

## Operating Instructions

# Firmware SPECFIRM\_XXX

spectraVal 1501 / 1511  
RU40/90  
RU60  
SDCM3 / SDCM4 / PE60\_2



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## 1 Overview of Commands by Application

Direct communication with a *JETI* device/electronics can be done with 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 Bd, 115 200 Bd, 230 400 Bd, 921 600 Bd and 3 000 000 Bd.

The default baud rates are:

spectraval 1501/1511: 921 600 Bd

SDCM3: 3 000 000 Bd (921 600 Bd with Bluetooth module)

SDCM4 / PE60\_2: 115 200 Bd (only symbolic, real transfer rate is USB HS)

The following list shows the available command by categories. They match the SCPI standard regulations and begin with \* and have the following keywords:

*PARAMeter	Get and set general parameters
*CONFigure	Get and set configuration data
*CONTRol	Control peripheral components
*CALCulate	Calculate data from the previous measurement
*CALIBrate	Get and set for calibration parameters
*MMEMory	Handling of data storage
*MEASure	Configure, start the measurement and get the data (combination of *CONF, *INIT and *FETCH)
*FETCH	Get data from previous measurement
*STATus	Information about error and enquiry status
*HELP	Output of help information

These keywords 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 are optional.

Several commands can be extended by arguments. The meanings of the arguments are as follows:

tint	Integration time in ms, range from 0.01 ms to 65 000.0 ms
av	Average counts for measurement (1 to 10 000)

format	Output format of spectral data (for detailed description see Structure of Data Stream) 0 no output (affects all data, also calculated values) 1 L/H binary output with length 2 ASCII output, space separated (only for testing purposes). Wavelengths are interpolated with a step set by *CONF:WSTP
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.

<b>Note:</b>	A space sign between command and argument is necessary (not in case of ?).
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If a command which accepts arguments is used without arguments, then the configured arguments will be used.

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 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): <i>data sequence</i> <CR>
*INIT	ACK (06 hex) immediately after command input BELL (07 hex) after finishing the measurement
*MEAS	ACK (06 hex) immediately after command input BELL (07 hex) after finishing the measurement <i>data sequence</i> <CR> <CR>
*FETCH *CALC	<i>data sequence</i> <CR> <CR> (in case of spectral data output) or <i>value</i> <CR> (in case of single value output)
*HELP	<i>List with commands and description</i> <CR>

## **3 Commands**

### **3.1 General Commands**

BOOT; HELP; IDN; RST; SLEEP; VERS;

### **3.2 PARAMeter**

Get and set general parameters.

?; ADCR; ADCV; ALLPARA; ANCFAC; AVER; BACKUP; BAUD; BOXCA; CALIBN;  
DATE; DEVNUM; DIRECT; ETH:DHCP;ETH:GWADDR; ETH:IPADDR;  
ETH:MACADDR; ETH:SNMASK; FAULTPI; FAST; FIT; FLAS; FORM; FUNC; GAIN;  
GPIO; LAMPE; LAMPP; LASERINT; LASERLIM; MAXTIN; MAXAVER; OFFCORR;  
OFFS; OVSAMP; PDAG; PIXBIN; PIXEL; PIXRAN; PONTIM; PRESC; RESTORE;  
SAVE; SDEL; SENS; SERN; SYNCFREQ; SYNCMOD; SPNUM; TEMPC; TIME; TINT;  
TRIG; TRSL; WRAN;

### **3.3 CONFigure**

Get and set configuration data

?; BATTEN; BTEN; DISPEN; ETHEN; PIEZOEN; RTCEN; SDCARDEN; MINTIN;

### **3.4 CONTRol**

Control peripheral elements

?; GPIO; LAMP; LASER;

### **3.5 CALIBrate**

Get and set calibration data

?; DATA; DEL; STAT;

### **3.6 MEASure**

Start a specific measurement

?; BATT; DARK; FLIC; LIGHT; REFE; TEMPE; TIADAPT;



### **3.7 FETCH**

Get data from previous measurement.

?; AVER:ADAPT; AVER:DARK; AVER:LAST; AVER:LIGHT; AVER:REFER; DARK;  
LEVEL; LIGHT; REFE; TINT:ADAPT; TINT:DARK; TINT:LAST; TINT:LIGHT;  
TINT:REFER;

### **3.8 CALCulate**

Calculate data from the previous measurement.

?; CCT; CHROMUV; CHROMXY; CRI; DARK:WAV; DWLPE; LIGHT:WAV; PHOTO; RA-  
DIO; REFER:PIX; REFER:WAV; RGB; SPRAD;

### **3.9 MMEMory**

Access to mass memory.

