



WVCM-4 COLORIMETER

Operating Manual



powered by Admesy

Contents

1	Introduction.....	6
1.1	WVCM-4	6
1.2	WVCM-4 highlights.....	6
1.3	Standards.....	6
2	Interfaces.....	7
2.1	USB-interface.....	7
2.2	RS232 interface	7
2.3	Trigger in/out.....	8
2.4	Power connections	8
3	Communications protocol	9
3.1	USB	9
3.2	RS232.....	9
4	Device drivers	10
4.1	USB	10
4.2	RS232.....	10
5	Command set overview.....	11
5.1	Command set categories.....	11
5.2	System commands	11
5.3	Configuration commands	12
5.4	Measurement commands	13
5.5	User EEPROM configuration commands	14
5.6	User calibration commands.....	15
6	Detailed command list.....	16
6.1	System commands	16
6.1.1	:*IDN?	16
6.1.2	:*RST	16
6.1.3	:*FWD?	16
6.1.4	:SYSTem:VERSion?	16
6.1.5	:BOOT:REBOOT	16
6.2	Configuration commands	17
6.2.1	:SENSe:INT	17
6.2.2	:SENSe:INT?	17
6.2.3	:SENSe:REALINT?	17
6.2.4	:SENSe:AVERage	17

6.2.5	:SENSe:AVERage?	17
6.2.6	:SENSe:GAIN	18
6.2.7	:SENSe:GAIN?	18
6.2.8	:SENSe:SBW	18
6.2.9	:SENSe:SBW?	18
6.2.10	:SENSe:AUTORANGE	18
6.2.11	:SENSe:AUTORANGE?	18
6.2.12	:SENSe:AUTOMODE	19
6.2.13	:SENSe:AUTOMODE?	19
6.2.14	:SENSe:AUTOPARMS	19
6.2.15	:SENSe:AUTOPARMS?	19
6.2.16	:SENSe:ARPARMS	20
6.2.17	:SENSe:ARPARMS?	20
6.2.18	:SENSe:SHUTter	20
6.2.19	:SENSe:SHUTter?	20
6.2.20	:SENSe:WHITE	20
6.2.21	:SENSe:WHITE?	21
6.2.22	:SENSe:FREQ	21
6.2.23	:SENSe:FREQ?	21
6.2.24	:SENSe:ARFREQ	21
6.2.25	:SENSe:ARFREQ?	21
6.2.26	:SENSe:SATURATION?	22
6.2.27	:SENSe:DARKMODE	22
6.2.28	:SENSe:TRIG	22
6.2.29	:SENSe:TRIG?	22
6.2.30	:SENSe:FPGATRIG	23
6.2.31	:SENSe:FPGATRIG?	23
6.2.32	:SENSe:TRIGDELAY	23
6.2.33	:SENSe:TRIGDELAY?	23
6.2.34	:SENSe:RETURNACK	23
6.2.35	:SENSe:POINter	24
6.2.36	:SENSe:UHLAVER	24
6.2.37	:SENSe:UHLAVER?	24
6.2.38	:SENSe:UHLAUTORANGE	24
6.2.39	:SENSe:UHLAUTORANGE?	24
6.3	Measurement commands	25

6.3.1	:MEASure:TEMPerature	25
6.3.2	:MEASure:XYZ	25
6.3.3	:MEASure:YXY	25
6.3.4	:MEASure:YUV	25
6.3.5	:MEASure:CCT	25
6.3.6	:MEASure:DWL	26
6.3.7	:MEASure:Y	26
6.3.8	:MEASure:DARK	26
6.3.9	:MEASure:FASTDARK	27
6.3.10	:MEASure:FREQuency	28
6.3.11	:MEASure:FLICKer	28
6.3.12	:MEASure:SEQY	29
6.3.13	:MEASure:SEQXYZ	29
6.3.14	:MEASure:DTCAL	29
6.3.15	:MEASure:ARPARMS?	29
6.3.16	:SAMPLE:Y	30
6.3.17	:SAMPLE:FAST:Y	31
6.3.18	:SAMPLE:XYZ	32
6.3.19	:MEASure:ALL	32
6.3.20	:MEASure:VSYNCFREQuency	33
6.3.21	:RESET:VSYNCFREQuency	33
6.3.22	:MEASure:UHLXYZ	33
6.3.23	:SAMPLE:NORMAL:XYZ	34
6.3.24	:SAMPLE:FAST:XYZ	34
6.3.25	:SAMPLE:INTTIME:XYZ	35
6.4	User EEPROM configuration commands	36
6.4.1	:EEPROM:STARTUP:WRITE	36
6.4.2	:EEPROM:STARTUP:READ	37
6.4.3	:EEPROM:CONFigure:BAUDrate	37
6.4.4	:EEPROM:CONFigure:BAUDrate?	37
6.4.5	:EEPROM:CONFigure:TRIG	37
6.4.6	:EEPROM:CONFigure:TRIG?	38
6.4.7	:EEPROM:CONFigure:TRIGDELAY	38
6.4.8	:EEPROM:CONFigure:TRIGDELAY?	38
6.4.9	:EEPROM:CONFigure:LPFREQ	38
6.4.10	:EEPROM:CONFigure:LPFREQ?	38

6.4.11	:EEPROM:CONFigure:AVG	38
6.4.12	:EEPROM:CONFigure:AVG?	38
6.4.13	:EEPROM:CONFigure:WHITE	39
6.4.14	:EEPROM:CONFigure:WHITE?	39
6.4.15	:EEPROM:CONFigure:AUTO:FREQ	39
6.4.16	:EEPROM:CONFigure:AUTO:FREQ?	39
6.4.17	:EEPROM:CONFigure:AUTO:FRAMES	39
6.4.18	:EEPROM:CONFigure:AUTO:FRAMES?	39
6.4.19	:EEPROM:CONFigure:AUTO:Orange	39
6.4.20	:EEPROM:CONFigure:AUTO:Orange?	40
6.4.21	:EEPROM:CONFigure:AUTO:ADJMIN	40
6.4.22	:EEPROM:CONFigure:AUTO:ADJMIN?	40
6.4.23	:EEPROM:CONFigure:AUTO:MAXINT	40
6.4.24	:EEPROM:CONFigure:AUTO:MAXINT?	40
6.4.25	:EEPROM:CONFigure:AUTO:MODE	41
6.4.26	:EEPROM:CONFigure:AUTO:MODE?	41
6.4.27	:EEPROM:CONFigure:INT	41
6.4.28	:EEPROM:CONFigure:INT?	41
6.4.29	:EEPROM:CONFigure:GAIN	41
6.4.30	:EEPROM:CONFigure:GAIN?	41
6.4.31	:EEPROM:CONFigure:SBW	42
6.4.32	:EEPROM:CONFigure:SBW?	42
6.4.33	:EEPROM:READ:SN	42
6.4.34	:EEPROM:WRITE:ID	42
6.4.35	:EEPROM:READ:ID	42
6.5	User calibration commands	43
6.5.1	:EEPROM:READ:USERCAL	43
6.5.2	:EEPROM:WRITE:USERCAL	43
6.5.3	:EEPROM:SBW:WRITE	44
6.5.4	:EEPROM:SBW:READ	45
6.5.5	:EEPROM:READ:SBWNAME	45
6.5.6	:CALibrate:INLINEDARK	46
6.5.7	:CALibrate:REFRed	46
6.5.8	:CALibrate:REFGreen	46
6.5.9	:CALibrate:REFBlue	47
6.5.10	:CALibrate:REFWhite	47

6.5.11	:CALibrate:ADIRed	47
6.5.12	:CALibrate:ADIGreen	47
6.5.13	:CALibrate:ADIBlue	47
6.5.14	:CALibrate:ADIWhite	48
6.5.15	:CALCulate:MATRix	48
6.5.16	:EEPROM:WRITE:MATRix	48
7	External triggering	49
7.1	Normal Trigger mode	49
8	3x3 matrix – how to calculate	50
9	Coding examples	51
9.1	Configuration and measurement examples	51
9.2	User eeprom configuration example	51
9.3	Calc and calibrate matrix example	52
10	Auto-range function	53
10.1	Introduction	53
10.2	How autoranging works	53
10.3	Auto-range measurement parameters	54
10.4	Auto-range measurement time	54
10.5	WVCM-4 auto-range good practice settings	54

1 INTRODUCTION

1.1 WVCN-4

The WVCN-4 is a high speed XYZ colorimeter. The WVCN-4 offers near-perfect filter characteristics and ultra-high sensitivity packed in a typical robust and compact package.

1.2 WVCN-4 highlights

- Measurement of luminance and colour.
- Flicker measurement
- Mechanical shutter
- Low noise
- Auto-range function
- Excellent linearity
- Dark current compensated
- Optional laser pointer
- USBTMC compliant, SCPI command set, high speed device
- USB, RS232 and trigger in & out for ideal system integration
- Internal calculations for most common parameters, saving processing power in production environments
- Robust housing, optimized for mounting and protection in harsh production environments

1.3 Standards

The WVCN-4 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 (www.ni.com/visa) and using the open source drivers on Linux (i686, x86_64 and ARM).

2 INTERFACES

2.1 USB-interface

The USB-B connector is used to connect the WVCM-4 to a PC/Laptop. USB uses the USBTMC class protocol and can therefore be used directly with third party provided VISA compliant libraries like NI-VISA. The WVCM-4 can be USB or externally powered.

2.2 RS232 interface

RS232 is provided to connect any host that does not provide USB or Ethernet or for which no USBTMC drivers exist. Using RS232, the functions that generate a lot of data (:sample:Y) are still available, but the use of it is highly discouraged due to the low speed of RS232.

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

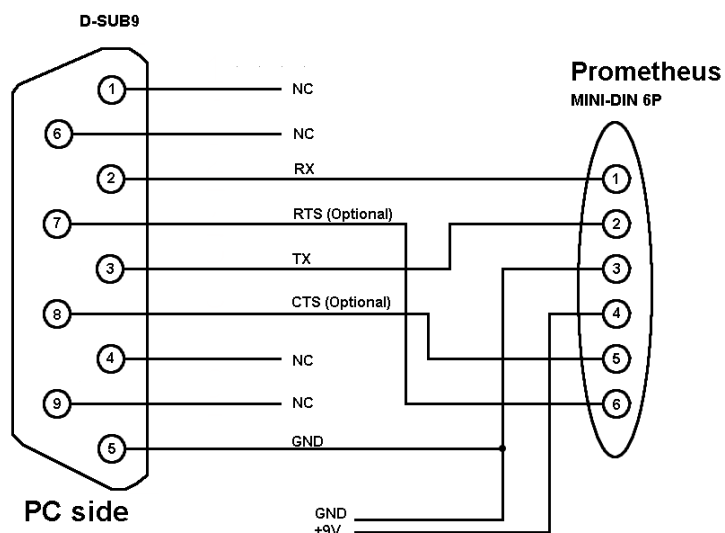


Figure 1 WVCM-4 RS232 Connections

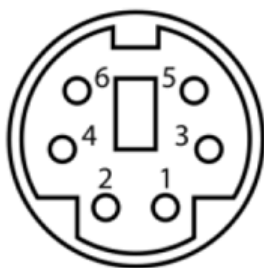


Figure 2 Rear side mini-DIN-6 pin connector

2.3 Trigger in/out

Two trigger connections are available. One trigger output and one trigger input. The connectors are SMA connectors. 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. It will stay at a high level until the next command is carried out but has a minimum high level of $5\mu\text{s}$. A trigger will carry out the last send command (:MEASURE or :SAMPLE) and send the result to the host via the selected interface (last used interface when sending the command).

