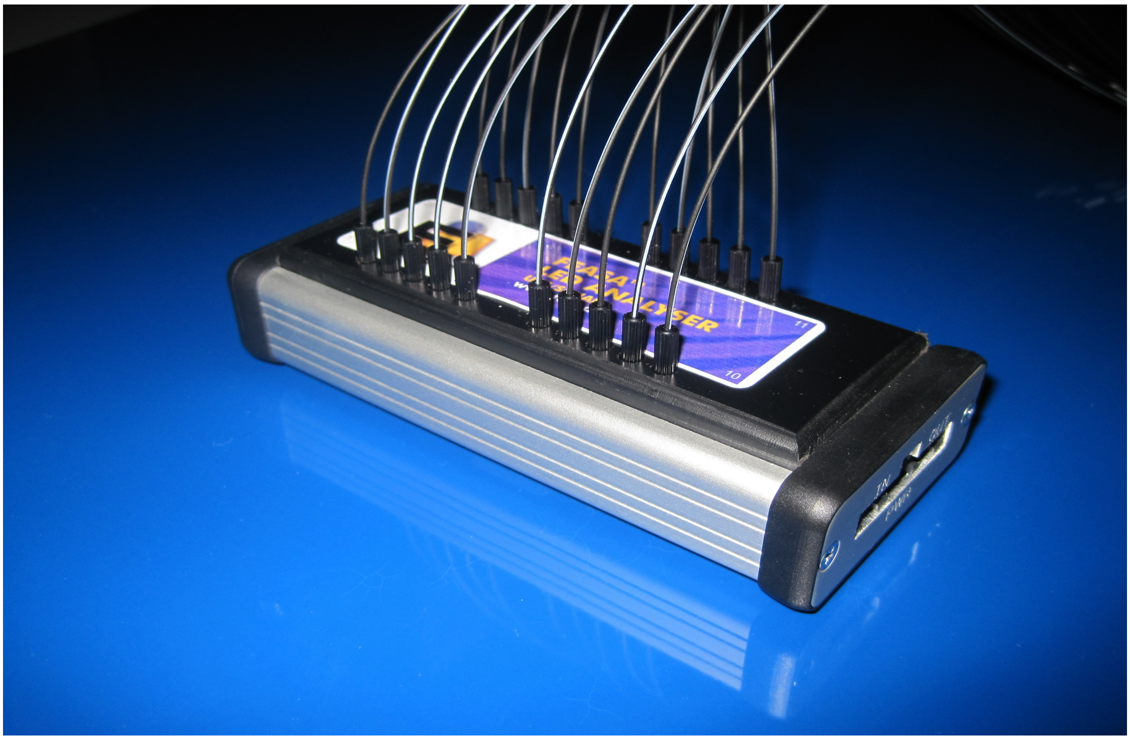
FEASA LED ANALYSER

User Manual for Functional Models Feasa 20-F, 10-F and 6-F



Feasa Enterprises Ltd,
Holland Road,
National Technology Park,
Castletroy,
Limerick,
Ireland.
www.feasa.ie
Email: sales@feasa.ie

Rev. 2.2 Functional Version
Date: March, 2010

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 models Feasa 20-F, 10-F and 6-F Functional Test LED Analysers.

The 20-F model will test up to 20 LED's, the 10-F will test up to 10 LED's and the 6-F will test up to 6 LED's.

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Introduction

The Feasa LED Analyser is an instrument that tests the Color and Intensity of Light Emitting Diodes (LEDs) in a test process.
The Analyser has 20* flexible Fiber-Optic Light Guides which are mounted individually over the LEDs to be tested.

Emitted Light from the LEDs is guided through these Fiber-Optic Light Guides to the Analyser where the Color, Saturation and Intensity are tested. The test results can then read out of the Analyser through the Serial or USB Interfaces.

The USB Interface is 2.0 compatible and the Serial Interface is RS-232C compatible.

Color, Saturation and Intensity values are output as ASCII strings through the USB and Serial Interfaces.

All colors are derived from the three primary colors, Red, Green and Blue (RGB). The RGB values are used to identify different color LEDs.

Every LED tested by the LED Analyser will have a set of RGB values generated for analysis. The RGB results for each LED tested can be read out through the Serial or USB Port.

* There are 10 channel and 20 channel versions available.

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Color and Saturation

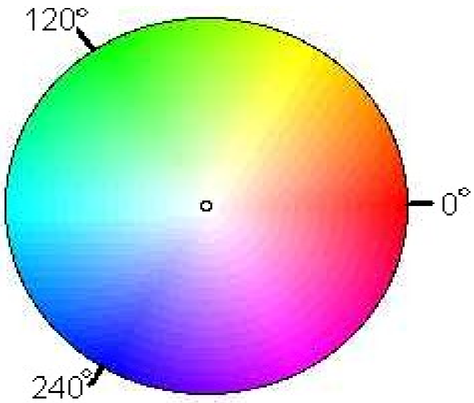

Figure 1: Hue (Color) Wheel

RED = *0º*
GREEN = *120º*
BLUE = *240º*

Colours can represented by a 360° degree circular Colour wheel. The three Primary RGB values can also be represented as a single value called *Hue*.
Hue is a measured location on a Colour wheel and is expressed in degrees.

For example, Red will have a Hue value near 0°, Green will have a Hue value near 120° and Blue will have a value near 240°.

A pure Colour will be represented on the Colour wheel as a point near the outer edge. White will be represented by a point near the center of the wheel.
The degree of whiteness in a LED will affect its position on the wheel – the greater the amount of white the closer it will be to the center.

The degree of whiteness emitted by the LED is represented by the term ***Saturation***. A Saturation value of 0% represents pure White. A Saturation value of 100% represents a pure Colour such as Red, Blue, Green, etc.

Usually the user must determine the Hue and Saturation values by testing a number of LED's and recording the results.

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The RGB and Hue values in *Figure 2* show how different Colour LEDs can be identified.

LED	***R***	***G***	***B***	***HUE***	***SATURATION***
Red	253	1	1	0	100%
Green	24	208	23	120	89%
Blue	2	13	240	238	99%
Yellow	76	171	8	95	96%
Orange	224	28	2	7	99%
White	71	72	112	See Page 8	37%

Figure 2

The RGB or Hue values are used to identify different Colour LEDs.

Every LED tested by the LED Analyser will have a set of RGB values generated for analysis.   These values are converted automatically to Hue and Saturation (whiteness) and can be read out through the Serial or USB ports.

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Intensity

Intensity is a measure of the amount of light being emitted by the LED.
The Analyser tests the Intensity of each LED and outputs this value to the Test System.
The value is output as a number in the range 0-99,999. The Analyser is calibrated to a fixed standard and all measurements are relative.

Factors that influence Intensity Measurement:

- The position of the Fiber in relation to the LED.
- Offset from the Optical Centre of the LED.
- The Gap between the end of the Fiber Light Guide and LED to be measured.
- The condition of the Fiber end. It must be kept clean with a 90º Cleave.
- Is the LED Static or Flashing ?
- External Influences – Other LEDs in close proximity, Ambient Lighting.