?; CAT; COPY; DATA; DEL; MOVE;

### **3.10 STATus**

Information about error and configuration status.

ENQU; ERR; TXTERR;

## 4 Explanation of Commands

### 4.1 General Commands

*BOOT<CR>	Jump to boot loader
*HELP?<CR>	help text for all commands
*RST<CR>	Software reset
*IDN?<CR>	Get device ID Example of answer: JETI_SDCM3 12345678
*VERS?<CR>	Get firmware version 64-bytes field of char (plain text ASCII); bytes 0–63 of the parameter block Example of answer: SPECFIRM_1511 VERSION 1.3.10 070217
*SLEEP<CR>	enter power save mode

### 4.2 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.

**Remark:** Keep in mind that changed parameters can cause errors in measurement.

#### 4.2.1 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.
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*PARAMeter:SPNUMBER arg<CR>	Get/ Set spectrometer number arg: some number with maximal 7 digits (because of float numbers precision)
	Example of answer for '*PARA:SPNUM?<CR>': spectrometer number: 2005184
*PARAMeter:SERNumber arg<CR>	Get/ Set serial number of the electronics board. arg: some number with maximal 7 digits (because of float numbers precision)
	Example of answer for '*PARA:SERN?<CR>': 15105
*PARAMeter: DEVNUMBER arg<CR>	Get/ Set device serial number. arg: some number with maximal 7 digits (because of float numbers precision)
	Example of answer for '*PARA:DEVNUM?<CR>': 1500044

#### 4.2.2 Settings Concerning the Detector Array and the AD Converter

*PARAMeter:SENSor arg arg<CR>	Get/ Set imaging sensor type and pixel number arg = any valid sensor number arg = up to 2048 name of sensor
	Example of answer for '*PARA:SENS?<CR>': 100 2048 (S11639,S13496)
*PARAMeter:PIXBINning arg<CR>	Get/ Set the pixel to bins arg = 1 ... 16
	Example of answer for '*PARA:PIXBIN?<CR>': 2
*PARAMeter: PIXEL?<CR>	Get effective pixel number (depending on pixel binning *see PIXBIN
	Example of answer for '*PARA:PIXEL?<CR>': 1024
*PARAMeter:DIRECTion arg<CR>	Change scan direction arg = 0 (lowest pixel first) or 1 (highest pixel first)
	Example of answer for '*PARA:DIRECT?<CR>': Scan direction : 0
*PARAMeter:FASTscan arg<CR>	Get/ Set time to next fast cycle (in ms) arg: 0 ms to 350 ms
	Example of answer for '*PARA:FAST?<CR>': 50 ms

*PARAMeter:PRESCan arg<CR>	Get/ Set count of fast scans before measurement scan arg = 0 ... 8
	Example of answer for '*PARA:PRESC?<CR>': 2
*PARAMeter:PDAGain arg<CR>	Get/ Set line array gain (only S8378, S9226 and G11620) arg = 0 (low) or 1 (high)
	Example of answer for '*PARA:PDAG?<CR>': 0 (low)
*PARAMeter: ADCResolution arg<CR>	Get/ Set ADC resolution (in bit) arg = 8 ... 16 [bits] Default value: 16
	Example of answer for '*PARA:ADCR?<CR>': 16
*PARAMeter:ADCVoltage arg<CR>	Get/ Set input voltage range of ADC arg = 2: 2 V, arg = 4: 4 V
	Example of answer for '*PARA:ADCV?<CR>': 2 V
*PARAMeter:OFFSet arg<CR>	Get/ Set offset value arg: -300 mV to 300 mV
	Example of answer for '*PARA:OFFS?<CR>': 150 mV
*PARAMeter:GAIN arg<CR>	Get/ Set gain value arg: 1.0 to 5.0 Default value: 1
	Example of answer for '*PARA:GAIN?<CR>': 1.0
*PARAMeter: OVSAMPling arg<CR>	Get/ Set oversampling arg: 1 to 32 Default value: 1
	Example of answer for '*PARA:GAIN?<CR>': 12

<p>*PARAMeter:BAUD arg&lt;CR&gt;</p>	<p>Get/ Set baudrate          arg = 384: 38 400 Bd          arg = 115: 115 200 Bd          arg = 230: 230 400 Bd          arg = 921: 921 600 Bd          arg = 3000: 3 000 000 Bd          Default value: 921</p>
	<p>Example of answer '*PARA:BAUD?&lt;CR&gt;': 921600</p>

### 4.2.3 Settings for Peripheral Components

It is possible to connect several peripheral components to the SDCM3 board. The following commands are used to control these components.