Supplied code examples show how to use this feature in an application. The trigger output line is used to indicate that the measurement is ready. Trigger signals should comply to the following timing (Figure 3).

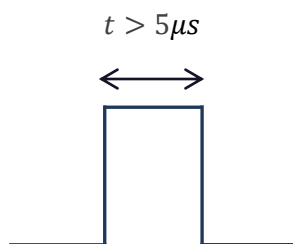


Figure 3 Trigger-in Timing

Trigger pulses arriving faster than the device can measure will be ignored, but it may slowdown overall performance. Trigger pulses should not arrive faster than the measurement takes to complete. The best way is to use the trigger output to make sure measurement was finished.

The trigger out port provides a continuous low signal when the device is executing a measurement. Signal turns high when the device is not executing any commands.

Connection	Low level	High level
Trigger out	0 V	5 V
Trigger In	0 V	5 V

2.4 Power connections

The WVCN-4 must be externally powered, by default we recommend using the supplied power supply however using your own supply is also possible.

The unit shall be powered by a 9V DC voltage, reinforced separated from Mains, with a limited energy of $< 150\text{VA}$ and $< 1.2\text{A}$.

Connection	Min. Voltage	Typ. voltage	Max. voltage
DC powered	8.50 V	9.00 V	15.00 V

3 COMMUNICATIONS PROTOCOL

3.1 USB

The WVCM-4 can be connected to any USB host and is a USBTMC compliant device which is a standard USB class. Device drivers for this class are available for most popular operating systems (also embedded). This makes the WVCM-4 directly usable in popular programming languages like NI's Labview, Labwindows and Matlab but also C++, Visual basic, C#, Java etc. The WVCM-4 has two interfaces build in, which require a different device driver to be used.

- WVCM-4 bootloader - USB RAW device driver, Vendor ID: 0x23CF, Product ID 0x0109
- WVCM-4 - USBTMC device driver, Vendor ID: 0x23CF, Product ID 0x10D0

When the WVCM-4 is connected to the host, it will start the WVCM-4 firmware. As soon as the firmware is idle to receive commands, the Power LED goes to the ON state. The Admesy bootloader is a RAW USB device and in order to use this device in Windows, a driver must be installed which is supplied by Admesy and WellVision. Besides upgrading to new firmware, it is also allowed to downgrade firmware in case this is required. *Note: that older firmware also may require the use of older software libraries and/or executable versions of software.* The WVCM-4 is USBTMC compliant and can be used with libraries that contain a USBTMC compliant driver like NI-VISA. The WVCM-4 is a USB 2.0 high speed device.

3.2 RS232

All commands are equal for all interfaces. Note that for high speed transfers it is best to use USB.

4 DEVICE DRIVERS

4.1 USB

The following table shows an overview of USB support on various operating systems.

OS	NI-VISA	Libusb	Native kernel	Agilent USBTMC
Windows 7	✓	✓	Not available	Not tested ¹
Windows 8(.1)	✓	Not tested ¹	Not available	Not tested ¹
Windows 10	✓	✓	Not available	Not tested ¹
Apple OSX Intel	✓	Not tested ¹	Not available	Unknown
Linux i386 (32bit)	✓	✓	✓	✓
Linux i386 (64bit)	✓	✓	✓	✓
Linux ARM	Not available	✓	✓	✓
Linux other	Not available	✓	✓	✓

¹ Not tested: Available, but not tested, ² Native Kernel: Driver included with OS.

² Windows 7 is supported: ended on January 14, 2020

³ Windows 8(.1) is supported: ended on January 9, 2018

Admesy and WellVision support all tested platforms but does not provide standard applications on all platforms. The overview is provided to show the possible platforms for software development. Admesy and WellVision does however provide software examples for most of the tested platforms. Most of these examples can be found in our SDK on our support web page.

Additionally the WVCN-4 also supports the USB CDC driver which acts like a COM port when connecting the device to the PC

4.2 RS232

When no USB driver is available or the host system does not provide USB, RS232 can be used as it does not require additional drivers for the WVCN-4.

5 COMMAND SET OVERVIEW

5.1 Command set categories.

The functions of the WVCM-4 can be described through the following categories.

- System commands
- Configuration commands
- Measurement commands
- User EEPROM configuration commands
- User EEPROM calibration commands

The WVCM-4 uses SCPI like commands for control and measurement. These are ASCII based commands and follow specific rules regarding syntax.

5.2 System commands

The following commands can be used set to read back information. These commands are general system commands.

Command	Write Parameter	Read Result	Description
:*IDN?	—	device name	identification query
:*RST	—	—	reset command
:*FWD?	—	firmware date	reads the firmware date
:SYSTem:VERSion?	—	firmware version	returns the firmware version
:BOOT:REBOOT	—	—	Reboot the instrument

5.3 Configuration commands

Configuration commands are used to set parameters of the WVCN-4 that are used by the measurement functions. The settings are used by measurement functions.

Command	Write Parameter	Read Result	Description
:SENSe:INT	Integration time	—	Writes the integration time
:SENSe:INT?	—	—	Reads the integration time
:SENSe:REALINT?	—	—	Reads the integration time used by auto-range.
:SENSe:AVERage	Average	—	sets averaging
:SENSe:AVERage?	—	Average	Reads the averaging
:SENSe:GAIN	Gain (1-3)	—	Set the gain (1 is most sensitive)
:SENSe:GAIN?	—	Gain	Reads the gain
:SENSe:SBW	Calibration matrix	—	Sets the active calibration matrix
:SENSe:SBW?	—	Calibration matrix	Reads the active calibration matrix
:SENSe:SHUTter	Shutter state	—	close (1) or open (0) shutter
:SENSe:SHUTter?	—	Shutter state	Reads the shutter state
:SENSe:AUTORANGE	Auto-range	—	Auto-range on (1) or off (0)
:SENSe:AUTORANGE?	—	Auto-range	Reads the auto-range setting
:SENSe:AUTOMODE	mode (fast, normal, slow, hisense, manual)	—	Writes the auto-range mode
:SENSe:AUTOMODE?	—	Mode	Reads the current mode.
:SENSe:AUTOPARMS	freq, frames, adjmin	—	Sets the auto-range parameters
:SENSe:AUTOPARMS?	—	freq, frames, adjmin	Reads the auto-range parameters
:SENSe:ARPARMS	freq,adjmin,frames,max-int,average	—	Sets the auto-range parameters
:SENSe:ARPARMS?	—	freq,adjmin,frames,max-int,average	Reads the auto-range parameters
:SENSe:FREQ	Frequency	—	Writes the DUT frequency
:SENSe:FREQ?	—	Frequency	Reads the DUT frequency
:SENSe:ARFREQ	Autorange frequency	—	Sets the frequency to be used for auto ranging
:SENSe:ARFREQ?	—	Autorange frequency	Reads the frequency that is used for auto ranging
:SENSe:SATURATION?		SaturationX, SaturationY, SaturationZ [0-1 float]	Reads the saturation level of the last performed measurement
:SENSe:WHITE	reference white ("D65")	—	Sets the white point for dominant wavelength calculation
:SENSe:WHITE?	—	reference white ("D65")	Reads the white point
:SENSe:DARKMODE	Dark mode	—	Sets the dark mode (1=on, 0=off)
:SENSe:TRIG	Trigger mode	—	enable (1) or disable (0) external triggering. FPGA trigger enabled = 2.
:SENSe:TRIG?		Trigger mode	reads the trigger mode
:SENSe:FPGATRIG	Frame delay,additional delay	—	Configures the FPGA trigger mode
:SENSe:FPGATRIG?	—	Frame delay,additional delay	reads the FPGA trigger parameters
:SENSe:TRIGDELAY	trigger delay	—	sets the trigger delay
:SENSe:TRIGDELAY?	—	trigger delay	reads the trigger delay
:SENSe:RETURNACK	ACK (1=on, 0=off)	—	return an acknowledge ">>"

5.4 Measurement commands

The following table shows the measurement commands available of the WVCM-4.

Command	Write Parameter	Read Result	Description
:MEASure:XYZ	—	X, Y, Z, clip, noise	measure XYZ
:MEASure:YXY	—	Y, ClEx, ClEy, clip, noise	measure Yxy
:MEASure:YUV	—	Y, u, v, clip, noise	measure Yuv
:MEASure:CCT	—	CCT, clip, noise	measure CCT
:MEASure:DWL	—	DWL, Pe, Y, ClEx, ClEy, clip, noise	measure dominant wavelength
:MEASure:Y	—	Y, clip, noise	measure luminance
:MEASure:DARK	Xlimit,Ylimit,Zlimit, average	temperature, darkOK, X, Y, Z, X, Y, Z, etc	Measures dark and check against the limits.
:MEASure:FASTDARK	Xlimit,Ylimit,Zlimit, average	temperature, darkOK, X, Y, Z, X, Y, Z, etc	Measures dark and check against the limits.
:MEASure:FREQuency	Samples	frequency, amplitude, clip	Measure the detected frequency of the DUT plus the amplitude of this frequency
:MEASure:TEMPerature	—	temperature	measure temperature
:MEASure:FLICker	method, samples, delay	Flicker value	Measures MIN/MAX, RMS, JEITA, VESA, percentage or index flicker
:MEASure:SEQY	Frames	—	Measures Y of a specified number of frames
:MEASure:SEQXYZ	Frames	—	measures XYZ of a specified number of frames
:MEASure:DTCAL	—	Delta temperature	Delta of current temperature versus the temperature at which dark calibration was done.
:MEASure:ARPARMS?	—	inttime,average,gain	gets the resulting auto-range parameters after auto-ranging
:SAMPle:XYZ	samples, delay	dt, clip, temperature, XYZ data	XYZ data per sample
:SAMPle:Y	samples, delay	dt, clip, temperature, Y data	Y data per sample with 2k speed
:SAMPle:FAST:Y	samples, delay	dt, clip, temperature, Y data	Y data per sample with 3.125k speed
:MEASure:ALL		X,Y,Z,Y,x,y,Xoff,Yoff,Zoff,Xsat,Ysat,Zsat,clip,noise	Measure all data XYZ and Yxy calibrated, XYZ without Calibration and XYZ saturation
:MEASure:VSYNCFREQuency	—	VsyncMax, VsyncMin, NrOfPulses	Measures Vsync frequency on the trigger input. It is advised to first send the :RESET:VSYNCFREQ command.
:RESET:VSYNCFREQ	—	—	Resets the Vsync counter.
:SAMPle:NORMAL:XYZ	samples, delay	dt, clip, temperature, XYZ data	XYZ data per sample with 2k speed
SAMPle:FAST:XYZ	samples, delay	dt, clip, temperature, XYZ data	XYZ data per sample with 3.125k speed
SAMPle:INTTIME:XYZ	samples, delay, int time	dt, clip, temperature, XYZ data	XYZ data per sample with set speed

5.5 User EEPROM configuration commands

Below table shows the configuration setting commands which can be used to store values in the user EEPROM space. It is advised to reboot the WVCN-4 after writing new values to the EEPROM.

