Operating Instructions

Spectroradiometer
Firmware

Version: 1.5x (specbos 1211)

Version: 1.8x (specbos 1201)

Version: 2.x (SDC-BB)

JETI Technische Instrumente GmbH
Tatzendpromenade 2
D-07745 Jena
Tel. +49-3641-225 680
Fax. +49-3641-225 681
e-mail: sales @ jeti.com
Internet: www.jeti.com

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Table of Contents

1. Introduction 6

2. Remarks 7

2.1. General Remarks 7

2.2. Overview about Instrument Answers to the Firmware Commands 10

2.3. Meaning of Error Codes 10

3. Firmware Commands 12

3.1. Parameter Commands 12

3.2. Configuration Commands 20

3.3. Control Commands 22

3.4. Initiate and Abort Commands 24

3.5. Read Commands 24

3.6. Fetch Commands 24

3.7. Measuring Commands 25

3.8. Calculation Commands 27

3.9. Status Commands 29

3.10. Help Commands 30

3.11. Structure of Data Stream 32

4. Wavelength Range Definitions for JETI Firmware 36

5. Default Settings for JETI Instruments 37

6. Explanation of Split Time Concept 39

7. Examples of Measurement Procedures using Firmware Commands 40

7.1. Raw Data Operations 40

7.1.1 Raw Data Emission Measurement 40

7.1.2 Transmission Measurement (Pre configured) 40

7.2. Radiometric Measurements 41

7.2.1 Simple xyY measurement 41

7.2.2 Continuous source measurement 41

7.2.3 Pulsed source measurement (e.g. monitor) 43

8. Service 44

1. Introduction

The SCPI compatible JETI firmware commands allow to control the instruments in many variations. Generally it is possible to separate between

1 configuration of the measurement (*PARAmeter, *CONFigure)

2 initialization of the measurement (*INIT) and

3 control of output data (*FETCH, *CALCulate).

Alternatively it is possible to combine these tasks in one measurement command (*MEASure).

An overview about possible general procedures are given in application note 8 on www.jeti.com/cms/index.php/application-notes.

2. Remarks

2.1. General Remarks

Communication with the device can be using by special commands via the USB interface. This interface is designed as a virtual COM port, so it can be handled similarly to a serial port with the settings 8n1/ no protocol. The allowed transfer rates are 38 400, 115 200 and 921 600 Bd.

Remark! Baudrate 921 600 is not allowed for specbos 1211 RS and BT.

Default baud rate	Device
115 200 Bd	specbos 1211 RS specbos 1211 BT
921 600 Bd	specbos 1201 specbos 1211 SDC-BB

The following list shows the available command categories. They match the SCPI standard regulations, begin with * (except ESC) and have the following key words:

Commands	
*PARAmeter	Get and set general parameters
*CONfigure	Get and set configuration data
*INITiate	Start a configured measurement
*FETCH	Get data from previous measurement
*READ	Start a configured measurement and get the data (combination of *INIT and *FETCH)
*MEASure	Configure, start the measurement and get the data (combination of *CONF, *INIT and *FETCH)
*CALCulate	Calculate data from the previous measurement
*STATus	Information about error and configuration status
*HELP	Output of help information

These key words can be followed by one or two additional words, separated by colons, and by arguments. It is only necessary to use the indicated capital letters, other letters can be omitted.
Several commands can be extended by arguments. The meanings of the arguments are as follows:

tint	Integration time in ms, range from 1 … 64 999 ms
av	Average counts for measurement (1 … 10 000)

format	Output format (for a description of the data stream see chapter 3.11) 0 no output 1 L/H binary output without length and checksum 2 ASCII output, space separated (only for testing purposes) 3 L/H binary output with length and checksum 4 ASCII output, separated by <CR> 5 H/L binary output without length and checksum 6 H/L binary output with length and checksum 7 Raw data with wavelength 9 Interpolated ASCII output without wavelengths 10 Interpolated ASCII output with wavelengths 11 H/L binary integer interpolated output 12 H/L binary float interpolated output

function	Selection of output function 0 None 1 light (exposured) spectrum (with shutter opened/lamp on) 2 dark spectrum 3 reference spectrum (difference of exposured spectrum and dark spectrum) 4 transmission spectrum, unit: ‰ 5 absorption spectrum, unit: AU 6 radiometric spectrum, unit: depending from selected calibration file Radiance W/(m^2·sr·nm) Irradiance W/(m^2·nm) Radiant flux W/nm Radiant intensity W/(sr·nm) 7 Radiometric value, unit: dependend from selected calibration file Radiance W/(m^2·sr) Irradiance W/m^2 Radiant flux W Radiant intensity W/sr 8 Photometric value, unit: dependend from selected calibration file Luminance cd/m^2 Illuminance lx Luminous flux lm Luminous intensity cd 9 Chromaticity xy 10 Chromaticity u´v´ 11 Dominant wavelength and color purity 12 Radiometric, photometric, xy and u´v´ values, dominant wavelength and colour purity 13 Correlated color temperature (CCT) 14 CRI values
wbeg	Start of wavelength range, in nm (200 … 1099 nm)
wend	End of wavelength range, in nm (201 … 1100 nm)
wstp	Wavelength step (1 … 10 nm (integer)) (for radiometric calculation will be used 1 nm step)
temp	Color temperature of reference source for CRI calculation
filenr	Number of calibration file
arg	Other arguments, described in text

If commands with get and set options are used with ?, the stored value(s) will be given. If an argument is used, this argument will be set.

A space sign between command and argument is necessary (not in case of ?).

If a command which accepts arguments is used without arguments, then the configured arguments will be used (exception: tint – see *CONFigure:EXPOsure).
If a command was successfully proceeded it will be answered by an Acknowledge sign (ACK, 06 hex), otherwise the error message “Not acknowledged” (NAK, 15 hex) will be returned. The reason of an error can be read by the command *stat:err?<CR>.
Several commands can be written successively in one line, they have to be separated by semicolons.

2.2. Overview about Instrument Answers to the Firmware Commands

Command category	Answer
*PARA *CONF *CONTR	with setting of value and *PARA:SAVE: *ACK (06 hex),* if value is accepted *NAK (15 hex),* if value is not accepted with ? (data request): *data sequence* <CR>
*INIT	*ACK (06 hex)* immediately after command input *BELL (07 hex)* after finishing the measurement
*READ *MEAS	*ACK (06 hex)* immediately after command input **BELL (07 hex) after finishing the measurement** *data sequence* *<CR> <CR>* in case of spectral data output *<CR>* in case of single value output
ESC	*NAK (15 hex) (Error 147 – breakscan)* [1]
*FETCH *CALC	*data sequence* *<CR> <CR>* in case of spectral data output *<CR>* in case of single value output
*CALIB	with get: *data sequence* <CR> <CR> with state: *value* <CR>
*STAT	*Status information* <CR>
*HELP	*List with commands and description* <CR>

2.3. Meaning of Error Codes

Error codes:

0 : no error
4 : command error
7 : error password
8 : digit error
10 : error argument 1
11 : error argument 2
12 : error argument 3
13 : error argument 4
20 : error parameter argument
21 : error config argument
22 : error control argument
23 : error read argument
24 : error fetch argument

1 Valid for all scan functions

25 : error measuring argument
26 : error calculation argument
27 : error calibration argument
101 : error parameter checksum
102 : error userfile checksum
103 : error userfile2 checksum
104 : error userfile2 argument
120 : error overexposure
121 : error underexposure
123 : error adaption integration time
130 : error shutter not exist
131 : error no dark measurement
132 : error no reference measurement
133 : error no transmission measurement
134 : error no radiometric calculation
135 : error no cct calculation
136 : error no cri calculation
137 : error no dark compensation
138 : error no light measurement
139 : error no peak calculation
140 : error calibration data
141 : error exceed calibration wavelength
147 : error scan break
160 : error timeout cycle optical trigger
161 : error divider cycle time
170 : error write parameter to flash
171 : error read parameter from flash
172 : error erase flash
180 : error no calib file
181 : error calib file header
182 : error write calib file
183 : error calib file values
184 : error calib file number
186 : error clear calib file
187 : error clear calib file argument
190 : error no lamp file
191 : error lamp file header
192 : error write lamp file
193 : error lamp file values
194 : error lamp file number
196 : error clear lamp file
197 : error clear lamp file argument
200 : error ram check
220 : error data output
225 : error insufcient ram
230 : error first memory allocation
231 : error second memory allocation
232 : error third memory allocation
251 : error wavelength range for radiometric calculation
280 : error jump boot by battery power
500 : error trigger configuration 1
501 : error trigger configuration 2