#### 4.2.3.1 Lamps/Shutter

Different pins of the SDCM3/SDCM4/PE60\_2 boards can be used as LV-TTL lamp or shutter control output. This signal is programmable in active polarity by parameter lamp polarity (0/1). If the parameter lamp enable is set to 1 (enabled, normal mode), it will be set active before the scan of the line array for the time determined by scan delay parameter and during the light scan or inactive during the dark scan. Additionally the signal can be controlled by control lamp command. If the parameter lamp enable is set to 2 (enabled, flash mode), the signal can control a flash light or act as a PWM signal. One can configure the interval time and the pulse length by parameter flash mode. If lamp enable is set to disabled, the signal will be left inactive and switching with control command will return an error.

In JETI devices (spectraval 15x1) and spectrometers (RU40/90, RU60) an internal mechanical shutter is connected to this pin. Therefore the parameters should not be changed.

<p>*PARAMeter: LAMPEnable arg&lt;CR&gt;</p>	<p>Get/ set enable state of external lamp/shutter control output          arg = 0: <i>disabled</i>, arg = 1: <i>enabled (normal)</i>,          arg = 2: <i>enabled (flash / PWM mode)</i>          Default value: 1</p>
	<p>Example of answer for          '*PARAMeter:LAMPEnable?&lt;CR&gt;':          1 (enabled)</p>

*PARAMeter: LAMPpolarity arg<CR>	Get/ set polarity of external lamp/shutter control arg = 0: <i>high</i> , arg = 1: <i>low</i> Default value: 1
	Example of answer for '*PARA:LAMPp?<CR>': 1 (high)
*PARAMeter:FLAShmode arg1 arg2<CR>	Get/ set interval and pulse length for external flash light arg1 (Interval in ms): 1.0...333.0 arg2 (Pulse length in $\mu$ s): 2.0...10000.0 Default value: 1
	Example of answer for '*PARAMeter:FLAShmode?<CR>': 100 20
*PARAMeter:SDELay arg<CR>	Get/ Set scan delay (time difference between initiating a measurement and its real start, in ms), is necessary for full shutter opening (or lamp stability). arg: 0 ms to 60 000 ms
	Example of answer for '*PARA:SDEL?<CR>': 35 ms

#### 4.2.3.2 Target Laser

*PARAMeter:LASERLIMit arg<CR>	Get/ Set maximum PWM duty cycle for laser diode arg = 1 ... 100% (password protected)
	Example of answer for '*PARA:LASERLIM?<CR>': 100 %
*PARAMeter: LASERINTensity arg<CR>	Get/ Set effective PWM duty cycle for laser diode arg = 1 ... 100%
	Example of answer for '*PARA:LASERINT?<CR>': 100 %

### 4.2.3.3 LAN Interface

*PARAMeter:ETHernet: IPADDRess arg<CR>	Get/ Set network IP address arg = 0.0.0.0 to 255.255.255.255
	Example of answer for *'PARA:ETHernet:IPADDR?<CR>': 192.168.115.100
*PARAMeter:ETHernet: GWADDRess arg<CR>	Get/ Set network gateway address arg = 0.0.0.0 to 255.255.255.255
	Example of answer for *'PARA:ETHernet:IPADDR?<CR>': 192.168.115.1
*PARAMeter:ETHernet: SNMASK arg<CR>	Get/ Set network subnet mask arg = 0.0.0.0 to 255.255.255.255
	Example of answer for *'PARA:ETHernet:SNMASK?<CR>': 255.255.255.0
*PARAMeter:ETHernet: MACADDRess arg<CR>	Get/ Set network MAC address (only variable part) arg = 80:00 to 8F:FF
	Example of answer for *'PARA:ETHernet:MACADDR?<CR>': 70:B3:D5:93:80:02
*PARAMeter:ETHernet: DHCPmode arg<CR>	Get/ Set DHCP mode arg = 0: <i>disabled,static</i> , arg = 1: <i>enabled</i>
	Example of answer for *'PARA:ETHernet:DHCP?<CR>': 1 - DHCP enabled

### 4.2.3.4 Date and Time (Real-Time-Clock)

*DATE arg<CR>	Get/ Set actual date in format YYYY-MM-DD arg = YYYY-MM-DD
	Example of answer for '*DATE?<CR>': 2016-03-20

*TIME arg<CR>	Get/ Set the actual time in format HH:MM:SS (24h format) arg = HH:MM:SS
	Example of answer for '*TIME?<CR>': 10:10:32
*PARAMeter:PONTIME arg<CR>	Get/ Set on-time till device is switched off due to inactivity arg: 0 .. 60 minutes
	Example of answer for '*TIME?<CR>': 5 min