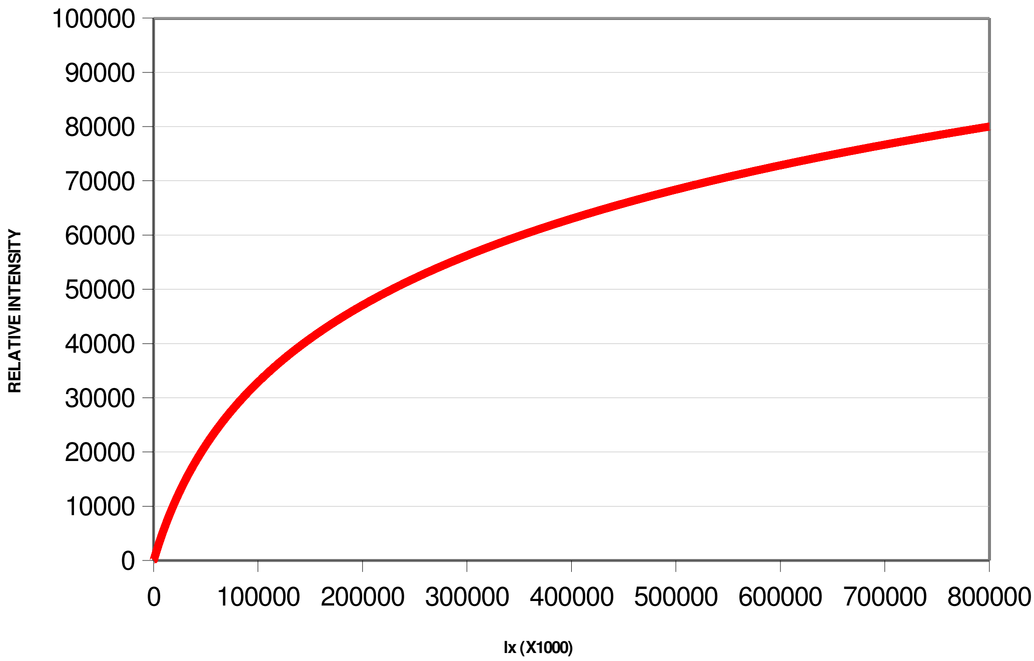

Figure 2. Relative Intensity vs LUX using the Medium Range

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White LED's

White LED's must be treated differently to coloured LED's when being tested. White is not a colour – it is a mix of all other colours. The three Primary colours Red, Green and Blue will be mixed in approximately equal proportions to display a White colour. The Hue and Saturation values must be used when testing White LED's. The Saturation is a value between 0% and 100%. A value of 0% indicates a pure white and a value of 100% indicates a pure Colour.

In reality, the Saturation value of white LED's vary significantly with values of 30% being typical. Remember, the Saturation value is an indication of how white the LED is.
The correct values must be determined experimentally with the particular LED's to be tested.

Most LED manufacturers will specify their White LED's using Chromaticity co-ordinates xy. This is a two-dimensional Chart with x on the horizontal axis and y on the vertical axis. The range of x and y lies between 0 and 1.

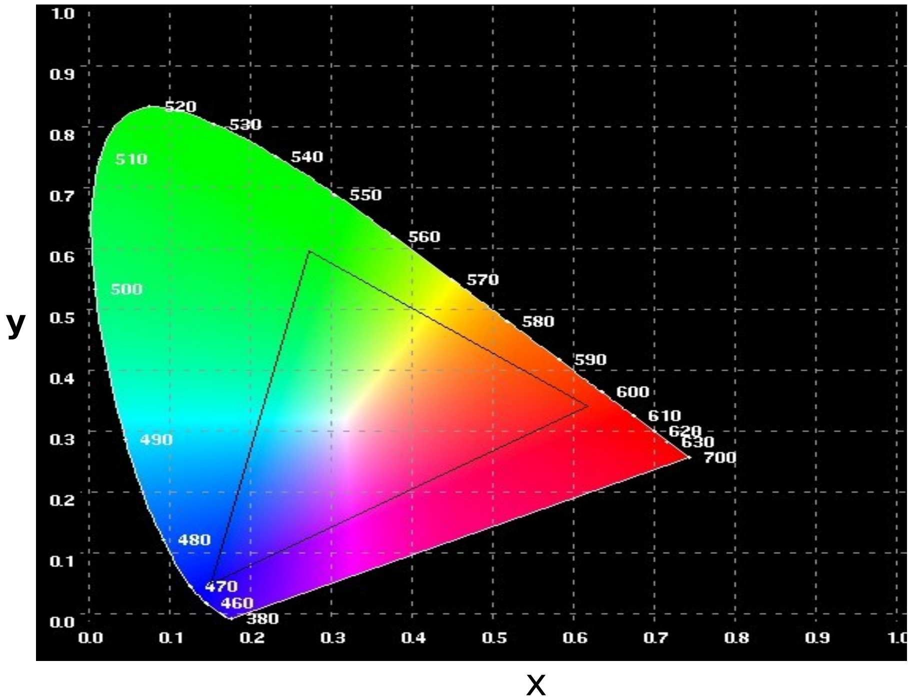

Figure 3. CIE 1931 Chromaticity Co-Ordinates

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White LED's Cont'd

White LED's will have approximate co-ordinates of 0.33, 0.33. This may vary depending on the manufacturer of the LED where some LED's will have a Blue tint and other LED's will have an Orange tint.

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Setting Tolerance Limits for Color and Intensity

The test procedure requires the user to set the Pass/Fail limits for Color and Intensity for each LED which then become the standard against which LEDs to be tested are compared.

The Pass/Fail limits for Color are chosen, in conjunction with manufacturer's specifications, from measurements taken from a sample number of typical LEDs.

Because Hue is expressed as a single number it is more convenient to set the limits for the color in terms of their Hue value.

Sample Hue Pass/Fail Limits

LED	Minimum	Maximum
Red	0	5
Green	110	130
Blue	220	250
Amber	5	10
Yellow	60	80
Orange	10	20

Figure 4.

White LED's should be identified in RGB or XY Chromaticity co-ordinates. The Red, Green and Blue values should all lie between 70-90 for a white LED and approximately 0.3,0.3 in XY. The *Saturation* value should be determined experimentally and should be less than 60%.

The Pass/Fail limits for intensity are chosen from the average intensity values from a number of sample LEDs.

Sample Intensity Pass/Fail Limits

Intensity Value	Upper Limit	Lower Limit	Comments
125	150	100	Dim LED
25000	28000	22000	Average LED
60000	64000	56000	Bright LED

Figure 5.

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Physical Layout

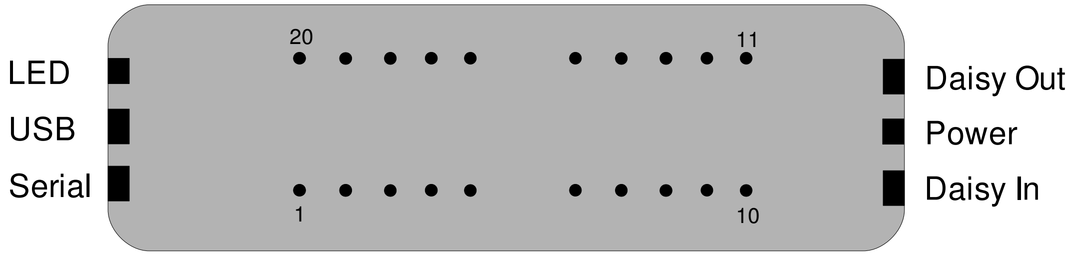

Figure 6.

Figure 6 shows the physical layout of the Analyser. The fibers are labeled 1-20.

USB Port Control

Connect the LED Analyser 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.

