

Feasa LED Spectrometer

User Manual for Feasa S2 Spectrometer



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Feasa LED Spectrometer

About this Manual

Feasa operates a policy of continuous development. Feasa reserves the right to make changes and improvements to any of the products described in this document without prior notice.

Feasa reserves the right to revise this document or withdraw it at any time without prior notice.

This manual is written for the Feasa LED Spectrometer version S2.

The interface on these units is USB or RS232-Serial.

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Introduction

The **Feasa Led Spectrometer** is a single channel instrument that has been designed specifically to allow testing of LEDs on populated PCB's where access is limited and to measure LEDs in a Laboratory.

The Feasa Led Spectrometer includes customised on board firmware for automatic colour calculation in multiple colour spaces. It uses a similar easy-to-use set of commands as the Feasa Led Analyser.

The Spectrometer can be supplied with miniature Integrating Spheres, Luminance Heads and Millicandela Heads which are used to measure LEDs mounted on Printed Circuit Boards. The adapters allow single LEDs to be measured on a PCB.

When your quality demands Traceable Measurements, the Feasa Led spectrometer provides an ideal solution. Traceable measurements can be obtained for Luminous Flux (Lumens), Luminous Intensity, Luminance and Wavelength.

The Feasa Led Spectrometer is compatible with all Feasa Led Analysers to ensure production setup meets customer requirements. LED test and measurement functions have been incorporated into the Spectrometer so that minimum data processing is required.

A USB interface is included in the device for computer access. Power for the Spectrometer is derived from the USB Interface. The USB Interface is 2.0 compatible. The Spectrometer is also fitted with a Serial Interface 3-Pin Connector with a 3 pin to 9 pin dtype cable (supplied) compatible with the RS-232C ports on machines. An external 5V @200mA PSU is required for this.

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IMPORTANT INFORMATION for Programmers

set / put Commands

The *Set* / *Put* commands are used to adjust various settings in the Spectrometer such as Intensity, Exposure and offsets.

The *Set* commands are written to the on-board Flash.

These settings remain programmed in the Spectrometer even when the power is removed. The Spectrometer has a capacity limit of approximately 100,000 writes to the flash.

Use the *Set* command only to store relevant information on the Spectrometer. Please refrain from using *Set* commands in your high volume production programs as this constant writing to the Flash will eventually corrupt the Spectrometer. Use the *Put* command instead.

The *Put* commands are written to the on-board RAM.

These settings will NOT remain programmed in the Spectrometer after the power is removed.

Use the *Put* command as often as you need in your program. This will prolong the life of the Spectrometer particularly in high volume testing environment.

Commands are transmitted and received using ASCII characters and are case-insensitive. All commands must be terminated with a **<CR>** or **<LF>** character.

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Safety Instructions

Safety precautions should be implemented when testing LEDs. Care should be taken to avoid adverse effects on the human eye caused by light stimulation.

Eye protection should be worn especially when testing high power LEDs.

Never look directly into the optical parts or fibers since light can be coupled from the other end.

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Physical Layout

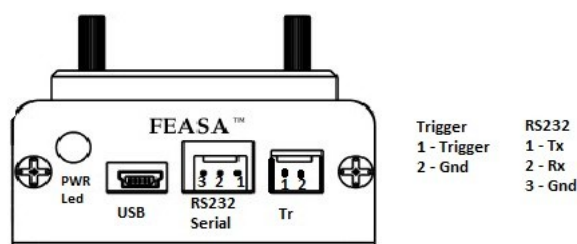


Figure 1a (Front Panel).

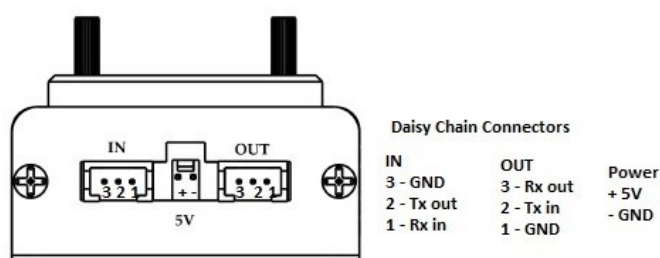


Figure 1b (Rear Panel).

This shows the layout of the Connectors viewed from the edge of the board.

Figure 1a shows the physical layout of the Feasa S2 Led Spectrometer Front Panels.

Figure 1b shows the physical layout of the Feasa S2 Led Spectrometer Rear Panels.

These units are enclosed in an Aluminium Case. The Serial port is a 3 pin connector with the Serial and Power cables supplied and the USB connector is the mini usb again the cable is supplied with the unit.

Please refer to the Fixturing Guidelines Manual for connector pin out details.

Power Requirements:

If the USB Interface is used then the Spectrometer will draw its power from the USB Port on the Computer. The Power requirements for the Spectrometer when using the Serial Port Communication are 5V DC @ 200mA. Do NOT Exceed 6.5V as this will damage the Spectrometer.

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USB Port Control

Connect the LED Spectrometer to the PC using the supplied USB cable. Power is supplied through the USB Cable so there is no need to plug in the Power cable. The installed Software Driver will configure the USB Port automatically. The USB Port is configured as a Virtual Com Port and will be designated a name such as COM5, COM6, etc.

Serial Port Control (RS232)

For serial communications the LED Spectrometer must be connected from the 3-pin Serial Connector to the PC or Controller using the supplied serial cable **(LA-SER-02)**. 5VDC @ 200mA must be supplied to the 2-pin Power Connector using the Power Cable provided **(LA-PWR-01)**. See figure 3. **Prolonged Voltages > 6.5V can damage the Spectrometer.** The Green LED should turn on to indicate the Analyser is ready for use.

The default serial communications settings are **57,600 Baud, 8 Data bits, 1 Stop bit and No Parity.**

The baud rate can be changed to any of the following:- 9600, 19200, 38400, 57600, 115200. See the [setbaud](#) command for more details.

Serial Connector (RS232C)

Pin	Signal	Pin on 9-Pin D-type
1	Tx from Spectrometer	2
2	Rx from Spectrometer	3
3	GND	5

Figure 2.

Power Connector

Pin No	Signal
1	Power (5V 200mA DC)
2	GND

Figure 3.

Please Ensure the RS232 GND (pin3) and the PSU GND are connected together.

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Trigger Port Control

The Feasa Led Spectrometer includes a Trigger function that allows an external signal to trigger a capture. For Trigger Function to operate the LED Spectrometer must be connected from the 2-pin Trigger Connector (Figure 4) to the PC or Controller using the supplied serial cable (**LA-TR-01**). The Trigger function must first be enabled by sending commands to the Spectrometer. The capture is triggered by a high-to-low transition on the Trigger Pin. See the **External Trigger Mode** section of this manual for the programming details.

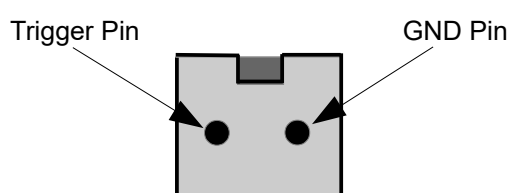


Figure 4.

The layout of the Trigger Connector is shown above Figure 4. The trigger is activated on the Trigger Pin. This pin has an internal pull-up resistor to 3.3V. The Trigger is activated by driving this pin to GND. The Trigger timing sequence is shown below in figure 5.

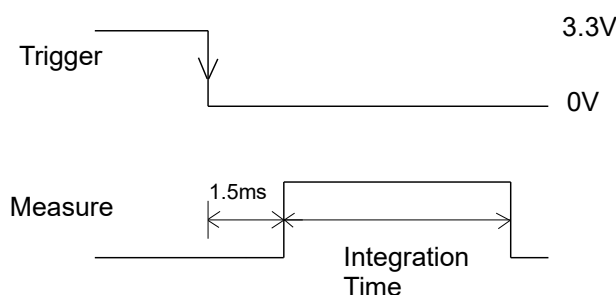


Figure 5. Trigger Timing

When the Trigger is activated there is a 1.5ms +/- 0.1ms delay before the light capture begins. The commands must be transmitted through the USB or Serial Port of the Led Analyser. The Feasa Terminal program can be used to perform this task.

Trigger Connector

Pin	Signal
1	Trigger Pin
2	GND

Figure 6.

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Connecting the Patch Cord to the Spectrometer



Remove the protective end caps from the patch cord.
Using the surface cleaner sachet wipe provide, clean both ends.
This wipe is suitable for one time use only.
For periodic cleaning, use isopropyl and lint free wipes.

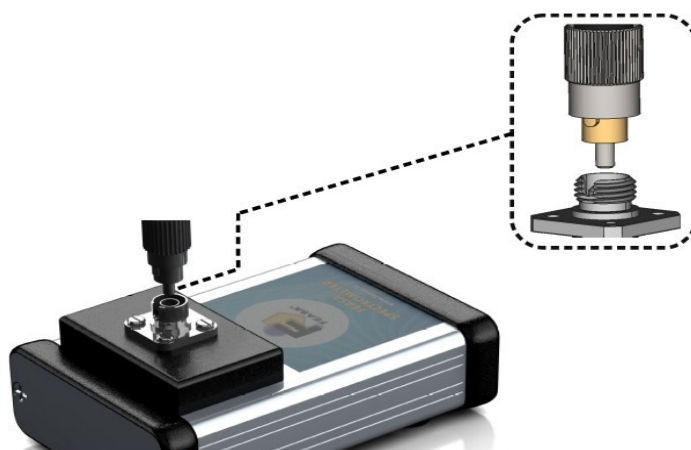


Figure 7.

Remove the protective caps from the fiber optic patch cord. Prior the connecting, clean both ends of the patch cord with the cleaning wipe provided. Connect the FC/PC adaptor (Figure 8) of the patch cord to the Spectrometer module. When connecting the Patch Cord to the Spectrometer ensure that the indent on the Patch Cord connector fits into the slot on the Spectrometer housing as shown above.



Figure 8.

Connect the SMA adaptor Figure 9.of the patch cord to the Optical Adaptor (Spxx). Fasten securely.



Figure 9.

