commands are used to set parameters of the Vates Colorimeter that are used by the measurement functions.

The settings are used globally by other measurement functions. The selected white standard is used for CIEL*a*b* and Lu'v' measurements.

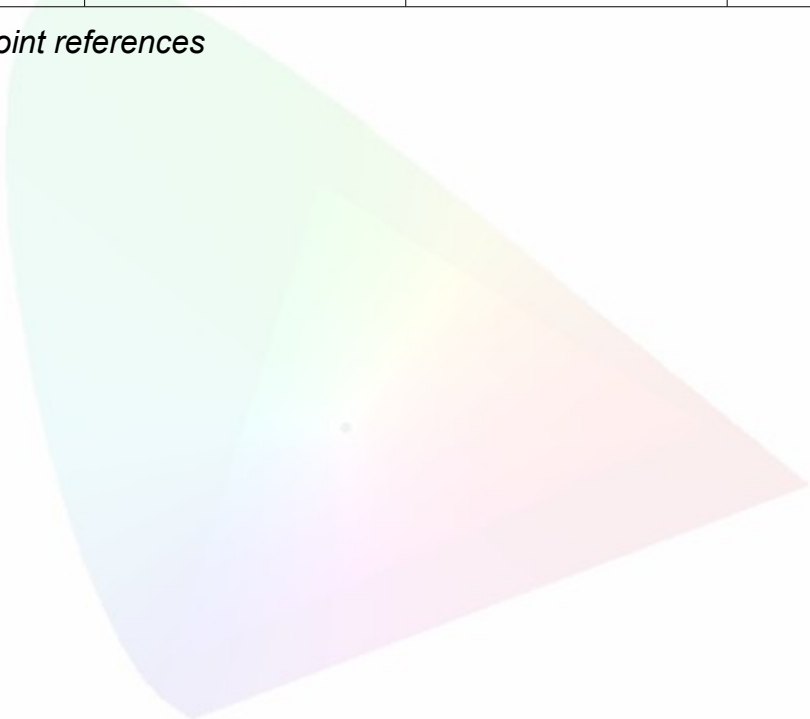
The gain setting can be varied over 8 stages. The largest gain factor is "1". Results from the Vates Colorimeter include a clip and noise indication which indicate whether the measured light is too bright (clip) or too low (noise). When clipping is detected, the resulting colour will not be correct and a higher gain value should be chosen. When noise is detected, a lower gain value should be chosen. Note that when measuring light from alternating sources, the lowest and highest peaks detected during averaging determine the clip and noise indication levels.

Table 5: Configuration commands

Command syntax	parameters	Range	Purpose
:SENSe:GAIN	Gain	0 – 8 (0 = auto)	Set Gain value
:SENSe:GAIN?	none		Returns the current setting.
:SENSe:AVERAge	Averaging (integer)	0 - 4000	Set Averaging value
:SENSe:AVERAge?	none		Query Averaging value
:SENSe:SBW	string	"small", "wide", "off"	Set calibration matrix
:SENSe:SBW?	none		Query selected calibration matrix
:SENSe:Angle	Sensor	0 – 3 (0 ⁰ , 20 ⁰ , 45 ⁰ , 60 ⁰)	Set Sensor angle to measure
:SENSe:Angle?	Sensor	0 – 3 (0 ⁰ , 20 ⁰ , 45 ⁰ , 60 ⁰)	Query Sensor angle to measure
:SENSe:LEDangle	LED	0 – 2 (20 ⁰ , 45 ⁰ , 60 ⁰)	Set LED angle to measure
:SENSe:LEDangle?	LED	0 – 2 (20 ⁰ , 45 ⁰ , 60 ⁰)	Query LED angle to measure
:SENSe:REF	None		Measures white ref. Of 45/0 angle
:CONFigure:WHITE	string	A, B, C, D40, D42, D50, D55, D65, D75, D90, D95, E, F2, F7, F11 (see table 6 for used values)	Set reference white value for Lab/Luv colour space.
:CONFigure:WHITE?	none		Query white reference
:CONFigure:WHITE:USE	Boolean	0 = no, 1 = yes	Use the stored white value for XYZ, Lab and Luv calculation and stand alone modes. This allows relative measurements
:CONFigure:WHITE:USE?	None	0 – 1	Check if the stored white value is being used.
:CONFigure:MODE	Enum (0,1,2,3)	USB,RS232, Ethernet	Configure the Vates mode
:CONFigure:MODE?	none	0 - 3	Returns the current setting.
:CONFigure:BAUDRATE	baud-rate	0 – 5 (9600 - 230400)	Set RS232 baud rate
:CONFigure:BAUDRATE?	none		Returns the current setting.
:CONFigure:TRIG	Trigger	0 – 1	Set trigger mode
:CONFigure:TRIG?	none		Returns the current setting.