3. Firmware Commands

3.1. Parameter Commands

These commands allow the basic settings of the instrument. They are set in factory and normally the user has no reason to change them. **Keep in mind that changed parameters can cause errors in measurement.**

General Settings

*PARAmeter? <CR>	Get a help list of the parameter commands

	Example of answer:
	`*RST<CR>: softwarereset`
	`*IDN?: get device ID`
	`*VERS?: get firmware version`
	`*PARAmeter:CHANnel?: get channel count`
	`*PARAmeter:PIXel: get/set pixelcount`
	`*PARAmeter:SENSor: get/set sensor type`
	`*PARAmeter:SDELay: get/set scan delay`
	`*PARAmeter:ADCType: get/set adc parameters`
	`etc.`

*RST<CR>	Software reset
*IDN? <CR>	Get device ID
	Example of answer: `JETI_SB1211`
*VERS? <CR>	Get device ID

	Example of answer:
	`SB1211_M30626_SPEC_RAD`
	`VERSION 1.49 121211`

*PARAmeter:SPNUMber? <CR>	Get spectrometer number
	Example of answer: `spectrometer number: 2005184`
*PARAmeter:SERNumber? <CR>	Get serial number (internal number)
	Example of answer: `serial number: 1072`
*PARAmeter:PIXel? <CR>	Get pixel quantity
	Example of answer: `pixel: 2048`

*PARAmeter:SENSor? <CR>	Get sensor type TSL 1301: 2 TSL1401: 3 S8378-256: 4 TSL1402: 5 MLX90255: 6 S9227-512: 9 LIS-1024: 10 LIS-1024 sg: 11 S3901-256: 15 S3901-512: 16 S3901-1024: 17 ILX511: 20 S9840-2048: 33 S9840-2048_OS4: 34 S9840-1024: 35 S9840-1024-OS4: 93 S9840-512: 44 S9840-512-OS4: 94 G8160_1: 36 G8160_4: 37 SU256LSB_1: 40 SU256LSB_4: 41
	Example of answer: `Sensor: 35`
*PARAmeter:ADCResolution arg <CR>	Get/ Set ADC resolution 14 bit: 14 15 bit: 15 16 bit: 16
	Example of answer: `AdcResolution: 15`
Remark: Use only 14 or 15 bit for radiometric applications!	
*PARAmeter:ADCVoltage arg <CR>	Get/ Set input voltage range of ADC (1 = 2V, 0 = 4V)
	Example of answer: `ADC input range: 1`
*PARAmeter:ADPWdown? <CR>	Get power down active (on = 1, off = 0), will be deactivated automatically with the next command
	Example of answer: `power down ADC: 1`
*PARAmeter:BAUD arg <CR>	Get/ Set baudrate 38 400 Bd: 384 115 200 Bd: 115 921 000 Bd: 921
	Example of answer: `Baud: 921`

Time Settings

*PARAmeter:TINT tint <CR>	Get/ Set default integration time (from 1… 64 999 ms), preset value: 100 ms

	Example of answer: `Tint: 100`
*PARAmeter:SDELay arg <CR>	Get/ Set scan delay (time difference between initiating a measurement and its real start, in ms)
	Example of answer: `ScanDelay: 400`
*PARAmeter:BORDer arg arg <CR>	Get/ Set low and high limits for the adaption of integration time (percent of fullscale)
	Example of answer: `border: 70 98`
*PARAmeter:FASTscan arg <CR>	Get/ Set time to next fast cycle (in ms)
	Example of answer: `Fastscan: 50`
*PARAmeter:FLASHlight arg arg <CR>	Get/ Set parameters (flash interval in ms and length in µs) for control of an external flash lamp
	Example of answer: `FlashPara: 20 20`
*PARAmeter:FLMODe arg <CR>	Get/ Set flash mode scan will be executed with control an external flash lamp, the real intergration time is dependent from flashligth parameters
	Example of answer for "*para:flmod?<CR>": `Flash mode: 0`
*PARAmeter:CYCTIM arg <CR>	Get/ Set predefined cycle time in µs
	Example of answer for "*para:cyctim?<CR>": `Cycle time: 3500`
*PARAmeter:SPLITTime arg <CR>	Get/ Set splitting interval for the integration time (arg between 400 and 6000 ms), for S9840 and ELIS array (0 = no split), special solution to avoid a high dark signal of the detector at long tint (see chapter 6)
	Example of answer: `Split time: 1000`

Settings for Peripherical Units

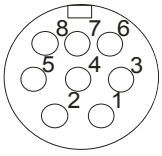
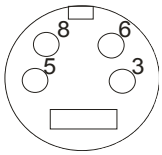
*PARAmeter:SHUTter arg <CR>	Get/ set external shutter availability (available = 1 (dark measurement with shutter possible), not available = 0 (only dark compensation possible))
	Example of answer: `Shutter: 1`
Remark: This setting has to be 1 to ensure that the dark measurements with shutter will work correctly. Shutter 1 is necessary for radiometric measurements.	

The following commands are used to set the status of the ext. lamp/ shutter control (Mini DIN connector pin 3 see next page).

*PARAmeter:LAMPEnable?<CR>	Get enable state of external lamp/shutter control output (enable = 1, disable = 0)

	Example for answer: `Lamp enable: 1`
*PARAmeter:LAMPEnable arg<CR>	Set enable state of external lamp output/shutter control (enable = 1, disable = 0)
*PARAmeter:LAMPPolarity?<CR>	Get polarity of external lamp/shutter control (low, high)
	Example of answer: `Lamp low: 1`
*PARAmeter:LAMPPolarity arg<CR>	Set polarity of external lamp/shutter control (low = 1, high = 0)

The following commands are used to set the status of the external trigger control (Mini DIN connector pin 5).

*PARAmeter:TRIGger?<CR>	Get trigger mode (enable = 1, disable = 0)
	Example of answer: `Trigger on:  1`
*PARAmeter:TRIGger arg<CR>	Set mode for trigger (disable = 0, enable = 1, enquire=2) 1: start of a configured measurement with hardware trigger (shortcut with switch or TTL signal), similar to the command *INITiate, last output: 07 (measurement finished, data are ready) 2: send enquire with hardware trigger
	Example of answer: `Trigger: 0`
*PARAmeter:TRSLope?<CR>	Get the trigger slope
	Example of answer: `Trigger falling edge: 0` Pin out (view to female connector Mini DIN4 or Mini DIN8 on instrument): 2 – TTL UART receive input (optional) 3 - Lamp out 5 V CMOS signal (flash lamp trigger) 5 - Meas. trigger input 6 - VCC +5V 7 - TTL UART transmit output (optional) 8 - Ground Mini DIN 8  Mini DIN 4 
*PARAmeter:TRSLope arg<CR>	Set trigger slope 1 = triggering with switch closing/ falling TTL signal, 0 = with switch opening/ rising TTL signal
*PARAmeter:LASMODulation arg1 arg2 <CR>	Get/ Set laser modus arg1: intensity in ‰ arg2: 0 – laser off 1 – PWM 7Hz 2 – PWM 28Hz 3 – PWM 255Hz
	Example of answer for “*para:lasmod?<CR>”: `Laser parameters: 1000 3`

*PARAmeter:OPTICal arg <CR>	Get/ Set availability of optical trigger 0-not available, 1-available
	Example of answer for "*para:optic?<CR>": `Optical trigger: 1`