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Spectrometer Block Diagram

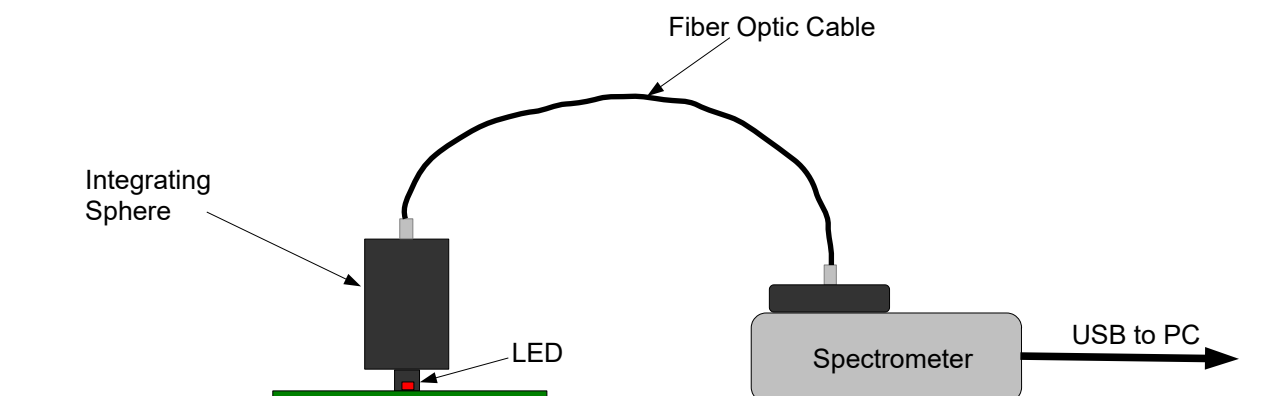


Figure 10.

Figure 10 shows a block diagram of the Spectrometer connected to an Integrating Sphere. The Integrating Sphere is placed over the LED to be measured.

The Spectrometer is connected to a PC using a USB cable in this example but the RS232 Interface can also be used.

The *Feasa Spectrometer Software*, running on the PC, is used to control the Spectrometer and display the results.

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Spectrometer Front End Software

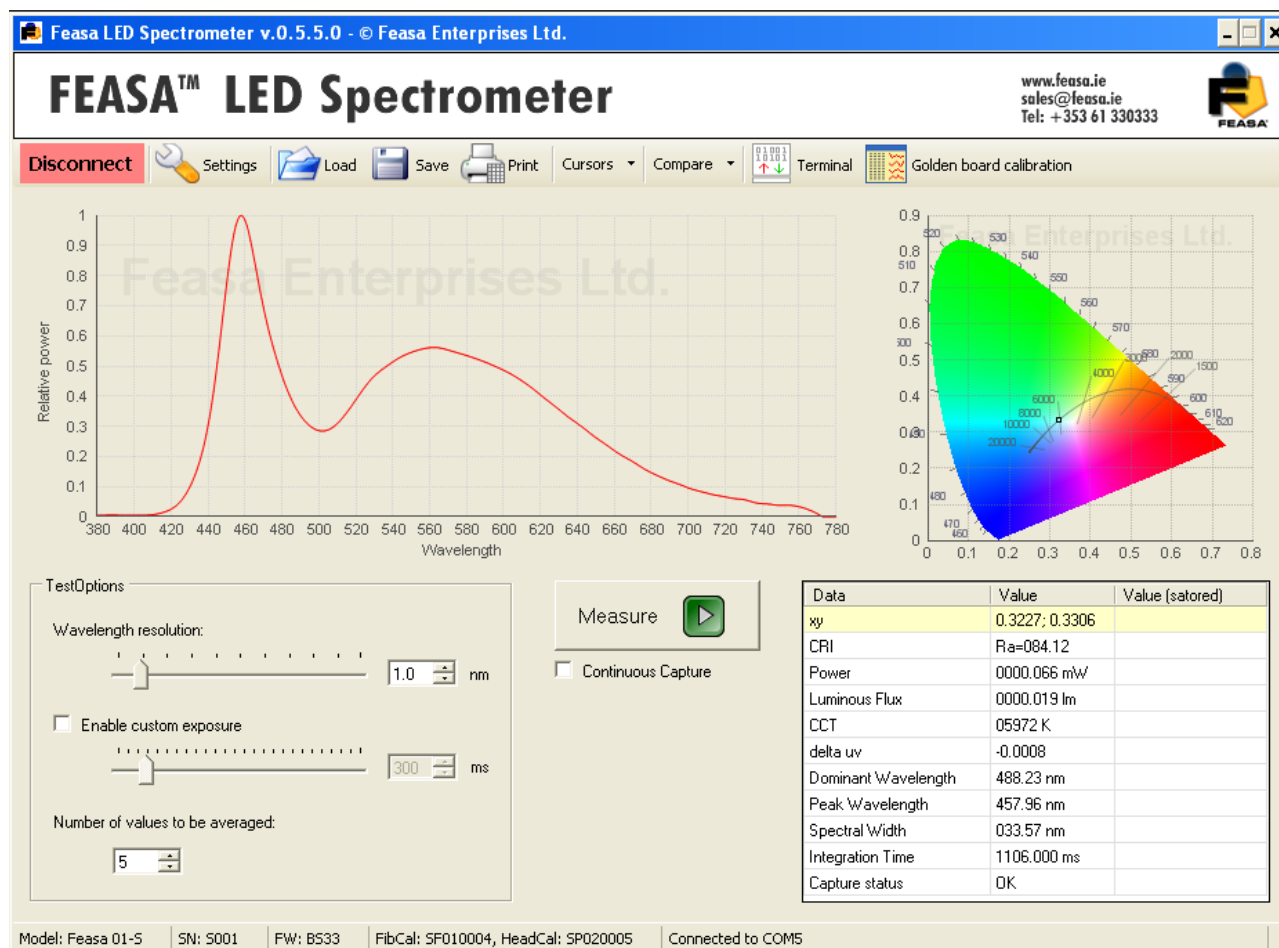


Figure 11.

The Feasa Spectrometer Software is used to configure and make measurements with the Spectrometer. The Spectrometer must be connected to a PC with a USB cable before running this software.

Click on the *Connect/Disconnect* icon to connect the Spectrometer. The *Measure* icon is used to measure a LED and display the results on the screen.

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Spectrometer Definitions

Peak Wavelength

The Peak Wavelength is the wavelength where the spectrum reaches its highest intensity i.e the maximum power as emitted by a LED. This point is shown in the graph below and is labeled peak.

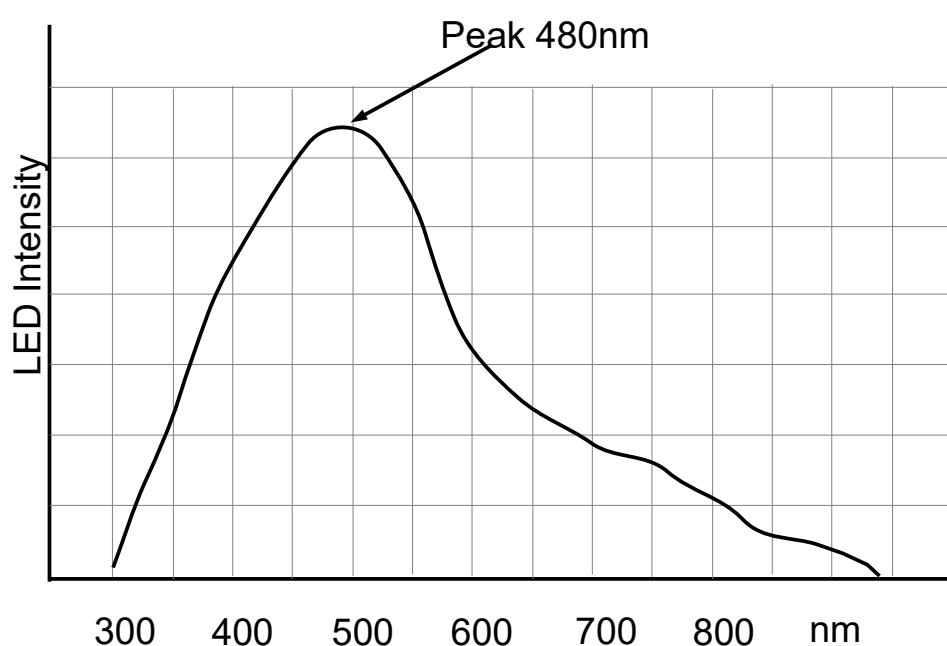


Figure 12. Peak Wavelength

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Spectrometer Definitions

Dominant Wavelength

The dominant wavelength of a colour is defined on the 1931 CIE Chromaticity diagram. A straight line is drawn from the White Point (co-ordinates 0.33,0.33) through the point whose co-ordinates represent the colour being tested and is extended to the edge of the diagram. The point where the line intersects the edge is the Dominant wavelength of the colour being measured.

The value of the wavelength can be read off the Chromaticity diagram at the edge.

The Dominant Wavelength is a single monochromatic colour which describes the multicolor polychromatic value of the LED.

The Dominant Wavelength of a LED can be found in the Manufacturer's Data sheet.

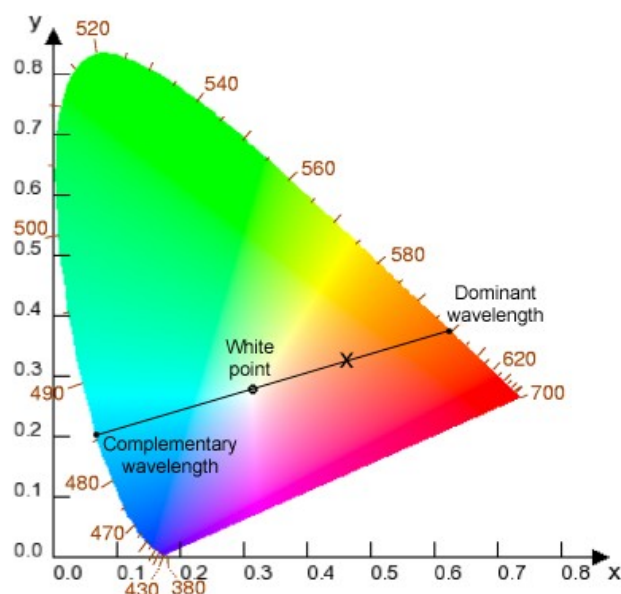


Figure 13. CIE 1931 Dominant Wavelength

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Spectrometer Definitions

Correlated Colour Temperature CCT

Correlated Colour Temperature is a measure of how warm or cool the light given off by a white LED appears.

Warm colours appear tinged with yellow while cool colours are tinged with blue and appear whiter to the observer.

Colour temperature is measured in degrees Kelvin (K). The lower the colour temperature value in Kelvin, the warmer the color while higher values refer to cooler colours.