Command	Write Parameter	Read Result	Description
:EEPROM:STARTUP:WRITE	—	—	stores startup values to eeprom
:EEPROM:STARTUP:READ	—	—	read all startup eeprom values
:EEPROM:CONFigure:BAUDRATE	baudrate setting	—	write RS232 baudrate setting
:EEPROM:CONFigure:BAUDRATE?	—	baudrate setting	read RS232 baudrate setting
:EEPROM:CONFigure:TRIG	mode	—	write trigger mode on (1) or off (0)
:EEPROM:CONFigure:TRIG?	—	mode	read trigger mode
:EEPROM:CONFigure:TRIGDELAY	delay	—	write trigger delay [us]
:EEPROM:CONFigure:TRIGDELAY?	—	delay	read trigger delay [us]
:EEPROM:CONFigure:LPFREQ	Low pass frequency	—	sets the low pass frequency
:EEPROM:CONFigure:LPFREQ?	—	Low pass frequency	reads the low pass frequency
:EEPROM:CONFigure:AVG	average	—	sets the initial averaging for all channels
:EEPROM:CONFigure:AVG?	—	average	reads the initial averaging
:EEPROM:CONFigure:WHITE	reference white ("D65")	—	sets the reference point for dominant wavelength calculation.
:EEPROM:CONFigure:WHITE?	—	reference white	reads the reference white point
:EEPROM:CONFigure:GAIN	gain (1-3)	—	Sets the initial gain value
:EEPROM:CONFigure:GAIN?	—	gain (1-3)	Reads the initial gain setting
:EEPROM:CONFigure:INT	Integration time	—	Sets the initial integration time
:EEPROM:CONFigure:INT?	—	Integration time	Reads the initial integration time
:EEPROM:CONFigure:SBW	matrixID	—	Sets the initial calibration matrix
:EEPROM:CONFigure:SBW?	—	matrixID	reads the initial calibration matrix
:EEPROM:CONFigure:AUTO:Orange	State	—	read auto-range state
:EEPROM:CONFigure:AUTO:ORANGE?	—	State	write auto-range state
:EEPROM:CONFigure:AUTO:FREQ	Frequency	—	writes the DUT frequency
:EEPROM:CONFigure:AUTO:FREQ?	—	Frequency	reads the DUT frequency
:EEPROM:CONFigure:AUTO:FRAMES	Frames	—	write the number of frames to measure
:EEPROM:CONFigure:AUTO:FRAMES?	—	Frames	reads the number of frames
:EEPROM:CONFigure:AUTO:ADJMIN	Adjmin	—	write the adjmin value
:EEPROM:CONFigure:AUTO:ADJMIN?	—	Adjmin	reads the adjmin value
:EEPROM:CONFigure:AUTO:MAXINT	Maxint	—	writes maximum integration time
:EEPROM:CONFigure:AUTO:MAXINT?	—	Maxint	reads the maximum integration time
:EEPROM:CONFigure:AUTO:MODE	Mode	—	write the autorange mode
:EEPROM:CONFigure:AUTO:MODE?	—	Mode	reads the autorange mode
:EEPROM:WRITE:ID	Device ID	—	Writes an ID number to the device
:EEPROM:READ:ID	—	Device ID	Reads the device ID number from the device
:EEPROM:READ:SN	—	Serial number	Reads the instrument serial number

5.6 User calibration commands

Below table shows the commands which can be used to store user calibrations (matrices).

It is advised to reboot the WVCN-4 after writing new values to the EEPROM.

Command	Write Parameter	Read Result	Description
:EEPROM:READ:USERCAL	—	—	Transfers user calibration data from EEPROM to RAM
:EEPROM:WRITE:USERCAL	—	—	Transfers user calibration data from RAM to EEPROM
:EEPROM:SBW:WRITE	matrixID, row, col, value	—	Write matrix values
:EEPROM:SBW:READ	matrixID, row, col	value	reads matrix values
:EEPROM:READ:SBWNAME	matrixID	name	Reads the matrix name
:CALibrate:INLINEDARK	Mode (0=slow, 1=fast)	Testresult	Performs a dark calibration and returns either 0 on success or a negative value for failure.
:CALibrate:REFRed	Xref,Yref,Zref		XYZ values of reference instrument for Red
:CALibrate:REFGreen	Xref,Yref,Zref		XYZ values of reference instrument for Green
:CALibrate:REFBlue	Xref,Yref,Zref		XYZ values of reference instrument for Blue
:CALibrate:REFWhite	Xref,Yref,Zref		XYZ values of reference instrument for White
:CALibrate:ADIRed	Xoff,Yoff,Zoff		XYZoff values of Colorimeter Device Instrument for Red
:CALibrate:ADIGreen	Xoff,Yoff,Zoff		XYZoff values of Colorimeter Device Instrument for Green
:CALibrate:ADIBlue	Xoff,Yoff,Zoff		XYZoff values of Colorimeter Device Instrument for Blue
:CALibrate:ADIWhite	Xoff,Yoff,Zoff		XYZoff values of Colorimeter Device Instrument for White
:CALCulate:MATRIX	Method	Matrix	Calculate matrix
:EEPROM:WRITE:MATRIX	MatrixID, name, date		Write calculated matrix to eeprom

6 DETAILED COMMAND LIST

6.1 System commands

6.1.1 :*IDN?

Reads the identification query of the device

Action	Data	Termination	Format
write	:*IDN?	LF	ASCII
read	Wellvision WVCM-4-10	LF	ASCII

6.1.2 :*RST

Resets the device and settings are set back to original start up value

Action	Data	Termination	Format
write	:*RST	LF	ASCII
read	Not applicable		

6.1.3 :*FWD?

Reads the date of the firmware

Action	Data	Termination	Format
write	:*FWD?	LF	ASCII
read	Mon Mar 23 14:32:19 2020	LF	ASCII

6.1.4 :SYSTem:VERSion?

Reads the firmware version

Action	Data	Termination	Format
write	:SYSTem:VERSion?	LF	ASCII
read	1.20	LF	ASCII

6.1.5 :BOOT:REBOOT

Reboots the device

Action	Data	Termination	Format
write	:BOOT:REBOOT	LF	ASCII
read	Not applicable		

6.2 Configuration commands

Configuration commands are in general commands which have impact on measurement commands, many of these commands determine the quality of the measurement or at least have an influence on it.

6.2.1 :SENSe:INT

This command sets the integration time in microseconds [uS]. Integration time is the time in which the sensor is exposed to light.

Action	Data	Termination	Format
write	:SENSe:INT 16666	LF	ASCII
Read	Not applicable	LF	ASCII

6.2.2 :SENSe:INT?

This command gets the current integration time in microseconds [uS].

Action	Data	Termination	Format
write	:SENSe:INT?	LF	ASCII
Read	16666	LF	ASCII

6.2.3 :SENSe:REALINT?

This command gets the current integration time in microseconds [uS] when device is operating in auto-range mode.

Action	Data	Termination	Format
write	:SENSe:REALINT?	LF	ASCII
Read	16666	LF	ASCII

6.2.4 :SENSe:AVERage

This command sets the averaging.

Action	Data	Termination	Format
write	:SENSe:AVERage 1	LF	ASCII
Read	Not applicable	LF	ASCII

6.2.5 :SENSe:AVERage?

This command gets the current averaging.

Action	Data	Termination	Format
write	:SENSe:AVERage?	LF	ASCII
Read	1	LF	ASCII

6.2.6 :SENSe:GAIN

This command sets the gain. The gain can be 1,2 or 3. Gain 3 is the least sensitive (for high luminance). Gain 1 is the most sensitive, to be used for low luminance measurements.

Action	Data	Termination	Format
write	:SENSe:GAIN 1	LF	ASCII
Read	Not applicable	LF	ASCII

When in auto-range mode, it can save tact time to set the gain to a correct value. For example when it is known that the next pattern to be measured is a dark pattern it saves a little time to manually set gain=1 and then perform “:MEASure:XYZ”. The same applies for a high luminance pattern, setting the gain to 3.

6.2.7 :SENSe:GAIN?

This command gets the current gain setting.

Action	Data	Termination	Format
write	:SENSe:GAIN?	LF	ASCII
Read	3	LF	ASCII

6.2.8 :SENSe:SBW

This command sets the calibration matrix.

Action	Data	Termination	Format
write	:SENSe:SBW user1	LF	ASCII
Read	Not applicable	LF	ASCII

6.2.9 :SENSe:SBW?

This command reads the calibration matrix. The raw sensor’s XYZ value is multiplied by this matrix to produce calibrated output data.

Action	Data	Termination	Format
write	:SENSe:SBW?	LF	ASCII
Read	user1	LF	ASCII

6.2.10 :SENSe:AUTORANGE

With this command, auto-range can be set on (1) or off (0).

Action	Data	Termination	Format
write	:SENSe:AUTORANGE 1	LF	ASCII
Read	Not applicable	LF	ASCII

6.2.11 :SENSe:AUTORANGE?

Read the auto-range state of the instrument.

Action	Data	Termination	Format
write	:SENSe:AUTORANGE?	LF	ASCII
Read	1	LF	ASCII

6.2.12 :SENSe:AUTOMODE

This command sets the auto-range mode.

Action	Data	Termination	Format
write	:SENSe:AUTOMODE 1	LF	ASCII
Read	Not applicable	LF	ASCII

Automode can be fast(0), normal(1), slow(2), hisense(3), manual(4). The underlying settings for these selections can be seen in the table below.

Mode	Meaning	Adjmin	Maxint
0	Fast	20	50000
1	Normal	20	250000
2	Slow	20	600000
3	Hi-sense	20	1000000
4	Manual	manual	manual

6.2.13 :SENSe:AUTOMODE?

This command reads the auto-range mode.

Action	Data	Termination	Format
write	:SENSe:AUTOMODE?	LF	ASCII
Read	0	LF	ASCII

6.2.14 :SENSe:AUTOPARMS

This command sets the auto-range parameters. This command is provided for backwards compatibility and deprecated. The :SENSe:ARPARMS command is preferred.

Parameter:	Range:	
Frequency [Hz]	0 – 500.0	frequency of the DUT
Frames	1 – 255	number of frames to measure
Adjmin [%]	1 – 30	scale of ADC level to regulate to in percentage

Action	Data	Termination	Format
write	:SENSe:AUTOPARMS 60,1,15	LF	ASCII
Read	Not applicable	LF	ASCII

6.2.15 :SENSe:AUTOPARMS?

This command gets the auto-range parameters.

Action	Data	Termination	Format
write	:SENSe:AUTOPARMS?	LF	ASCII
Read	60,1,15	LF	ASCII

6.2.16 :SENSe:ARPARMS

This command sets the auto-range parameters.

Parameter:	Range:	
Frame Frequency [Hz]	0 – 500.0	frequency of source
Adjmin [%]	1 – 30	scale of ADC level to regulate to in percentage
Frames	1 – 255	number of frames to measure
Max int time [μs]	1/freq – 1 sec	maximum integration time to use in μs
Average	1 - 255	number of measurements to average

Action	Data	Termination	Format
write	:SENSe:ARPARMS 60,15,1,300000,1	LF	ASCII
Read	Not applicable	LF	ASCII

6.2.17 :SENSe:ARPARMS?

This command gets the auto-range parameters.

Frame Frequency [Hz]	0 – 500.0	frequency of source
Adjmin [%]	1 – 30	scale of ADC level to regulate to in percentage
Frames	1 – 255	number of frames to measure
Max int time [μs]	1/freq – 1 sec	maximum integration time to use in μs
Average	1 - 255	number of measurements to average

Action	Data	Termination	Format
write	:SENSe:ARPARMS?	LF	ASCII
Read	60,15,1,300000,1	LF	ASCII

6.2.18 :SENSe:SHUTter

With this command the shutter can be opened (0) or closed (1).