Settings for Measurement

*PARAmeter:OFFSet arg <CR>	Get/ Set offset value (-300 … 300 mV)
	Example of answer: `Offset Channel 1:  50`
*PARAmeter:GAIN arg <CR>	Get/ Set gain value (1.0 … 5.0)
	Example of answer: `Gain Channel 1:  1.0`
*PARAmeter:FITn arg <CR>	Get/ Set wavelength fit parameters λ(p) = fit0 + fit1·p +fit2·p2 + fit3·p3 + fit4·p4 p = pixel number; n= 0 ... 4
	Example of answer for fit0: `Fit0 Channel 1:  2.729578e+02`
*PARAmeter:CALIBNumber arg <CR>	Get/ Set calibration file to be used for radiometric calculations 0 – accept signal of hall sensors "ab" (for sensor signal see *CONTR:MHEAD) Sensor signal 00: uses calibration file 1 Sensor signal 01: uses calibration file 2 Sensor signal 10: uses calibration file 3 Sensor signal 11: uses calibration file 4 1 … CalCnt[1] – use the selected calibration file (No. 1 … CalCnt)
	Example of answer: `calib number: 0`
*PARAmeter:DISTAnce arg <CR>	Get/ set the measurement distance for Luminous intensity measurement in mm
	Example of answer: `Measurement distance:  316`
*PARAmeter:BASIC? <CR>	Get configured basic parameters

	Example of answer:
	`SB1211_M30626_R1__SPEC_RAD VERSION 1.21 220910 S/N 1002`
	`CHANNELS  :  1`
	`PIXEL PER LINE  :  1024`
	`LAMP PREHEAT TIME[ms] :  200`
	`INTEGRATION TIME[ms]  :  100`
	`CHANNEL 1 FITx^0  : 1.183144E+02`
	`CHANNEL 1 FITx^1 : 8.358500E-01`
	`CHANNEL 1 FITx^2 : 4.126269E-05`
	`CHANNEL 1 FITx^3 : -3.375814E-08`
	`CHANNEL 1 FITx^4 : -5.471622E-12`

*PARAmeter:EXTENDed? <CR>	Get configured extended parameters

1 CalCnt: number of calibration files

	Example of answer:
	`fastscan time:  50 ms`
	`Image sensor: S9840-1024-OS4`
	`gain  value : 1.00`
	`offset value :  250 mV`
	`lamp enable`
	`lamp low  active`
	`flash intervall :  20 ms`
	`flash length  :  20 µs`

	Get a list of all parameters

*PARAmeter:ALLPARAmeter? <CR>	Example of answer: Firmware: SB1211_M30626_R1__SPEC_RAD VERSION 1.21 220910 Spectrometer number: 2010024 Serial number: 1002 Channel count: 1 Pixel count: 1024 Image sensor nr.: 54 PDA gain (1-low, 0-high): 1 Frame mode ELIS (1-on, 0-off): 0 PLL multiplayer (1-on, 0-off): 1 ADC type (0-AD9826, 1-HT82V26, 2-HT82V36): 0 ADC resolution: 15 ADC range (1-2V, 0-4V): 0 ADC Power down (1-on, 0-off): 0 Baudrate : 921 Integration time[ms] : 100 Split tint [ms]: 1000 Scan delay[ms] : 200 Border min [%]: 75 Border max [%]: 98 Fastscan [ms]: 50 Flash mode (0-off 1-on): 0 Flashlight intervall [ms]: 20 Flashlight length [µs]: 20 Lamp enable: 1 Lamp low: 1 Trigger (2-enqu, 1-on, 0-off): 1 Trigger slope (1-falling, 0-raising): 0 Shutter (1-exist, 0-not available): 1 SPI enable (1-on, 0-off): 0 Offset value [mV]: 250 Gain value : 1.00 Channel 0 FITx^0 : 1.183144E+02 Channel 0 FITx^1 : 8.358500E-01 Channel 0 FITx^2 : 4.126269E-05 Channel 0 FITx^3 : -3.375814E-08 Channel 0 FITx^4 : -5.471622E-12 Calib number: 0 Measurement distance: 65535 Scan direction (1-backw, 0-forw): 0 Predefined function: 1 Predefined format: 4 Predefined exposition mode: 2 Predefined adaption mode: 1 Boxcar count: 1 Wave min [nm]: 118 Wave max [nm]: 974 Wave beg limit [nm]: 200 Wave end limit [nm]: 1000 Wave beg defined [nm]: 350 Wave end defined [nm]: 1000 Wave step defined [nm]: 5 config: 0043819c

*PARAmeter:EXPOsure arg <CR>	Get/set predefined exposure mode (handling of integration time tint) 0 – uses previous tint (default value) 1 – always adaption of tint 2 – uses configured tint (see *CONF:TINT)
	Example of answer: `Predefined exposure mode: 0`
*PARAmeter:ADAPtion arg <CR>	Get/set predefined adaption mode 0-no adaption if under or overexposition 1-new adaption if overexposition 2-new adaption if under or overexposition
	Example of answer: `Predefined adaption mode: 1`
Remark: If exposure is set to 1, the setting of adaption is without effect.	
*PARAmeter:FORMat format<CR>	Get/set predefined output format (see the list of arguments in chapter 2.1)
	Example of answer: `Predefined format: 4`
*PARAmeter:FUNCtion function<CR>	Get/ set predefined measurement function (see the list of arguments in chapter 2.1)
	Example of answer: `Predefined function: 1`
*PARAmeter:BOXCAr arg <CR>	Get/ Set boxcar mode (running average of pixels, odd number (1 … 25), 1 – no boxcar integration)
	Example of answer: `Boxcar count : 7`
*PARAmeter:WAVBEGin wbeg <CR>	Get/ Set predefined begin of wavelength range (see chapter 4)
	Example of answer: `Predefined start wave: 350`
*PARAmeter:WAVEND wend <CR>	Get/ Set predefined end of wavelength range (see chapter 4)
	Example of answer: `Predefined end wave: 900`
*PARAmeter:WAVSTEP wstp <CR>	Get/ Set predefined wav step (see chapter 4)
	Example of answer: `Predefined wave step: 1`
*PARAmeter:WAVLIMIT min max <CR>	Get/ Set predefined wav limit (see chapter 4)
	Example of answer: `Wave limit: 200 1000`
*PARAmeter:DIRECtion arg <CR>	Get/ Set scan direction 0-forward, 1-backward
	Example of answer for “*para:direct?<CR>”: `Scan direction : 0`

Parameter only for specbos 1211

*PARAmeter:REFADC arg<CR>	Get/ Set reference voltage CPU_ADC
	Example of answer: `ADC reference:  4.504000`
*PARAmeter:ENCHARge arg <CR>	Get/ Set predefined charge mode 0-disable, 1-enable
	Example of answer: `Charge enable :  0`
*PARAmeter:PONTIMe arg <CR>	Get/ Set on time in min
	Example of answer: `Pon time:  15`
*PARAmeter:UMINTIme arg <CR>	Get/ Set scan switch off time at undervoltage in min
	Example of answer: `Umin time:  5`
*PARAmeter:PONMODe arg <CR>	Get/ Set power on mode if no battery detected
	Example of answer: `power mode:  0`

Permanent Storage of Parameters
After any change of parameters this change has to be saved to make it permanent.

*PARAmeter:SAVE<CR>	Write parameters to flash ROM
	Example of answer: `ACK (06 hex)`
*PARAmeter:SAVE 1<CR>	Write parameters to flash ROM, calculate and store pixel wavelength (only necessary, if wavelength fit coefficients were changed)
	Example of answer: `ACK (06 hex)`

3.2. Configuration Commands

The configuration commands can be used to change the default status of several arguments. These arguments and their default values are as follows:

tint	set with *PARAmeter:TINT
function	12 (measurement of exposured spectrum)
format	7 (ASCII output, separated by <CR>)
av	1 (no averaging)
exposure mode	0 (uses previous tint, see *CONFigure:EXPOsure)
wbeg	set with *PARAmeter:WAVBEGin
wend	set with *PARAmeter:WAVEND
wstp	set with *PARAmeter:WAVSTEP

*CONFigure? <CR>	Get a help list of the configuration commands
*CONFigure:TINT tint <CR>	Get/ Set integration time (from 1 … 64 999 ms), in contradiction to *PARA:TINT the configured time will be saved only temporarily