A warm color LED will have a color temperature in the region of 2800K while cool white LED will have a color temperature in the region of 6800K.

Colour temperature is derived from the color of light given off by a Black Body radiator as it is heated up. Since LEDs are not Black Body radiators a new definition called *correlated color temperature* has been introduced to help classify white LEDs.

"The **correlated color temperature** (cct) is the temperature of the Planckian radiator whose perceived color most closely resembles that of a given stimulus at the same brightness and under specified viewing conditions."

— CIE/IEC 17.4:1987, *International Lighting Vocabulary* (ISBN 3900734070)[13]

When the Spectrometer measures the cct of a LED, it reports the cct value and the distance the LED is from the Planckian locus plotted on the CIE 1931 chart. This is called the Delta E value. If Delta E is positive it indicates the LED lies above the locus. If Delta E is negative the LED lies below the locus. See the chart in Figure 14.

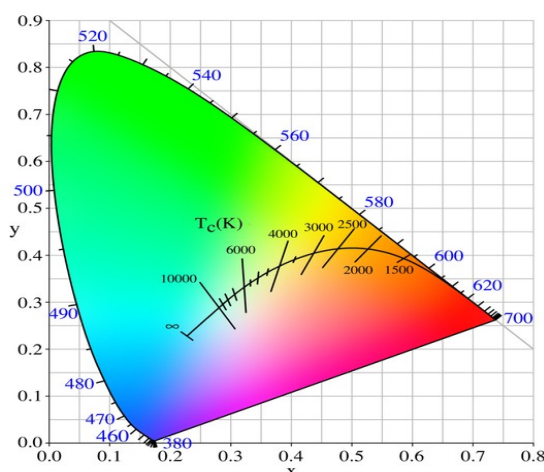


Figure 14. CCT plotted on CIE 1931 Chromaticity Co-Ordinates

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Spectrometer Definitions

Luminous Flux – Lumen (lm)

The lumen is the unit of the total luminous flux emitted by a LED. This is the total amount of visible light emitted by the LED in all directions.

The lumen is characterized by the response of the human eye to the different wavelengths of visible light. Therefore, it is not the same as radiant flux (Power) which is a measure of the total light power emitted by the LED regardless of the human eye response.

Lumens are measured using a calibrated Integrating Sphere (Spxx) Figure 16 which is used to collect all the available light and present it at a measurement port.

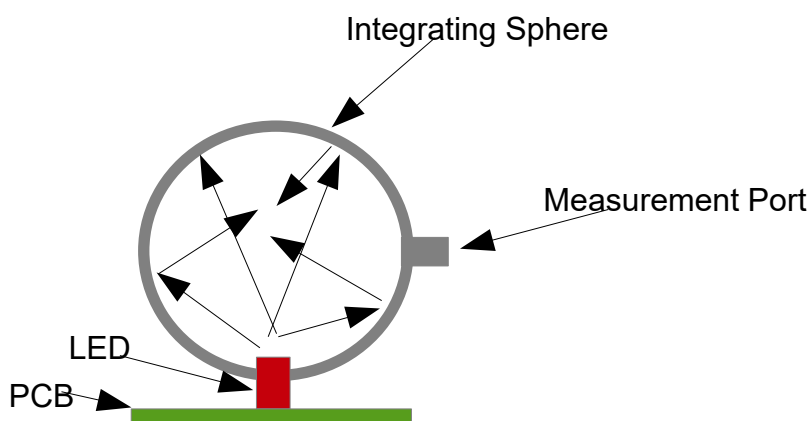


Figure 15.



Figure 16.

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Spectrometer Definitions

Luminous Intensity -Candela (cd)

The luminous intensity (in candelas) is a measure of wavelength weighted power emitted by a Led in a particular direction (how bright the beam in a particular direction is).

Candelas are measured using a calibrated Luminous Intensity Head (CDxx) Figure 17 which is used to collect all the available light and present it at a measurement port.



Figure 17.

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Spectrometer Definitions

Luminance – Candella per m² (cd/m²)

Luminance is often used to characterize emission or reflection from flat, diffuse surfaces. Luminance levels indicate how much luminous power could be detected by the human eye looking at a particular surface from a particular angle of view. Luminance is thus an indicator of how bright the surface will appear.

The Feasa Luminance Head has been specifically designed to measure the Luminance/Radiance and colour of Automotive Displays.

Candella per meter squared (cd/m²) are measured using a calibrated Luminance Head (Luxx) Figure 18 which is used to collect all the available light and present it at a measurement port.



Figure 18.

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Command Structure

There are a number of commands that can be used to control the Spectrometer.

In general they can be divided up into five distinct groups:-

Capture – capture the Colour, Intensity and Spectral data of the LED's

Get Data – retrieve the stored data

Set Data – program various parameters

General Functions – configuration and set-up

Commands are transmitted and received using ASCII characters and are **case-insensitive**. All commands must be terminated with a **<CR>** and **<LF>** character.

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Capture Mode

Capture - Capture LED Wavelength and Intensity Data

Transmit	Receive
capture	OK

Description

This command instructs the Spectrometer to capture and store the Wavelength and Intensity data for the LED that is being measured. The Spectrometer automatically determines the correct settings to capture the LED data. The data is stored until the power is removed or another **capture** command is issued. When completed the Spectrometer will transmit the character **OK** on the receive line to the transmitting device (i.e. the PC).

Example:

capture
OK

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Capture Mode

Capture##### - Capture LED Data for a specific Integration Time

Transmit	Receive
capture#####	OK

Where:

represents the integration time in microseconds from 100uS to 4000000uS.

Description

This command instructs the Spectrometer to capture and store the Wavelength and Intensity data for the LED that is being measured. The Spectrometer will use the integration time specified in the command to capture the LED data.

The integration time can be set from 100uSec to 4000000 uSec (4seconds)

The data is stored until the power is removed or another **capture** command is issued. When completed the Spectrometer will transmit the character **OK** on the receive line to the transmitting device (i.e. the PC).

The integration time can be entered in 3 to 7 digit formats eg 100uS can be entered as capture100 or capture0000100

Example:

capture500 ! capture using an integration time of 500usec
OK

capture0000500 ! capture using an integration time of 500usec
OK

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Capture Mode

CC – Capture LED Data for a predetermined Integration Time.

Transmit	Receive
cc	OK

Description

This command instructs the Spectrometer to capture and store the Wavelength and Intensity data for the LED that is being measured. It uses the predetermined Integration time as set by the command **setcustomtime**

The integration time can be from 100uSec to 4000000 uSec (4seconds)

The data is stored until the power is removed or another **cc** command is issued. When completed the Spectrometer will transmit the character **OK** on the receive line to the transmitting device (i.e. the PC).

This command is most relevant when using the Daisy Chain Function.

Example:

setcustomtime0000500

cc ! capture using an integration time of 500usec
OK

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Get Data Commands

The *get data* commands are used to read out the Colour, Intensity and Spectral data stored by the *capture* command.

The data from the last *capture* command remains in memory until a new *capture* command is issued or the power is removed from the Spectrometer.

Commands are transmitted and received using ASCII characters and are **case-insensitive**. All commands must be terminated with a **<CR>** or **<LF>** character.

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Get Data Mode

GetAverage - ***Get the number of readings that are averaged***

Transmit	Receive
GetAverage	###

Where:

represents the number the range 001 – 450.

Description

This command instructs the Spectrometer to return the number of captures to take before averaging the results.

These values are stored permanently in memory and can only be changed by using the *setAverage* command again.

The command *getaverage* will display the current stored gain setting.

Example:

getaverage
010

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Get Data Mode

getCaptureTime - Get the LED Capture Time

Transmit	Receive
getcapturetime	XXXXX us

Where:

xxxxx represents the time in usec to capture the LED data.

Description

This command is used to get the Capture time (Integration time) of the LED being measured. The command must be preceded by a *Capture* **C** command to ensure valid LED data is stored in the memory of the Spectrometer. The Capture time is output in uSeconds.

Example:

getcapturetime
00100 us

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Get Data Mode

getSIGNALLEVEL - Intensity as a percentage of the Range

Transmit	Receive
getsignallevel	iii.i %

Where:

iii.i% represents the intensity value in percentage terms. This 3 digit number is in the range 001 – 100. 000% and represents no Intensity or under range(i.e. the LED is off) and 999% will represent over range or the LED is too bright.

Description

This command is used to get the level of Intensity in percentage terms.
This command should be preceded by a capture command to ensure valid LED data is stored in the memory of the Spectrometer.

Example:

The PC transmits getsignallevel to the Spectrometer to instruct it to send the stored Intensity data for the LED under test. The Spectrometer will return iii% to the PC.

Getsignallevel
050.6 %

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Get Data Mode

getCCT - Get Correlated Color temperature

Transmit	Receive
getcct	XXXXX ±0.yyyy

Where:

xxxxx represents the correlated colour temperature of the LED source.

± 0.yyyy represents the distance the LED is from the Plankian locus (Delta E)

Description

This command is used to get the Correlated Colour Temperature (CCT) of the Light Source being tested.

The command must be preceded by a *Capture C* command to ensure valid LED data is stored in the memory of the Spectrometer. The CCT value is only valid for white sources and the maximum value allowed for Delta E is +/- 0.0500.

Example:

getcct
04621 +0.0340

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Get Data Mode

getDominantWavelength - ***Get the Dominant Wavelength***

Transmit	Receive
getdominantwavelength	XXX.XX

Where:

xxx.xx represents the dominant wavelength of the LED in nanometers.

Description

This command is used to get the value of the Dominant Wavelength for the LED being measured.

This command should be preceded by the **capture** command to ensure valid LED data is stored in the memory of the Spectrometer.

Example:

getdominantwavelength
513.00 nm

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Get Data Mode

getGAI - **Get the Gamut Area Index of the Led**

Transmit	Receive
getgai	xxx.xx

Where:

xxx.xx represents the Gamut Area Index of the LED.

Description

This command is used to get the Gamut Area Index of the LED being measured. This command should be preceded by the **capture** command to ensure valid LED data is stored in the memory of the Spectrometer.

Example:

getgai
082.82

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Get Data Mode

***getLuminousFlux** - Get the Lumen value*

Transmit	Receive
getluminousflux	X.XXXXXE-XX lm

Where:

x.xxxxE-xx Luminous flux (in lumens) is a measure of the total amount of light a lamp puts out.

Description

This command is used to get the Lumen value of the for the LED being measured. This command should be preceded by the **capture** command to ensure valid LED data is stored in the memory of the Spectrometer.