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Serial Port Control

For serial communications the LED Analyser must be connected from the 3-pin Serial Connector to the PC or Controller using the supplied serial cable.

5V DC Power must be supplied to the 2-pin Power Connector using the Power Cable. 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. These can be selected using the setbaud command.

Serial Connector (RS232C)

Pin	***Signal***	***Pin on 9-Pin D-type***
1	Tx from LED Analyser	2
2	Rx from LED Analyser	3
3	GND	5

Power Connector

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

Figure 7.

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Capture Commands

The Capture commands are used to capture the Color and Intensity of the LED's to be tested and store the results in the memory of the Analyser.

These results can be read out later using the GET *DATA* commands.

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

There are two Programs on the supplied CD that can be used to send commands to the Analyser:- **Feasa LED Analyser User** and the **Feasa LED Analyser Test** Programs.

The **Feasa LED Analyser User** Program is a graphical tool that can be used to send commands and receive results from the Analyser. It allows one LED to be tested at a time. This Program also allows a Terminal Window to be opened so that the User can type the commands directly and send them to the Analyser. The responses from the Analyser can be observed in the Window.

The **Feasa LED Analyser Test** Program allows the User to test all the LED's together. Pass and Fail limits can be set and results can be printed and logged.

Alternately, the User may generate a customised Program that sends commands and receives data through the virtual USB Com Port.

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Capture Mode

CAPTURE - Store LED Color and Intensity Data

Transmit	Receive
capture	**OK**

Description

This command instructs the LED Analyser to capture and store the Color and Intensity of all the LED's positioned under the fibers. The Analyser automatically determines the correct settings to capture the LED data. In the case of a 20 channel unit the data for all 20 LED's is captured simultaneously and stored in internal memory of the LED Analyser. The data is stored until the power is removed or another **capture** command is issued. When completed the Analyser will transmit the character **OK** on the receive line to the transmitting device (i.e. the PC).

This command uses a wide Intensity range to be able to test dim and bright LED's simultaneously. However, if the LED's to be tested are of similar Intensity then better results will be obtained by using the *Capture#* command described on the next page.

Example:

The PC transmits **capture** to the LED Analyser and the LED Analyser sends **OK** to the PC to acknowledge that the command is completed.

capture
OK

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Capture Mode

CAPTURE# *- Store LED Color and Intensity Data*

Transmit	Receive
CAPTURE#	**OK**

Where:

represents the ranges 1, 2, 3, 4, 5.

The LED brightness level for each range is as follows:-

Range 1 = Low
Range 2 = Medium
Range 3 = High
Range 4 = Super
Range 5 = Ultra

Description
This command uses a pre-selected exposure time designated Range1, Range2 etc. For low light or dim LED's use Range 1 and for brighter LED's use higher ranges. The higher ranges lead to faster test times because the exposure time is shorter.
This command instructs the LED Analyser to read and store the Color and Intensity of all the LED's positioned under the fibers using a fixed range.

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

Example:
The PC transmits **capture** to the LED Analyser and the LED Analyser sends **OK** to the PC to acknowledge that the command is completed.

capture2
OK

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Capture Mode

CAPTUREPWM - *Capture PWM LED Color and Intensity*

Transmit	Receive
CAPTUREPWM	**OK**

Description

Pulse-Width-Modulated(PWM) LED's are switched on and off rapidly to save power and to control Intensity. The Analyser automatically determines the correct settings required to execute the test.

This command uses the *auto-ranging* feature and a pre-set *averaging factor* to capture the LED data. This command is useful if it is required to test very dim and very bright PWM LED's together.

The command instructs the LED Analyser to read and store the Color and Intensity of all the LED's positioned under the fibers. The data is stored until the power is removed or another **capture** command is issued. When completed the Analyser will transmit the character **OK** on the receive line to the transmitting device (i.e. the PC).

Example:

The PC transmits **capturepwm** to the LED Analyser. The Analyser sends **OK** to the PC to acknowledge that the command is completed.

capturepwm
OK

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Capture Mode

CAPTURE#PWM@@ - Store LED Color and Intensity Data PWM LED's

Transmit	Receive
CAPTURE#PWM@@	**OK**

Where:

\# represents the exposure Range 1 – 5.
@@ represents an averaging factor in the range 1 - 15.

Description

This command allows the User to specify the *exposure range* and an *averaging factor* when testing PWM LED's. Select the *exposure range (1-5) to match the Intensity of the LED's.* The Analyser tests these LED's by taking a number of readings and averaging the results. A larger factor will lead to more stable results. The *averaging factor* is a number in the range 1-15.

This command instructs the LED Analyser to read and store the Color and Intensity of all the LED's positioned under the fibers. The data is stored until the power is removed or another **capture** command is issued. When completed the Analyser will transmit the character **OK** on the receive line to the transmitting device (i.e. the PC).

capture1pwm05
OK

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Get Data Commands

The *get data* commands are used to read out the Color, Saturation and Intensity data stored by the *capture* commands.

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

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

Under Range Condition

An under range condition will occur when insufficient light from the LED reaches the sensor for the range selected. This will be indicated by **999.99 999 00000** for **HSI, 000 000 000 00000** for **RGBI** and **0.0000 0.0000** for xy and uv.

If this condition occurs select the next **lower** range and test again.

Over Range Condition

An over range condition will occur when too much light from the LED reaches the sensor for the range selected by the switch. This will be indicated by **999.99 999 99999** for **HSI, 255 255 255 99999** for **RGBI** and **0.0000 0.0000** for xy and uv.

If this condition occurs select the next **higher** range and test again.

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Get Data Mode

getRGBI## - Get RGB and Intensity for a LED

Transmit	Receive
getRGBI##	**Rrr ggg bbb iiiii**

Where:

represents the Fiber Number and is a number in the range 01 – 20.

rrr , ggg and **bbb** are the **red, green** and **blue** components of the LED color. These values are normalized and are in the range 0 – 255.

iiiii represents the intensity value of the LED under Fiber xx. This 5-digit number is in the range 0000 – 99999. 0000 represents no Intensity or under range(i.e. the LED is off) and 99999 will represent over range or the LED is too bright.

Description

This command instructs the LED Analyser to return RGB and Intensity data for fiber ## (01-20) in format **rrr ggg bbb iiiii** where rrr, ggg and **bbb** are the red, green and blue components of the color. The **iiiii** value indicates the intensity value.
This command should be preceded by a **capture** command to ensure valid LED data is stored in the memory of the LED Analyser. The data for each LED can only be read out one-at-the-time, in any order. Note: it is important for the PC to use 01, 02, 03, etc to indicate Fibers 1, 2 and 3, etc.

Example:

The PC transmits **getrgbi05** to the LED Analyser to instruct it to send the stored Color and Intensity data for the LED positioned under Fiber No 5. The LED Analyser will return a string **rrr ggg bbb iiiii** to the PC.

Getrgbi05
006 230 018 06383

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Get Data Mode

getHSI##   - Get Hue, Saturation and Intensity

Transmit	Receive
getHSI##	**Hhh.hh sss iiiii**

Where:

represents the Fiber Number and is a number in the range 01 – 20.

hhh.hh represents the Hue (color) and is a number in the range 0.00 – 360.00.

sss represents the Saturation (whiteness) and is a number in the range 0–100.

iiiii represents the intensity value of the LED under fiber **##**. This 5-digit number is in the range 0000 – 99999. 0000 represents no Intensity or under range(i.e. the LED is off) and 99999 will represent over range or the LED is too bright.