Action	Data	Termination	Format
write	:SENSe:SHUTter 1	LF	ASCII
Read	Not applicable	LF	ASCII

6.2.19 :SENSe:SHUTter?

With this command it can be checked if the shutter is open(0) or closed(1)

Action	Data	Termination	Format
write	:SENSe:SHUTter?	LF	ASCII
Read	0	LF	ASCII

6.2.20 :SENSe:WHITE

With this command the reference white point for dominant wavelength calculation can be set.

Action	Data	Termination	Format
write	:SENSe:WHITE D65	LF	ASCII
Read	Not applicable	LF	ASCII

6.2.21 :SENSe:WHITE?

With this command the reference white point can be read.

Action	Data	Termination	Format
write	:SENSe:WHITE?	LF	ASCII
Read	D65	LF	ASCII

6.2.22 :SENSe:FREQ

This command sets the DUT frequency.

Action	Data	Termination	Format
write	:SENSe:FREQ 59.567	LF	ASCII
Read	Not applicable	LF	ASCII

6.2.23 :SENSe:FREQ?

This command reads the DUT frequency setting [Hz].

Action	Data	Termination	Format
write	:SENSe:FREQ?	LF	ASCII
Read	59.567	LF	ASCII

6.2.24 :SENSe:ARFREQ

This command sets the frequency [Hz] to be used during autorange mode. In case “:SENSe:FREQ” is set to a low frequency it is possible to speed up autoranging by setting this to a higher value. This frequency however should match the real display frame frequency (60Hz for example).

Action	Data	Termination	Format
write	:SENSe:ARFREQ 60	LF	ASCII
Read	Not applicable	LF	ASCII

6.2.25 :SENSe:ARFREQ?

This command reads the autorange frequency setting

Action	Data	Termination	Format
write	:SENSe:ARFREQ?	LF	ASCII
Read	60	LF	ASCII

6.2.26 :SENSe:SATURATION?

Returns the saturation levels of X,Y and Z parameter of the last measurement.

Parameter:	Range:	
X	0 – 1.0	ADC level scaled 0-1
Y	0 – 1.0	ADC level scaled 0-1
Z	0 – 1.0	ADC level scaled 0-1
	0.01	low saturation level
	1.00	ADC is saturated, measurement is not valid

Action	Data	Termination	Format
write	:SENSe:SATURATION?	LF	ASCII
Read	0.678,0.898,0.776	LF	ASCII

6.2.27 :SENSe:DARKMODE

This command switches dark mode on(1) or off(0). The dark mode means that after a measurement a dark measurement is performed (same settings with shutter closed) and subtracted.

Action	Data	Termination	Format
write	:SENSe:DARKMODE 1	LF	ASCII
Read	Not applicable	LF	ASCII

6.2.28 :SENSe:TRIG

This command sets the external trigger mode on (1) or of (0) or FPGA trigger mode (2).

The FPGA trigger mode can be used with “Measure” and “Sample” commands. The normal trigger mode does use software commands to control the FPGA, which contains a little more latency. *Note:* trigger mode 2 will be disabled after 1 trigger measurement.

Action	Data	Termination	Format
write	:SENSe:TRIG 1	LF	ASCII
Read	Not applicable	LF	ASCII

6.2.29 :SENSe:TRIG?

This command reads the trigger mode setting.

Action	Data	Termination	Format
write	:SENSe:TRIG?	LF	ASCII
Read	1	LF	ASCII

6.2.30 :SENSe:FPGATRIG

This command sets the parameters for FPGA triggering and starts the FPGA trigger mode.

Parameter:	Range:	
Frame delay	0 – int32	Number of frames to delay from receiving the trigger.
Additional delay	0 – int32	Additional delay in microseconds [uS].

When this command is received, the settings of frame delay and additional delay are sent to the FPGA. The FPGA starts counting trigger pulses up to the amount of frame delay and starts the measurement after the additional delay.

Action	Data	Termination	Format
Write	:SENSe:FPGATRIG 10,0	LF	ASCII
Read	Not applicable	LF	ASCII

6.2.31 :SENSe:FPGATRIG?

This command reads the trigger mode setting.

Action	Data	Termination	Format
write	:SENSe:FPGATRIG?	LF	ASCII
Read	10,0	LF	ASCII

6.2.32 :SENSe:TRIGDELAY

This command sets the trigger delay in microseconds [uS] in normal trigger mode (:SENSe:TRIG 1).

Action	Data	Termination	Format
write	:SENSe:TRIGDELAY 0	LF	ASCII
Read	Not applicable	LF	ASCII

6.2.33 :SENSe:TRIGDELAY?

This command reads the configured trigger delay in microseconds [uS].

Action	Data	Termination	Format
write	:SENSe:TRIGDELAY?	LF	ASCII
Read	0	LF	ASCII

6.2.34 :SENSe:RETURNACK

This command sets return acknowledge mode in RS232. When set, the WVCM-4 will return ">>" after receiving a command.

Action	Data	Termination	Format
write	:SENSe:RETURNACK 1	LF	ASCII
Read	Not applicable	LF	ASCII

6.2.35 :SENSe:POINter

This command sets the intensity of the optional laser pointer. Valid values are 0(off) to 3 (max intensity).

Action	Data	Termination	Format
write	:SENSe:POINter 1	LF	ASCII
Read	Not applicable	LF	ASCII

6.2.36 :SENSe:UHLAVER

This command sets the averaging for command :MEASure:UHLXYZ

Action	Data	Termination	Format
write	:SENSe:UHLAVER 50	LF	ASCII
Read	Not applicable	LF	ASCII

6.2.37 :SENSe:UHLAVER?

This command gets the current set UHL averaging.

Action	Data	Termination	Format
write	:SENSe:UHLAVER?	LF	ASCII
Read	50	LF	ASCII

6.2.38 :SENSe:UHLAUTORANGE

With this command, UHL auto-range can be set on (1) or off (0). This mode should only be enabled when measurements with :SENSe:AUTORANGE would result in clipped measurements. See :MEASure:UHLXYZ for more detail about UHL.

Action	Data	Termination	Format
write	:SENSe:UHLAUTORANGE 1	LF	ASCII
Read	Not applicable	LF	ASCII

6.2.39 :SENSe:UHLAUTORANGE?

Read if the instrument may use UHL auto-range mode or not.

Action	Data	Termination	Format
write	:SENSe:UHLAUTORANGE?	LF	ASCII
Read	1	LF	ASCII

6.3 Measurement commands

6.3.1 :MEASure:TEMPerature

Returns the temperature [C°].

Action	Data	Termination	Format
write	:MEASure:TEMPerature	LF	ASCII
read	26.6	LF	ASCII

6.3.2 :MEASure:XYZ

This command returns the CIE1931 XYZ result, clip and noise value. The parameters are separated by a comma “,”. In total 5 parameters are returned. If clip and noise (both boolean) are 0 the measurement is fine, if clip is 1 the measurement is clipped (thus wrong). And if noise is 1 the luminance level is not high enough. In case very dark patterns are measured, the noise indication can be 1 even while results are still usable. In case of clip, a measurement is always wrong.

Action	Data	Termination	Format
write	:MEASure:XYZ	LF	ASCII
read	100.1234,100.432,100.78932,0,0	LF	ASCII

6.3.3 :MEASure:YXY

Measures Yxy. This command also returns 5 parameters: Y,x,y,clip,noise and similar to “:MEASure:XYZ”.

Action	Data	Termination	Format
write	:MEASure:YXY	LF	ASCII
Read	100.01,0.312,0.329,0,0	LF	ASCII

6.3.4 :MEASure:YUV

Measures Yuv. This command also returns 5 parameters: Y,u,v,clip,noise and similar to “:MEASure:XYZ”.

Action	Data	Termination	Format
write	:MEASure:YUV	LF	ASCII
Read	100.01,0.257,0.378,0,0	LF	ASCII

6.3.5 :MEASure:CCT

Measures Corelated Colour Temperature. This command also returns 3 parameters: CCT,Clip and noise behave the same as “:MEASure:XYZ”.

Action	Data	Termination	Format
write	:MEASure:CCT	LF	ASCII
read	2800.265,0,0	LF	ASCII

6.3.6 :MEASure:DWL

Measures dominant wavelength. This uses the reference white point as set by the “:SENSe:WHITE” command. Return parameters are: DWL, Purity, Y, x, y, clip, noise

Action	Data	Termination	Format
write	:MEASure:DWL	LF	ASCII
read	543.94,0.913,184.765422,0.26289,0.69592,0,0 420.3,0.95,50.156,0.1512,0.045,0,0	LF	ASCII

6.3.7 :MEASure:Y

Measures luminance and additionally returns clip and noise.

Action	Data	Termination	Format
write	:MEASure:Y	LF	ASCII
read	100.2561,0,0	LF	ASCII

6.3.8 :MEASure:DARK

Measures dark and checks it against the limit settings. It returns temperature, pass/fail and raw data (with dark subtracted) in counts. Output is compatible with “:MEASure:FASTDARK” but at different integration times.

The return parameters are separated by a comma “,”. In total 20 parameters are returned. First parameter is temperature, second is pass or fail and next values are XYZ raw values for two different integration times and 3 different gains (see on of the tables below for the details on int time and gain)

Pass or fail is determined whether the X/Y/Z value in raw counts (and with dark subtracted) for each integration time and gain is within the limit set when sending the command. The value is in count but can be influenced

Set parameter:	Range:	Description:
Xlimit	1 – 255	Limit count for X
Ylimit	1 – 255	Limit count for Y
Zlimit	1 – 255	Limit count for Z
Average	1 – 255	Average used for every measurement

Return Parameter:	Range:	Description:
Temp	float	Temperature value
Result	0/1	1 is pass, 0 is fail
X1	float	X value in counts at first int time and gain 1
Y1	float	Y value in counts at first int time and gain 1
...		
Y6	float	Y value in counts at second int time and gain 3
Z6	float	Z value in counts at second int time and gain 3

Action	Data	Termination	Format
write	:MEASure:DARK 30,30,30,1	LF	ASCII
Read	26.6,1,0.134,-2.0165,0.0245,etc	LF	ASCII

The dark measurement is done in 6 steps, each producing a set of XYZ values.

Step	gain	Integration time	result
1	1	100ms	XYZdark
2	2	100ms	XYZdark
3	3	100ms	XYZdark
4	1	1000ms	XYZdark
5	2	1000ms	XYZdark
6	3	1000ms	XYZdark

6.3.9 :MEASure:FASTDARK

Measures dark in a fast mode and checks it against the limit settings. It returns temperature, pass/fail and raw data (with dark subtracted) in counts. Output is compatible with “:MEASure:DARK” but at different integration times.

The return parameters are separated by a comma “,”. In total 20 parameters are returned. First parameter is temperature, second is pass or fail and next values are XYZ raw values for two different integration times and 3 different gains (see on of the tables below for the details on int time and gain)

Pass or fail is determined whether the X/Y/Z value in raw counts (and with dark subtracted) for each integration time and gain is within the limit set when sending the command. The value is in count but can be influenced

Set parameter:	Range:	Description:
Xlimit	1 – 255	Limit count for X
Ylimit	1 – 255	Limit count for Y
Zlimit	1 – 255	Limit count for Z
Average	1 – 255	Average used for every measurement

Return Parameter:	Range:	Description:
Temp	float	Temperature value
Result	0/1	1 is pass, 0 is fail
X1	float	X value in counts at first int time and gain 1
Y1	float	Y value in counts at first int time and gain 1
....		
Y6	float	Y value in counts at second int time and gain 3
Z6	float	Z value in counts at second int time and gain 3

Action	Data	Termination	Format
write	:MEASure:FASTDARK 15,15,15,3	LF	ASCII
Read	26.6,1,0.134,-2.0165,0.0245,etc	LF	ASCII

The dark measurement is done in 6 steps, each producing a set of XYZ values.