	Example of answer:
	`Previous tint: 2`
	`Configured tint: 3`

*CONFigure:MINTINT?<CR>	Get the shortest possible integration time in ms
	Example of answer: `Shortest integration time: 3`
*CONFigure:MAXTINt arg <CR>	Get/ Set max integration time 1000 <= MaxTint <= 64 999
	Example of answer: `MaxTint: 64999`
*CONFigure:EXPOsure arg <CR>	Get/ Set handling of integration time 0 – uses previous tint (default value) 1 – always adaption of tint 2 – uses configured tint (*CONF:TINT)
	Example of answer: `Exposure: 0`
*CONFigure:ADAPtion <CR>	Get/set adaption mode 0-no adaption if under or overexposition 1-new adaption if overexposition 2-new adaption if under or overexposition
	Example of answer: `Adaption: 1`
Remark: If exposure is set to 1, the setting of adaption is without effect.	
*CONFigure:AVERage av <CR>	Get/ Set the number of measurement scans for average calculation (1 … 10 000)
	Example of answer: `Average: 5`
*CONFigure:FUNCtion function <CR>	Get/ Set measurement function

	Example of answer:
	`Previous function: 1`
	`Configured function: 7`

*CONFigure:FORMat format <CR>	Get/ Set output format

	Example of answer:
	`Previous format: 2`
	`Configured format: 4`

Attention: If other commands are used with wbeg and wend these settings will overwrite the values of *conf:wran!	
	Get/ Set wavelength range and step

*CONFigure:WRANge wbeg wend wstp <CR>	Example of answer:
	`Wave begin: 380`
	`Wave end: 800`
	`Wave step: 1.0`

*CONFigure:BEGin <CR>	Get/ Set wavelength begin
	Example of answer: `Wave beg: 350`
*CONFigure:END <CR>	Get/ Set wavelength end
	Example of answer: `Wave end: 900`
*CONFigure:WSTP wstp <CR>	Get/ Set wavelength step width (1 to 10 nm)
	Example of answer: `Wave step: 1`
*CONFigure:ALL tint av format function <CR>	Get/ Set all measurement parameters (except wavelength range and step)

	Example of answer:
	`Configured tint: 100`
	`Configured average: 1`
	`Configured format: 4`
	`Configured function: 1`

*CONFigure:CYCTIMe <CR>	Get/ Set cycle time in µs
	Example of answer: `Cycle time: 3500`
*CONFigure:CYCMODe arg <CR>	Get/ Set cycle mode 0 – tint as integration time 1 – tint as cycle count with cycle time
	Example of answer. `Cycle mode: 0`
*CONFigure:STABILIty arg <CR>	Get/ Set stability level in % a scan above splittime will be aborted, if the deviation of an individual scan exceeds the set stability level compared to the first scan or if it produces overexposure
	Example of answer: `StabValue: 20`
*CONFigure:CYCDIV arg <CR>	Get/ Set cycle divider 1 < cycdiv value <= 20
	Example of answer: `CycDiv: 3`
*CONFigure:LEVEL?<CR>	Get the maximum of the previously measured spectrum in counts and %

	Example of answer:
	`Level/cnt: 15463`
	`Level/%: 0064`

*CONFigure:DEFault <CR>	Set all measurement parameters to the default values (see chapter 5)

3.3. Control Commands

These commands are used to control the peripherical elements lamp/ shutter, laser, hall sensors, optical trigger and battery.

*CONTRol?<CR>	Get a help list of the control commands
*CONTRol:LASER arg <CR>	Get/ Set laser status (1 – laser on, 0 – laser off)
	Example of answer: `laser: 0`
*CONTRol:MHEAD? <CR>	Get measuring head configuration “ab” (signal of hall sensors) Sensor signal 00: uses calibration file 1 Sensor signal 01: uses calibration file 2 Sensor signal 10: uses calibration file 3 Sensor signal 11: uses calibration file 4
	Example of answer: `mhead: 0`
*CONTRol:LAMP arg <CR>	Get/ Set lamp/ shutter status (1 – lamp on, shutter opened, 0 – lamp off, shutter closed)
	Example of answer: `lamp: 1`
*CONTRol:CYCTIMe?<CR>	Get cycle time from optical trigger in ms without average and with 10000ms timeout
	Example of answer: `cyctim: 10.23`
*CONTRol:CYCTIMe n t<CR>	Get cycle time from optical trigger in ms with n averages and t timeout in ms It is recommended to use n=200 and t=5000 for display measurements.
	Example of answer: `cyctim: 10.23`

Control Comands only for specbos 1211

*CONTRol:INPUT?<CR>	Get input power voltage (only for specbos1211)
	Example of answer: `Input voltage: 4.83`
*CONTRol:CHARGE?<CR>	Get charge state (only for specbos 1211 BT) (1 – charge on, 0 – charge off)
	Example of answer: `charge: 0`
*CONTRol:ENCHAR arg <CR>	Get/ Set charge enable (only for specbos 1211 BT) (0 – charge disabled, 1 – charge enabled)
	Example of answer: `enable charge: 0`

*CONTRol:CURRENT?<CR>	Get charge current (only for specbos 1211 BT)
	Example of answer: `Charge current:  0.00`

3.4. Initiate and Abort Commands

*INITiate <CR>	Run a measurement configured before (without data output)
ESC	Abort a running measurement

3.5. Read Commands

*READ format <CR>	Initiate a measurement configured before and output of data

3.6. Fetch Commands

A *FETCH command can only be used if the appropriate measurement was proceeded before.

*FETCH? <CR>	Get a help list of the fetch commands
*FETCH format <CR>	Output of previous measurement
*FETCH:LIGHT format <CR>	Output of exposured spectrum values
*FETCH:DARK format <CR>	Output of dark spectrum values
*FETCH:REFErence format <CR>	Output of reference values
*FETCH:TRANSmission format <CR>	Output of transmission values
*FETCH:SPRADiance format <CR>	Output of spectral radiance values
*FETCH:RADIOmetric <CR>	Output of radiometric value
*FETCH:PHOTOmetric <CR>	Output of photometric value
*FETCH:CHROMXY <CR>	Output of xy values
*FETCH:CHROMUV <CR>	Output of u´v´ values
*FETCH:DWLPE <CR>	Output of dominant wavelength and color purity
*FETCH:XYZ <CR>[1]	Output XYZ values
*FETCH:ALLVAlue <CR>	Output of radiometric-, photometric-, xy- and uv values, dominant wavelength and colour purity
*FETCH:CCT <CR>	Output of CCT
	Example of answer: `color temperature[°K]:  3007`
Remark: Can only applied **after** *calc:CCT **or** *conf:form 13 **and** *init	
*FETCH:CRI <CR>	Output of CRI values

1 Available from firmware version 1.53 (specbos 1211)

	Example of answer: color temperature of reference source: 2968 K CRI_DC: 3.681963e-04 CRI_Ra: 99.3 CRI_R01: 99.2 CRI_R02: 99.8 CRI_R03: 99.1 ….
Remark: Can only applied **after** *calc:CRI **or** *conf:form 14 **and** *init	

3.7. Measuring Commands

The measuring commands contain a measurement scan and the following output of data.

*MEASure? <CR>	Get a help list of the measuring commands
*MEASure tint av format <CR>	Run measurement with parameters and output of data Raw data: ADC counts as unsigned integer word (2 Byte, MSB first)
	Example of answer : 4714 4744 4669 4787 4652 4826 4744 4780 4745 4846 4724 4829 4739 4835 4708 4704 4546 4817 4652 4819 4748 4757 4711 4749 4696 4730 4708 4782 4740 4818 4655 4791 4687 4737 ……
*MEASure:COMPDARK<CR>	Run dark compensation (in connection with *conf:darkm 0) data storage in dark buffer
	Example of answer: ACK (06 hex) BEL (07 hex)
*MEASure:DARKspectra tint av format <CR>	tint ≠ 0: Run dark measurement tint=0: last dark integration time will be used data storage in dark buffer
	Example of answer for *meas:dark 100 1 4<CR>: ACK (06 hex) BEL (07 hex) 552 551 544 549 ... ...
	Example of answer for *meas:dark 100 1 2<CR>: ACK (06 hex) BEL (07 hex) 551 553 544 552 540 549 544 544 547 552 549 549 545 552 545 550 544 553 546 555 546 554 550 553 550 556 550 553 547 555 552 552 549 551 547 555 548 553 549 555 551 ....