Description

This command instructs the LED Analyser to return Hue, Saturation and Intensity data for fiber ## (01-20) in format **hhh.hh sss iiiii** where **hhh.hh** represents the Hue(Color), **sss** represents the Saturation(whiteness) of the LED under Fiber ##. The **iiiii** value indicates the intensity value.
This command should be preceded by a **capture** command to ensure valid LED data is stored in the memory of the LED Analyser. The data for each LED can only be read out one-at-the-time, in any order. Note: it is important for the PC to use 01, 02, 03, etc to indicate Fibers 1, 2 and 3, etc.

Example:

The PC transmits **gethsi05** to the LED Analyser to instruct it to send the stored Color and Intensity data for the LED positioned under Fiber No 5. The LED Analyser will return a string **hhh.hh sss iiiii** to the PC.

gethsi05
123.47 098 06383

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Get Data Mode

getxy## - Return the xy Chromaticity values

Transmit	Receive
getxy##	**0.xxxx 0.yyyy**

Where:

represents the Fiber Number and is a number in the range 01 – 20.

0.xxxx represents the x Chromaticity value

0.yyyy represents the y Chromaticity value

Description

This command is used to return the xy Chromaticity value for the LED under the Fiber number ##. This command is used for testing White LED's.
This command should be preceded by a **capture** command to ensure valid LED data is stored in the memory of the LED Analyser. The data for each LED can only be read out one-at-the-time, in any order. Note: it is important for the PC to use 01, 02, 03, etc to indicate Fibers 1, 2 and 3, etc.

Example:

The PC transmits **getxy01** to the LED Analyser to instruct it to send the stored xy Chromaticity data for the LED positioned under Fiber No 1. The LED Analyser will return a string **0.xxxx 0.yyyy** to the PC.

getxy01
0.6461 0.3436

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Get Data Mode

getxoffset## - Return the x Chromaticity offset

Transmit	Receive
getxoffset##	**±0.xxx**

Where:

represents the Fiber Number and is a number in the range 01 – 20.
±0.xxx represents the x Chromaticity offset

Description

This command is used to return the x Chromaticity offset for the LED under the Fiber number ##. The value of this offset must be set by the setxoffset## command. The default value is 0.000.

Example:

The PC transmits **getxoffset01** to the LED Analyser to instruct it to send the stored x Chromaticity offset for the LED positioned under Fiber No 1. The LED Analyser will return a string **±0.xxx** to the PC.

getxoffset01
+0.155

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Get Data Mode

getyoffset## - Return the y Chromaticity offset

Transmit	Receive
getyoffset##	**±0.yyy**

Where:

represents the Fiber Number and is a number in the range 01 – 20.
±0.yyy represents the y Chromaticity offset

Description

This command is used to return the y Chromaticity offset for the LED under the Fiber number ##. The value of this offset must be set by the setyoffset## command. The default value is 0.000.

Example:

The PC transmits **getyoffset01** to the LED Analyser to instruct it to send the stored y Chromaticity offset for the LED positioned under Fiber No 1. The LED Analyser will return a string **±0.yyy** to the PC.

getyoffset01
-0.025

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Get Data Mode

getuv## - Return the u'v' Chromaticity values

Transmit	Receive
getuv##	**0.uuuu 0.vvvv**

Where:

represents the Fiber Number and is a number in the range 01 – 20.
0.uuuu represents the u Chromaticity value
0.vvvv represents the v Chromaticity value

Description

This command is used to return the u'v' Chromaticity value for the LED under the Fiber number ##. This command is used for testing White LED's.
The u'v' values are derived from the xy Chromaticity co-ordinates including any xy offsets that may be applied.
This command should be preceded by a **capture** command to ensure valid LED data is stored in the memory of the LED Analyser. The data for each LED can only be read out one-at-the-time, in any order. Note: it is important for the PC to use 01, 02, 03, etc to indicate Fibers 1, 2 and 3, etc.

Example:

The PC transmits **getuv01** to the LED Analyser to instruct it to send the stored XY Chromaticity data for the LED positioned under Fiber No 1. The LED Analyser will return a string **0.uuuu 0.vvvv** to the PC.

getuv01
0.1809 0.4414

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Get Data Mode

getINTENSITY## - Get the Intensity

Transmit	Receive
getINTENSITY##	**IIIII**

Where:

represents the Fiber Number and is a number in the range 01 – 20.
IIIII represents the Intensity value.

Description

This command is used to get the Intensity value for the LED under the Fiber number ##.
This command should be preceded by a **capture** command to ensure valid LED data is stored in the memory of the LED Analyser. The data for each LED can only be read out one-at-the-time, in any order. Note: it is important for the PC to use 01, 02, 03, etc to indicate Fibers 1, 2 and 3, etc.

Example:

The PC transmits **getintensity01** to the LED Analyser to instruct it to send the stored XY Chromaticity data for the LED positioned under Fiber No 1. The LED Analyser will return a string **IIIII** to the PC.

getintensity01
06734

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Get Data Mode

getIntGain - Get the Intensity Gain Factor

Transmit	Receive
getIntGain##	**xxx**

Where:

represents the Fiber Number and is a number in the range 01 – 20.
xxx represents the Intensity gain value. Default 100.

Description

This command is used to get the Intensity gain value for each Fiber.
The default values set at the factory are 100 i.e. 100% of nominal. The values can be adjusted by the SetIntGain command.

Example:

The PC transmits **getintgain01** to the LED Analyser to instruct it to send the stored intensity gain data for Fiber No 1.

getIntGain01
100

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Get Data Mode

getfactor - Get the exposure Factor

Transmit	Receive
getfactor	**xx**

Where:

xx represents the exposure factor value. The default value is 01.

Description

This command is used to get the exposure factor value for all Fibers.
The default value set at the factory are 01. The values can be adjusted by the SetFactor command.

Example:

The PC transmits **getfactor** to the LED Analyser to instruct it to send the stored exposure factor for all Fibers. The default value is 01.

getfactor
01

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Get Data Mode

get7seg# - Get the value of a 7 Segment Display

Transmit	Receive
get7seg#	**x**

Where:

represents the Number 1 or 2

x represents the value of the display 0 - 9

Description

The LED Analyser can be used to test LED-based 7-Segment displays. To set up the LED Analyser to interrogate a single 7-Segment display, fit fibers labeled 1 to 7 over segments a-g on the 7-Segment display. See *Figure 8* on the next page.
To set up the LED Analyser to interrogate an additional 7-Segment display, fit fibers labeled 11 to 17 over segments a-g on the additional display.

To interrogate the digit displayed on the first 7-Segment Display send the command **get7seg1** to the LED Analyser. The LED Analyser will return the digit displayed. The LED Analyser will return the character **X** when the displayed value is not recognized **(0 to 9)**.

To interrogate the digit displayed on the second 7-Segment display send the command **get7seg2** to the LED Analyser. The LED Analyser will return the digit displayed. Again, the LED Analyser will return the character **X** when the displayed value is not recognized **(0 to 9)**.

Note:- it is not necessary to send any *capture* commands prior to using the **get7seg1** or **get7seg2** commands.

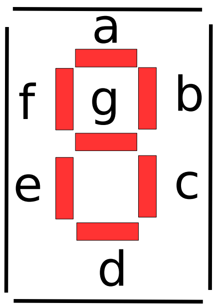

Figure 8.