Reference white	X	Y	Z
A	109.8405	100.0000	35.5583
B	99.0899	100.0000	85.3242
C	98.0708	100.0000	118.1847
D40	99.6092	100.0000	60.9432
D42	98.7058	100.0000	65.4253
D50	96.3758	100.0000	82.4087
D55	95.6559	100.0000	92.0311
D65	95.0182	100.0000	108.7485
D75	94.9524	100.0000	122.5079
D90	95.2270	100.0000	138.5514
D95	95.3315	100.0000	142.9635
E	100.0000	100.0000	100.0000
F2	99.1869	100.0000	67.3944
F7	95.0392	100.0000	108.7460
F11	100.9631	100.0000	64.3522

Table 6: White point references



6.4 Measurement commands

Table 5 shows the measurement commands of the Vates Colorimeter. Regarding colour/luminance measurement there are two kind of commands (MEASure/SAMPlE).

The MEASure commands measure the requested values using the set averaging and gain and returns the result in a single structure of three single precision floating point values. Averaging can be set using the :SENSe:AVERage configure command.

The SAMPlE commands measure the requested parameters using a sample count and delay time and return an array of data. The array contains single floating point data. Each sample count equals one complete structure, for example one XYZ structure of data.

Command syntax	Parameters	Range	Purpose
:MEASure:XYZ	none		Measure XYZ
:MEASure:Lab	none		Measure CIE L a b colour point (needs reference to be set)
:MEASure:LEDXYZ	none		Measure LEDXYZ
:SAMPlE:XYZ	Samples, delay	0-4000, 0 - 255	Sample XYZ
:SAMPlE:Lab	Samples, delay	0-4000, 0 - 255	Sample Lab
:MEASure:TEMPerature	Angle	0-4 (0°/20°/45°/60°)	Measure temperature of the Sensor.
:MEASure:LEDTEMPerature	Angle	0-2 (20°/45°/60°)	Measure temperature LED.
:MEASure:Gloss	Angle	0-2 (20°/45°/60°)	Measure Gloss units

Table 7: Measurement commands

Notes :

- 1) The delay time is set in sample times, meaning a delay of one will skip one sample.
- 2) When using high sample amount make sure timeout values in the application software are set accordingly.

6.5 User EEPROM commands

The following commands can be used to store values in the user EEPROM space. Note that they are not stored until a :EEPROM:WRITE command is given. It is advised to reboot the Vates after writing new values to the EEPROM.

Command syntax	Parameters	Range	Purpose
:EEPROM:STARTUP:READ	none		Copies start up conditions from EEPROM to internal variables. Values can then be read using
:EEPROM:STARTUP:WRITE	Vates mode, amp factor	0 – 4 , 0 -8	Copies internal variables to EEPROM and sets mode and amp factor.
:EEPROM:USERREF:READ	None		Copies the white references, gloss references and gloss standards of all sensors to internal variables.
:EEPROM:USERREF:WRITE			Copies internal white references, gloss references and gloss standards of all sensors to the EEPROM.
:EEPROM:WHITEREF:READ	LED, Angle, White	0 – 2, 0-3, 0 = X, 1 = Y, 2 = Z	Retrieves the EEPROM white references values
:EEPROM:WHITEREF:WRITE	LED, Angle, White	0 – 2, 0-3, 0 = X, 1 = Y, 2 = Z	Sets the white references values
:EEPROM:GLOSSSTANDARD:READ	Angle, gloss	0 – 3 0 = X, 1 = Y, 2 = Z	Retrieves the EEPROM gloss standards values
:EEPROM:GLOSSSTANDARD:WRITE	Angle, gloss	0 – 3 0 = X, 1 = Y, 2 = Z	Sets the gloss standards values
:EEPROM:GLOSSREF:READ	Angle, gloss	0 – 3 0 = X, 1 = Y, 2 = Z	Retrieves the EEPROM gloss reference values
:EEPROM:GLOSSREF:WRITE	Angle, gloss	0 – 3 0 = X, 1 = Y, 2 = Z	Sets the gloss reference values
:FACTEEPROM:REF:READ	None		Copies the white references, gloss references and gloss standards of all sensors to internal variables.
:FACTEEPROM:WHITEREF:READ	LED, Angle, White	0 – 2, 0-3, 0 = X, 1 = Y, 2 = Z	Retrieves the EEPROM white references values
:FACTEEPROM:GLOSSSTANDARD:READ	Angle, gloss	0 – 3 0 = X, 1 = Y, 2 = Z	Retrieves the EEPROM gloss standards values
:FACTEEPROM:GLOSSREF:READ	Angle, gloss	0 – 3 0 = X, 1 = Y, 2 = Z	Retrieves the EEPROM gloss reference values
:EEPROM:SENSE:GAIN	Gain	0 – 8 (0 = auto)	Set the default gain level
:EEPROM:SENSE:GAIN?	None		Retrieves the EEPROM Gain value
:EEPROM:SENSE:AVERAGE	Average	0 – 4000	Set the default number of samples to average
:EEPROM:SENSE:AVERAGE?	None		Retrieves the EEPROM average value