Remark: In case of SDC-BB the user has to ensure that the optical input of the instrument is darkened during the *meas:compdark and *meas:dark measurements (closed external shutter or switched off lamp).	
*MEASure:LIGHTspectra tint av format <CR>	Run light measurement (exposured spectrum – opened external shutter or lamp switched on), data storage in light buffer, data output according to selected format
*MEASure:REFERence tint av format <CR>	Run reference measurement (Difference between light measurement and dark spectrum obtained before), same integration-time as for dark scan is obligatory, data storage in reference buffer data output according to selected format
*MEASure:TRANSmission format <CR>	Run light measurement and calculate the ratio to the actual reference spectrum (both dark signal subtracted, uses same integration time), data storage in a temporary buffer (only for 14 or 15 bit setting)
*MEASure:SPRADiance tint av format <CR>[1]	Run spectral radiometric measurement

	Example of answer:
	`Sp Radiance[W/(sr*m^2*nm)]`
	`380 2.77656364e+00 3.24814868e+00`
	`3.61431837e+00 3.96225500e+00`
	`400 4.43705416e+00 5.07714462e+00`
	`5.52717924e+00 6.09837151e+00....`

*MEASure:RADIOmetric tint av <CR>[2]	Run radiometric measurement
	Example of answer: `radiance[W/(sr*m^2)]: 1.452e^2`
*MEASure:PHOTOmetric tint av <CR>[3]	Run photometric measurement
	Example of answer: `luminance[cd/m^2]: 2.417e^3`
*MEASure:CHROMXY tint av <CR> [4]	Run xy measurement

	Example of answer:
	`x: 0.4423`
	`y: 0.4067`

*MEASure: CHROMUV tint av <CR>[5]	Run u´v´ measurement

	Example of answer:
	`u': 0.2521`
	`v': 0.5229`

*MEASure:DWLPE tint av <CR>[6]	Run dominant wavelength and color purity measurement
	Example of answer: `dominant wavelength` [nm]: 583.0 `colour purity: 53.9`
*MEASure:XYZ tint av <CR>[7]	Run XYZ measurement

1 Spectral Radiance, Radiance, Luminance, x, y, u', v' will be calculated in addition
2 CalCnt: number of calibration files
3 CalCnt: number of calibration files
4 CalCnt: number of calibration files
5 CalCnt: number of calibration files
6 CalCnt: number of calibration files
7 Available from firmware version 1.53 (specbos 1211)

*MEASure:ALLVAlue tint av <CR>	Run a measurement for radiometric-, photometric-, xy-, u´v´-values,dominant wavelength and colour purity

	Example of answer:
	`radiance[W/(sr*m^2)]:  1.452e^2`
	`luminance[cd/m^2]:  2.417e^3`
	`x:  0.4392`
	`y:  0.4053`
	`u':  0.2515`
	`v':  0.5222`
	`dominant wavelength[nm]:  583.0`
	`colour purity:  53.4`

*MEASure:CCT tint av <CR>[1]	Run Correlated Color Temperature (CCT) measurement
	Example of answer: `color temperature[°K]: 3007`
*MEASure:CRI tint av <CR> [2]	Run CRI measurement (according to CIE 13.3)

	Example of answer:
	`color temperature[°K]: 3016`
	`color temperature of reference source: 3016 °K`
	`CRI_DC:  3.109599e-04`
	`CRI_Ra:  99.2`
	`CRI_R01:  99.1`
	`CRI_R02:  99.8`
	`CRI_R03:  99.3`
	`CRI_R04:  99.0`
	`CRI_R05:  99.2`
	`CRI_R06:  99.8`
	`CRI_R07:  99.3`
	`CRI_R08:  98.5`
	`CRI_R09:  97.0`
	`CRI_R10:  99.7`
	`CRI_R11:  99.0`
	`CRI_R12:  99.3`
	`CRI_R13:  99.3`
	`CRI_R14:  99.5`

3.8. Calculation Commands

The calculation commands use the measuring data obtained before.

*CALCulate? <CR>	Get a help list of the calculation commands
	Linear interpolation of dark values (wstp ≥ 1 nm)

1 Spectral Radiance, Radiance, Luminance, x, y, u', v' will be calculated in addition
2 CalCnt: number of calibration files

*CALCulate:LINT:DARK wbeg wend wstp <CR>	Example of answer: 400.0 4775.31 402.0 4764.11 404.0 4752.92 406.0 4786.45 408.0 4829.23 …..
*CALCulate:LINT:LIGHT wbeg wend wstp <CR>	Linear interpolation of light values
*CALCulate:LINT:REFER wbeg wend wstp <CR>	Linear interpolation of reference values
*CALCulate:LINT:TRANS wbeg wend wstp <CR>	Linear interpolation of transmission
*CALCulate:SPLIN:DARK wbeg wend wstp <CR>	Spline interpolation of dark values (wstp ≥ 0.1 nm) The step count will be limited by the available memory (set by pixel count of sensor) If exceeded, then error 230…232
	Example of answer: 400.0 4.94943506e+03 402.0 4.78587012e+03 404.0 4.74870703e+03 406.0 4.78368457e+03
*CALCulate:SPLIN:LIGHT wbeg wend wstp <CR>	Spline interpolation of light values (wstp ≥ 0.1 nm)
*CALCulate:SPLIN:REFER wbeg wend wstp <CR>	Spline interpolation of reference values (wstp ≥ 0.1 nm)
*CALCulate:SPLIN:TRANS wbeg wend wstp <CR>	Spline interpolation of transmission values (wstp ≥ 0.1 nm)
*CALCulate:RADIOmetric wbeg wend <CR>[1]	Run radiometric calculation
	Example of answer: radiance[W/(sr*m^2)]: 1.452e^2
*CALCulate:PHOTOmetric wbeg wend <CR> [2]	Run photometric calculation
	Example of answer: luminance[cd/m^2]: 2.417e^3
*CALCulate:CHROMXY wbeg wend <CR> [3]	Run xy calculation
*CALCulate:CHROMUV wbeg wend <CR> [4]	Run u´v´ calculation
*CALCulate:DWLPE wbeg wend <CR> [5]	Run dominant wavelength and colour purity calculation
*CALCulate:XYZ wbeg wend <CR>[6]	Run XYZ calculation

1 Spectral Radiance, Radiance, Luminance, x, y, u', v' will be calculated in addition
2 CalCnt: number of calibration files
3 CalCnt: number of calibration files
4 CalCnt: number of calibration files
5 CalCnt: number of calibration files
6 Available from firmware version 1.53 (specbos 1211)

*CALCulate:ALLVAlue wbeg wend <CR>	Run calculation of radiometric-, photometric-, xy-, uv-values as well as of dominant wavelength and colour purity
*CALCulate:CCT wbeg wend <CR>[1]	Run Correlated Color Temperature (CCT) calculation
*CALCulate:CRI temp <CR> [2]	Run CRI measurement (the argument temp is used for the reference source calculation, without argument the measured CCT will be used), calculation according to CIE 13.3 publication

	Example of answer:
	`color temperature of reference source: 4000 °K`
	`CRI_DC: 2.984050e-02`
	`CRI_Ra: 79.0`
	`CRI_R01: 84.9`
	`CRI_R02: 95.4`
	`CRI_R03: 71.0`
	`CRI_R04: 72.7`
	`CRI_R05: 84.3`
	`CRI_R06: 89.4`
	`CRI_R07: 74.8`
	`CRI_R08: 59.3`
	`CRI_R09: 34.9`
	`CRI_R10: 84.1`
	`CRI_R11: 73.1`
	`CRI_R12: 74.3`
	`CRI_R13: 91.7`
	`CRI_R14: 82.3`

3.9. Status Commands

The status commands are used to get the information of the error and configuration conditions.