Example:

The PC transmits **get7seg1** to the LED Analyser and the Analyser will return the value of the display.

get7seg1
6

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Set Commands

The *Set* commands are used to adjust various settings in the LED Analyser such as Intensity and Exposure.

These settings remain programmed in the Analyser even when the power is removed.

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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Set Data Mode

SetIntGain - Set the Intensity GainFactor

Transmit	Receive
SetIntGain##xxx	**OK**

Where:

represents the Fiber Number and is a number in the range 01 – 20.
xxx represents a 3 digit gain factor, default 100.

Description

This command allows the user to adjust the Intensity Gain Factor for each Fiber. This is useful when it is required to balance all or some of the Fibers to give the same Intensity when Testing similar LED's. The Factory default setting is 100. The value for each Fiber can be adjusted from 050 – 200.

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

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

Example:

Set the Intensity gain for Fiber 1 to 095.
setIntGain01095
OK

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Set Data Mode

SetFactor## - Set the Exposure Factor

Transmit	Receive
SetFactor##	**OK**

Where:

represents the Factor Number and is in the range 01 – 20 (default 01).

Description

This command allows the user to adjust the *Exposure Factor* for **all** Fibers. This is useful when it is required to test very dim LED's. The Factory default setting is 01. The value can be adjusted from 01 to 20. The exposure time will be increased when the factor is increased which will lead to longer test times.
Try the low range(*capture1*) first before adjusting the Exposure Factor.

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

The current value can be read out using the getfactor command.

Example:

Set the Factor Number for all Fibers to 05.

setfactor05
OK

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Set Data Mode

setxoffset##0.xxx- Set the x Chromaticity Offset

Transmit	Receive
Setxoffset##±0.xxx	**OK**

Where:

represents the Fiber Number and is a number in the range 01 – 20.
0.xxx represents the x Chromaticity offset value (±0.000 – 0.300).

Description

This command is used to set an offset to the displayed x Chromaticity value. The limit of the offset is ±0.300 which means values must be in the range ±0.000 – 0.300. This command is useful when the user wishes to set the x Chromaticity to be the same as that specified by the LED Manufacturer. The default value of the offset is 0.000. The offset is stored in non-volatile memory and will remain at the programmed setting until changed by a new *Setxoffset* command.

Example:

The PC transmits **setxoffset01+0.050** to the LED Analyser to instruct it to set the X offset on Fiber 1 to +0.050.

setxoffset01+0.050
OK

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Set Data Mode

setyoffset##0.yyy - *Set the y Chromaticity Offset*

Transmit	Receive
Setyoffset##±0.yyy	**OK**

Where:

represents the Fiber Number and is a number in the range 01 – 20.
0.yyy represents the y Chromaticity offset value (±0.000 – 0.300).

Description

This command is used to set an offset to the displayed y Chromaticity value. The limit of the offset is ±0.300 which means values must be in the range ±0.000 – 0.300. This command is useful when the user wishes to set the y Chromaticity to be the same as that specified by the LED Manufacturer. The default value of the offset is 0.000. The offset is stored in non-volatile memory and will remain at the programmed setting until changed by a new *Setyoffset* command.

Example:

The PC transmits **setyoffset01-0.050** to the LED Analyser to instruct it to set the y offset on Fiber 01 to -0.050.

setyoffset01-0.050
OK

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Daisy Chain Mode

The Daisy chain is a method used to communicate with multiple Led Analyser units to save connections and simplify the wiring.

One Led Analyser (1st in the chain) is connected to the computer using a RS232 or USB cable and the remaining LED Analysers are interconnected in a Daisy Chain or Serial Bus. The LED Analyser connected to the computer receives a command and this command is received by all the other LED Analysers through the Daisy Chain Bus.

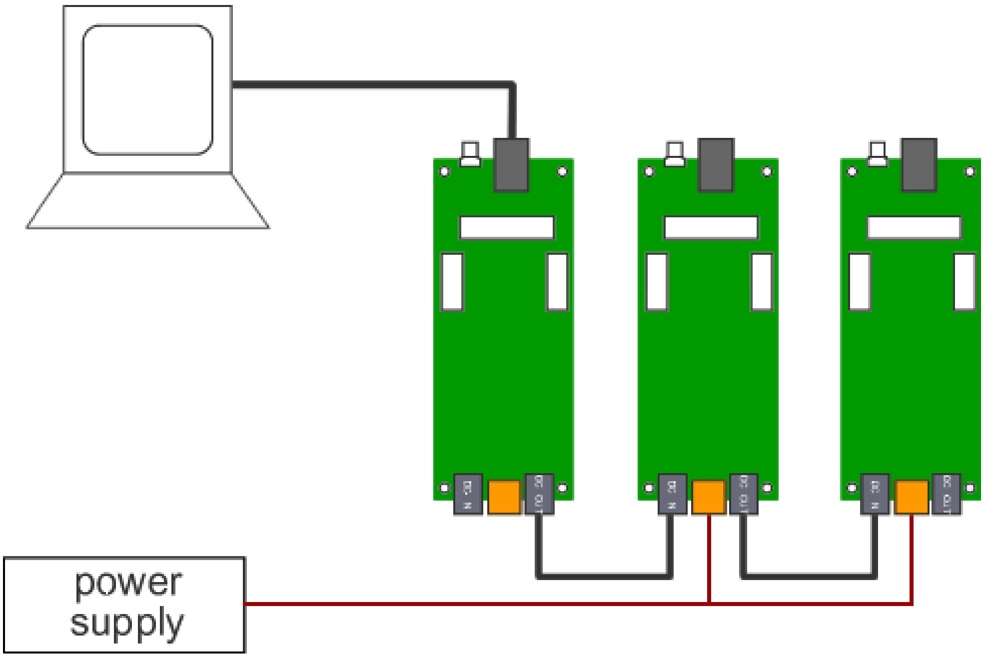

Figure 9 Daisy Chain

Only one LED Analyser is active at any one time and all commands from the Controlling Computer are directed to the active LED Analyser. All responses received by the Computer will be from the active LED Analyser.

Each LED Analyser is identified using a unique 4-character *Serial Number*. This *Serial Number* is fixed to each Analyser or can be read out using the getSerial command.

There are a number of commands which are used to control the Analysers in the Daisy Chain. These commands are described on the following pages.

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Daisy Chain Mode

BusFree - Deactivate any active Analysers

Transmit	Receive
BusFree	**OK**

Description

This command is used to deactivate any active Analysers on the Daisy Chain Bus. This will free the Bus to allow an Analyser to be made active. This command should be issued at the start of a sequence. It is the responsibility of the Controlling Computer to issue commands and monitor the responses. If an Analyser does not respond within 500mSec then the Controlling Computer should issue a new BusFree command and report an error.

The Analyser connected to the computer will operate as a standalone unit after the command is issued.

Example:

The PC transmits **BusFree** to the 1st LED Analyser to instruct it to free up the Daisy Chain Bus.

busfree
OK

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Daisy Chain Mode

BusGet#### - Activate a LED Analyser

Transmit	Receive
BusGet####	**OK**

Where:

represents the Serial Number of the Analyser.

Description

This command will activate the LED Analyser with the specified Serial Number. This command should be preceded by a *BusFree* command. All the *Capture*, *Set, Get*, etc commands can now be used with the active Analyser in the chain.

It is the responsibility of the Controlling Computer to issue commands and monitor the responses. If an Analyser does not respond within 500mSec then the Controlling Computer should issue a new BusFree command and report an error.

