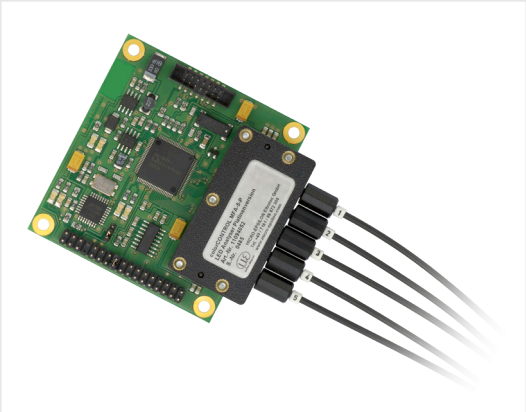
MICRO-EPSILON



Instruction Manual

colorCONTROL MFA-5-P

Sensor system for LED tests of function, color and intensity

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Certified according to DIN EN ISO 9001: 2008

Contents

Appendix

1. Safety

The handling of the system assumes knowledge of the instruction manual.

1.1 Symbols Used

The following symbols are used in this instruction manual:

⚠ CAUTION	Indicates a hazardous situation which, if not avoided, may result in minor or moderate injuries.
NOTICE	Indicates a situation which, if not avoided, may lead to property damage.
➡	Indicates a user action.
i	Indicates a user tip.

1.2 Warnings

⚠ CAUTION

Connect the power supply and the display / output device in accordance with the safety regulations for electrical equipment.
> Danger of injury

> Damage to or destruction of the sensor

The power supply must not exceed the specified limits.
> Danger of injury

> Damage to or destruction of the sensor

NOTICE

Avoid shock and vibration to the sensor.
> Damage to or destruction of the sensor

Never kink the fiber optics and do not bend tightly.
> Damage to or destruction of the fiber optics; partial failure of the sensor.

Protect the ends of the fiber optics from dirt and contamination (use protective caps).
> Failure of the testing device

1.3 Proper Use

The colorCONTROL MFA-5-P is a testing system that uses an opto-electronic sensor in combination with a fiber optic cable (POF 2.2 mm) to test intensity, color and function of illuminants such as LEDs and incandescent bulbs.

- The system may only be operated within the limits specified in the technical data, see Chap. 2.
- Use the testing system in such a way that in case of malfunctions or failure personnel or machinery are not endangered.
- Take additional precautions for safety and damage prevention for safety-related applications.

1.4 Proper Environment

- Protection class:	IP 0
- Operating temperature:	
▪ Sensor:	0 ... 50 °C (+32 up to +122 °F)
▪ Optical fibers	-20 ... +80 °C (-4 up to +176 °F)
- Storage temperature:	-20 ... +80 °C (-4 up to +176 °F)
- Humidity:	20 - 80 % (non-condensing)
- Ambient pressure:	Atmospheric pressure

2. Functional Principle, Technical Data

2.1 Short Description

The colorCONTROL MFA-5-P is a testing system that measures both color and function as well as intensity of light emitting diodes (LEDs) quickly and automatically.

2.2 Technical Data

Model		**MFA-5-P**
Checkpoints		5
Power supply		5 VDC +/- 10% residual ripple
Current consumption		80 mA
Port		RS232, USB, Daisy Chain
Photo receiver		5x True Color photo chip
Accuracy		±4 nm
Resolution		9 - 81 pixels per measuring point
Object distance		Typically 1 - 5 mm
Optical fiber length		Including POF 0.5 m; max. POF 2 m / glass 5 m
Color space		HSI, RGB, XY + color temperature in K
Dynamic range		200 lx - 4000 lx
Testing frequency		≤ 1 Hz (100 checkpoints ≤ 1 s)
Operating temperature	Sensor	0 ... +50 °C (+32 up to +122 °F)
	Optical fibers	-20 ... +80 °C (-4 up to +176 °F)
Storage temperature		-20 ... +80 °C (-4 up to +176 °F)
Humidity		20 % to 80 % rel. humidity (non-condensing)
Protection class		IP 0
Housing material	Optical fibers	Plastic (POF) [1]

1) POF = Polymer Optical Fiber

3. Delivery

3.1 Unpacking

1 colorCONTROL MFA-5-P sensor

5 optical fibers POF-2.2; 0.5 m length (ø 2.2 mm)

1 instruction manual and software CD

For optional accessories, see Chap. A 1

➡ Check for completeness and shipping damage immediately after unpacking.