*STATus:ERRor?<CR>	Get the error code (list of error codes see chapter 4.2.)
	Example of answer: `Error Code: 0`
*STATus:TXTERRor?<CR>	Get error code and description of the error
	Example of answer: `0 : error none`
*STATus:EXPOSition?<CR>	Get the exposition state (after reference and radiometric measurements) 1 – under exposure 2 – over exposure 0 – correct exposure
	Example of answer: `Exposition state: 0`

1 New calculation of Spectral Radiance, Radiance, Luminance, x, y, u', v' only if the arguments are different from the previous measurement
2 Available from firmware version 1.53 (specbos 1211)

*STATus:ENQUire?<CR>	Get enquire state A enquire code (0x05) will be send, if any event occurs. With this command the reason of the enquire event can be detected. (only for specbos1211) 1 – Trigger event with trigger mode = 2 2 – device has been switched off 3 – switched off device due to low battery 4 – measurement head has been changed 5 – laser state has been changed 7 – on time has been expired 8 – warning low battery 9 – break scan of overexposure 10 – break scan of instability 11 – Cyctime time out
	Example of answer: `EnqCode: 1`

3.10. Help Commands

The help commands gives all information to the SCPI-commands.

*HELP:PARA<CR>	Get a summary of all parameter commands

	Example of answer:
	`*RST<CR>: softwarereset`
	`*IDN?: get device ID`
	`*vers?: get firmware version`
	`*PARAmeter:CHANnel?: get channel count`
	`*PARAmeter:PIXel : get/set pixel count`
	`*PARAmeter:SENSor : get/set sensor type`
	`*PARAmeter:SDELay : get/set scan delay`

*HELP:PARA:<cmd2><CR>	Get the description of the selected parameter command (cmd2)

	Example of answer to “help:para:tint<CR>”
	`predefined integration time/ms,`
	`valid values 1 ... 60 000`

*HELP:CONF<CR>	Get a summary of all configuration commands

	Example of answer:
	`*CONFigure:TINT?<CR> : get last integration time`
	`*CONFigure:TINT arg<CR>: set preset integration time`
	`*CONFigure:AVERage?<CR> : get last average counts`
	…

*HELP:CONF:<cmd2><CR>	Get the description of the selected configuration command (cmd2)

	Example of answer to “help:conf:expos<CR>”
	`exposition mode`
	`0-exposition with last integrationtime`
	`1-exposition with new adaption integration time`
	`2-exposition with configured integration time`

*HELP:CONTR<CR>	Get a summary of all control commands

	Example of answer: *CONTRol:LAMP?<CR>: get lamp/shutter state *CONTRol:LAMP arg<CR>: set lamp/shutter on/off ...
*HELP:READ<CR>	Get a description of the read commands
	Example of answer: *READ format<CR>: initiate and output a pre configured measurement ...
*HELP:FETCH<CR>	Get a summary of all fetch commands
	Example of answer: *FETCH format<CR>: output last measurement *FETCH:LIGHT format<CR>: output light values *FETCH:DARK format<CR>: output dark values *FETCH:REFErence format<CR>: output reference values …
*HELP:MEAS<CR>	Get a summary of all measurement commands
	Example of answer: *MEASure tint av format<CR>: run measurement with parameters *MEASure:DARKspectra tint av format<CR>:run dark measurement *MEASure:LIGHTspectra tint av format<CR>:run light measurement *MEASure:REFERence tint avformat<CR>:run reference measurement *MEASure:SPRADIance tint av format<CR>: run spectro radadiometric measurement …
*HELP:CALC<CR>	Get a summary of all calculate commands
	Example of answer: *CALCulate:SPRADIance wbeg wend <CR>: run spectral radiance calculation *CALCulate:RADIOmetric wbeg wend<CR>: run radiometric calculation *CALCulate:PHOTOmetric wbeg wend<CR>: run photometric calculation …
*HELP:STAT<CR>	Get a summary of all status commands (only for specbos1211)
	Example of answer: *STATus:ERRor?<CR>: get last error code *STATus:TXTERror?<CR>: get last error text *STATus:ENQUire?<CR>: get enquire state *STATus:CON4?<CR>: get status flags *STATus:EXPO?<CR>: get exposition state (1-under 2-overexposure) …
*HELP:STAT:ERR<CR>	Get a summary of error codes

	Example of answer:
	`Error codes:`
	`0 : no error`
	`4 : command error`
	`7 : error password`
	`8 : digit error`
	`10 : error argument 1`
	`11 : error argument 2`
	…
	For the full list of error messages – see chapter 2.3

*HELP:STAT:ENQU<CR>	Get a summary of enquire codes

	Example of answer:
	`EnqCode:`
	`0 : EnqCode enquire none`
	`1 : EnqCode trigger event`
	`2 : EnqCode switch power off`
	`3 : EnqCode switch off low battery`
	`4 : EnqCode change head`
	`5 : EnqCode change laser`
	`7 : EnqCode on time expired`
	`8 : EnqCode warning low battery`

3.11. Structure of Data Stream

All data transmitted via uart (RS232 , no parity, 1 stop-bit, no Handshake; USB virtual COM Port; BT)

Format = 1

(L/H binary output without length and checksum)

All data transmitted as 16 bit word, low-byte first (Little Endian)

Byte	Value	Definition
0	xx yy	first Pixel
2	xx yy	second Pixel
		:
		:
n*2	xx yy	last Pixel

n: number of pixel per line

Format = 2

(ASCII output, separated by space)

938 930 919 967 944 911 941 971 933 941 959 941 903 947 952 951 916 945 947 951 957 941 954 961 947 951 959 962 977 939 960 981 977 966 949 962 951 988 1012 978 1022 1072 1072 1091 1107 1144 1130 1138 1209 1180 1244 1219 1264 1287 1281 1336 1312 1407 1406 1383 1451 1440 1451 1450 1472 1451 1497 1494 1511 1547 1508 1531 1546 1534 1554 1546 1559 1523 1513 1561 1566 1552 ....

Format = 3

(L/H binary output with length and checksum)

All data transmitted as 16 bit word, low-byte first (Little Endian)

Byte	Value	Definition
0	xx yy	length
2	xx yy	first Pixel
4	xx yy	second Pixel
		:
		:
2+ n*2	xx yy	last Pixel
4+n*2	xx yy	checksum

n: number of pixel per line

Format = 4

(ASCII output, separated by <CR>)

819
858
807
841
793
.....

Format = 5

(H/L binary output without length and checksum)

All data transmitted as 16 bit word, high-byte first (Big Endian)

Byte	Value	Definition
0	xx yy	first Pixel
2	xx yy	second Pixel
		:
		:
n*2	xx yy	last Pixel

n: number of pixel per line

Format = 6

(H/L binary output with length and checksum)

All data transmitted as 16 bit word, high-byte first (Big Endian)

Byte	Value	Definition
0	xx yy	length
2	xx yy	first Pixel
4	xx yy	second Pixel
		:
		:
2+ n*2	xx yy	last Pixel
4+n*2	xx yy	checksum

n: number of pixel per line

Format = 7

(ASCII output with wavelength, separated by <CR>)

```
250.1    4153
250.5    4118
250.9    4126
251.4    3690
251.8    2425
252.2    1765
252.6    1452
253.0    1317
253.4    1277
253.8    1345
254.2    1525
254.6    1680
255.0    1728
.....    ......
```

Format = 9

(Line interpolated ASCII output without wavelength, separated by <CR>)

```
2316.75
2405.70
2505.48
2592.03
2614.35
2630.52
2584.60
2737.96
2814.95
....
```

Format = 10

or by command “*calc:lint:dark”

(Line interpolated ASCII output with wavelength, separated by <CR>)

400.0	2316.75
405.0	2405.70
410.0	2505.48
415.0	2592.03
420.0	2614.35
425.0	2630.52
430.0	2584.60
435.0	2737.96
440.0	2814.95
...	....