Example:

The PC transmits **BusGet####** to the Master LED Analyser to instruct it to activate the LED Analyser with Serial Number ####.

busgetF044
OK

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Daisy Chain Mode

BusC - Initiate Capture for all LED Analyser's

Transmit	Receive
BusC	**OK**

Description

This command will cause all LED Analysers in the Daisy Chain to initiate a capture sequence using the Automatic Range Mode. To specify a Range manually see the command *BusC#* on the next page.

This command should be preceded by a *BusFree* command.

After the capture cycle use the the command BusGet#### to activate a specific LED Analyser. All the standard commands can then be used to read back the LED Test data.

Example:

The PC transmits **BusC** to the 1st LED Analyser to instruct all LED Analysers in the Daisy Chain to initiate a Capture cycle.

busc
OK

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Daisy Chain Mode

BusC# - Initiate Capture for all LED Analyser's

Transmit	Receive
BusC#	**OK**

Where:

represents the ranges 1, 2, 3, 4, 5.

The LED brightness level for each range is as follows:-

Range 1 = Low
Range 2 = Medium
Range 3 = High
Range 4 = Super
Range 5 = Ultra

Description
This command uses a pre-selected exposure time designated Range1, Range2 etc. For low light or dim LED's use Range 1 and for brighter LED's use higher ranges. The higher ranges lead to faster test times because the exposure time is shorter.
This command should be preceded by a *BusFree* command.

This command instructs all LED Analyser's in the Daisy Chain to capture and store the Color and Intensity of all the LED's positioned under the fibers using a fixed range.

*The range setting must be specified. The data is stored until the power is removed or another **capture** command is issued. When completed the Analyser will transmit the character **OK** on the receive line to the transmitting device (i.e. the PC).Example:*

The PC transmits **BusC#** to the 1st LED Analyser to instruct all LED Analysers in the Daisy Chain to initiate a Capture cycle.

busc2
OK

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Daisy Chain Mode

Ports Description and Wiring.

Figure 10

The Daisy Chain Connectors are shown on the right-hand side of figure 10. The D_OUT connector is connected to the D_IN connector of the next Analyser in the chain.

The Power Connector is used to supply +5V DC to each Analyser in the chain. Allow 200mA @5V for each Analyser and ensure the wiring is adequate to supply the current without incurring large voltage drops. **For reliable operation it is necessary to have 5V at the Power Connector of each Analyser**.

There is one exception for the 1st Analyser in the chain. If the USB Connector is used on the 1st Analyser then the power for it will be supplied by the USB Connection.

If the Serial Connector is used for communications then +5V must also be supplied through the 2-pin Power Connector.

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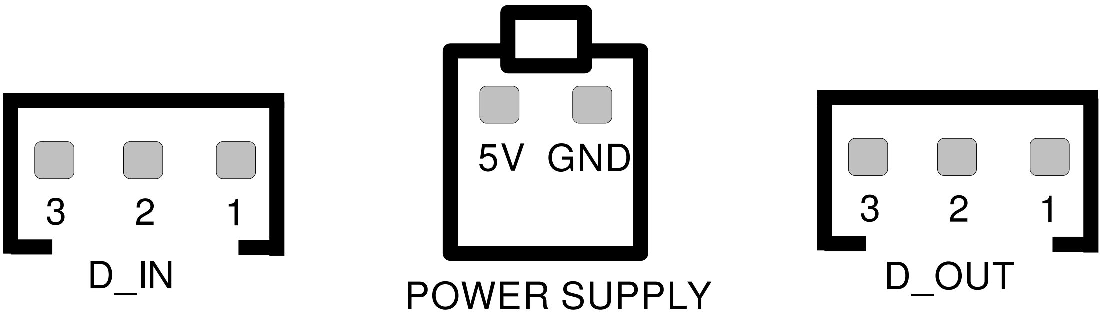
Daisy Chain Mode

Daisy Chain Pinout



PIN	D_IN	D_OUT
1	RX_in	RX_out
2	TX_out	TX_in
3	GND	GND

Figure 11

Figure 11 shows the layout of the Connectors viewed from the edge of the board.

The *GND* line of *D_OUT* is connected with the *GND* line of *D_IN*, the *RX_out* of *D_OUT* is connected to *RX_in* of *D_IN* and the line *TX_in* of *D_OUT* is connected to the line *TX_out* of *D_IN*.

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Daisy Chain Mode

Step-by-Step method for DaisyChaining

To sucessfully implement Daisychaining the following steps are recommended:-

1. Decide how many Analysers are to be daisychained.

2. Make a list of the Serial Numbers of the Analysers and note the order in which they will be interconnected.

Chain Order	Serial No	Comments
1	F3041	Tests D40 – D59 Connected to PC
2	F4611	Tests D60 - D69
3	F2014	Tests LED01 – LED20 All White
4	F0061	Tests LED21 – LED40 All Red

3. Locate the Daisy Chain cables and connect the Daisy_Out of F3041 to the Daisy_In of F4611. Connect Daisy_Out of F4611 to Daisy_In of F2014. Connect Daisy_Out of F2014 to Daisy_In of F0061.

4. Next locate the 2-pin Power cable supplied with each Analyser. It is necessary to apply 5V power to each LED Analyser in the chain using this cable. The only exception to this is if Analyser 1 (F3041) is connected to the Host Computer using the USB Cable. In this case Analyser 1 will draw its Power from the USB port.

5. Connect Analyser 1 to the Host Computer using either a Serial or USB cable. Apply power to all the Analysers. The Green LED on each Analyser should come on.

6. The supplied Terminal Program can be used to verify the operation of the Daisy Chain. Connect to the port on which the 1st Analyser is installed. See USB Port Control

Daisy Chain Mode

7. Send 'CAPTURE' to verify the communications with the 1st Analyser. The response should be 'OK'.

8. Send 'GETSERIAL' and the response should be 'F3011'.

9. To connect to Analyser 2 (F4611) send:-

   BUSFREE
   OK — Response from the Analyser
   BUSGETF4611
   OK — Response from the Analyser

   The host computer is now connected to Analyser 2 (F4611). This can be verified by requesting the Serial Number:-

   GETSERIAL
   F4611 — Response from the Analyser

   All the LED Analyser commands can now be directed to Analyser 2.

10. To connect to Analyser 3 (F2014) send the following:-

   BUSFREE
   OK — Response from the Analyser
   BUSGETF2014
   OK — Response from the Analyser

11. It is possible to instruct all Analysers in the chain to capture LED data simultaneously. This makes programming easier and saves time. There are six capture commands in total but only one can be used at a time. The commands are *busc*, *busc1*, *busc2*, *busc3*, *busc4* and *busc5*. *Busc* uses the automatic capture range whereas *busc1 – busc5* use pre-selected manual ranges. It is recommended to use the manual ranges busc1 – busc5 wherever possible. The *busc* command should only be used where dim and bright LED's must be tested simultaneously.

Daisy Chain Mode

Example

```
BUSFREE                'free the bus
OK
BUSC3                  'All Analysers capture using range 3 High
OK
BUSFREE
OK
BUSGETF3041           'Connect to the 1st Analyser
OK
GETSERIAL             'Confirm to Analyser
F3041
GETHSI01              'Get the Data for Fiber 1
000.51 100 36491
GETHSI02
      .
      .
GETHSI20
120.51 100 66542   'Get the Data for Fiber 20
BUSFREE
OK
BUSGETF4611           'Connect to the 1st Analyser
OK
GETSERIAL             'Confirm to Analyser
F4611
GETHSI01              'Get the Data for Fiber 1
000.51 100 36491
GETHSI02
      .
      .
GETHSI20              'Get the Data for Fiber 20
       .
```

Repeat this sequence for all Analysers in the chain.