Example:

getluminousflux
03.37819E-01 lm

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Get Data Mode

getLuminousIntensity - ***Get the milliCD value***

Transmit	Receive
getluminousintensity	X.XXXXXX

Where:

x.xxxxxx The luminous intensity (in candelas) is a measure of how bright the beam in a particular direction is.

Description

This command is used to get the Luminous Intensity (candela) value of the LED being measured.

This command should be preceded by the **capture** command to ensure valid LED data is stored in the memory of the Spectrometer.

Example:

getluminousintensity
0.01800 cd

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Get Data Mode

getLuminance - ***Get the cd/m^2 value***

Transmit	Receive
getluminance	cd/m^2

Where:

X.xxxxx Luminance is often used to characterize emission or reflection from flat, diffuse surfaces. Luminance levels indicate how much luminous power could be detected by the human eye looking at a particular surface from a particular angle of view. Luminance is thus an indicator of how bright the surface will appear.

Description

This command is used to get the Luminance (candela per m^2) value of the LED being measured.

This command should be preceded by the **capture** command to ensure valid LED data is stored in the memory of the Spectrometer.

Example:

getluminance
0.01800 cd/m^2

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Get Data Mode

getPeakWavelength - ***Get the Peak Wavelength***

Transmit	Receive
getPeakWavelength	XXX.XX

Where:

xxx.xx represents the Peak wavelength of the LED in nanometers.

Description

This command is used to get the value of the Peak Wavelength for the LED being measured. This command should be preceded by the **capture** command to ensure valid LED data is stored in the memory of the Spectrometer.

Example:

getpeakwavelength
518.00

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Get Data Mode

getPower - ***Get the Radiant Power of the LED***

Transmit	Receive
getPower	XXXX.XXX

Where:

XXXX.XXX represents the Radiant Power emitted by the LED in Watts.

Description

This command is used to get the value of the Radiant Power for the LED being measured. This command should be preceded by the **capture** command to ensure valid LED data is stored in the memory of the Spectrometer.

Example:

getpower
7.45678E-04 W

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Get Data Mode

getSpectralWidth - ***Get the Spectral width of the Led***

Transmit	Receive
getSpectralWidth	XXX.xx nm

Where:

xxx.xx represents the Spectral width (Full width half maximum) of the LED in nanometers.

Description

This command is used to get the value of the Spectral Width for the LED being measured. This command should be preceded by the **capture** command to ensure valid LED data is stored in the memory of the Spectrometer.

Example:

getspectralwidth
014.37 nm

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Feasa LED Spectrometer

Get Data Mode

getxy - **Get the xy Chromaticity of the Led**

Transmit	Receive
getxy	0.XXXX 0.YYYY

Where:

0.xxxx represents the x Chromaticity of the LED.

0.yyyy represents the y Chromaticity of the LED.

Description

This command is used to get the xy Chromaticity of the LED being measured.

This command should be preceded by the **capture** command to ensure valid LED data is stored in the memory of the Spectrometer.

Example:

getxy
0.3246 0.3378

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Feasa LED Spectrometer

Get Data Mode

get1960uv - Get the CIE 1960 uv Chromaticity of the Led

Transmit	Receive
get1960uv	0.0000 0.0000

Where:

0.0000 represents the u Chromaticity of the LED.
0.0000 represents the v Chromaticity of the LED.

Description

This command is used to get the CIE 1960 uv Chromaticity of the LED being measured. This command should be preceded by the **capture** command to ensure valid LED data is stored in the memory of the Spectrometer.

Example:

get1960uv
0.2026 0.4748

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Feasa LED Spectrometer

Get Data Mode

get1976uv - ***Get the CIE 1976 u'v' Chromaticity of the Led***

Transmit	Receive
get1976uv	0.0000 0.0000

Where:

0.0000 represents the u' Chromaticity of the LED.

0.0000 represents the v' Chromaticity of the LED.

Description

This command is used to get the CIE 1976 u'v' Chromaticity of the LED being measured. This command should be preceded by the **capture** command to ensure valid LED data is stored in the memory of the Spectrometer.

Example:

get1976uv
0.2026 0.4748

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Feasa LED Spectrometer

Get Data Mode

getSPD - **Get the Spectral Data of the Led**

Transmit	Receive
getSPD	www.ww s.sssss (Multiple)

Where:

www.ww represents the wavelength of the Spectral data in nanometers.

s.sssss represents the Optical Power normalized to 1.

Description

This command is used to get the spectral data for the LED being measured.

This command should be preceded by the **capture** command to ensure valid LED data is stored in the memory of the Spectrometer. The resolution of the Spectrum is set by the **setWaveResolution** command. This command should be executed before the **capture** command.

Example:

```
getspd
380.00 0.00277
381.00 0.00295
382.00 0.00314
```

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Feasa LED Spectrometer

Get Data Mode

getCRI - ***Get the Colour Rendering Index of the Led***

Transmit	Receive
getCRI	XXX.XX (Multiple)

Where:

XXX.XX represents the CRI data of the LED

Description

This command is used to get the CRI data for the LED being measured.
This command should be preceded by the **capture** command to ensure valid LED data is stored in the memory of the Spectrometer.

Example:

```

getcri
R01=081.58
R02=089.73
R03=095.80
R04=083.53
R05=082.91
R06=087.32
R07=084.24
R08=062.34
R09=010.13
R10=075.51
R11=083.26
R12=077.35
R13=083.38
R14=097.46
Ra=083.30

```

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Feasa LED Spectrometer

Get Data Mode

getCQS - Get the Colour Quality Scale of the Led

Transmit	Receive
getCQS	XXX.XX (Multiple)

Where:

XXX.XX represents the CQS data of the LED

Description

This command is used to get the CQS data for the LED being measured.
This command should be preceded by the **capture** command to ensure valid LED data is stored in the memory of the Spectrometer.

Example:

```

getcqs
Q01=080.88
Q02=097.14
Q03=085.54
Q04=082.94
Q05=079.10
Q06=077.37
Q07=079.40
Q08=087.37
Q09=096.97
Q10=082.17
Q11=079.32
Q12=076.33
Q13=076.84
Q14=070.66
Q15=074.38
Qa=080.96

```

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Feasa LED Spectrometer

General Commands

getBAUD - Get the Baud Rate

Transmit	Receive
getBAUD	X bps

Where: **X** = 9600, 19200, 38400, 57600, 115200 for **Serial RS232 Port**

Where: **X** = 9600, 19200, 38400, 57600, 115200, 230400, 460800, 921600 for **USB Port**

Description

This command will get the baud rate of the Serial and USB Port's that the Analyser is communication through.

The default Port settings of the Analyser are 57,600, 8 Data bits, 1 Stop bit and No Parity.

It can also be seen on the comment section of the Feasa terminal window.

Example:

To get the baud rate of the Analyser transmit the command **getbaud** to the Analyser.

getbaud
57600 bps

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Feasa LED Spectrometer

Set Commands

IMPORTANT INFORMATION for Programmers

set / put Commands

The *Set* / *Put* commands are used to adjust various settings in the Spectrometer such as Intensity, Exposure and offsets.

The *Set* commands are written to the on-board Flash.

These settings remain programmed in the Spectrometer even when the power is removed. The Spectrometer has a capacity limit of approximately 100,000 writes to the flash.

Use the *Set* command only to store relevant information on the Spectrometer. Please refrain from using *Set* commands in your high volume production programs as this constant writing to the Flash will eventually corrupt the Spectrometer. Use the *Put* command instead.

The *Put* commands are written to the on-board RAM.

These settings will NOT remain programmed in the Spectrometer after the power is removed.

Use the *Put* command as often as you need in your program. This will prolong the life of the Spectrometer particularly in high volume testing environment.

Commands are transmitted and received using ASCII characters and are case-insensitive. All commands must be terminated with a **<CR>** or **<LF>** character.

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Feasa LED Spectrometer

Set Data Mode

Set Commands

Setcustomtime##### - set a specific Integration time

Transmit	Receive
Setcustomtime#####	OK
Putcustomtime#####	OK

Where:

represents the Integration Time in uSec from 100uS to 4Sec.

100us = 0000100

3Sec = 30000000

Description

setcustomtime allows the user to set a predetermined Integration time for the Spectrometer. It is most useful when the spectrometers are connected in Daisy Chain mode. (See Application note).

Example:

To set an Integration Time of 456uS

setcustomtime0000456

OK

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Feasa LED Spectrometer

Set Data Mode

SetPWM# - Enable/Disable PWM capture mode

Transmit	Receive
SetPWM#	OK
PutPWM#	OK

Where:

represents the 1 or 0.

1 = PWM capture mode ON
 0 = PWM capture mode OFF

Description

Pulse-Width-Modulated(PWM) LED's are switched on and off rapidly to save power and to control Intensity. When PWM LEDs are being tested, the PWM mode should be enabled.

Example:

Enable PWM capture mode.

setPWM1
OK

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Feasa LED Spectrometer

Set Data Mode

SetAverage### - Set the number of readings to average

Transmit	Receive
SetAverage###	OK
PutAverage###	OK

Where:

represents the Fiber Number in the range 001 – 450.

Description

This command allows the user to adjust the number of captures(readings) to take before averaging the results. This leads to more stable readings.

These values are stored permanently in memory and can only be changed by using the *setAverage* command again.

The command *getaverage* will display the current stored gain setting.

Example:

Set the Average value to 5.

setaverage005
OK

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Feasa LED Spectrometer

Set Data Mode

SetWaveRangeMin###.## - Set minimum wavelength

Transmit	Receive
SetWaveRangeMin###.##	OK
PutWaveRangeMin###.##	OK

Where:

###.## represents the minimum wavelength to be measured.

Description

This command allows the user to set the value of the minimum wavelength to be measured. These values are stored permanently in memory and can only be changed by using the *setWaveRangeMin* command again.

The command *getWaveRangeMin* will display the current stored setting.

The minimum wavelength should not be set lower than 380.00nm.

Example:

Set the minimum wavelength range value to 450.50 nm.

Setwaverangemin450.50

OK

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Feasa LED Spectrometer

Set Data Mode

SetWaveRangeMax###.## - Set maximum wavelength

Transmit	Receive
SetWaveRangeMax###.##	OK
PutWaveRangeMax###.##	OK

Where:

###.## represents the maximum wavelength to be measured.

Description

This command allows the user to set the value of the maximum wavelength to be measured. These values are stored permanently in memory and can only be changed by using the *setWaveRangeMax* command again.