Step	gain	Integration time	result
1	1	16.666ms	XYZdark
2	2	16.666ms	XYZdark
3	3	16.666ms	XYZdark
4	1	100ms	XYZdark
5	2	100ms	XYZdark
6	3	100ms	XYZdark

6.3.10 :MEASure:FREQuency

Measures the detected frequency of the DUT plus the amplitude of this frequency. It takes the number of samples as parameter. WVCN-4 has a maximum sample rate of 2000 Samples/s.

Action	Data	Termination	Format
write	:MEASure:FREQuency 500	LF	ASCII
read	59.578,288.258,0	LF	ASCII

6.3.11 :MEASure:FLICKer

Measures MIN/MAX, RMS, JEITA, VESA, percentage or index flicker. The example measures JEITA flicker.

Parameter:	Range:	
method	0 – 5	Flicker method. 0=MIN/MAX, 1=RMS, 2=JEITA, 3=VESA, 4=percentage, 5=index.
Samples	0 – 6000	Number of samples, see “:SAMPle:Y”
Delay	0 – 255	delay, see “:SAMPle:Y”

Action	Data	Termination	Format
write	:MEASure:FLICKer 2,2000,0	LF	ASCII
read	-39.45	LF	ASCII

The value of JEITA is in dB.

6.3.12 :MEASure:SEQY

Measures luminance per frame. This uses the DUT frequency to calculate the integration time and averaging. This command can be used by the FPGA trigger mode or as software command (not synchronized by Vsync then). For more details see the chapter External triggering.

Action	Data	Termination	Format
write	:MEASure:SEQY 20	LF	ASCII
read	26.6,0.0,40,99.39,100.124,101.2548,99.37, etc	LF	ASCII

6.3.13 :MEASure:SEQXYZ

Measures XYZ per frame. This uses the DUT frequency to calculate the integration time and averaging. This command can be used by the FPGA trigger mode or as software command (not synchronized by Vsync then). For more details see the chapter External triggering.

Action	Data	Termination	Format
write	:MEASure:SEQXYZ 20	LF	ASCII
read	26.6,0.0,40,99.39,50.124,101.2548,60.37,50.554,100.321,60.45 etc	LF	ASCII

6.3.14 :MEASure:DTCAL

Measures the delta temperature between the current temperature and the temperature when dark calibration was performed.

Action	Data	Termination	Format
write	:MEASure:DTCAL	LF	ASCII
read	5.124	LF	ASCII

6.3.15 :MEASure:ARPARMS?

Performs an auto-range measurement and returns the found integration time, average and gain.

Action	Data	Termination	Format
write	:MEASure:ARPARMS?	LF	ASCII
read	16666,1,2	LF	ASCII

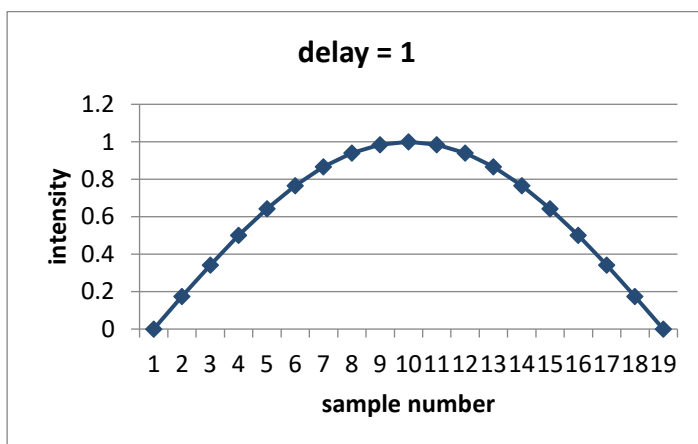
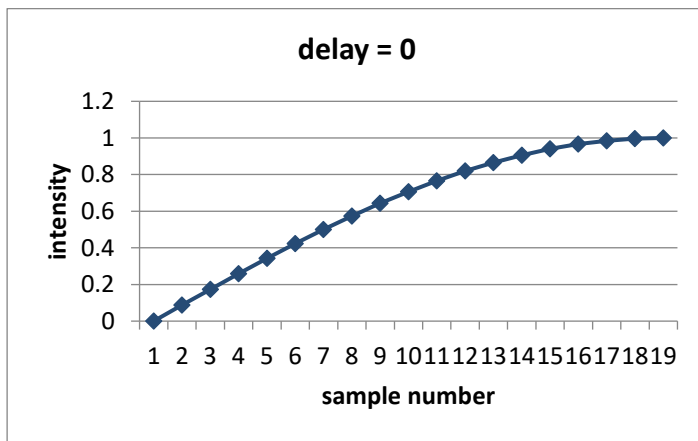
6.3.16 :SAMPLE:Y

Measures luminance in sample mode using a fixed integration time of 500us. When auto-range is enabled, this will adjust the gain.

Parameter:	Range:	
samples	1 – 100000	The number of samples to measure
delay	0 – 255	Delay in number of samples.

Return Parameter:	Range:	Description:
dt	float	1 st 4 bytes are delta time, time step
Clip level	float	2 nd 4 bytes are clip level, value between 0 and 1
Temp	float	3 rd 4 bytes are temperature
Y samples	float	Y values for given number of samples

A delay of one, means that 2 samples are getting averaged. A delay of 2 means that 3 samples will be averaged. So, with a delay of 1 measures the double amount of time is measured.



Action	Data	Termination	Format
write	:SAMPLE:Y 2000,0	LF	ASCII
read	0x3A 0x03 0x12 0x6F 0x00 0x00 0x00 0x00 0x42 0xC8 0x77 0xCF 0x42 0xC6 0x77 0xCF etc		Binary (4-bytes float array), big endian

6.3.17 :SAMPLE:FAST:Y

Measures in sample mode using a fixed integration time of 320us (3.125k sampling speed). When auto-range is enabled, this will adjust the gain.

Parameter:	Range:	
samples	1 – 100000	The number of samples to measure
delay	0 – 255	Delay in number of samples.
Return Parameter:	Range:	Description:
dt	float	1 st 4 bytes are delta time, time step
Clip level	float	2 nd 4 bytes are clip level, value between 0 and 1
Temp	float	3 rd 4 bytes are temperature
Y samples	float	Y values for given number of samples

A delay of one, means that 2 samples are getting averaged. A delay of 2 means that 3 samples will be averaged. So, with a delay of 1 measures the double amount of time is measured.

Action	Data	Termination	Format
write	:SAMPLE:FAST:Y 3125,0	LF	ASCII
read	0x3A 0x03 0x12 0x6F 0x00 0x00 0x00 0x00 0x42 0xC8 0x77 0xCF 0x42 0xC6 0x77 0xCF etc		Binary (4-bytes float array), big endian

6.3.18 :SAMPLE:XYZ

Measures in sample mode using either autorange or a fixed integration time. Parameters have the same meaning as with “:SAMPLE:Y”. The returned data is in XYZ format.

Parameter:	Range:	
samples	1 – 50000	The number of samples to measure
delay	0 – 255	Delay in number of samples.

Return Parameter:	Range:	Description:
dt	float	1 st 4 bytes are delta time, time step
Clip level	float	2 nd 4 bytes are clip level, value between 0 and 1
Temp	float	3 rd 4 bytes are temperature
XYZ samples	float	XYZ values for given number of samples

Action	Data	Termination	Format
write	:SAMPLE:XYZ 200,0	LF	ASCII
Read	0x3A 0x83 0x12 0x6F 0x00 0x00 0x00 0x00 0x42 0xC8 0xAE 0x14 0x42 0xC6 0x77 0xCF 0x42 0xC9 0x14 0x7B etc....		Binary (4-bytes float array), big endian

When using this command one should be very careful when using autorange, since integration time is part of this function integration time (and gain off course) will be automatically set depending on the luminance level. In other words at low luminance levels this function can take a very long time.

6.3.19 :MEASure:ALL

This command returns the CIE1931 XYZ result, Yxy, the XYZ result with SBW=OFF, Saturation of XYZ and clip and noise. The parameters are separated by a comma “,”. In total 14 parameters are returned. If clip and noise (both boolean) are 0 the measurement is fine, if clip is 1 the measurement is clipped (thus wrong). If noise is 1 the luminance level is not high enough. In case very dark patterns are measured, the noise indication can be 1 even while results are still usable. In case of clip, a measurement is always wrong.

Return Parameter:	Range:	Description:
XYZ	float	CIE1931 XYZ using the selected SBW (:SENSe:SBW)
Yxy	float	Yxy luminance and colour
XYZoff	float	XYZ without before calibration matrix (SBW=OFF).
XYZsat	float	Saturation level of X, Y and Z ranging between 0-1.0.
Clip	0-1	signal ok (0) or clipped (1).
Noise	0-1	Signal ok (0) or low signal (1).

Action	Data	Termination	Format
write	:MEASure:ALL	LF	ASCII
read	10.185714,10.090810,7.069953,1 0.090810,0.372469,0.368999,10. 508475,10.359972,7.362185,0.42 2745,0.409356,0.122578,0,0	LF	ASCII

6.3.20 :MEASure:VSYNCFREQuency

This command measured the Vsync frequency on the instrument's trigger input terminal.

Before using this command, it is advised to use :RESET:VSYNCFREQuency to start the counter at zero.

Return Parameter:	Range:	Description:
VsyncMax		Maximum frequency [Hz]
VsyncMin		Minimum frequency [Hz]
NrOfPulses		Number of measured Vsync pulses.

Action	Data	Termination	Format
write	:MEASure:VSYNCFREQuency	LF	ASCII
read	60.978, 59.898,100	LF	ASCII

6.3.21 :RESET:VSYNCFREQuency

This command resets the counter for Vsync measurement.

Action	Data	Termination	Format
write	:RESET:VSYNCFREQUENCY	LF	ASCII
Read	Not applicable	LF	ASCII

6.3.22 :MEASure:UHLXYZ

Measures the CIE 1931 XYZ returns the same as :MEASure:XYZ but the values are measured in Ultra High Luminance mode (UHL).

This measurement should only be used for very high luminance values, where the normal measurement functions (:MEASure:XYZ) cannot measure correctly anymore. Care must be taking when measuring PWM signal, advised is to test the output stability with increasing the UHL averaging (:SENSe:UHLAVER).

The applied averaging is set by :SENSe:UHLAVER! The :SENSe:AVERage is **not** used in this measurement.

Action	Data	Termination	Format
write	:MEASure:UHLXYZ	LF	ASCII
read	10000.1234,10000.432,10000.78 932,0,0	LF	ASCII

6.3.23 :SAMPLE:NORMAL:XYZ

Measures XYZ in sample mode using a fixed integration time of 500us (2k sampling speed). When auto-range is enabled, this will adjust the gain.

Parameter:	Range:	
samples	1 – 50000	The number of samples to measure
delay	0 – 255	Delay in number of samples.