Command syntax	Parameters	Range	Purpose
:EEPROM:SENSe:SBW	:SENSe:SBW	string	“small”, “wide”, “off”
:EEPROM:SENSe:SBW?	:SENSe:SBW?	none	
:EEPROM:CONFigure:MODE	Enum (0,1,2,3)	USB,RS232, Ethernet	Configure the Vates mode
:EEPROM:CONFigure:MODE?	None		Retrieves the default operating mode.
:EEPROM:CONFigure:BAUDRATE	baud-rate	0 – 5 (9600 - 230400)	Set the default RS232 baud rate of the device.
:EEPROM:CONFigure:BAUDRATE?	none		Retrieves the default value for RS232 baud rate
:EEPROM:CONFigure:TRIG	Trigger	0 – 1	Set the external trigger mode (on/off)
:EEPROM:CONFigure:TRIG?	none		Retrieves the set values for the external trigger mode
:EEPROM:USE:WHITE	Use white	0 = No , 1 = Yes	Use the stored white value at start-up for XYZ, Lab and Luv calculation.
:EEPROM:USE:WHITE?	None		Retrieves if the stored white value is being used at start-up.
:EEPROM:CONFigure:WHITE	String	A, B, C, D40, D42, D50, D55, D65, D75, D90, D95, E, F2, F7, F11 (see table 6 for used values)	Set the default white point reference. This is only used for internal colour space conversions
:EEPROM:CONFigure:WHITE?	None		Retrieves the set default white reference
:EEPROM:CONFigure:IP	string	x.x.x.x	Set the IP
:EEPROM:CONFigure:IP?	none		Query the IP
:EEPROM:CONFigure:GW	String	x.x.x.x	Set the gateway
:EEPROM:CONFigure:GW?	none		Query the gateway
:EEPROM:CONFigure:MASK	String	x.x.x.x	Set the network Mask
:EEPROM:CONFigure:MASK?	none		Query the network Mask
:EEPROM:CONFigure:MAC?	none		Query the MAC address

6.6 Returned results

:MEASure command return their result in ASCII formatted floating point as shown below :

(X,Y,Z,clip,noise) → %f,%f,%f,%d,%d\n
 (X,Y,Z can be substituted for L,a,b or other colour spaces).

Exceptions to the above are the :MEASure:TEMPerature , :MEAS:Y and :SAMPLe:Y commands.

:MEASure:TEMPerature → (Sensor temperature) → %f\n
 :MEASure:LEDTEMPerature → (LED PCB temperature) → %f\n

:SAMPLe:Y command returns the result in “unsigned int 16” format. (Y in counts)

:SAMPLe:XYZ, :SAMPLe:Yxy, :SAMPLe:Yuv, :SAMPLe:Lab and :SAMPLe:Luv commands return their result in “32 bit single precision floating-point” format when operating in USB Mode.

The first three values indicate the delta time between samples and the clip and noise values.

:Sample:XYZ		:Sample:Y	
dt	%f\n	dt	%u\n
clip	%f\n	clip	%u\n
noise	%f\n	noise	%u\n
Value 1 (X)	%f\n	Value 1	%u\n
Value 1 (Y)	%f\n	Value 2	%u\n
Value 1 (Z)	%f\n	Value...	%u\n
Value n (n-1) (Y)	%f\n	Value (n-1)	%u\n
Value n (n) (Z)	%f\n	Value n	%u\n