The command *getWaveRangeMax* will display the current stored setting.

The minimum wavelength should not be set higher than 780.00nm.

Example:

Set the maximum wavelength range value to 650.50 nm.

Setwaverangemax650.50
OK

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Feasa LED Spectrometer

Set Data Mode

SetWaveResolution#.# - Set the wavelength resolution

Transmit	Receive
SetWaveResolution#.#	OK
PutWaveResolution#.#	OK

Where:

#.# represents the wavelength resolution and is a value in the range 0.1nm – 9.9nm.

Description

This command allows the user to adjust the wavelength resolution of the spectrum to be measured.

These values are stored permanently in memory and can only be changed by using the *setWaveResolution* command again.

The command *getWaveResolution* will display the current stored setting.

Example:

Set the wavelength resolution to 5.0nm.

Setwaveresolution05.0
OK

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Feasa LED Spectrometer

General set/put Commands

setBAUD - Change the baud rate

Transmit	Receive
Setbaudxxxxx	OK

Where: **X** = 9600, 19200, 38400, 57600, 115200 for **Serial RS232 Port**

Where: **X** = 9600, 19200, 38400, 57600, 115200, 230400, 460800, 921600 for **USB Port**

Description

This command will change the baud rate of the Serial and USB Port's in the Analyser.

The default Port settings of the Analyser are 57,600, 8 Data bits, 1 Stop bit and No Parity. If an incompatible baud rate is selected the Analyser will not respond. Please disconnect and reconnect the Analyser to return the Analyser to the default 57600 bps. A correct baud rate selected will remain stored in memory even after power off. The command getbaud will return the set baud rate. It can also be seen on the comment section of the Feasa terminal window.

Test times are improved by increasing the baudrate from the default to higher values and this can be further enhanced by decreasing the latency (windows default 16) to latency of 1. Refer to the App Note in the documentation folder of the CD to carry out this.

Example:

To change the baud rate to 19,200 transmit the command **setbaud19200** to the Analyser .

setbaud19200
OK

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Feasa LED Spectrometer

Command Summary

COMMAND	DESCRIPTION
Capture	Capture LED Color and Intensity Data - Auto Range
Capture####	Capture Colour and Intensity – specified Integration Time
getAverage	Get the value of the number of readings to average
getCaptureTime	Get the Integration time
GetSignalLevel	Get the signal level
getCCT	Get the Correlated Color Temperature
getDominantWavelength	Get the Dominant Wavelength of the LED
getGAI	Get the Gamut Area Index
getLuminousFlux	Get the Lumen value
getLuminousIntensity	Get the value in Candellas
getPeakWavelength	Get the Peak Wavelength of the LED
getPower	Get the Radiant Power
getSpectralWidth	Get the Spectral width of the LED
getxy	Get the xy Chromaticity values
get1960uv	Get the CIE 1960 uv value
get1976uv	Get the CIE 1976 u'v' value
getSPD	Get the Spectral Data for the LED
getCRI	Get the CRI values of the LED
getCQS	Get the CQS values for the LED
SetPWM#	Enable/Disable PWM capture mode
SetAverage	Set the number of readings to average
SetWaveRangeMin	Set the minimum wavelength
SetWaveRangeMax	Set the maximum wavelength
SetWaveResolution	Set the wavelength resolution

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Feasa LED Spectrometer

Trigger Mode

External Trigger Mode:

The following pages list the commands that are required to implement the Trigger Function. These commands must be transmitted through the USB Port of the Spectrometer. The Feasa Terminal program can be used to perform this task.

EnableTrigger – *Enable the Trigger Function*

Transmit	Receive
enabletrigger	OK

Description

This command instructs the Spectrometer to enable the Trigger function. This function is disabled by default.

Example:

enabletrigger
OK

DisableTrigger – *Disable the Trigger Function*

Transmit	Receive
disabletrigger	OK

Description

This command instructs the Spectrometer to disable the Trigger function.

Example:

disabletrigger
OK

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Feasa LED Spectrometer

Trigger Mode

SetTriggerTime##### – Set the Trigger Integration Time

Transmit	Receive
settriggertime#####	OK

Description

This command sets the Integration time of the Trigger function. The Integration time is a 5 digit number and is specified in milliseconds. The minimum Integration time is 100 microseconds (0000001) and the maximum is 4 seconds.

If the Trigger Time is set to 00000 then the Spectrometer executes an Auto Capture where the Integration time is determined by the Spectrometer.

Example:

settriggertime002500
OK

! set the integration time to 25ms

GetTriggerTime – get the Trigger Integration Time

Transmit	Receive
gettriggertime	XXXXXXXX us

Description

This command instructs the Spectrometer to return the Trigger Integration time. The Integration time is a 7 digit number and is specified in microseconds.

Example:

gettriggertime
0002500 us

!set the integration time to 25ms

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Feasa LED Spectrometer

Trigger Mode

SetAverage01 – Set the number of measurements to 1

Transmit	Receive
setaverage01	OK

Description

This command instructs the Spectrometer to set the number of measurements to 1. In order for the Trigger function to operate within the Integration time the Average must be set to 01.

Example:

setaverage01
OK

GetAverage – get the number measurements to be averaged

Transmit	Receive
getaverage	##

Where:

represents the number the range 01 – 99.

Description

This command instructs the Spectrometer to return the number of captures to take before averaging the results.

These values are stored permanently in memory and can only be changed by using the setAverage command again.

The command getaverage will display the current stored gain setting.

Example:

getaverage
01

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Feasa LED Spectrometer

Trigger Mode

Measurement Sequence

```
Enabletrigger          ! send command to the spectrometer
OK                   ! responses from the spectrometer
settriggertime00025
OK
setaverage01
OK
```

High-to-low transition on the Trigger input Pin 1

Capturing....

```
OK
getluminousflux
0005.018 lm
getcct
04621 +0.0340
.
.
```

Trigger Error Messages

OverRange

This message is displayed if the Spectrometer is saturated by too much light. This will happen when the Integration/Trigger time is too long. To correct this error select a shorter Trigger time.

UnderRange

This message is displayed if the Spectrometer is not receiving enough light for the Integration/Trigger time selected. If this is the case then increase the Trigger time and try again. The Trigger time can be increased to 99999 milliseconds maximum.

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Feasa LED Spectrometer

Daisy Chain Mode

Daisy Chain Setup:

Connecting the Patch Cord to the Spectrometer



Remove the protective end caps from the patch cord. Using the surface cleaner sachet wipe provide, clean both ends. This wipe is suitable for one time use only. For periodic cleaning, use isopropyl and lint free wipes.

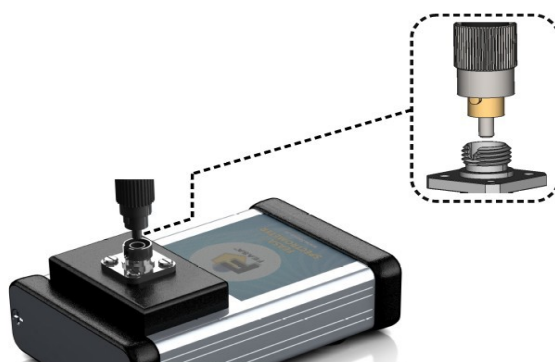


Figure 8.

Remove the protective caps from the fiber optic patch cord (FP0x). Prior the connecting, clean both ends of the patch cord with the cleaning wipe provided. Connect the FC/PC adaptor end (Figure 8) of the patch cord to the Spectrometer module. When connecting the Patch Cord to the Spectrometer ensure that the indent on the Patch Cord connector fits into the slot on the Spectrometer housing as shown above.



Figure 9.

Connect the SMA adaptor end Figure 9.of the patch cord to the Optical Adaptor (Spxx). Fasten securely.



Figure 9.

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Feasa LED Spectrometer

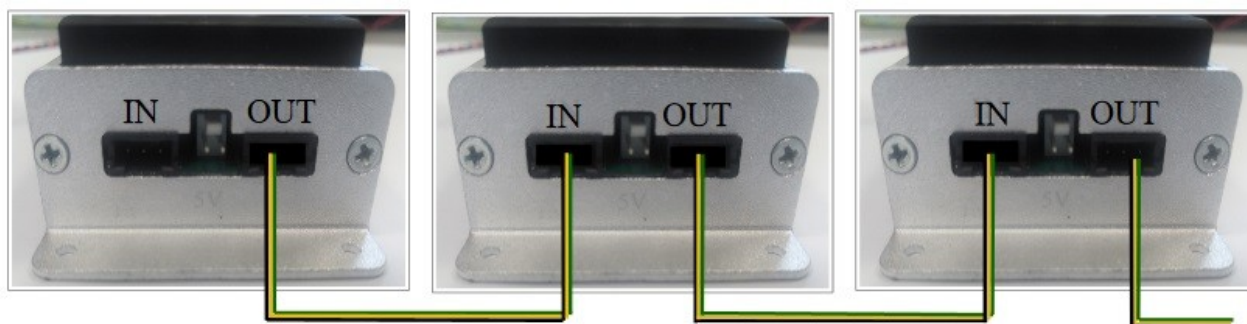
Daisy Chain Mode

Using the Daisy Chain cable provided, connect the OUT port of the 1st Spectrometer to the IN port of the 2nd Spectrometer.



Connect the OUT port of the 2nd Spectrometer to the IN port of the 3rd Spectrometer. Connect the OUT port of the 3rd Spectrometer to the IN port of the 4th Spectrometer. Continue this procedure for all remaining Spectrometers.

NOTE: Power to the Spectrometers should be turned OFF when Daisy Chain cables are being connected/disconnected.