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General Commands

getSerial *- Get the Serial Number of the Analyser*

Transmit	Receive
getSerial	**xxxx**

Where: xxxx is an alphanumeric value.

Description

This command will return the Serial Number of the Analyser. This is a unique number and is useful if multiple LED Analysers are used in a System. The Controlling Software can query each LED Analyser for it's Serial Number to ensure the correct Analyser is being controlled.

Example:

The PC transmits **getserial** to the LED Analyser an it will return **xxxx** to the PC.

getserial
75A6

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General Commands

getVersion *- Get the Firmware Version*

Transmit	Receive
getVersion	**xxxx**

Where: xxxx is an alphanumeric value.

Description

This command will return the Version Number of the firmware in the Analyser.

Example:

The PC transmits **getversion** to the LED Analyser an it will return **xxxx** to the PC.

getversion
F002

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General Commands

getHW - Get the Hardware Version

Transmit	Receive
getHW	**xxxxxxxxxx**

Where: xxxxxxxxxx is an alphanumeric value.

Description

This command will return the hardware version of the Analyser.

Example:

The PC transmits **gethw** to the LED Analyser an it will return **xxxxxxxxxx** to the PC.

gethw
Feasa 20-F

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General Commands

***Setbaud** - Change the baud rate*

Transmit	Receive
SetbaudX	**OK**

Where: **X** = 9600,19200,38400,57600,115200,230400

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.

Example:

To change the baud rate to 9600 transmit the command **setbaud9600** to the Analyser .

Setbaud9600
OK

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General Commands

help *- Command Summary Listing*

Transmit	Receive
help	**Command listing**

Description

This command will generate a summary listing of all the LED Analyser commands. This is useful when using a terminal program such as HyperTerminal.

Example:

To generate the listing transmit **help** to the Analyser .

help

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Step-by-Step approach to Testing a LED

Standard Capture Mode

To Test the Color and Intensity of up to 20 LEDs simultaneously carry out the following:

1. Ensure that the LEDs to be Tested are turned on and that the fibers are centered over the LEDs.

2. To Test the Color and Intensity in **RGB** first send the command **capture** to the LED Analyser. The LED Analyser will return the characters **OK** indicating that the Color and Intensity data for the LEDs has been stored in the internal memory.

3. Transmit the command **getrgbi01** to retrieve the results for Fiber 1. Any fiber can be queried by sending the command **getrgbi##** to the LED Analyser, where **##** is the fiber number in the range **01 to 20**. The LED Analyser will return the results in the format **rrr ggg bbb iiiiiE** where **rrr**, **ggg** and **bbb** are the **red**, **green** and **blue** components of the light in decimal format in the range **000 to 255**. The **iiiii** value indicates the intensity value of the light in the range **00000 to 99999**.

4. Alternatively, the Led Analyser may also be queried to retrieve the Hue, Saturation and Intensity results for the LEDs under test. After step 2 send the command **gethsi##** to the LED Analyser where **##** is the fiber number. The LED Analyser will return the results for that fiber in the format **hhh.hh sss iiiiiE** where **hhh.hh** is the Hue, **sss** is the Saturation(whiteness) and **iiiii** are the Intensity results for that Fiber.

5. An Intensity value of 0000 will indicate that the LED under test is not bright enough. To compensate for this move the fiber closer to the LED or increase the LED intensity. An Intensity value of 99999 will indicate that the LED is too bright and the LED Analyser has an over-range condition. In this case increase the distance of the LED to the Fiber or decrease the LED Intensity.

6. In general, try to keep the Intensity less than 80,000 and greater than 20,000.

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PWM LED Mode

Effect of PWM on Intensity Testing

The effect of Pulse Width Modulation (PWM) of a typical LED on the Analyser Intensity can be seen in Figure 8. In this graph the LED will always be on at 100% modulation. When the modulation has been reduced to 50% (i.e. the LED is off 50% of the time) the relative Intensity drops to approximately 90%.

At 20% modulation (the LED is off 80% to the time) the relative Intensity drops to approximately 50%.

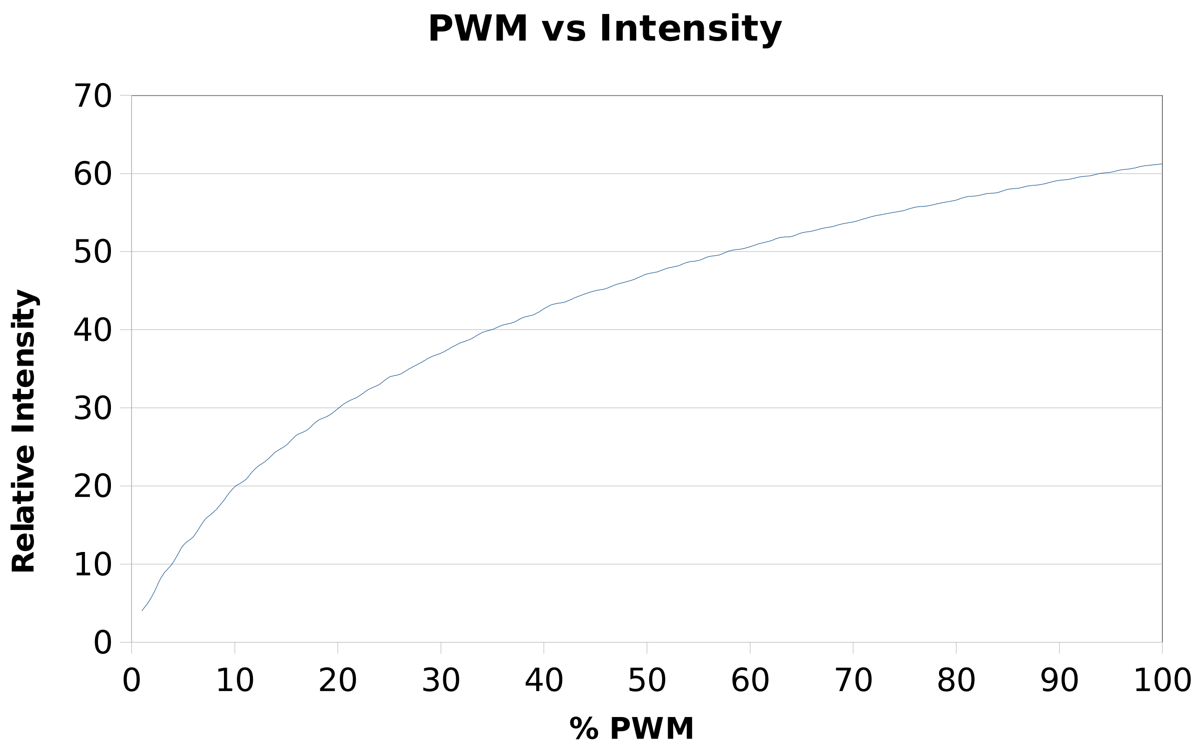

Figure 12: Relative Intensity versus Modulation

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Step-by-Step approach to Testing a PWM LED

PWM LED Mode *

To test PWM LEDs use the following commands on the LED Analyser for Fiber 1:

1. Decide how many readings are required to test the PWM LED's. The Analyser can be programmed to take between 1 and 15 readings. The more readings that are taken the greater the stability of the results.