#### 4.2.3.5 Trigger

<p>*PARAMeter:TRIGger arg&lt;CR&gt;</p>	<p>Get/ Set trigger mode          arg = 0: <i>disabled</i>          arg = 1: <i>enabled, measure mode</i>; start of a configured measurement with hardware trigger (shortcut with switch or TTL signal), last output: 07 (measurement finished, data are ready)          arg = 2: <i>enabled, enquiry mode</i>; send enquire with hardware trigger          arg = 3: <i>enabled, measure and output mode</i></p>
	<p>Example of answer for '*PARAMeter:TRIG?&lt;CR&gt;': 1 (measure mode)</p>
<p>*PARAMeter:TRSLope arg&lt;CR&gt;</p>	<p>Get/ Set the trigger slope          arg = 0: triggering with rising edge          arg = 1: triggering with falling edge          Default value: 0</p>
	<p>Example of answer for '*PARAMeter:TRSL?&lt;CR&gt;': 1 (falling edge)</p>

#### 4.2.3.6 General-purpose input/output(GPIO)

Pin 17 to 23 and pin 8 can be used as GPIO pins. They can be configured as digital input with either pull-up, pull-down or floating or as digital output by using '\*PARAMeter:GPIO arg1 arg2 arg3' with three arguments. The first argument is the GPIO number, the second argument is direction (0 – output, 1 – input) and the third argument is the GPIO mode when configured as input (0 – floating, 1 – pull-up, 2 – pull-down). The GPIO mode will be ignored if configured as output.

The configuration can be requested by '\*PARAMeter:GPIO? arg' where arg is the GPIO number.

The pins can be controlled by using '\*CONTR:GPIO arg1 arg2' with two arguments. The first argument is the GPIO number and the second argument sets the pin in case of output configuration (0 – set to low, 1 – set to high). If it is configured as input the status can be requested with '\*CONTR:GPIO? arg' where arg is the GPIO number.

The following GPIO pins are available:

GPIO	Hardware Pin
GPIO0	17
GPIO1	18
GPIO2	19
GPIO3	20
GPIO4	21
GPIO5	22
GPIO6	23
GPIO7	8

*PARAMeter:GPIO arg1 arg2 arg3<CR>	Get/ Set GPIO configuration <i>see description above</i>
	Example of answer for '*PARAMeter:GPIO? 7<CR>': 0 1
*CONTRol:GPIO arg1 arg2<CR>	Get/ Set GPIO state <i>see description above</i>
	Example of answer for '*CONTRol:GPIO? 7<CR>': 1

#### 4.2.4 Time Settings

*PARAMeter:TINT tint<CR>	Get/ Set default integration time (preset value: 100.0 ms) tint: 0.1 ms to 65 000.0 ms
	Example of answer for '*PARA:TINT?<CR>': 100.000 ms
*PARAMeter:MAXTINT maxtint<CR>	Get/ Set maximum integration time used by adaption. <b>Note</b> , this parameter has nothing to do with TINT set with *PARA:TINT. Its meaning is the upper border by adaption, and it is relevant <i>only</i> for adaption algorithm. With other words, it is possible that TINT (if set explicitly) > MAXTINT. maxtint: 400.0 ms to 6000.0 ms
	Example of answer for '*PARA:MAXTIN?<CR>': 4000.000

*PARAMeter:MAXAVER arg<CR>	Get/ Set maximum average count for adaption arg: 1 ... 100
	Example of answer for '*PARA:MAXAVER?<CR>': 2
*PARAMeter: SYNCFREQuency arg<CR>	Get/ Set source repetition rate arg: 0.100 ... 5000.00 [Hz]
	Example of answer for '*PARA:SYNCFREQ?<CR>': 300.00 Hz
*PARAMeter:SYNCMODE arg<CR>	Get/ Set synchronization mode for adaption of tint arg = 0: <i>disabled</i> arg = 1: <i>enabled</i>
	Example of answer for '*PARA:SYNCMOD?<CR>': 1 (enabled)