Using the USB cable provided, connect the first (master) Spectrometer to the controlling PC

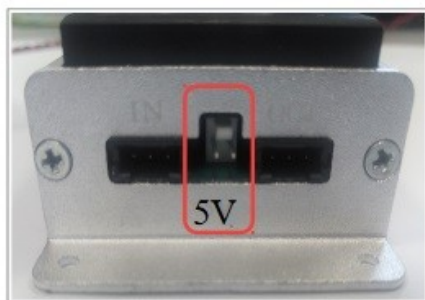


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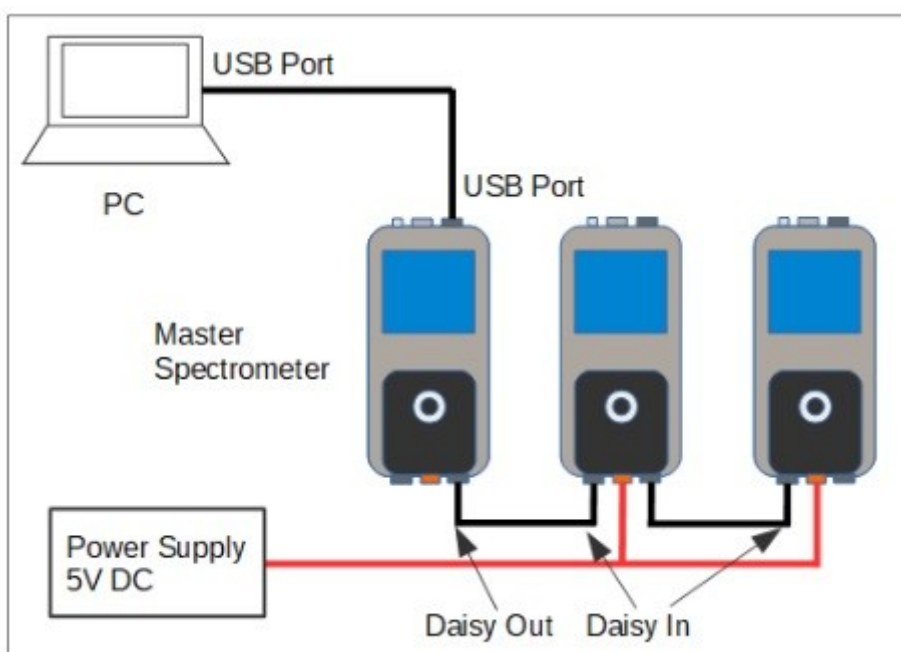
Feasa LED Spectrometer

Daisy Chain Mode

Each Spectrometer except the first (master) Spectrometer must be powered by 5V DC@200mA. A power cable (LA-PWR-02) is supplied with each Spectrometer.



Power and communication are supplied to the first (master) Spectrometer via USB. Therefore, no power cable is required for this Spectrometer.



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Feasa LED Spectrometer

Daisy Chain Mode

NOTE: Before attempting to use the Daisy Chain Mode please ensure the Spectrometers are connected and powered as per the steps outlined above.

Understanding the Daisy Chain Bus

Daisy chaining is a method used to communicate with multiple LED Spectrometers via a single computer port. The first Spectrometer in the daisy chain is connected to the computer using the supplied USB cable. This is referred to as the 'Master' Spectrometer. The remaining Spectrometers are interconnected in a daisy chain bus using the cables provided. These are referred to as 'Slave' Spectrometers.

Figure 19 illustrates an example of a daisy chain bus.

There are 3 Spectrometers: 1 x Master unit and 2 x Slave units and 1 x 5V Power Supply.

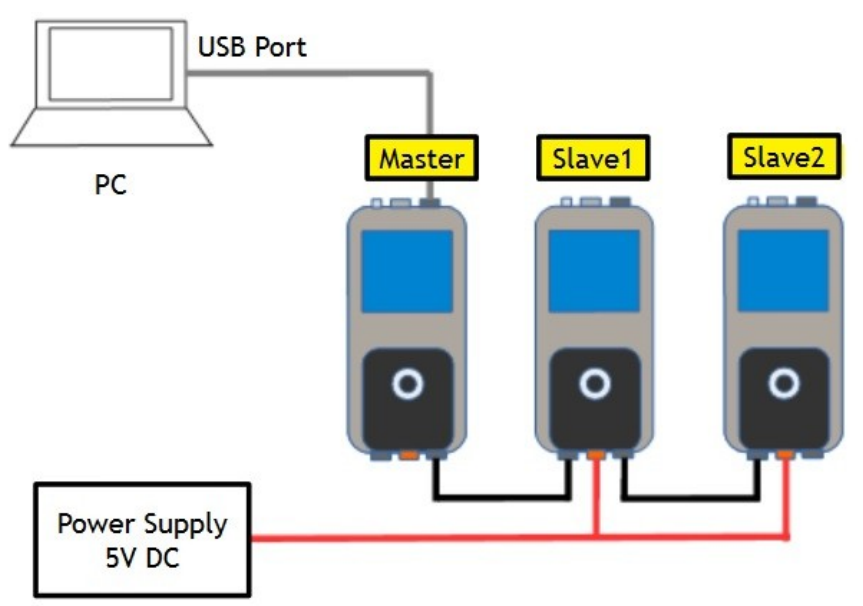


Figure 17.

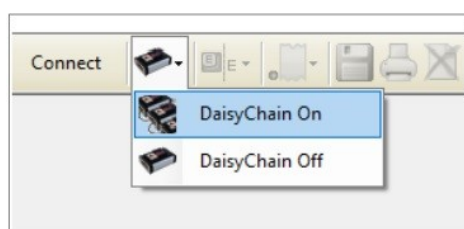
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Feasa LED Spectrometer

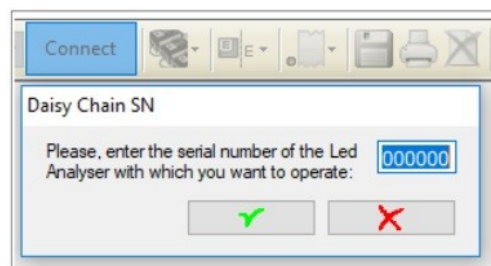
Daisy Chain Mode

Setup Spectrometer No 1 / Master

- 1.00 Open the Feasa Terminal Program. (version 2.7.0 or greater)
- 1.01 Using the drop down menu located on the top toolbar, select the 'DaisyChain On' option.



- 1.02 Enter the 4 digit Serial of the first (master) Spectrometer as prompted.



- 1.03 In the command bar at the bottom of the terminal window, enter the command GETSTATUS. This returns information on the active Spectrometer such as:
Serial Number: Confirm that this s/n of the Spectrometer you wish to operate.
PWM mode: For RGB leds this should be set to 1. This means that the Spectrometer's PWM capture mode is activated.
Average Factor: This is the number of captures that will be executed. This may be increased to improve stability.

```
Feasa LED Spectrometer
-----
Serial number: S301
Firmware version: BY32
Capture: manual 0000000 us
PWM mode: 1
Calibration date: 03/10/2018
Patch cord serial: NODEVICE
Optical adapter serial: SP000000
Average factor: 50
Minimum wavelength: 380.00 nm
Maximum wavelength: 780.00 nm
Wavelength resolution: 05.0 nm
Trigger status: DISABLE
```

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Feasa LED Spectrometer

Daisy Chain Mode

1.04 Cover the aperture of the SPxx sphere connected to the master Spectrometer. Ensure no light is entering the device.

1.05 In the Terminal command bar, type the command **CAPTUREDARK** and press the return key. An **OK** response is returned on completion of the capture dark.

```
CAPTUREDARK
Acquiring...
OK
```

1.06 Uncover the aperture of the Spxx.

1.07 Place a Golden Sample in the appropriate fixture position in front of the SPxx sphere of the Master Spectrometer. Power the sample and allow light from the sample to enter the sphere.

1.08 In the Terminal command bar, type the command **CAPTURE** and press the return key. An **OK** response is returned on completion of the capture.

1.09 Type the command **GETLUMINOUSFLUX** in the command bar and press the return key. An intensity value in lumen(lm) is returned. Ensure data is valid.

1.10 Type the command **GETSIGNALLEVEL** in the command bar and press the return key. A signal level is returned in %. Ensure data is valid.

1.11 Type the command **GETXY** in the command bar and press the return key. An XY chromaticity value is returned. Ensure data is valid.

1.12 Type the command **GETINTEGRATIONTIME** in the command bar and press the return key. An integration time in is returned. Record the results.

```
C
OK
GETLUMINOUSFLUX
1.00784e+00 lm
GETSIGNALLEVEL
092.8 %
GETXY
0.2914 0.2491
GETINTEGRATIONTIME
00043.843 ms
```

Record the results.

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Feasa LED Spectrometer

Daisy Chain Mode

1.13 Determine a suitable fixed integration time for production.

The auto capture command (CAPTURE) may be too slow to be used in production. To avoid this an individual, fixed integration time can be set on each Spectrometer.

A number of factors need to be considered when choosing a suitable integration time.

- ◆ Taking the integration time returned in step 1.12 as an example: the Auto capture command deemed an integration time of 43.843 ms to be optimum time for the Golden Sample LED.
- ◆ As a rule of thumb, an integration value that is 60% of that returned by the **GETINTEGRATIONTIME** command is advised. Choosing a lower integration time will allow the Spectrometer to measure test parts that may have a higher or lower intensity value without generating an Underrange or Overage response.

EXAMPLE: Calculating a suitable integration time for the Master Spectrometer based on an Integration time response of 43.834ms

- ◆ $43.834 \times 60\% = 26.300\text{ms}$

1.14 Enter the command **SETCUSTOMTIME#####**

Where ##### is the previously determined integration time in μS . This is a 7-digit number.

For the above example of 26.300 ms, the SETCUSTOMTIME command is entered as follows:

```
setcustomtime0026300
OK
```

An OK response is returned.

The fixed integration time has now been set on the **first / master** Spectrometer.

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Feasa LED Spectrometer

Daisy Chain Mode

Setup Spectrometer No 2 / Slave No 1

- 2.00 Type the command **BUSFREE** in the command bar and press the return key. An **OK** response is returned on completion.

This command is used to deactivate any active Spectrometers on the Daisy Chain bus. This will free the Bus to allow any Spectrometer be activated.

- 2.01 Type the command **BUSGET####** in the command bar and press the return key. An **OK** response is returned on completion.