Return Parameter:	Range:	Description:
dt	float	1 st 4 bytes are delta time, time step
Clip level	float	2 nd 4 bytes are clip level, value 0 or 1
Temp	float	3 rd 4 bytes are temperature
XYZ samples	float	XYZ values for given number of samples

Action	Data	Termination	Format
write	:SAMPle:NORMAL:XYZ 200,0	LF	ASCII
Read	0x3A 0x83 0x12 0x6F 0x00 0x00 0x00 0x00 0x42 0xC8 0xAE 0x14 0x42 0xC6 0x77 0xCF 0x42 0xC9 0x14 0x7B etc....		Binary (4-bytes float array), big endian

6.3.24 :SAMPLE:FAST:XYZ

Measures XYZ in sample mode using a fixed integration time of 320us (3.125k sampling speed). When auto-range is enabled, this will adjust the gain.

Parameter:	Range:	
samples	1 – 50000	The number of samples to measure
delay	0 – 255	Delay in number of samples.

Return Parameter:	Range:	Description:
dt	float	1 st 4 bytes are delta time, time step
Clip level	float	2 nd 4 bytes are clip level, value 0 or 1
Temp	float	3 rd 4 bytes are temperature
XYZ samples	float	XYZ values for given number of samples

Action	Data	Termination	Format
write	:SAMPle:FAST:XYZ 200,0	LF	ASCII
Read	0x3A 0x83 0x12 0x6F 0x00 0x00 0x00 0x00 0x42 0xC8 0xAE 0x14 0x42 0xC6 0x77 0xCF 0x42 0xC9 0x14 0x7B etc....		Binary (4-bytes float array), big endian

6.3.25 :SAMPLE:INTTIME:XYZ

Measures XYZ in sample mode using a flexible integration time (set by the third parameter). When auto-range is enabled, this will adjust the gain.

Parameter:	Range:	
samples	1 – 50000	The number of samples to measure
delay	0 – 255	Delay in number of samples.
Int time	320-1000000	integration time in us

Return Parameter:	Range:	Description:
dt	float	1 st 4 bytes are delta time, time step
Clip level	float	2 nd 4 bytes are clip level, value 0 or 1
Temp	float	3 rd 4 bytes are temperature
XYZ samples	float	XYZ values for given number of samples

Action	Data	Termination	Format
write	:SAMPle:INTTIME:XYZ 200,0,2000	LF	ASCII
Read	0x3A 0x83 0x12 0x6F 0x00 0x00 0x00 0x00 0x42 0xC8 0xAE 0x14 0x42 0xC6 0x77 0xCF 0x42 0xC9 0x14 0x7B etc....		Binary (4-bytes float array), big endian

6.4 User EEPROM configuration commands

With the user EEPROM configuration commands the user can program the device start-up values. This determines the configuration on how the devices powers up without writing any command. If a user has multiple devices and configures the EEPROM values with the same values the program to control the device can be dramatically simplified. Programming the user EEPROM values can be done by the software supplied by Admesy and WellVision or by writing your own program with below described commands.

When writing the EEPROM configuration commands one should always finish the sequence with the “:EEPROM:STARTUP:WRITE” command. This command copies the values from RAM to EEPROM. All the other commands write to RAM only.

A small example is given in the sample section.

It is recommended after writing and storing the values into the EEPROM that you re-power or reboot (:BOOT:REBOOT) the device.

6.4.1 :EEPROM:STARTUP:WRITE

This command stores all the values from RAM to EEPROM. It is important to wait 20ms after sending this command. Storing physically to the EEPROM requires some time.

Action	Data	Wait	Termination	Format
write	:EEPROM:STARTUP:WRITE	20ms	LF	ASCII
read	Not applicable	—	—	—

6.4.2 :EEPROM:STARTUP:READ

This command reads the values from EEPROM back to RAM.

Before reading EEPROM values (by EEPROM:CONFigure:...? Commands) it is recommended to send this command first.

Action	Data	Termination	Format
Write	:EEPROM:STARTUP:READ	LF	ASCII
Read	Not applicable	—	—

6.4.3 :EEPROM:CONFigure:BAUDRate

The baudrate of RS232 can be set with this command. Baudrate [bits/s] setting is the following

Value	Baudrate [bits/s]
0	9600
1	19200
2	38400
3	57600
4	115200

Action	Data	Termination	Format
write	:EEPROM:CONFigure:BAUDRATE 0	LF	ASCII
read	Not applicable	—	—

6.4.4 :EEPROM:CONFigure:BAUDRate?

The baudrate of RS232 can be read back. Baudrate values read back correspond to the following Baudrate:

Value	Baudrate [bits/s]
0	9600
1	19200
2	38400
3	57600
4	115200

Action	Data	Termination	Format
write	:EEPROM:CONFigure:BAUDRATE?	LF	ASCII
read	0	LF	ASCII

6.4.5 :EEPROM:CONFigure:TRIG

Sets the initial trigger mode to on (1) or off (0)

Action	Data	Termination	Format
write	:EEPROM:CONFigure:TRIG 0	LF	ASCII
read	Not applicable	LF	ASCII

6.4.6 :EEPROM:CONFigure:TRIG?

Reads the initial trigger mode.

Action	Data	Termination	Format
write	:EEPROM:CONFigure:TRIG?	LF	ASCII
read	0	LF	ASCII

6.4.7 :EEPROM:CONFigure:TRIGDELAY

Sets the trigger delay in microseconds [uS]. WVCN-4 measurement will start after this delay.

Action	Data	Termination	Format
Write	:EEPROM:CONFigure:TRIGDELAY 166666	LF	ASCII
Read	Not applicable	LF	ASCII

6.4.8 :EEPROM:CONFigure:TRIGDELAY?

Reads the trigger delay value in microsecond [uS]

Action	Data	Termination	Format
Write	:EEPROM:CONFigure:TRIGDELAY?	LF	ASCII
Read	166666	LF	ASCII

6.4.9 :EEPROM:CONFigure:LPFREQ

Sets the low pass frequency [Hz]. This is used for MIN/MAX and RMS flicker method only.

Action	Data	Termination	Format
write	:EEPROM:CONFigure:LPFREQ 40	LF	ASCII
read	Not applicable	LF	ASCII

6.4.10 :EEPROM:CONFigure:LPFREQ?

Reads the low pass frequency [Hz].

Action	Data	Termination	Format
write	:EEPROM:CONFigure:LPFREQ?	LF	ASCII
read	40	LF	ASCII

6.4.11 :EEPROM:CONFigure:AVG

Sets the initial averaging.

Action	Data	Termination	Format
write	:EEPROM:CONFigure:AVG 1	LF	ASCII
read	Not applicable	LF	ASCII

6.4.12 :EEPROM:CONFigure:AVG?

Reads the initial averaging value.

Action	Data	Termination	Format
write	:EEPROM:CONFigure:AVG?	LF	ASCII
read	1	LF	ASCII

6.4.13 :EEPROM:CONFigure:WHITE

Sets the white reference to be used for dominant wavelength calculation.

Action	Data	Termination	Format
write	:EEPROM:CONFigure:WHITE D65	LF	ASCII
read	Not applicable	LF	ASCII

6.4.14 :EEPROM:CONFigure:WHITE?

Reads the white reference point that is used for dominant wavelength calculation.

Action	Data	Termination	Format
write	:EEPROM:CONFigure:WHITE?	LF	ASCII
read	D65	LF	ASCII

6.4.15 :EEPROM:CONFigure:AUTO:FREQ

Sets the DUT frequency [Hz].

Action	Data	Termination	Format
write	:EEPROM:CONFigure:AUTO:FREQ 59.789	LF	ASCII
read	Not applicable	LF	ASCII

6.4.16 :EEPROM:CONFigure:AUTO:FREQ?

Reads the DUT frequency [Hz].

Action	Data	Termination	Format
write	:EEPROM:CONFigure:AUTO:FREQ?	LF	ASCII
read	59.789	LF	ASCII

6.4.17 :EEPROM:CONFigure:AUTO:FRAMES

Sets the number of frames to be measured. Only in case a display is not stable, this value can be set higher.

Action	Data	Termination	Format
write	:EEPROM:CONFigure:AUTO:FRAMES 1	LF	ASCII
read	Not applicable	LF	ASCII

6.4.18 :EEPROM:CONFigure:AUTO:FRAMES?

Reads the number of frames to be measured.

Action	Data	Termination	Format
write	:EEPROM:CONFigure:AUTO:FRAMES?	LF	ASCII
read	1	LF	ASCII

6.4.19 :EEPROM:CONFigure:AUTO:Orange

Sets the autorange on (1) or off (0)

Action	Data	Termination	Format
write	:EEPROM:CONFigure:AUTO:Orange 1	LF	ASCII
read	Not applicable	LF	ASCII

6.4.20 :EEPROM:CONFigure:AUTO:Orange?

Reads whether auto-range is used.

Action	Data	Termination	Format
write	:EEPROM:CONFigure:AUTO:Orange?	LF	ASCII
read	1	LF	ASCII

6.4.21 :EEPROM:CONFigure:AUTO:ADJMIN

Sets the ADJMIN value. ADJMIN is a percentage of the saturation. 100% saturation equals clip. In auto-range mode measurement data is passed when the signal level is higher than ADJMIN (15% for example). ADJMIN should normally not be set higher than 30.

Action	Data	Termination	Format
write	:EEPROM:CONFigure:AUTO:ADJMIN 15	LF	ASCII
read	Not applicable	LF	ASCII

6.4.22 :EEPROM:CONFigure:AUTO:ADJMIN?

Reads the ADJMIN value in percentual value [%].

Action	Data	Termination	Format
write	:EEPROM:CONFigure:AUTO:ADJMIN?	LF	ASCII
read	15	LF	ASCII

6.4.23 :EEPROM:CONFigure:AUTO:MAXINT

Sets the maximum integration time in microseconds [uS]. Best practice is to chose a maximum integration time of a multitude of frame. For example when a DUT is 60Hz, chose maximum integration time as a multiple of 16.666ms for example 300000.

Action	Data	Termination	Format
write	:EEPROM:CONFigure:AUTO:MAXINT 300000	LF	ASCII
read	Not applicable	LF	ASCII

6.4.24 :EEPROM:CONFigure:AUTO:MAXINT?

Sets the maximum integration time in microseconds [uS].

Action	Data	Termination	Format
write	:EEPROM:CONFigure:AUTO:MAXINT?	LF	ASCII
read	200000	LF	ASCII

6.4.25 :EEPROM:CONFigure:AUTO:MODE

Sets the autorange mode.

Action	Data	Termination	Format
write	:EEPROM:CONFigure:AUTO:MODE 1	LF	ASCII
read	Not applicable	LF	ASCII

Mode	Meaning	Adjmin	Maxint
0	Fast	20	50000
1	Normal	20	250000
2	Slow	20	600000
3	Hi-sense	20	1000000
4	Manual	manual	manual

6.4.26 :EEPROM:CONFigure:AUTO:MODE?

Reads the autorange mode.

Action	Data	Termination	Format
write	:EEPROM:CONFigure:AUTO:MODE?	LF	ASCII
read	1	LF	ASCII

6.4.27 :EEPROM:CONFigure:INT

Sets the initial integration time in microseconds [uS].

Action	Data	Termination	Format
write	:EEPROM:CONFigure:INT 16666	LF	ASCII
read	Not applicable	LF	ASCII

6.4.28 :EEPROM:CONFigure:INT?

Reads the initial integration time in microseconds [uS].