#### 4.2.5 Correction and Smoothing

*PARAMeter:FAULTPIxel arg1 arg2 ... arg20<CR>	Get/ Set faulty pixel (the order is arbitrary, successive pixel can be used, pixel 0 and 2047 cannot be used because of their missing neighbor) 0 ... real sensor pixel count - 1 arg = 0 or -1 means: faultpixel is deactivated
	Example of answer for '*PARA:FAULTPI?<CR>': 38 57
*PARAMeter: OFFCORRrange start end<CR>	Get/ Set offset correction pixel range start/end: 0 ... real sensor pixel count
	Example of answer for '*PARA:OFFCORR?<CR>': 100 200
*PARAMeter:ANCFACtor arg<CR>	Get/ Set the reducing factor in ANC correction (special zero line correction procedure) 0.0 ... 1.00 arg = 1.0 : no correction arg = 0.0 : negative values set to zero
	Example of answer for '*PARA:ANCFAC?<CR>': 0.0

*PARAMeter:BOXCAr arg<CR>	Get/ Set boxcar mode arg: running average of pixels, odd number 1, 3, 5 ... 11. arg = 1: no boxcar integration Default value: 1
	Example of answer for '*PARA:BOXCA?<CR>': 1
*PARAMeter:AVERAge arg<CR>	Get/ Set default average value arg: 1 ... 10000 Default value: 1
	Example of answer for '*PARA:AVER?<CR>': 1
*PARAMeter:TEMPCorr arg<CR>	Get/ Set Get temperature correction value arg: -5.0 ... 5.0 [K]
	Example of answer for '*PARA:TEMPC?<CR>': 0.0 K

#### 4.2.6 Settings for Measurement

*PARAMeter: CALIBNumber arg<CR>	Get/ Set calibration file number used for radiometric calculations arg = 0 ... 8 (Calibration file number) (0 = automatic selection according to attached accessory)
	Example of answer for '*PARA:CALIBN?<CR>': 1
*PARAMeter:FITn fit <sub>n</sub> <CR>	Get/ Set wavelength fit parameters $\lambda(p) = fit_0 + fit_1 \cdot p + fit_2 \cdot p^2 + fit_3 \cdot p^3 + fit_4 \cdot p^4$ p = pixel number; n = 0 to 4; fit <sub>n</sub> : any legal float number
	Example of answer for '*PARA:FIT0?<CR>': Fit0 Channel 1: 2.729578e+02
*PARAMeter:WRANge start end step<CR>	Get/ Set wavelength range and step width for radiometric calculation and all spectra with wavelength output start = 190 ... 2699 nm end = 191 ... 2700 nm step = 1 or 5 nm
	Example of answer for '*PARA:WRAN?<CR>': 400 800 5

*PARAmeter:PIXRANge start end<CR>	Get/ Set pixel range for spectra output start = 0 ... sensor pixel count-1 end = 1 ... sensor pixel count
	Example of answer for '*PARA:PIXRAN?<CR>': 0 2047
*PARAmeter:FORMat format<CR>	Get/set predefined output format (see the list of arguments in format)
	Example of answer: for '*PARA:FORM?<CR>': 2
*PARAmeter:FUNcTion function<CR>	Get/ set predefined measurement function (see the list of arguments in function) Default value: 1
	Example of answer for '*PARA:FUNC?<CR>': 1

<p>*PARAMeter: ALLPARA?&lt;CR&gt;</p>	<p>Get a list of all parameters</p> <hr/> <p>Example of answer:</p> <pre>*PARAMeter:SERNumber 1630020 *PARAMeter:SPNUMber 4215044 *PARAMeter:DEVNUMber 1510030 *PARAMeter:SENSor 100 2048 (S11639,S13496) *PARAMeter:PIXBINning 2 *PARAMeter:DIRECTion 1 *PARAMeter:FASTscan 0 ms *PARAMeter:PDAGain 0 (low) *PARAMeter:ADCResolution 16 *PARAMeter:ADCVoltage 4 V *PARAMeter:OFFSet -220 mV *PARAMeter:GAIN 3.0 *PARAMeter:OVSAMPLing 16 *PARAMeter:BAUDrate 115200 *PARAMeter:LAMPEnable 1 (enabled) *PARAMeter:LAMPpolarity 1 (high) *PARAMeter:SDElay 200 ms *PARAMeter:LASERLIMit 100 *PARAMeter:LASERINTensity 100 *PARAMeter:FIT0 1.206140e+01 *PARAMeter:FIT1 1.335971e+00 *PARAMeter:FIT2 1.476031e-03 *PARAMeter:FIT3 -2.679267e-06 *PARAMeter:FIT4 1.604261e-09 *PARAMeter:WRANge 380 780 1 *PARAMeter:TINT 20.000 ms *PARAMeter:MAXTINT 1000.000 *PARAMeter:MAXAVER 60 *PARAMeter:SYNCFREquency 100.0 Hz *PARAMeter:SYNCMODE 1 (enabled) *PARAMeter:FORMat 1 *PARAMeter:FUNCTion 3 *PARAMeter:PONTIME 0 min *PARAMeter:FAULTPIXel 0 *PARAMeter:OFFCORRrange 50 200 *PARAMeter:ANCFAC 1.00 *PARAMeter:BOXCAR 1 *PARAMeter:AVERage 1 *PARAMeter:TEMPCorr 0.00 K *PARAMeter:TRIGger 0 *PARAMeter:TRSLope 0 *PARAMeter:CALIBNumber 0</pre>
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#### 4.2.7 Permanent Storage/Backup of Parameters