Format = 11

(H/L binary integer interpolated output with length and checksum)

All data transmitted as 16 bit word, high-byte first

Byte	Value	Definition
0	xx yy	length
2	xx yy	first wavelength value
4	xx yy	second wavelength value
		:
2+n*2	xx yy	last wavelength value
4+n*2	xx yy	checksum

n: 1+(wavmax-wavmin)/wavstep

Format = 12

(H/L binary float interpolated output with length and checksum)

All data transmitted as 32 bit word, high-byte first

Byte	Value	Definition
0	xx yy	length
2	uu vv xx yy	first wavelength value
6	uu vv xx yy	second wavelength value
		:
2+n*4	uu vv xx yy	last wavelength value
6+n*4	xx yy	checksum

n: 1+(wavmax-wavmin)/wavstep

Line interpolated output by dual trigger (binary output)

Byte	Value	Definition
1	<ACK>	command ok
2	<BEL>	measurement complete
3	cc	trigger type 0-dark, 1-reference, 2-transmission
5-6	xx yy	wavbegin
7-8	xx yy	wavend
9	ss	wavstep
10-11	xx yy	value by wavbegin
		:
10+n*2	xx yy	value by wavend
12+n*2	xx yy	Checksum

n = 1 + (wavend – wavbegin) / (wavstep)

4. Wavelength Range Definitions for JETI Firmware

Description	Range		Command
Basically possible wavelength range	190 nm ---------- 2 800 nm		fixed
Wavelength range according to wavelength-pixel-fit	wavemin |------|----------|- | wavemax	Factory settings	wavemin and wavemax in *para:allpara?
Defined range for instrument (max. 1000 nm)	minlimwav ||-------|----------|---------|| maxlimwav max. 1000 nm		*para:wavlimit?
Predefined setting for commands (valid after start and reset)	wavbeg |||--|------|--- ---||| wavend	User settings	*para:wavbeg *para:wavend
Actual wavelength range	wbeg |||--|----------|---||| wend		*para:wavend *conf:wrange

5. Default Settings for JETI Instruments

(settings which should not be modified by the user are marked in gray)

Parameter	Meaning	Default settings			Unit	Command	Remark
		scb1201	scb1211	SDC_BB			
tint	Integration time (exposure time of detector)	100	100	200	ms	*PARA:TINT, *CONF:TINT	minimum: *CONF:MINTINT? (depending from detector) maximum: 60 000 ms
split time	splitting time, due to high dark signal at long integration times	5000	1000	5000	ms	*PARA:SPLIT	used for ELIS and S9840 detectors, split of integration into several parts, allows to measure with long tint
av	Number of scans for averaging	1	1	1		*CONF:AVER	up to 10000 average scans
format	data output format	7	7	4		*PARA:FORM, *CONF:FORM	
function	kind of measurement	12	12	12		*PARA:FUNC, *CONF.FUNC	
exposition	defines, which integration time will be used	0	0	0		*PARA:EXPO, *CONF:EXPO	use previous integration time
sens	type of sensor	28	34	33		*PARA:SENS	[1]
ADCR	resolution of ADC	14	15	15	bit	*PARA:ADCR	Can be set to 14, 15 or 16 bit (16 bit is not allowed for radiometric and transmission/ reflexion calculations)
ADCV	Input voltage of ADC	2	4	2	V	*PARA :ADCV	2 or 4 V
ADPW	Power down modus of ADC	1	0	0		*PARA:ADPW	on
Baud	interface Baud rate	921600	921600[2]	921600	bd	*PARA:BAUD	
Scan delay	Delay between initialization of measurement and real start	400	200	200	ms	*PARA:SDEL	
gain	Amplification factor of ADC	3	1.2	1		*PARA:GAIN	

1 ELIS for specbos 1201 and S9840 for specbos1211
2 115200 for specbos1211 RS and specbos1211 BT

Parameter	Meaning	Default settings			Unit	Command	Remark
		scb 1201	scb1211	SDC-BB			
adaption	defines the behaviour in case of over or under exposure	1	1	1		*PARA:ADAPT, *CONF:ADAPT	new adaption of integration time only in case of over exposure
Fit n	Wavelength fit coefficients	-	-	-	-	*PARA:FITN	individually calibrated for each unit (has to be changed if pixel binning is changed, see sens)
wavbeg	predefined begin of wavelength range	380	350[1]	200	nm	*PARA:WAVBEG	valid after program start
wavend	predefined end of wavelength range	780	1000	1000	nm	*PARA:WAVEND	valid after program start
wavstep	Predefined wavelength step	5	5	5	nm	*PARA:WAVSTEP	valid after program start
pix	number of pixel	512	2048	2048		*PARA:PIX	will be changed, if pixel binning is used, wavelength fit has to be changed too
offset	ADC offset	-	-	-		*PARA.OFFS	Individually adjusted
Fast scan	Continuous scan without data output	50	50	50	ms	*PARA.FAST	
Lamp enable	Set lamp/ shutter control on/ off	1	1	1		*PARA.LAMPP	Lamp/ shutter signal enabled
Lamp polarity	Polarity of lamp/ shutter control	1	1	1		*PARA.LAMPE	Lamp/ shutter low active
Flash mode	Flash mode	0	0	0		*PARA.FLMOD	
Flash interval	Flashlight interval	20	20	20	ms	*PARA:FLASH	
Flash length	Flashlight length	20	20	20	ms	*PARA:FLASH	

1 Specbos 1211 UV: 250 nm

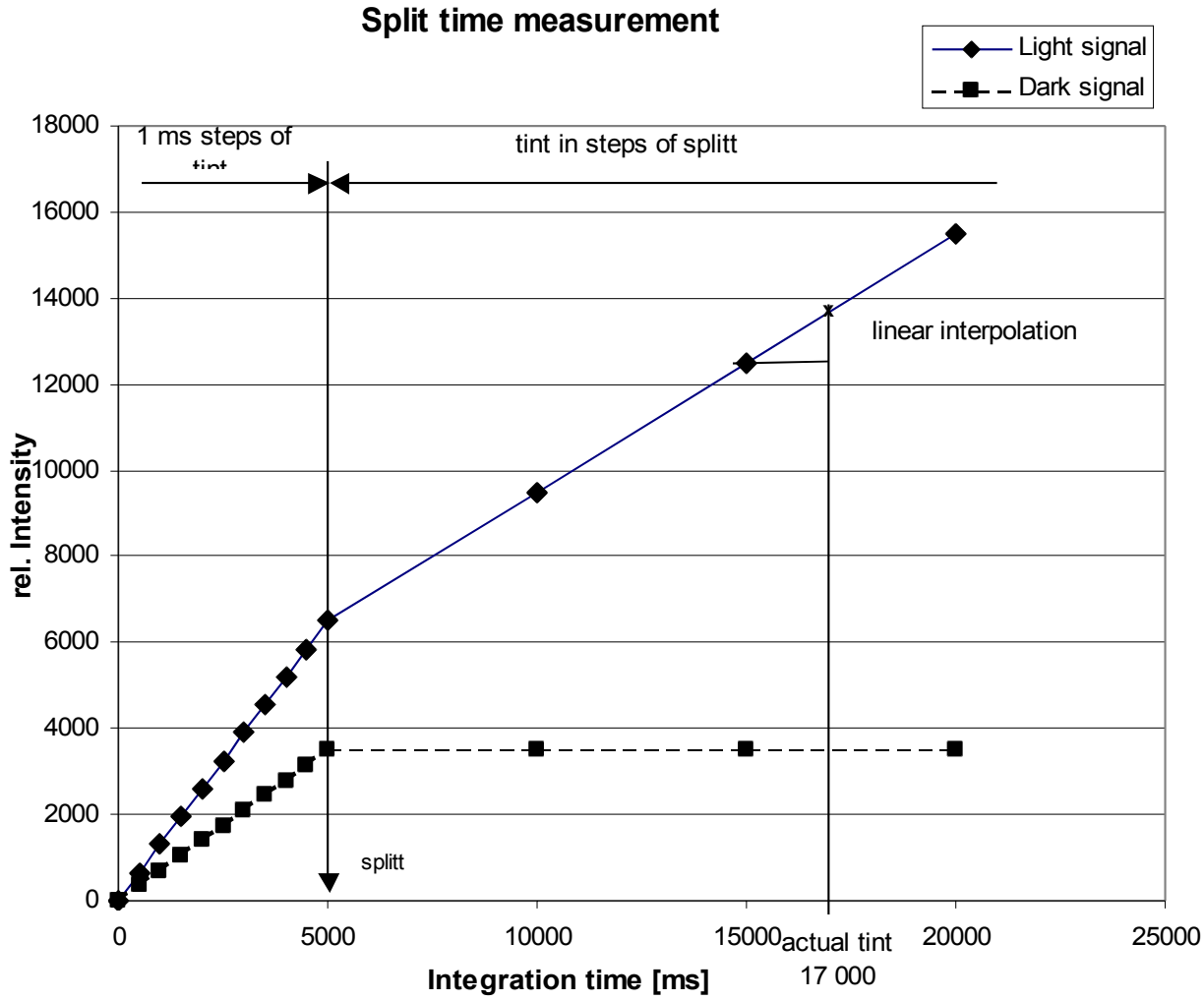
6. Explanation of Split Time Concept

Some low light applications demand a long an integration time of the detector. But detector arrays as S9840 (specbos 1211) and ELIS specbos 1201) already saturate by the dark signal of such long integration times. Therefore the split of the integration time was introduced. Above the preset split time (splitt) the measurement scan is divided into integer parts of the split time. E.g. 17 s will be split into three measurements of 5 s in case of splitt = 5000 ms (see diagram below).