2. Send the command **CAPTURE#PWM@@**, where **@@** is the number of readings to take and **#** is the Intensity range. The LED Analyser will capture and store the Color, Saturation and Intensity data for all fibers. The LED Analyser will respond with the Characters **OK** indicating that the command has been completed.

3. To read back the RGB and Intensity of the LED under fiber **##** send the command **GETRGBI##** to the LED Analyser. The LED Analyser will return the data in the format **rrr** **ggg** **bbb** **iiiii** where **rrr**, **ggg** and **bbb** are the **red**, **green** and **blue** components of the color. The **iiiii** value indicates the intensity value.

4. To read back the Hue and Intensity of the LED under fiber **xx** send the command **GETHSI##** to the LED Analyser. The LED Analyser will return the data in the format **hhh.hh sss iiiii** where **hhh.hh** represents the Hue value, **sss** represents the Saturation(whiteness) and **iiiii** indicates the intensity value.

* If the switching frequency for the LED > 150Hz then stable results can be obtained using the capture# commands. These commands are quicker to execute and will save test time.

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Testing a 7-Segment Display

The LED Analyser can be used to test LED-based 7-Segment displays. To set up the LED Analyser to interrogate a single 7-Segment display, fit fibers labeled 1 to 7 over segments a-g on the 7-Segment display.
To set up the LED Analyser to interrogate an additional 7-Segment display, fit fibers labeled 11 to 17 over segments a-g on the additional display.

To interrogate the digit displayed on the first 7-Segment Display send the command **get7seg1** to the LED Analyser. The LED Analyser will return the digit displayed. The LED Analyser will return the character **X** when the displayed value is not recognized **(0 to 9)**.

To interrogate the digit displayed on the second 7-Segment display send the command **get7seg2** to the LED Analyser. The LED Analyser will return the digit displayed. Again, the LED Analyser will return the character **X** when the displayed value is not recognized **(0 to 9)**.

Note:- it is not necessary to send any *capture* commands prior to using the **get7seg1** or **get7seg2** commands.

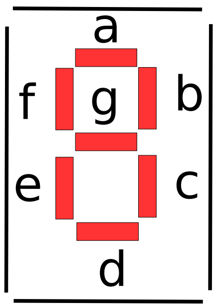

Figure 13: 7-Segment LED Display

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Intensity Responses

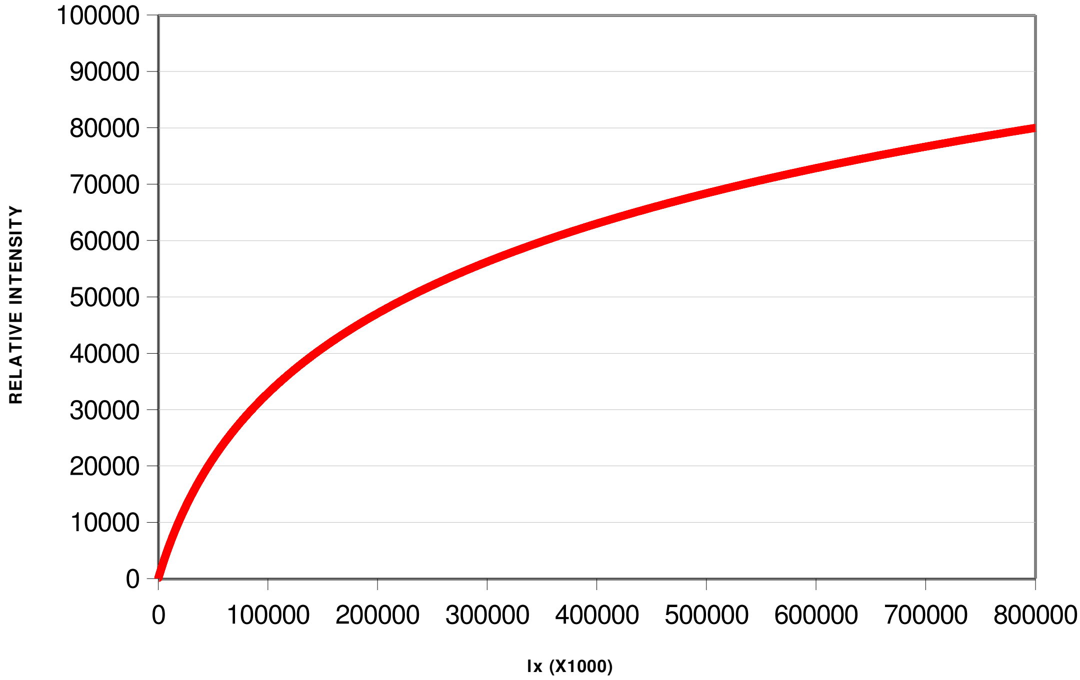

Figure 14: Relative Intensity vs LUX for the LED Analyser

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Command Summary

COMMAND	DESCRIPTION
Busfree	Free the Daisy Chain Bus of the active Analyser
Busget####	Make Analyser #### active on the Daisy Chain Bus
BusC	All Analysers on the Daisy Chain to Auto Capture
BusC#	All Analysers on the Daisy Chain to Manual Capture
Capture	Capture LED Color and Intensity Data - Auto Range
Capture#	Capture LED Color and Intensity Data - Manual Range
Capture#PWM@@	Capture LED Color and Intensity Data PWM Mode
getRGBI##	Get RGB, Saturation and Intensity for a LED
getHSI##	Get Hue, Saturation and Intensity for a LED
getxy##	Get the xy Chromaticity values
getuv##	Get the u'v' Chromaticity values
getIntensity##	Get the Intensity for a LED
get7seg#	Read a 7 Segment Display
getSerial	Get the Serial Number of the Analyser
getVersion	Get the Firmware Revision of the Analyser
getHW	Get the Hardware Version of the Analyser
Setbaud	Set the baud rate of the Serial and USB Port
help	Command Summary Listing

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Specifications

Part Number(s)

Feasa 20-F	LED Analyser with 20 Fibers
Feasa 10-F	LED Analyser with 10 Fibers
Feasa 6-F	LED Analyser with 6 Fibers

Physical

Dimensions 120mm x 54mm x 38mm (L x W x H)
Fiber Length 0.6m
Fiber Diameter 1.0mm
Fiber Core Diameter 0.5mm
Number of Fibers 6, 10, 20
Operating Temperature Range 0^0C to +50^0C

Electrical

Supply Voltage 5.0V
Supply Current 200 mA
USB 2.0 Interface, Serial RS232 Interface
Output Data Format RGB, HSI, XY, UV

Optical

Red Peak Efficiency Wavelength 615 nm
Green Peak Efficiency Wavelength 540 nm
Blue Peak Efficiency Wavelength 465 nm
Total Operating Wavelength Range 450 nm to 650 nm

Accuracy

White	X=± 0.0015, Y = ± 0.0015
Red (630nm)	± 3nm
Green (540nm)	± 4nm
Blue (630nm)	± 3nm

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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 war-
ranted, customer will be entitled to a refund of the purchase price upon prompt return of the product to Feasa.
4. Feasa products may contain remanufactured parts equivalent to new in performance or may
have been subject to incidental use.
5. The warranty period begins on the date of delivery.
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.

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