➡ In case of damage or missing parts, please contact the manufacturer or supplier.

3.2 Storage

Storage temperature:	-20 ... +80 °C (-4 up to +176 °F)
Humidity:	20 - 80 % (non-condensing)

4. Installation

4.1 Installation of the colorCONTROL MFA-5-P

➡ Mount the sensor in your test set-up using four M3 screws.

The colorCONTROL MFA-5-P can be mounted both on the top side as well as on the bottom side of your test set-up.

ℹ Ensure careful handling during installation and operation.

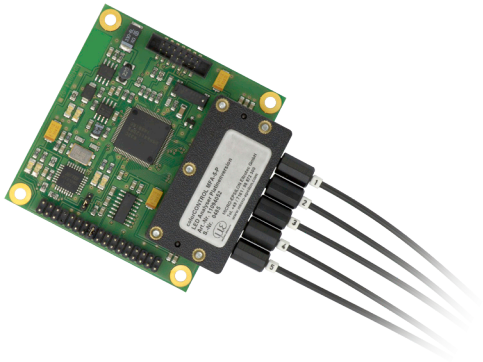


Fig. 1 colorCONTROL MFA-5-P

NOTICE

Ensure during the installation of the colorCONTROL MFA-5-P that the optical fibers can move freely and they are not exposed to any sharp bending and sharp corners.

> Damage to or destruction of the optical fiber, partial failure of the sensor

> Influence of the test result

The smallest radius of the optical fiber is 25 mm (.98 inches).

Ensure that all the light of the LEDs is routed to the color chip in the colorCONTROL MFA-5-P by the optical fiber.

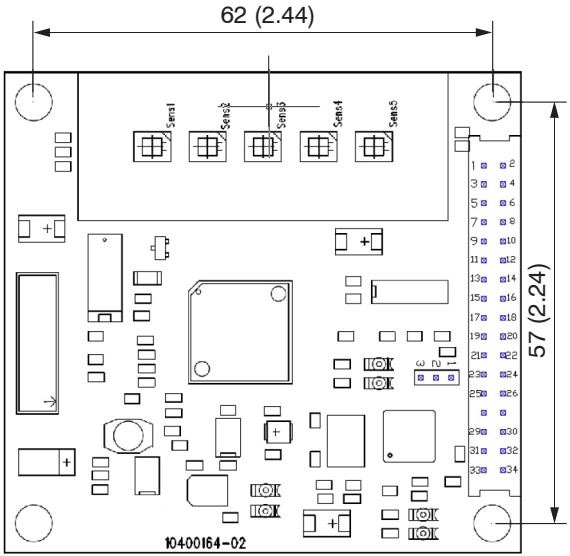


Fig. 2 Dimensional drawing of colorCONTROL MFA-5-P, dimensions in mm, (inches), not to scale

4.2 Mounting the Optical Fiber

4.2.1 Features

- Minimum bending radius 25 mm (.98 inches)
- Digital opening 0.5
- Angle of incidence approx. 60 degrees
- Damping for 650 nm - 0.18 dB/m (approx. 2 %/m)

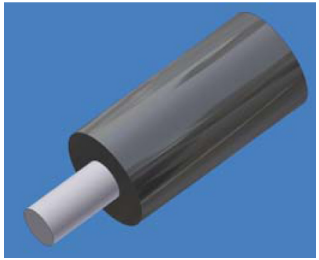


Fig. 3 Plastic optical fiber

➡ Position the optical fiber over the optical center of the LEDs.