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

<p>*PARAMeter: DEFault&lt;CR&gt;</p>	<p>load default parameter from internal flash storage</p> <hr/> <p>Example of answer: <i>ACK (06 hex)</i></p>
<p>*PARAMeter:SAVE&lt;CR&gt;</p>	<p>Write parameters to internal flash storage</p> <hr/> <p>Example of answer: <i>ACK (06 hex)</i></p>

*PARAMeter: BACKUP<CR>	backup all parameter (password protected)
	Example of answer: <i>ACK (06 hex)</i>
*PARAMeter: RESTORE<CR>	restore parameter (password protected)
	Example of answer: <i>ACK (06 hex)</i>

### 4.3 Configuration Commands

The configuration commands can be used to change the default status of several arguments. In contradiction to the \*PARA commands the configured parameters will be stored only temporarily.

*CONFigure?<CR>	Get a help list of the configuration commands
*CONFigure:BTENable arg<CR>	Get/ Set bluetooth configuration arg = 0: <i>disabled</i> , arg = 1: <i>enabled</i>
	Example of answer for "*CONF:BTEN?<CR>": 1 (bluetooth enabled)
*CONFigure:DISPENable arg<CR>	Get/ Set display configuration arg = 0: <i>disabled</i> , arg = 1: <i>enabled</i>
	Example of answer for "*CONF:DISPEN?<CR>": 1 (display enabled)
*CONFigure:ETHENable arg<CR>	Get/ Set ethernet configuration arg = 0: <i>disabled</i> , arg = 1: <i>enabled</i>
	Example of answer for "*CONF:ETHEN?<CR>": 1 (ethernet enabled)
*CONFigure: PIEZOENable arg<CR>	Get/ Set piezo shutter configuration arg = 0: <i>disabled</i> , arg = 1: <i>enabled</i>
	Example of answer for "*CONF:PIEZOEN?<CR>": 1 (piezo shutter enabled)
*CONFigure:RTCENable arg<CR>	Get/ Set rtc configuration arg = 0: <i>disabled</i> , arg = 1: <i>enabled</i>
	Example of answer for "*CONF:RTCEN?<CR>": 1 (rtc enabled)

*CONFigure: SDCARDENable arg<CR>	Get/ Set sd card configuration arg = 0: <i>disabled</i> , arg = 1: <i>enabled</i>
	Example of answer for '*CONF:SDCARDEN?<CR>': 1 (sd card enabled)
*CONFigure: MINTINT?<CR>	Get the shortest possible integration time in ms. It depends on the type of the detector array.
	Example of answer: Shortest integration time: 5

## 4.4 Control Commands

These commands are used to control the peripheral elements lamp/shutter.

*CONTRol?<CR>	Get a help list of the control commands
*CONTRol:LAMP arg<CR>	Lamp on/off or open/close a shutter arg = 1 or 0
*CONTRol:LASER arg<CR>	Get/ Set the laser status arg = 0: <i>off</i> , arg = 1: <i>on</i>
	Example of answer for '*CONTR:LASER?<CR>': 1 (target laser is on)

## 4.5 Calibration Commands

The SPECFIRM firmware contains radiometric measurements and calculations. The basis for this radiometry is the absolute sensitivity calibration of the unit.

*CALIBrate?<CR>	Get a help list of the calibration commands
*CALIBrate:DATA arg<CR>	Write/ read calibration data to/ from internal flash (up to 8 files) arg = 0 ... 8 (Calibration file number)
	Example of answer for '*CALIB:DATA?<CR>': calibfile
*CALIBrate:DElete arg<CR>	Delete a calibration file arg = 0 ... 8 Calibration file number



*CALIBrate: STATus?<CR>	Returns the calibration status
	Example of answer for '*CALIB:STAT?<CR>': 1