Where; #### represents the serial number of the second (slave1) Spectrometer on the bus. Spectrometer number 'S302' is used in the below example.

```
busfree
OK
busgetS302
OK
```

- 2.02 To verify the settings of the second (slave1) Spectrometer, type the command **GETSTATUS** in the command bar and press the return key. This returns information on the active Spectrometer such as:

Serial Number: Confirm that this s/n of the Spectrometer you wish to operate.
PWM mode: For RGB leds this should be set to 1. This means that the Spectrometer's PWM capture mode is activated.
Average Factor: This is the number of captures that will be executed. This may be increased to improve stability.

```
Feasa LED Spectrometer
-----
Serial number: S302
Firmware version: BY32
Capture: none
PWM mode: 1
Calibration date: 03/10/2018
Patch cord serial: NODEVICE
Optical adapter serial: SP000000
Average factor: 50
Minimum wavelength: 380.00 nm
Maximum wavelength: 780.00 nm
Wavelength resolution: 05.0 nm
Trigger status: DISABLE
```

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Feasa LED Spectrometer

Daisy Chain Mode

- 2.03 Cover the aperture of the SPxx sphere connected to the second (slave1) Spectrometer. Ensure no light is entering the device.
- 2.04 Type the command **CAPTUREDARK** in the command bar and press the return key. An **OK** response is returned on completion of the capture dark.

```
CAPTUREDARK
Acquiring...
OK
```

- 2.05 Uncover the aperture and position the Golden Sample in front of the second (slave1) Spectrometer's SPxx sphere. Allow light to enter the device.
- 2.06 Type the command **CAPTURE** in the command bar and press the return key. An **OK** response is returned on completion of the capture.
- 2.07 Type the command **GETLUMINOUSFLUX** in the command bar and press the return key. An intensity value in lumen(lm) is returned. Ensure data is valid.
- 2.08 Type the command **GETSIGNALLEVEL** in the command bar and press the return key. A signal level is returned in %. Ensure data is valid.
- 2.09 Type the command **GETXY** in the command bar and press the return key. An XY chromaticity value is returned. Ensure data is valid.
- 2.10 Type the command **GETINTEGRATIONTIME** in the command bar and press the return key. An integration time is returned.

```
C
OK
GETLUMINOUSFLUX
1.00924e+00 lm
GETSIGNALLEVEL
091.2 %
GETXY
0.2943 0.2490
GETINTEGRATIONTIME
00033.848 ms
```

Record the results.

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Feasa LED Spectrometer

Daisy Chain Mode

2.11 Determine a suitable fixed integration time for production.

The auto capture command (CAPTURE) may be too slow to be used in production. To avoid this an individual, fixed integration time can be set on each Spectrometer. A number of factors need to be considered when choosing a suitable integration time.

- ◆ Taking the integration time returned in step 2.10 as an example: the Auto capture command deemed an integration time of 33.848 ms to be optimum time for the Golden Sample LED.
- ◆ As a rule of thumb, an integration value that is 60% of that returned by the **GETINTEGRATIONTIME** command is advised. Choosing a lower integration time will allow the Spectrometer to measure test parts that may have a higher or lower intensity value without generating an Underrange or Overage response.

EXAMPLE: Calculating a suitable integration time for the second (slave1) Spectrometer based on an Integration time response of 33.848 ms

$$◆ 33.848 \times 60\% = 20.309 \text{ ms}$$

2.12 Enter the command **SETCUSTOMTIME#####**

Where ##### is the previously determined integration time in μS . This is a 7-digit number.

For the above example of 20.309 ms, the **SETCUSTOMTIME** command is entered as follows:

```
setcustomtime0026300
OK
```

An **OK** response is returned.

The fixed integration time has now been set on the **second / slave1** Spectrometer.

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Feasa LED Spectrometer

Daisy Chain Mode

Setup Spectrometer No 3 / Slave No 2

- 3.00 Type the command **BUSFREE** in the command bar and press the return key. An **OK** response is returned on completion.

This command is used to deactivate any active Spectrometers on the Daisy Chain bus. This will free the Bus to allow any Spectrometer be activated.

- 3.01 Type the command **BUSGET####** in the command bar and press the return key. An **OK** response is returned on completion.

Where; #### represents the serial number of the second (slave1) Spectrometer on the bus. Spectrometer number 'S303' is used in the below example.

```
busfree
OK
busgetS303
OK
```

- 3.02 To verify the settings of the second (slave2) Spectrometer, type the command **GETSTATUS** in the command bar and press the return key. This returns information on the active Spectrometer such as:

Serial Number: Confirm that this s/n of the Spectrometer you wish to operate.
PWM mode: For RGB leds this should be set to 1. This means that the Spectrometer's PWM capture mode is activated.
Average Factor: This is the number of captures that will be executed. This may be increased to improve stability.

```
Feasa LED Spectrometer
-----
Serial number: S303
Firmware version: BY32
Capture: none
PWM mode: 1
Calibration date: 03/10/2018
Patch cord serial: NODEVICE
Optical adapter serial: SP000000
Average factor: 50
Minimum wavelength: 380.00 nm
Maximum wavelength: 780.00 nm
Wavelength resolution: 05.0 nm
Trigger status: DISABLE
```

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Feasa LED Spectrometer

Daisy Chain Mode

- 3.03 Cover the aperture of the SPxx sphere connected to the second (slave2) Spectrometer. Ensure no light is entering the device.
- 3.04 Type the command **CAPTUREDARK** in the command bar and press the return key. An **OK** response is returned on completion of the capture dark.

```
CAPTUREDARK
Acquiring...
OK
```

- 3.05 Uncover the aperture and position the Golden Sample in front of the second (slave2) Spectrometer's SPxx sphere. Allow light to enter the device.
- 3.06 Type the command **CAPTURE** in the command bar and press the return key. An **OK** response is returned on completion of the capture.
- 3.07 Type the command **GETLUMINOUSFLUX** in the command bar and press the return key. An intensity value in lumen(lm) is returned. Ensure data is valid.
- 3.08 Type the command **GETSIGNALLEVEL** in the command bar and press the return key. A signal level is returned in %. Ensure data is valid.
- 3.09 Type the command **GETXY** in the command bar and press the return key. An XY chromaticity value is returned. Ensure data is valid.
- 3.10 Type the command **GETINTEGRATIONTIME** in the command bar and press the return key. An integration time is returned.

```
C
OK
GETLUMINOUSFLUX
1.00924e+00 lm
GETSIGNALLEVEL
091.2 %
GETXY
0.2943 0.2490
GETINTEGRATIONTIME
00033.848 ms
```

Record the results.

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Daisy Chain Mode

- 3.11 Determine a suitable fixed integration time for production. The auto capture command (CAPTURE) may be too slow to be used in production. To avoid this an individual, fixed integration time can be set on each Spectrometer. A number of factors need to be considered when choosing a suitable integration time.
- ◆ Taking the integration time returned in step 2.10 as an example: the Auto capture command deemed an integration time of 33.848 ms to be optimum time for the Golden Sample LED.
 - ◆ As a rule of thumb, an integration value that is 60% of that returned by the **GETINTEGRATIONTIME** command is advised. Choosing a lower integration time will allow the Spectrometer to measure test parts that may have a higher or lower intensity value without generating an Underrange or Overage response.

EXAMPLE: Calculating a suitable integration time for the second (slave1) Spectrometer based on an Integration time response of 33.848 ms

$$◆ 33.848 \times 60\% = 20.309 \text{ ms}$$

- 3.12 Enter the command **SETCUSTOMTIME#####**

Where ##### is the previously determined integration time in μS . This is a 7-digit number.

For the above example of 20.309 ms, the **SETCUSTOMTIME** command is entered as follows:

```
setcustomtime0026300
OK
```

An **OK** response is returned.

The fixed integration time has now been set on the **third / slave2** Spectrometer.

Repeat Steps 3.00 to 3.12 for any remaining Spectrometers on the bus.

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Feasa LED Spectrometer

Daisy Chain Mode

Summary of Setup Procedure

Master Spectrometer:

1. Open Feasa Terminal.
2. Turn Daisy Chain mode ON.
3. Press Connect.
4. When prompted, enter the serial number of the first (master) Spectrometer.
5. Enter the *GETSTATUS* command to verify active Spectrometer.
6. Prevent light from entering the active Spectrometer's SPxx sphere.
7. Enter *CAPTUREDARK* command.
8. Allow light to enter the SPxx.
9. Position Golden Sample part in front of the SPxx within the test fixture.
10. Enter *CAPTURE* command.
11. Enter the command *GETLUMINOUSFLUX* and confirm that the results are valid.
12. Enter the command *GETSIGNALLEVEL* and confirm that the results are valid.
13. Enter the command *GETXY* and confirm that the results are valid.
14. Enter the command *GETINTEGRATIONTIME*.
15. Determine a suitable fixed integration time (60% of 'GETINTEGRATIONTIME' response).
16. Enter the command *SETCUSTOMTIME#####*.
Where ##### is the desired integration time in μ S.

Slave Spectrometers:

17. Enter the command *BUSFREE*.
18. Enter the command *BUSGET####*.
Where #### is the serial number of the next Spectrometer on the bus.
19. Enter the *GETSTATUS* command to verify active Spectrometer.
20. Prevent light from entering the active Spectrometer's SPxx sphere.
21. Enter *CAPTUREDARK* command.
22. Allow light to enter the Spxx.
23. Position Golden Sample part in front of the SPxx within the test fixture.
24. Enter *CAPTURE* command.
25. Enter the command *GETLUMINOUSFLUX* and confirm that the results are valid.
26. Enter the command *GETSIGNALLEVEL* and confirm that the results are valid.
27. Enter the command *GETXY* and confirm that the results are valid.
28. Enter the command *GETINTEGRATIONTIME*.
29. Determine a suitable fixed integration time (60% of 'GETINTEGRATIONTIME' response).
30. Enter the command *SETCUSTOMTIME#####*.
Where ##### is the desired integration time in μ S.

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Feasa LED Spectrometer

Daisy Chain Mode

Operating the S2 Spectrometer in Daisy Chain Mode:

NOTE: Before attempting to use this procedure please ensure the steps that are outlined above have been correctly implemented. This document will explain the procedure that is necessary to operate the Feasa S2 Spectrometer using the daisy chain function.

As an example, a Daisy Chain bus of 3 x S2 Spectrometers will be used.

There are 3 Spectrometers in the example bus:

- ◆ 1 x Master unit (example serial number S301)
- ◆ 2 x Slave units (example serial numbers S302 and S303 respectively)

Capture Dark

The CAPTUREDARK command initiates a procedure through which the Feasa LED Spectrometer is adjusted to compensate for background noise that exists when no light is applied. It is important to run the CAPTUREDARK command periodically as background noise is affected by many external factors that can vary over time.

The capture dark process is required on power up of the Spectrometers. It is only required periodically after this – every 6 hours or every shift change for example.

- 1.0 Cover the aperture of all SPxx's that are on the Daisy Chain bus to prevent light entering the devices.
- 1.1 In the Terminal command bar, enter the command BUSFREE. An OK response is returned.
- 1.2 Enter the command BUSCAPTUREDARK. An OK response is returned.
- 1.3 Poll the first (master) Spectrometer to verify a Capture Dark has completed.
To do this: Enter the command BUSCDES301, where S301 is the serial number of the first (master) Spectrometer. A response of '1' will be returned to verify that the Capture Dark has completed on this Spectrometer. A response of 0 signifies that no Capture Dark has been done.