Action	Data	Termination	Format
write	:EEPROM:CONFigure:INT?	LF	ASCII
read	16666	LF	ASCII

6.4.29 :EEPROM:CONFigure:GAIN

Sets the initial gain 1 - 3.

Action	Data	Termination	Format
write	:EEPROM:CONFigure:GAIN 3	LF	ASCII
read	Not applicable	LF	ASCII

6.4.30 :EEPROM:CONFigure:GAIN?

Reads the initial gain.

Action	Data	Termination	Format
write	:EEPROM:CONFigure:GAIN?	LF	ASCII
read	3	LF	ASCII

6.4.31 :EEPROM:CONFigure:SBW

Sets the initial calibration matrix.

Action	Data	Termination	Format
write	:EEPROM:CONFigure:SBW 0	LF	ASCII
read	Not applicable	LF	ASCII

Note: user1=0, user2=1 etc...

6.4.32 :EEPROM:CONFigure:SBW?

Sets the initial calibration matrix.

Action	Data	Termination	Format
write	:EEPROM:CONFigure:SBW?	LF	ASCII
read	0	LF	ASCII

6.4.33 :EEPROM:READ:SN

Reads the instrument serial number.

Action	Data	Termination	Format
write	:EEPROM:READ:SN	LF	ASCII
read	00001	LF	ASCII

6.4.34 :EEPROM:WRITE:ID

Writes a device ID to the instrument. This ID can be used by applications to identify the device without using the serial number.

Action	Data	Termination	Format
write	:EEPROM:WRITE:ID 1	LF	ASCII
read	Not applicable	LF	ASCII

6.4.35 :EEPROM:READ:ID

Reads the device ID from the instrument.

Action	Data	Termination	Format
write	:EEPROM:READ:ID	LF	ASCII
read	1	LF	ASCII

6.5 User calibration commands

With the user EEPROM calibration commands the user can program calibration matrices or calibrate dark. The instrument can contain up to 30 matrices.

6.5.1 :EEPROM:READ:USERCAL

This command all calibration data from EEPROM to RAM.

Action	Data	Termination	Format
write	:EEPROM:READ:USERCAL	LF	ASCII
read	Not applicable		

6.5.2 :EEPROM:WRITE:USERCAL

This command stores the written values of the 3x3 matrices into the EEPROM.

Wait 20ms after writing this command. This is the necessary time for the EEPROM to physically store everything.

Action	Data	Wait	Termination	Format
write	:EEPROM:WRITE:USERCAL	20ms	LF	ASCII
read	Not applicable			

6.5.3 :EEPROM:SBW:WRITE

This command write the values of the 3x3 matrix to the device

XYZ values returning from the devices are multiplied with this matrix when SBW is set to “user”. This can be done with the “:SENSe:SBW” command.

Calculation inside the device will be the following

$$\begin{bmatrix} X_{new} \\ Y_{new} \\ Z_{new} \end{bmatrix} = M \times \begin{bmatrix} X_{dut} \\ Y_{dut} \\ Z_{dut} \end{bmatrix}$$

M is the matrix, the formula can also be written in the following equation

$$\begin{bmatrix} X_{new} \\ Y_{new} \\ Z_{new} \end{bmatrix} = \begin{bmatrix} CF_{0,0} & CF_{0,1} & CF_{0,2} \\ CF_{1,0} & CF_{1,1} & CF_{1,2} \\ CF_{2,0} & CF_{2,1} & CF_{2,2} \end{bmatrix} \times \begin{bmatrix} X_{dut} \\ Y_{dut} \\ Z_{dut} \end{bmatrix}$$

Writing the correction factors must be done in 9 steps where in each step you write five parameters.

After each write wait 5ms.

Command	Write Parameter
:EEPROM:SBW:WRITE	matrixID, row, col, value

Action	Data	Wait	Termination	Format
write	:EEPROM:SBW:WRITE 0,0,0,1.01	5ms	LF	ASCII
write	:EEPROM:SBW:WRITE 0,1,0,0.002	5ms	LF	ASCII
write	:EEPROM:SBW:WRITE 0,2,0,0.041	5ms	LF	ASCII
write	:EEPROM:SBW:WRITE 0,0,1,-0.035	5ms	LF	ASCII
write	:EEPROM:SBW:WRITE 0,1,1,0.98	5ms	LF	ASCII
write	:EEPROM:SBW:WRITE 0,2,1,0.11	5ms	LF	ASCII
write	:EEPROM:SBW:WRITE 0,0,2,0.021	5ms	LF	ASCII
write	:EEPROM:SBW:WRITE 0,1,2,-0.016	5ms	LF	ASCII
write	:EEPROM:SBW:WRITE 0,2,2,1.102	5ms	LF	ASCII
Read	Not applicable			

To write the matrix name, use index 11:

Action	Data	Wait	Termination	Format
write	:EEPROM:SBW:WRITE 0,11,0,myMatrix	5ms	LF	ASCII

To write the matrix calibration date, use index 12:

Action	Data	Wait	Termination	Format
write	:EEPROM:SBW:WRITE 0,12,0,20200706	5ms	LF	ASCII

Note : For names and dates, only use pure ASCII code without spaces, commas or any other special characters except underscores if needed.

6.5.4 :EEPROM:SBW:READ

This command reads the values of a 3x3 matrix from the device.

Command	Write Parameter
:EEPROM:SBW:READ	matrixID, row, col

Returned value is the correction factor.

Action	Data	Termination	Format
write	:EEPROM:SBW:READ 0,0,0	LF	ASCII
read	1.01	LF	ASCII
write	:EEPROM:SBW:READ 0,1,0	LF	ASCII
read	0.002	LF	ASCII
write	:EEPROM:SBW:READ 0,2,0	LF	ASCII
read	0.041	LF	ASCII
write	:EEPROM:SBW:READ 0,0,1	LF	ASCII
read	-0.035	LF	ASCII
write	:EEPROM:SBW:READ 0,1,1	LF	ASCII
read	0.98	LF	ASCII
write	:EEPROM:SBW:READ 0,2,1	LF	ASCII
read	0.11	LF	ASCII
write	:EEPROM:SBW:READ 0,0,2	LF	ASCII
read	0.021	LF	ASCII
write	:EEPROM:SBW:READ 0,1,2	LF	ASCII
read	-0.016	LF	ASCII
write	:EEPROM:SBW:READ 0,2,2	LF	ASCII
read	1.102	LF	ASCII

To read the matrix name, use index 11:

Action	Data	Termination	Format
write	:EEPROM:SBW:READ 0,11,0	LF	ASCII
read	myMatrix	LF	ASCII

To read the matrix calibration date, use index 12:

Action	Data	Wait	Termination	Format
write	:EEPROM:SBW:READ 0,12,0	5ms	LF	ASCII
read	20200706	LF	ASCII	

6.5.5 :EEPROM:READ:SBWNAME

This command reads the matrix name. It has the same functionality as “:EEPROM:SBW:READ” with index 11.

Action	Data	Wait	Termination	Format
write	:EEPROM:READ:SBWNAME	20ms	LF	ASCII
read	myMatrix			

6.5.6 :CALibrate:INLINEDARK

Does a zero calibration. Input is 0 (slow mode) or 1 (fast mode), slow function approximately takes 48 seconds but has a slightly higher accuracy, fast mode is faster but has slightly less accuracy.

Returns: 0 = success, negative values indicate dark calibration is failed. -1 is slope is positive, -2 is correlation coefficient out of range, -3 is intercept out of range.

Only on success the dark calibration is stored in the EEprom.

Action	Data	Wait	Termination	Format
write	:CALibrate:INLINEDARK 1		LF	ASCII
read	0			

The following tables show the used integration time and averaging.

Mode	Integration time	Averaging
Slow	500	50
Slow	2500	50
Slow	5000	40
Slow	10000	40
Slow	16666	40
Slow	33333	20
Slow	50000	20
Slow	100000	20
Slow	250000	10
Slow	500000	8
Slow	1000000	4

Mode	Integration time	Averaging
Fast	500	50
Fast	10000	50
Fast	250000	10

6.5.7 :CALibrate:REFRed

Sends red reference data to the firmware to use with the “:CALCulate:MATRix” command.

Action	Data	Wait	Termination	Format
write	:CALibrate:REFRed 316.8,148.2,3.867		LF	ASCII
read	Not applicable			

6.5.8 :CALibrate:REFGreen

Sends green reference data to the firmware to use with the “:CALCulate:MATRix” command.

Action	Data	Wait	Termination	Format
write	:CALibrate:REFGreen 169.9, 467.7, 25.27		LF	ASCII
read	Not applicable			

6.5.9 :CALibrate:REFBlue

Sends blue reference data to the firmware to use with the “:CALCulate:MATRix” command.

Action	Data	Wait	Termination	Format
write	:CALibrate:REFBlue 109.4, 35.62, 607.2		LF	ASCII
read	Not applicable			

6.5.10 :CALibrate:REFWhite

Sends white reference data to the firmware to use with the “:CALCulate:MATRix” command.

Action	Data	Wait	Termination	Format
write	:CALibrate:REFWhite 504.2, 536.5, 576.2		LF	ASCII
read	Not applicable			

6.5.11 :CALibrate:ADIRed

Sends red OFF data to the firmware to use with the “:CALCulate:MATRix” command.

Action	Data	Wait	Termination	Format
write	:CALibrate:ADIRed 332.008, 166.471, 1.351		LF	ASCII
read	Not applicable			

6.5.12 :CALibrate:ADIGreen

Sends green OFF data to the firmware to use with the “:CALCulate:MATRix” command.

Action	Data	Wait	Termination	Format
write	:CALibrate:ADIGreen 170.936, 492.498 25.9895		LF	ASCII
read	Not applicable			

6.5.13 :CALibrate:ADIBlue

Sends blue OFF data to the firmware to use with the “:CALCulate:MATRix” command.

Action	Data	Wait	Termination	Format
write	:CALibrate:ADIBlue 128.976, 31.1539, 665.915		LF	ASCII
read	Not applicable			

6.5.14 :CALibrate:ADIWhite

Sends white OFF data to the firmware to use with the “:CALCulate:MATRix” command.

Action	Data	Wait	Termination	Format
write	:CALibrate:ADIWhite 539.03, 571.878, 632.327		LF	ASCII
read	Not applicable			

6.5.15 :CALCulate:MATRix

Calculates a new matrix using the uploaded REF and ADI data from the previous commands using the selected method. The resulting matrix is returned by this command. In case all zeros are returned, the calculation has failed.

Parameter:	Range:	Description:
method	0,1,2,3	The matrix calculation method 0 = FCCM 1 = RGB 2 = RGBW 3 = Linear

When selecting linear, the REFWhite and ADIWhite data is used.

Action	Data	Wait	Termination	Format
write	:CALCulate:MATRix 0		LF	ASCII
read	0.940487,0.017045,-0.019766,- 0.034356,0.953750,0.015167,0.007618,0 .000569,0.904229			

6.5.16 :EEPROM:WRITe:MATRix

Write the matrix, calculated by the “:CALCulate:MATRix” command to eeprom.

Note, this command only write to EEPROM but does not automatically select this matrix. Use the “:SENSe:SBW” command to select the new matrix.