## 4.6 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:BATTery<CR>	Run battery voltage measurement - output of voltage, percent of battery capacity and whether USB powered
	Example of answer: 4.21 100 1
*MEASure:DARKspectra tint av format<CR>	tint $\neq$ 0: Run dark measurement Data storage in dark buffer The user has to ensure that the optical input of the unit is darkened during the *MEAS:DARK measurements (is closed with an external shutter or the lamp is switched off)
	Example of answer for *MEAS:DARK 100 1 4<CR>: <i>ACK (06 hex)</i> <i>BEL (07 hex)</i> 552 551 544 549 ... ...
*MEASure:LIGHTspectra tint av format<CR>	Run light measurement (exposed spectrum – opened external shutter or lamp switched on)
*MEASure:REFERence tint av format<CR>	Run reference measurement (Difference between light measurement and dark spectrum), data storage in reference buffer data output according to selected format
*MEASure:FLICKer<CR>	Perform a flicker frequency measurement - output of flicker frequency
	Example of answer: 234.49 Hz

*MEASure:TIADAPtion arg<CR>	Perform a measurement to get the optimal integration time - output of tint and av (see Time Settings) arg = 0: <i>only adaption</i> arg = 1: <i>with additional reference measurement</i>
	Example of answer: 63.914 1
*MEASure: TEMPERature<CR>	Measure Ambient temperature
	Example of answer for "*meas:tempe<CR>": 23.77°C

## 4.7 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:LIGHT format<CR>	Output of exposed spectrum values
*FETCH:DARK format<CR>	Output of dark spectrum values
*FETCH:REFErence format<CR>	Output of reference values
*FETCH:LEVEL<CR>	Read out of maximum counts and percentage of exposure
	Example of answer: 47186 72
*FETCH:AVER: ADAPT<CR>	Read out adapted average count (from: *meas:tiadapt)
	Example of answer: 1
*FETCH:AVER: DARK<CR>	Read out of previously used dark average count
	Example of answer: 1

*FETCH:AVER: LAST<CR>	Read out of previously used average count
	Example of answer: 1
*FETCH:AVER: LIGHT<CR>	Read out of previously used light average count
	Example of answer: 1
*FETCH:AVER: REFER<CR>	Read out of previously used reference average count
	Example of answer: 1
*FETCH:TINT: ADAPT<CR>	Read out adapted integration time (from: *meas:tiadapt)
	Example of answer: 142.040
*FETCH:TINT: DARK<CR>	Read out of previously used dark integration time
	Example of answer: 142.040
*FETCH:TINT: LAST<CR>	Read out of previously used integration time
	Example of answer: 142.040
*FETCH:TINT: LIGHT<CR>	Read out of previously used light integration time
	Example of answer: 142.040
*FETCH:TINT: REFER<CR>	Read out of previously used reference integration time
	Example of answer: 142.040

## 4.8 Calculation Commands

After proceeding the appropriate measurements it is possible to calculate additional values from the obtained spectrum. The \*CALC:REFER and \*CALC:SPRAD commands require a previous \*MEAS:REFER scan or the \*MEAS:DARK and \*MEAS:LIGHT scans.

#### 4.8.1 Raw Data

*CALCulate?<CR>	Get a help list of the calculation commands
*CALCulate:DARK:WAVE format<CR>	Proceed a dark spectra calculation in the defined wavelength range and step width (*PARA:WRAN).
	Example of answer: see chapter Structure of Data Stream
*CALCulate:LIGHT:WAVE format<CR>	Proceed a light spectra calculation in the defined wavelength range and step width (*PARA:WRAN).
	Example of answer: see chapter Structure of Data Stream
*CALCulate: REFERENCE:PIXel format<CR>	Proceed a reference spectra calculation at pixel wavelengths.
	Example of answer: see chapter Structure of Data Stream
*CALCulate: REFERENCE:WAVE format<CR>	Proceed a reference spectra calculation in the defined wavelength range and step width (*PARA:WRAN).
	Example of answer: see chapter Structure of Data Stream

#### 4.8.2 Radiometric Data

*CALCulate:SPRAD arg<CR>	Proceed a calculation of the radiometric spectrum in the defined wavelength range (*PARA:WRAN) arg = 0,1,2 (output format)
	Example of answer: see chapter Structure of Data Stream
*CALCulate:CCT<CR>	Proceed the calculation of the correlated color temperature
	Example of answer: 5749.0
*CALCulate: CHROMUV<CR>	Proceed the calculation of the chromaticity u'v'
	Example of answer: 0.2056 0.4735