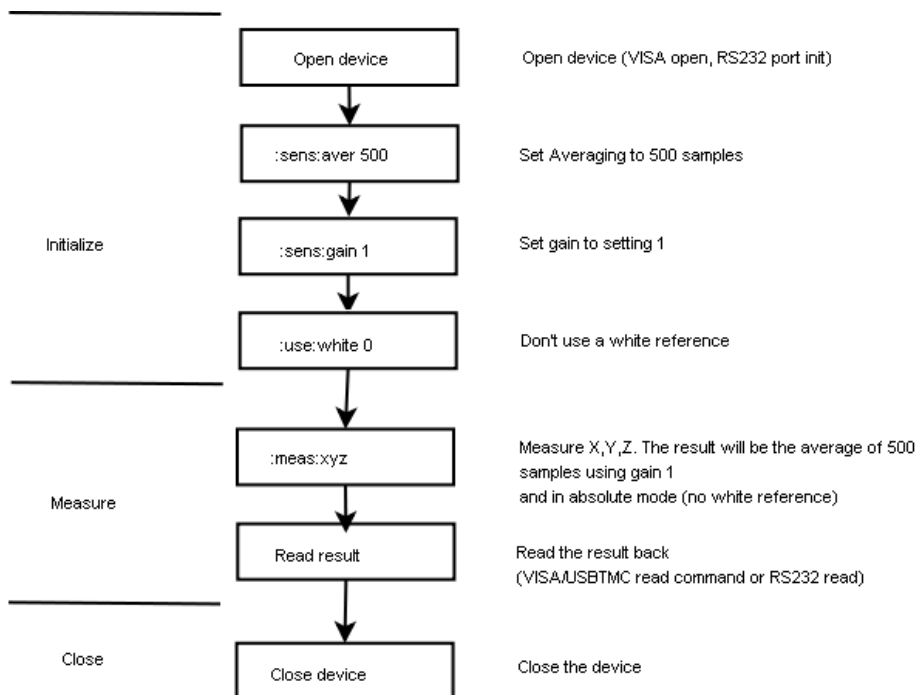
☞ :When operating in RS232 mode the data of the :SAMPLe commands will be returned in ASCII format. All data is separated using a TAB (\t) and the last value is terminated using an end of line constant (\n).

7 Measurement example

The Vates uses default settings when the device is started. These can be programmed by the end user so that the device starts with the same settings each time it is connected.

Although it's possible to program all Vates devices in a production environment to start with equal settings, it is recommended to set the averaging, gain and SBW values in the initialization routine of the host software.

A typical measurement example to measure XYZ would include the following commands :



8 Vates formulas.

The Vates Colorimeter uses an XYZ sensor, meaning that other colour spaces are being converted from XYZ. The following sections show the mathematical conversions that are used by the Vates Colorimeter to perform conversion from XYZ to other colour spaces.

8.1 XYZ to Yxy conversion

$$x = \frac{X}{(X+Y+Z)}$$

$$y = \frac{Y}{(X+Y+Z)}$$

$$z = \frac{Z}{(X+Y+Z)} = 1 - x - y$$

8.2 XYZ to Lab conversion

notes :

- 1) The Vates Colorimeter measures in CIEL*a*b* colour space.
- 2) For Lab measurements a white reference needs to be set. By default the Vates is set to D50.

$$e = 216/24389, k = 24389/27$$

$$x_r = X / \text{WhiteRef}X, \quad y_r = Y / \text{WhiteRef}Y, \quad z_r = Z / \text{WhiteRef}Z$$

$$f_x = \begin{cases} \sqrt[3]{x_r} & x_r > e \\ \frac{(kx_r + 16)}{116} & x_r \leq e \end{cases} \quad f_y = \begin{cases} \sqrt[3]{y_r} & y_r > e \\ \frac{(ky_r + 16)}{116} & y_r \leq e \end{cases} \quad f_z = \begin{cases} \sqrt[3]{z_r} & z_r > e \\ \frac{(kz_r + 16)}{116} & z_r \leq e \end{cases}$$

$$L = (116f_x) - 16$$

$$a = 500(f_x - f_y)$$

$$b = 200(f_y - f_z)$$

8.3 Delta E calculation

Delta E within the Vates is calculated according to the CIE1976 standard. Other formats are available through PC software.

$$\Delta E = \sqrt{(L_1 - L_2)^2 + (a_1 - a_2)^2 + (b_1 - b_2)^2}$$

Where $L_1 a_1 b_1$ is the target colour and $L_2 a_2 b_2$ is the new measured colour to compare to the target.

Note that for Lab measurements a reference white needs to be chosen. Both the target colour and new measured colour should be measured using the same chosen white point.