Parameter:	Range:	Description:
Matrix number	1-30	The user matrix number to write.
Matrix name	ASCII string	The name of the matrix (maximum length is 9)
Calibration date	ASCII string	The calibration date (maximum length is 11)

Action	Data	Wait	Termination	Format
write	:EEPROM:WRITe:MATRix 1,fccm,10032021		LF	ASCII
read	Not applicable			

7 EXTERNAL TRIGGERING

The WVCM-4 can make use of an external trigger. When using this feature, the WVCM-4 will repeat the last send “:MEASure” or “:SAMPLE” command when it receives a hardware trigger.

When WVCM-4 operates in trigger mode, the host software does only need to read data. This can be done by just polling or by first checking whether this is data available by reading the WVCM-4 trigger output, which becomes a high level after the triggered command has been finished. The latter is recommended.

7.1 Normal Trigger mode

Using external trigger mode can be enable by sending “:SENSe:TRIG 1” command. In this mode the WVCM-4 will start a measurement when receiving trigger in pulse. This mode is equivalent to the “:MEASure” or “:SAMPLE” commands.

Command	purpose
:SENSe:AUTOrange 1	Set autorange on
:MEASure:XYZ	Measure XYZ to be sure the applicable command is executed. <i>Note: always read the data output after this command!</i>
:SENSe:TRIG 1	Enable trigger mode
Send trigger pulse	
Wait for trigger output to become high again, or poll the communication bus for data.	

8 3X3 MATRIX – HOW TO CALCULATE

Below the formula is given on how to determine a 3x3 matrix.

- Matrix M is determined on RGB colors
- X_{rr} means X value of reference for the red color
- Y_{dg} means Y value of DUT for the green color
- T is a transposed matrix
- -1 is an inverse matrix

$$M = \begin{bmatrix} CF_{0,0} & CF_{0,1} & CF_{0,2} \\ CF_{1,0} & CF_{1,1} & CF_{1,2} \\ CF_{2,0} & CF_{2,1} & CF_{2,2} \end{bmatrix} = \left(\begin{bmatrix} X_{rr} & X_{rg} & X_{rb} \\ Y_{rr} & Y_{rg} & Y_{rb} \\ Z_{rr} & Z_{rg} & Z_{rb} \end{bmatrix} \times \begin{bmatrix} X_{dr} & X_{dg} & X_{db} \\ Y_{dr} & Y_{dg} & Y_{db} \\ Z_{dr} & Z_{dg} & Z_{db} \end{bmatrix}^T \right) \times \left(\begin{bmatrix} X_{dr} & X_{dg} & X_{db} \\ Y_{dr} & Y_{dg} & Y_{db} \\ Z_{dr} & Z_{dg} & Z_{db} \end{bmatrix} \times \begin{bmatrix} X_{dr} & X_{dg} & X_{db} \\ Y_{dr} & Y_{dg} & Y_{db} \\ Z_{dr} & Z_{dg} & Z_{db} \end{bmatrix}^T \right)^{-1}$$

9 CODING EXAMPLES

9.1 Configuration and measurement examples

First example how to perform an XYZ measurement in auto-range and measure a dark image not using auto-range.

Command	Result	Remark
:SENSe:AUTORANGE 1	---	set autorange on
:MEAS:XYZ	XYZ data	Acquire XYZ data
:SENSe:AUTORANGE 0	---	Set autorange off
:SENSe:GAIN 1	---	Select most sensitive gain
:SENSe:INT 200000	---	Set a high exposure time
:MEAS:XYZ	XYZ data	Acquire XYZ data

Perform a signal sampling using auto-range.

Command	Result	Remark
:SENSe:AUTORANGE 1	---	set autorange on
:SAMPle:Y 2000,0	2000 luminance points	Acquire high speed Luminance data. 2000 measurements per second.
:SENSe:AUTORANGE 0	---	Set autorange off
:SENSe:GAIN 1	---	Select most sensitive gain, for a low luminance DUT.
:SAMPle:Y 2000,0	---	Acquire high speed Luminance data. 2000 measurements per second.

9.2 User eeprom configuration example

A simple example is given for writing the baudrate and auto-range setting to the eeprom.

Command	Wait	Remark
:EEPROM:CONFigure:AUTOrange 1		write auto-range start up setting. Auto-range setting is switched on
:EEPROM:CONFigure:BAUDRATE 0		Baudrate setting is set to 9600
:EEPROM:STARTUP:WRITE	20ms	auto-range and baudrate setting are stored inside the eeprom.

9.3 Calc and calibrate matrix example

An example is given for a sequence which describes measuring, calculating and storing a calibration matrix into the WVCN-4.

Red is a customer action which is not related to the WVCN-4

Command	Wait	Remark
Set display to red	xx ms	
Measure XYZ with reference device		Get XYZref from reference device
MEASure:ALL		WVCN-4 returns XYZ,Yxy,XYZoff,XYZsat. Extract XYZoff from this data, this is needed for calibration
:CALibrate:REFRed Xref,Yref,Zref		Write XYZ reference values to WVCN-4 for red
:CALibrate:AIDRed Xoff,Yoff,Zoff		Write WVCN-4 XYZoff (uncalibrated) values to WVCN-4 for red
Set display to green	xx ms	
Measure XYZ with reference device		Get XYZref from reference device
MEASure:ALL		WVCN-4 returns XYZ,Yxy,XYZoff,XYZsat. Extract XYZoff from this data, this is needed for calibration
:CALibrate:REFGreen Xref,Yref,Zref		Write XYZ reference values to WVCN-4 for green
:CALibrate:AIDGreen Xoff,Yoff,Zoff		Write WVCN-4 XYZoff (uncalibrated) values to WVCN-4 for green
Set display to blue	xx ms	
Measure XYZ with reference device		Get XYZref from reference device
MEASure:ALL		WVCN-4 returns XYZ,Yxy,XYZoff,XYZsat. Extract XYZoff from this data, this is needed for calibration
:CALibrate:REFBlue Xref,Yref,Zref		Write XYZ reference values to WVCN-4 for blue
:CALibrate:AIDBlue Xoff,Yoff,Zoff		Write WVCN-4 XYZoff (uncalibrated) values to WVCN-4 for blue
Set display to white	xx ms	
Measure XYZ with reference device		Get XYZref from reference device
MEASure:ALL		WVCN-4 returns XYZ,Yxy,XYZoff,XYZsat. Extract XYZoff from this data, this is needed for calibration
:CALibrate:REFWhite Xref,Yref,Zref		Write XYZ reference values to WVCN-4 for white
:CALibrate:AIDWhite Xoff,Yoff,Zoff		Write WVCN-4 XYZoff (uncalibrated) values to WVCN-4 for white
CALCulate:MATRix 0		Calculate matrix based on method selection, returns the matrix by means of 9 values
:EEPROM:WRITE:MATRix 1,test,09032021		Matrix is programmed in user 1 with, name is called test and date of calibration is also written in the eeprom

10 AUTO-RANGE FUNCTION

10.1 Introduction

The WVCN-4 uses a gain and integration time setting for the sensor to perform the measurement. To manually set these values can be quite complex because the optimal settings depend on the luminance of the measured DUT.

In this case, the WVCN-4 will try to find the optimum setting which is a trade-off between speed and the stability of the instrument. The auto-range function can also be fine-tuned to reach better stability levels by setting a few parameters. Auto-ranging can be controlled by 3 parameters.

- Frequency : supposed to be frame frequency of the source (display) that is measured
- Adjmin : The minimum level to adjust to, this is the scale of the ADC expressed in %
- MAX int time: after this time has passed the device will not increase the integration time beyond this value even if the Adjmin level was not reached. This is to avoid a measurement time which takes forever. This can occur when virtually no light is present.

Adjmin can vary between 1 and 30. Adjmin effects the stability of the result. The higher the value the better the S/N ratio. If higher stability is needed, this setting must be increased (but measurements will become slower). If a faster measurement is needed and the stability level may be lowered a little, the value of adjmin can be decreased.

10.2 How autoranging works

The auto ranging works, by first setting a default integration time (1/FREQ). If this already meets the criteria for a good measurement, the measurement will be done using that integration time. It should be clear that this is the fastest because no adjustment will be done. In case the measured result is either too low or too high (clip) the WVCN-4 will adjust to a new level by using steps of at least 1/frequency. The following graph shows how levels inside the WVCN-4 work.

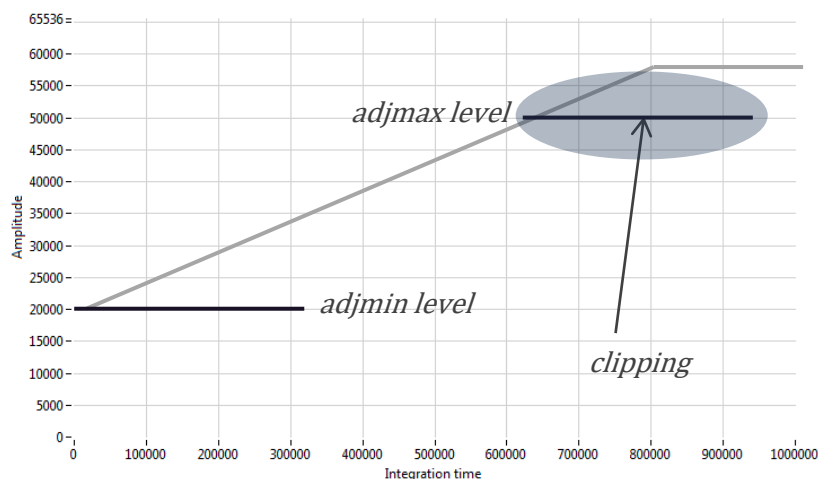


Figure 4 Autorange Levels

When auto-ranging is set, the WVCN-4 will accept any level between “Adjmin” and “Adjmax” as a good signal. The Adjmin level can be set by the user through a software command, allowing some fine tuning of the stability and the speed of the instrument.

10.3 Auto-range measurement parameters

Auto-range is controlled by the following parameters:

- Frequency: This setting must be set to the frame frequency of the measured sample. The range is 0 to 500 Hz.
- Adjmin: The adjmin parameter is very important. The higher this level is set, the more stable the measurement becomes, but it also slows down the measurement if set too high. That means, there is a trade-off between speed and stability. It mainly affects the lower grey scale levels. If these levels appear not stable, adjmin needs to be increased. Adjmin is set from 1-30, which means 1-30% of the Adjmax level (Adjmax is a fixed setting).
- Maximum integration time: Although not really part of the auto-ranging algorithm, this parameter is used when the auto-range algorithm would result in an integration time exceeding this value. This is to avoid measurement times which would last forever (in the case no light is present)
- Averaging: Average can be set by the user, average will not have influence on the time needed for finding the appropriate level, however when the appropriate level is found the “real” measurement is executed with the nr. of averages set.

10.4 Auto-range measurement time

The measurement time when using autorange usually is about 2 times the used integration time. Please consider this for your software time-out value. A good time-out value is in general 3x the max integration time but it doesn't hurt when setting a timeout value longer. The timeout setting does not affect the tact time.

10.5 WVCN-4 auto-range good practice settings

- Frequency: Frequency of your light source
- Display (DUT) 60Hz
- Adjmin: 10%
- Maximum integration time: 300000 us (0.3sec)
- Averaging: 1

The above settings are based on our experience and every application can be different. It is the responsibility of the end-user to validate the correct setting, no rights can be derived from above recommendation. It must be considered as a push in the right direction.

ADMESY

colorimeters | spectroradiometers | lightmeters

Sleestraat 3
6014 CA IJlervoorl
The Netherlands

+31 (0)475 600 232
info@admesy.com

admesy.com

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

Version 1.0.0 March 2026