*CALCulate: CHROMXY<CR>	Proceed the calculation of the chromaticity xy
	Example of answer: 0.32710.3348
*CALCulate:CRI<CR>	Proceed the calculation of the color rendering index Ra,DC,R1 . . . R15
	Example of answer: 91.26 5.2E-03 85.3 ... 84.8
*CALCulate: DWLPE<CR>	Proceed the calculation of the dominant wavelength and color purity
	Example of answer: 494.6 2.0
*CALCulate: PHOTometric<CR>	Proceed the calculation of the photometric value
	Example of answer: 9.988E+01
*CALCulate: RADIometric<CR>	Proceed the calculation of the radiometric value
	Example of answer: 3.299E-01
*CALCulate:RGB<CR>	Proceed the calculation of the RGB values
	Example of answer: 216.8 87.94 90.8

## 4.9 Mass Memory Commands

*MMEMory?<CR>	Get a help list of the memory commands
*MMEMory: CATalog?<CR>	Returns a list of all file names in user flash  Example of answer: filename1 filename2 ... <ETX>
*MMEMory:COPY src dst<CR>	Makes a duplicate of the requested src and copies its content to dst src = sourcefile dst = destinationfile
*MMEMory:DATA filename<CR>#ABC	Writes user data to internal flash (up to 15 files with max. 4KByte per file) filename = The filename can be any name up to 63 character. White-spaces are not allowed to be part of the filename! # = This character indicates the beginning of the data block. A = Number of decimal digits present in B (can be 1 - 4) B = Decimal number specifying the number of data bytes to follow in C (up to 4096 bytes are allowed) C = Actual binary user data  Read file with *MMEMory:DATA? filename<CR>
*MMEMory:DELeTe filename<CR>	Removes a file from the device
*MMEMory:MOVE src dst<CR>	Move/rename a file

## 4.10 Status Commands

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

*STATus:ERRor?<CR>	Get the error code (see list of error codes)
	Example of answer: Error Code: 0
*STATus: TXTError?<CR>	Get error code and description of the error
	Example of answer: 0 : error none
*STATus:ENQUIry?<CR>	Get the enquiry status (see list of enquiry codes)
	Example of answer: 5 (laser target state has been changed)

## 5 Meaning of Error Codes

0 : no error	50 : error lamp/shutter is disabled
4 : error unknown command	120 : error overexposure
7 : error password	123 : error could not adapt integration time
10 : error argument 1	180 : error no calib file
11 : error argument 2	226 : error no memory left
12 : error argument 3	227 : error file doesn't exist
13 : error argument 4	228 : error wrong file size
15 : error missing argument	229 : error src and dst are identical
16 : error no dark measurement	230 : error no disk available
17 : error no light measurement	300 : error device was in sleep mode
18 : error no reference measurement	301 : error could not switch to sleep mode
20 : error no spectroradiometer	302 : error no RTC available
30 : error no backup available	400 : error not possible in DHCP mode

## 6 Meaning of Enquiry Codes

0 : no enquiry
1 : external trigger recognized
4 : accessory attached/detached
5 : laser target state has been changed
20 : external triggered dark measurement
21 : external triggered light measurement
22 : external triggered reference measurement

## 7 Structure of Data Stream

### 7.1 Format = 1

#### A) \*MEAS:DARK / \*MEAS:LIGHT / \*FETCH:DARK / \*FETCH:LIGHT

(L/H binary output with length)

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+2·n	xx yy	last Pixel

*n: number of pixel per line*

#### B) \*MEAS:REFER / \*FETCH:REFER / \*CALC:REFER:PIX

(L/H binary output with length)

All data transmitted as 32 bit integer, low-byte first (Little Endian)

Byte	Value	Definition
0	xx yy	length
2	ww xx yy zz	first Pixel
6	ww xx yy zz	second Pixel
:	:	:
:	:	:
2+4·n	ww xx yy zz	last Pixel

*n: number of pixel per line*



### C) \*CALC:SPRAD / \*CALC:xxx:WAVE

(L/H binary output with length)

All data transmitted as 32 bit float, low-byte first (Little Endian)

Byte	Value	Definition
0	xx yy	length
2	ww xx yy zz	first value
6	ww xx yy zz	second value
:	:	:
:	:	:
2+4·n	ww xx yy zz	last value

*n: number of value, based on wavelength range (\*para:wran)*

## 7.2 Format = 2

### A) Pixel and Pixel Wavelength related Measurements

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

```
250.1<TAB>5153<CR>
250.5<TAB>4118<CR>
250.9<TAB>5126<CR>
251.4<TAB>4008<CR>
...<TAB>...<CR>
<ETX>
```

### B) Wavelength related Measurements (limited by \*PARA:WRAN)

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

```
380<TAB>277.81<CR>
381<TAB>299.34<CR>
382<TAB>316.14<CR>
383<TAB>370.88<CR>
...<TAB>...<CR>
<ETX>
```

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