➡ Maintain a distance of 2 to 8 mm between LED and the optical fiber.

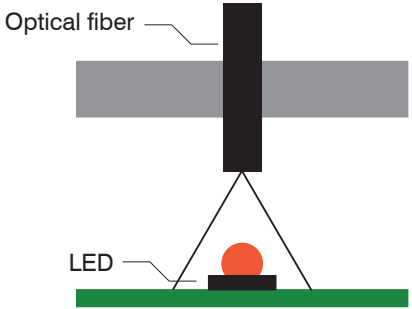


Fig. 4 Positioning of the optical fiber

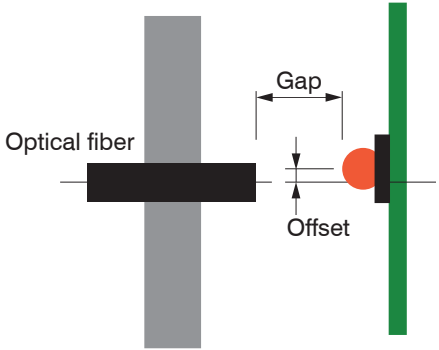


Fig. 5 Offset and gap

The intensity of any test depends on the "gap" distance and offset of the LED from the optical fiber.
There are various possibilities for positioning the optical fiber over the LED to be tested:

- Mounting with
  - threaded ferrule M4 or
  - threaded ferrule M4 + 6 mm attachment lens or
  - threaded ferrule M4 + 3 mm converging lens
- Mounting with a guide sleeve 1 mm in combination with a POF 1 mm optical fiber and a reducer adapter 2.2 to 1 mm
- Mounting with a clamping collet for thin optical fibers

4.2.2 Installation with Threaded Ferrules

➡ Mount the optical fiber using a threaded ferrule M4, threaded ferrule M4 + 6 mm attachment lens or a threaded ferrule M4 + 3 mm converging lens.

4.2.3 Installation with a Guide Sleeve 1 mm

➡ Mount the optical fiber (ø 1 mm/ .04 inches) using a guide sleeve 1 mm in combination with a reducer adapter and POF 1 mm.

The notch in the guide sleeve holds the optical fiber in position very effectively during debugging.

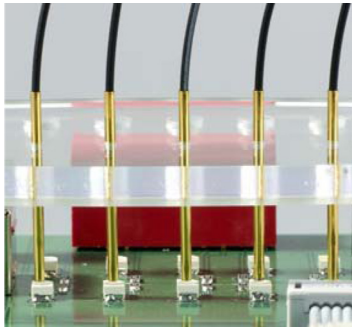


Fig. 6 Installation with guide sleeve 1 mm

The optical fiber can be fixed with silicone adhesive after debugging.

4.2.4 Mounting with a Clamping Collet for Thin Optical Fibers

Optical fibers smaller than ø 1 mm can also be fixed with a clamping collet E39-F9 in addition to the guide sleeves 1 mm. Fixing with a silicone adhesive is not necessary thereby.

i The optical fiber is fixed; however, it can be replaced if required.

Fig. 7 Clamping collet E39-F9

4.2.5 Shortening the Optical Fiber

The optical fibers of the colorCONTROL MFA-5-P are shipped with a length of approx. 600 mm (23.62 inches) as standard.

NOTICE

Shorten the optical fiber to the optimum length.
> This prevents damage to the optical fiber.

i Ensure during the cutting that the optical fiber is at 90° to the knife, otherwise light loss must be expected.

We recommend only using each cutter hole once to guarantee a clean cut of the optical fiber.