NOTE: If no response is returned then the Capture Dark is still being executed by the Spectrometer. The command BUSCDES301 (where S301 is the serial number of the first Spectrometer) should be repeated until a '1' is returned.

The capture dark process is required on power up of the Spectrometers. It is only required periodically after this – every 6 hours or every shift change for example.

- 1.4 Poll the second (Slave1) Spectrometer to verify a Capture Dark has completed. Enter the command BUSCDES302. Where S302 is the serial number of the first (master) Spectrometer. A response of '1' will be returned to verify that the Capture Dark has completed on this Spectrometer. A response of 0 signifies that no Capture Dark has been done.

NOTE: If no response is returned then the Capture Dark is still being executed by the Spectrometer. The command BUSCDES302 (where S302 is the serial number of the first Spectrometer) should be repeated until a '1' is returned.



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- 1.5 Poll the third (Slave2) Spectrometer to verify a Capture Dark has completed.

To do this: Enter the command BUSCDES303. Where S303 is the serial number of the first (master) Spectrometer. A response of '1' will be returned to verify that the Capture Dark has completed on this Spectrometer. A response of 0 signifies that no Capture Dark has been done.

NOTE: If no response is returned then the Capture Dark is still being executed by the Spectrometer. The command BUSCDES303 (where S303 is the serial number of the first Spectrometer) should be repeated until a '1' is returned.

Capture the Bus

Now that the CAPTUREDARK has been complete, the cover that was previously placed over the SPxx's (see point 1.0 above) should be removed.

Place the Sphere over the Leds to be tested. When the parts are powered up, light will enter the SPxx Spheres. A capture can now be made.

- 2.0 In the command line bar in the Feasa Terminal program, enter the command BUSFREE. An OK response is returned.
- 2.1 Enter the command BUSCC. An OK response is returned.

The BUSCC command will execute the individual, fixed capture times that have been previously set on each Spectrometer using the SETCUSTOMTIME##### as detailed above. Please refer to this section in the Manual if the capture times have not been set on each Spectrometer.

Retrieving the Data

As with the Capture Dark, each Spectrometer on the Daisy Chain Bus should be 'polled' to ensure that the capture has been successfully executed on every Spectrometer. Once this has been confirmed – Measurement data can be read back.

- 3.0 Poll the first (master) Spectrometer to verify the Capture has been completed.
To do this: Enter the command BUSCES301. Where S301 is the serial number of the first (master) Spectrometer. A response of '1' will be returned to verify that the Capture has completed on this Spectrometer.

Polling Command Responses:

- 1 = Capture has been successfully executed on the polled Spectrometer.
- 2 = The capture is underrange on the polled Spectrometer.
- 3 = The capture is overrange on the polled Spectrometer.
- 4 = The light source is unstable.
- No Response = The Spectrometer is busy capturing. Polling should be repeated.



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Daisy Chain Mode

- 3.1 Call on the first (master) Spectrometer to retrieve measurement data.
To do this: Enter the command BUSGETS301. Where S301 is the serial number of the first (master) Spectrometer. An OK response is returned.

Measurement data can now be retrieved from Spectrometer S301.

- 3.2 Type the command GETLUMINOUSFLUX in the command bar and press the return key. An intensity value for the active Spectrometer in lumen(lm) is returned.
- 3.3 Type the command GETXY in the command bar and press the return key. An XY chromaticity value for the active Spectrometer is returned.

NOTE: A wide range of 'GET' commands are available. These can be used to retrieve measurement data from the Feasa Spectrometer.

- 4.0 Poll the second (slave1) Spectrometer to verify the Capture has completed. To do this: Enter the command BUSCES302. Where S302 is the serial number of the second (slave1) Spectrometer. A response of '1' will be returned to verify that the Capture has completed on this Spectrometer.

Polling Command Responses:

- 1 = Capture has been successfully executed on the polled Spectrometer.
 - 2 = The capture is underrange on the polled Spectrometer.
 - 3 = The capture is overrange on the polled Spectrometer.
 - 4 = The light source is unstable.
- No Response = The Spectrometer is busy capturing. Polling should be repeated.

- 4.1 Call on the second (slave1) Spectrometer to retrieve measurement data.
To do this: Enter the command BUSGETS302. Where S302 is the serial number of the second (slave1) Spectrometer. An OK response is returned.

Measurement data can now be retrieved from Spectrometer S302.

- 4.2 Type the command GETLUMINOUSFLUX in the command bar and press the return key. An intensity value for the active Spectrometer in lumen(lm) is returned.
- 4.3 Type the command GETXY in the command bar and press the return key. An XY chromaticity value for the active Spectrometer is returned.

NOTE: A wide range of 'GET' commands are available. These can be used to retrieve measurement data from the Feasa Spectrometer.



Feasa LED Spectrometer

Daisy Chain Mode

- 5.0 Poll the third (slave2) Spectrometer to verify the Capture has completed. To do this: Enter the command BUSCES302. Where S302 is the serial number of the third (slave2) Spectrometer. A response of '1' will be returned to verify that the Capture has completed on this Spectrometer.

Polling Command Responses:

- 1 = Capture has been successfully executed on the polled Spectrometer.
- 2 = The capture is underrange on the polled Spectrometer.
- 3 = The capture is overrange on the polled Spectrometer.
- 4 = The light source is unstable.
- No Response = The Spectrometer is busy capturing. Polling should be repeated.

- 5.1 Call on the third (slave2) Spectrometer to retrieve measurement data.
To do this: Enter the command BUSGETS302. Where S302 is the serial number of the third (slave2) Spectrometer. An OK response is returned.

Measurement data can now be retrieved from Spectrometer S302.

- 5.2 Type the command GETLUMINOUSFLUX in the command bar and press the return key. An intensity value for the active Spectrometer in lumen(lm) is returned.
- 5.3 Type the command GETXY in the command bar and press the return key. An XY chromaticity value for the active Spectrometer is returned.

NOTE: A wide range of 'GET' commands are available. These can be used to retrieve measurement data from the Feasa Spectrometer.

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Feasa LED Spectrometer

Specifications

OPTICAL Spectral Range Resolution Integration Time	380nm to 780nm 0.1nm 100μsec to 4sec
ACCURACY Luminous Flux Power (Watts) xy Chromaticity Peak Wavelength	10% (with calibrated Integrating Sphere) 10% ±0.005 ±1nm
REPEATABILITY Wavelength Chromaticity xy Intensity	±0.5nm ±0.0007 < 1%
ELECTRICAL	Supply Voltage 5.0V +/- 0.5V Supply Current 200 mA max
PHYSICAL Dimensions Fiber Length Fiber Diameter Minimum Bend Radius of Fiber Operating Temperature Range	115mm x 54mm x 30mm 0.6m 5.0mm, incl. cladding 15mm 0°C to +50°C

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Feasa LED Spectrometer

Ordering Information

Feasa LED Spectrometer 	Part No.: Feasa S2
Feasa Integrating Spheres 	Part No.: SP13, SPL3, SP14, SP16 SP23, SP24, SP25, SP26 SP8025, SP8035, SP8045
Feasa Luminance Head 	Part No: LU01, LU02, LU04, LU07
Feasa Luminous Intensity Head 	Part No: CD02, CD04, CD08
Feasa Patch Cord	Part No: FP02

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Feasa LED Spectrometer

Error Messages

OverRange

This message is displayed if the Spectrometer is saturated by too much light.

This can occur with very bright LEDs or if the *Custom Exposure Time* is too long. If the *Enable Custom Exposure* Tick-Box is selected then set the exposure value to the minimum value of 100 uSec and try again.

UnderRange

This message is displayed if the Spectrometer is not receiving enough light for the exposure setting selected. This usually occurs when the *Enable Custom Exposure* Tick-Box is selected. If this is the case then increase the exposure time and try again. The exposure time can be increased to 4 seconds maximum.

Error: light signal not stable

This message is displayed if the Spectrometer is not receiving stable light. This may occur when PWM LEDs or LEDs that have a low frequency are being tested.

To prevent this, PWM capture mode should be enabled.

Timeout Occurred

The Timeout value is shown in the Settings menu. The minimum value it can be set to is 10 Seconds and the maximum value is 600 seconds. A timeout error will be displayed if the Spectrometer is taking longer to measure a LED than the Timeout value. Increase the value of the Timeout will give the Spectrometer more time to measure the LED.

Capture Dark Error

If the Capture Dark does not match the capture – i.e. If the user does an AutoCapture dark and then tries to do a custom exposure time capture.

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Feasa LED Spectrometer

Warranty

1. Feasa Enterprises Limited (herein referred to as Feasa) warrants Feasa hardware, accessories and supplies against defects in materials and workmanship for the period of one year. If Feasa receives notice of such defects during the warranty period, Feasa will, at its option, either repair or replace products which prove to be defective. Replacement products may be either new or like-new.
2. Feasa warrants that Feasa software will not fail to execute its programming instructions, for the period of one year, due to defects in material or workmanship when properly installed and used. If Feasa receives notice of defects during the warranty period, Feasa will replace software media which does not execute its programming instructions due to such defects.
3. Feasa does not warrant that the operation of Feasa products will be uninterrupted or error free. If Feasa is unable, within a reasonable time, to repair or replace any product to a condition as warranted, customer will be entitled to a refund of the purchase price upon prompt return of the product to Feasa.
4. Feasa products may contain re-manufactured parts equivalent to new in performance or may have been subject to incidental use
5. The warranty period begins on the date of deliver
6. Warranty does not apply to defects resulting from:
 - (a) improper or inadequate maintenance or calibration,
 - (b) software, interfacing, parts or supplies not supplied by Feasa,
 - (c) unauthorized modification or misuse,
 - (d) operation outside the published environmental specifications for the product, or
 - (e) improper site preparation or maintenance.
7. TO THE EXTENT ALLOWED BY LOCAL LAW, THE ABOVE WARRANTIES ARE EXCLUSIVE AND NO OTHER WARRANTY OR CONDITION, WHETHER WRITTEN OR ORAL, IS EXPRESSED OR IMPLIED AND FEASA SPECIFICALLY DISCLAIMS ANY IMPLIED WARRANTIES OR CONDITIONS OF MERCHANTABILITY, SATISFACTORY QUALITY, AND FITNESS FOR A PARTICULAR PURPOSE.
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