The dark signal is calculated by averaging the individual split scans. Therefore the dark signal does not rise any more if *tint* > *splitt*!

The light signal is calculated by a summation of the different scans. Furthermore there is done a linear interpolation to get the data for integration times between multiples of the split time.

The following diagram shows the sceme of the split time measurement.



7. Examples of Measurement Procedures using Firmware Commands

The following code sequences demonstrate the usage of the commands for five selected applications. Two examples use raw data operations (non-calibrated remission and transmission measurements) and three examples are radiometric measurements (continuous source and pulsed source measurements).
All examples require a shutter for control of the light source for dark measurements.

7.1. Raw Data Operations

7.1.1 Raw Data Emission Measurement

Task:

- Measurement of raw data of a light source
- Application of default values except wavelength range, step width and format
- The appropriate integration time *tint* has to be determined before
- The necessary dark measurement will be included automatically. That's not the case if a dark scan with the same *tint* was already proceeded
- Output of interpolated wavelengths and counts in the wavelength range of 400 to 600 nm with a step width of 5 nm

Program sequence:

```
*CONF:WRANGE 400 600 1<CR>      / setting of wavelength range and step
*CONF:FORM 10<CR>      / output format: interpolated ASCII values with
wavelengths
*MEAS:REFER tint<CR>      / start of measurement and data output
```

Output:

```
400   877                    / first wavelength and value
401   921
402   929
403   959
404   1022
405   1074
…
597   1183
598   1068
599    959
600    806                   / last wavelength and value
```

Variations:

- Wavelength output can be suppressed by changing *CONF:FORM 10 to format 9
- ASCII format can be changed into binary short (format 11) or binary float (format 12) – faster data transfer
- The integration time tint can be determined automatically using the value 0 (*MEAS:REFER 0<CR>).

7.1.2 Transmission Measurement (Pre configured)

Task:

- Reference measurement (100 % line) and sample measurement with a fixed integration time *tint*
- Dark measurement is obligatory (SDC-BB: inbuilt (specbos 1201, 1211) or external shutter or control of light source (SDC-BB)!)
- All measurements with 3 average scans

- Transmission data output from 400 to 700 nm in steps of 5 nm in promille in binary short format

Program sequence:

*CONF:FORM 11<CR> / data output in binary short format

*CONF:FUNCT 3<CR> / setting: reference spectrum

*CONF:WRANGE 400 700 5<CR> / setting of wavelength range and step

*CONF:TINT *tint*<CR> / setting: *tint*

*CONF:AVER 3<CR> / setting of average scan number

*INIT<CR> / start of measurement (adaption of *tint* and final dark scan)

Insertion of measuring object

*MEAS:TRANS<CR> / measurement and output of data

Output:

Line interpolated (binary output)

0x00 / length high byte

0x7A / length low byte

0x03 / value 400nm high byte (810)

0x2A / value 400nm low byte

…

0x02 / value 700nm high byte (763)

0xFB / value 700nm low byte

0x05 / checksum high byte

0x43 / checksum low byte

7.2. Radiometric Measurements

7.2.1 Simple xyY measurement

Task:

- Measure the xyY values of a light source

Program sequence:

*CONF:EXPO 1<CR> / setting: adaption of integration time

*CONF:WRAN 380 780 1<CR> / setting: wavelength range and step width

*MEAS:PHOTO<CR> / *tint* adaption, light and dark measurement and output of photometric value

*FETCH:CHROMXY<CR> / output of x y

Output:

luminance [cd/m2]: 9.001e^2

x: 0.3127

y: 0.3290

7.2.2 Continuous source measurement

Task:

- Measure the xyY values and the radiometric spectrum of a light source in Irradiance mode (with attached cosine diffusor)
- Delay of 1 s between initialization and start of measurement (e.g. heating up time of measuring object)
- Determination of *tint* in reduced limits (between 40 and 50 % of saturation level – to speed up the measurement)

- Adaption of *tint* in case of over and under exposure
- Average over 3 scans
- Additional output of Color Rendering Index for with a reference source of Illuminant A, exposure level and serial number of instrument

Program sequence:

*PARA:CALIBN?<CR> / request of calibration file number

*PARA:SDEL 1000<CR> / permanent setting of scan delay

*PARA:BORD 40 50<CR> / permanent setting of min and max exposure limits for adaption of *tint*

*CONF:EXPO 1<CR> / setting: adaption of *tint*

*CONF:AVER 3 / setting: average 3 scans

*MEAS:PHOTO<CR> / measurement and output phototmetric value Y (Illuminance)

*FETCH:CHROMXY / output of chromaticity coordinates x and y

*FETCH:SPRAD<CR> / output of radiometric spectrum

*CALC:CRI 2856<CR> / calculation and output of CRI for a reference of illuminant A

*CONF:LEVEL?<CR> / output of exposure level

*PARA:SPNUM?<CR> / output of serial number

Output:

Calib number : 0 / output of calibration file number (0 : select file automatically according to Hall sensor signal)

Illuminance[lx]:1.528e+03

Chrom_x:0.3534

Chrom_y:0.3739

WL[nm] Sp Irradiance[W/(m^2*nm)]

380 4.87725949e-03 / first wavelength and value

385 4.49027959e-03

390 5.99744590e-03

…

775 2.98083741e-02

780 2.95560490e-02 / last wavelength and value

Color temperature of reference source: 2856 K

CRI_DC: 2.2e-04

CRI_Ra: 57.49

CRI_R01: 55.0

CRI_R02: 56.7

…

CRI_R11: 47.2

CRI_R12: 53.6

CRI_R13: 44.8

CRI_R14: 72.4

Level/ cnt: 26377 / maximum counts in raw spectrum

Level/ %: 0088 / saturation level of measurement in %

Spectrometer number: 2012666

Variation:

- Output of radiometric spectrum in steps of 1 nm – insertion of command *CONF:WSTP 1 before the FETCH command
- The *CALC:CRI command can be used without argument to calculate the reference spectrum with the measured CCT.

7.2.3 Pulsed source measurement (e.g. monitor)

Task:

- Adjustment of measuring spot on the monitor
- u´v´and Y (L_v) measurement of a monitor
- Measurement synchronized to the monitor repetition rate (measurement of the cycle time with 200 averages and a timeout time of 1 s)

Program sequence:

*CONTR:LASER 1<CR> / switch on the target laser

adjustment of the measuring area on the monitor

*CONTR:LASER 0<CR> / switch off the target laser

*CONF:EXPO 1<CR> / setting: adaption of *tint*

*CONF:CYCMOD 1<CR> / switching to synchronized measuring mode

*CONTR:CYCTIM 200 4000<CR> / measurement of cycle time

*CONF:CYCTIM …<CR> / setting: cycle time to measured value (in µs)

*MEAS:CHROMUV<CR> / measurement and output of u´and v´

*FETCH:PHOTO<CR> / output of photometric value

Output:

cyctim: 19.99 / measuring result for cycle time in ms

u´: 0.2521

v´: 0.5229

luminance [cd/m2]: 9.241e^2

8. Service

Please contact in case of any question or technical problem:

JETI Technische Instrumente GmbH
Tatzendpromenade 2
D-07745 Jena
Tel. +49 3641 225 680
Fax +49 3641 225 681
e-mail: support@jeti.com
Internet: www.jeti.com

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29 August 2012