9 Operating modes

Operation is possible as slave device for a host PC or as stand alone device. In slave mode the Vates colorimeter listens to commands send by the host PC as mentioned in the previous paragraphs.

The modes of the Vates are :

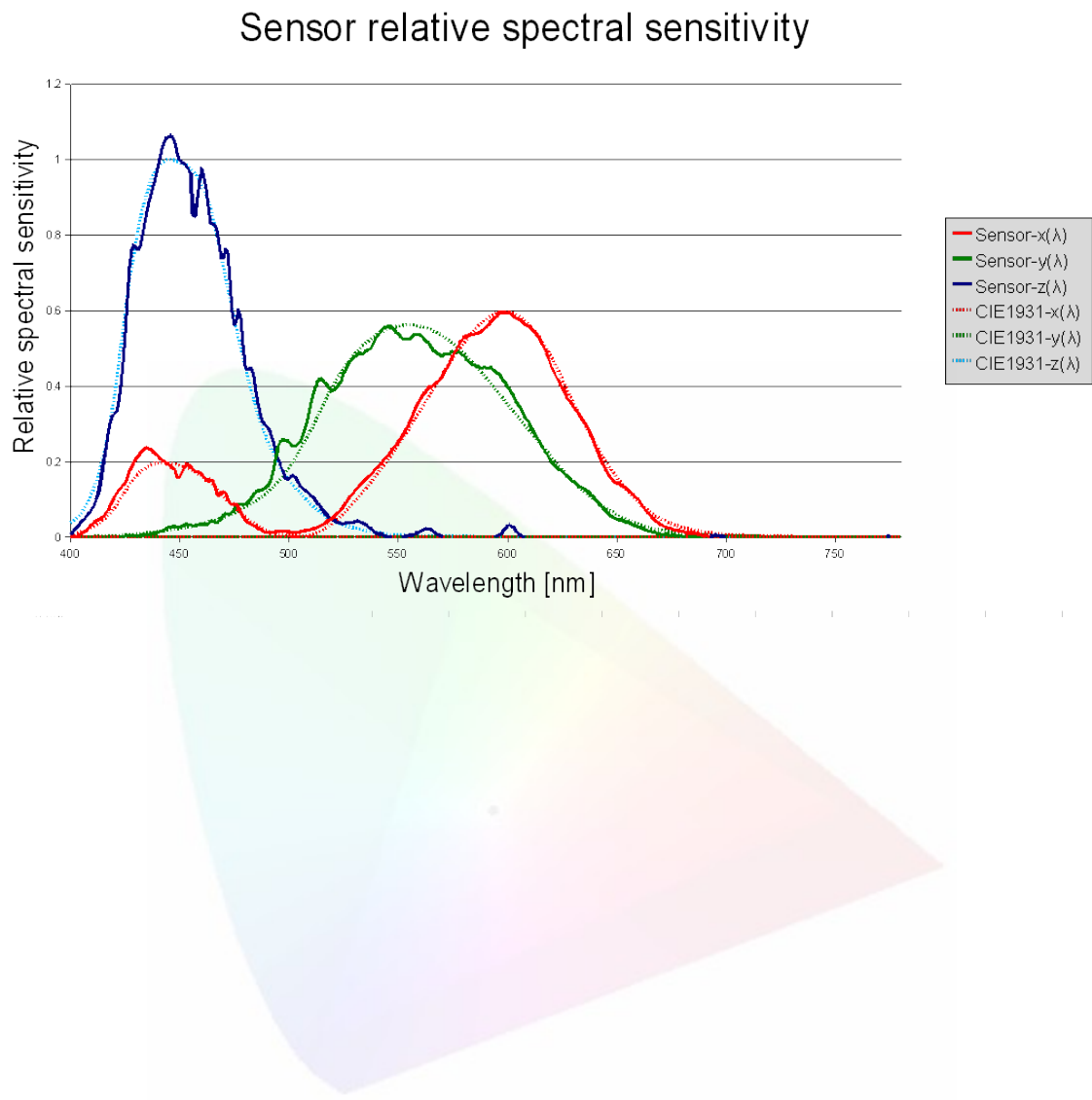
- 1) USB mode
- 2) RS232 mode
- 3) Ethernet

In all modes, USB is still active but when only USB is used, it is recommended to set it to USB mode so that the Vates responds in the fastest possible way to commands.

The operating mode must be selected via the Vates PC application. All target values can be measured using the configuration utility or input manually.



10 Typical spectral sensitivity



11 Mechanical drawing (mounting holes)