Fig. 8 Cutting tool for optical fiber

4.3 Pin Assignment

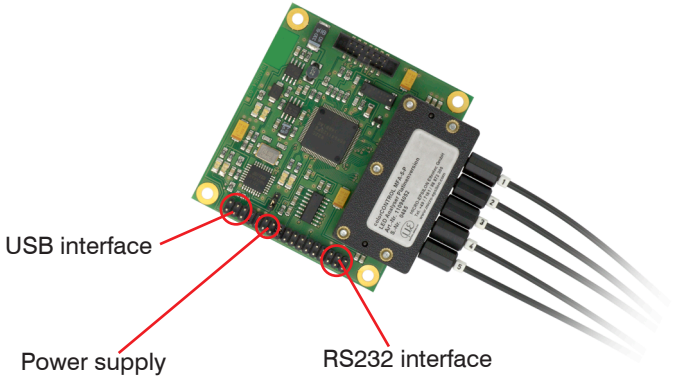


Fig. 9 colorCONTROL MFA-5-P pin assignment

The colorCONTROL MFA-5-P can be operated both via an RS232 as well as via an USB port.

4.3.1 Individual colorCONTROL MFA-5-P Sensor in USB Mode

In USB operation, the power (+5 VDC) for a sensor is supplied via the USB interface.

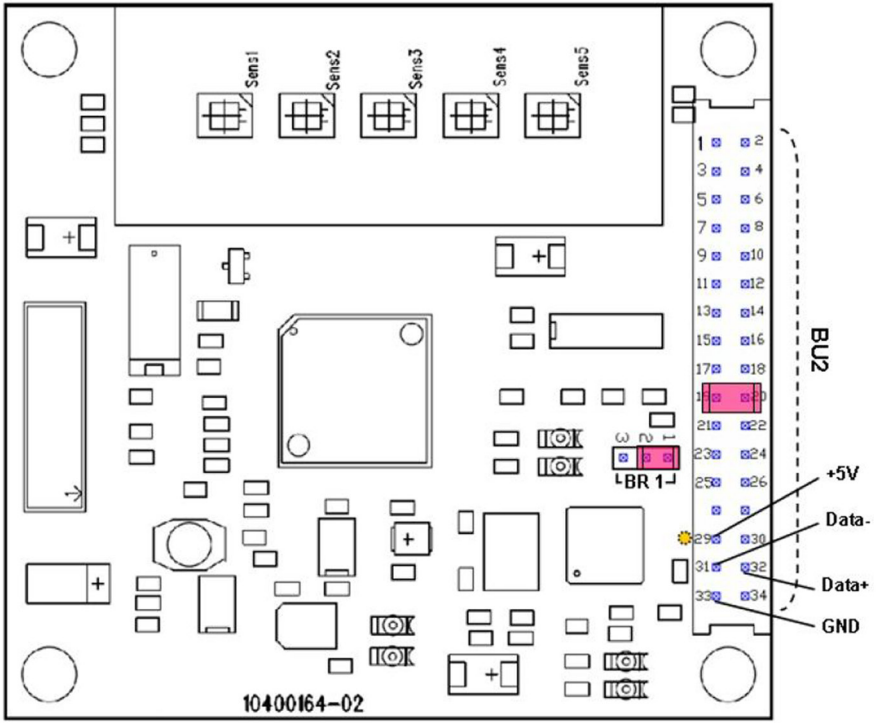


Fig. 10 Board with pin assignment for USB connection

i The jumper on BR1 must connect pin 1 with pin 2.

USB connection			USB cable CAB-socket board-6P-co-fm-straight; 1m-PVC; USB					
Male con-nector BU2	Pin	Description	Socket (board) P6	Pin	Description	USB male con-nector	Pin	Description
	29	+5 V		1	yellow marking		1	+5 V
	30	n.c.		2	n.c.		---	---
	31	Data-		3	Data-		2	Data-
	32	Data+		4	Data+		3	Data+
	33	GND		5	GND		4	GND
	34	n.c.		6	n.c.		---	---
BR1	1 + 2	Jumper						

You can order the USB cable CAB-socket board-6P-co-fm-straight; 1m-PVC; USB as accessories, see Chap. A 1

4.3.2 Individual Sensor colorCONTROL MFA-5-P in RS 232 Mode

In RS232 operation, an external power supply of 7 - 15 VDC, approx. 80 mA must be used.

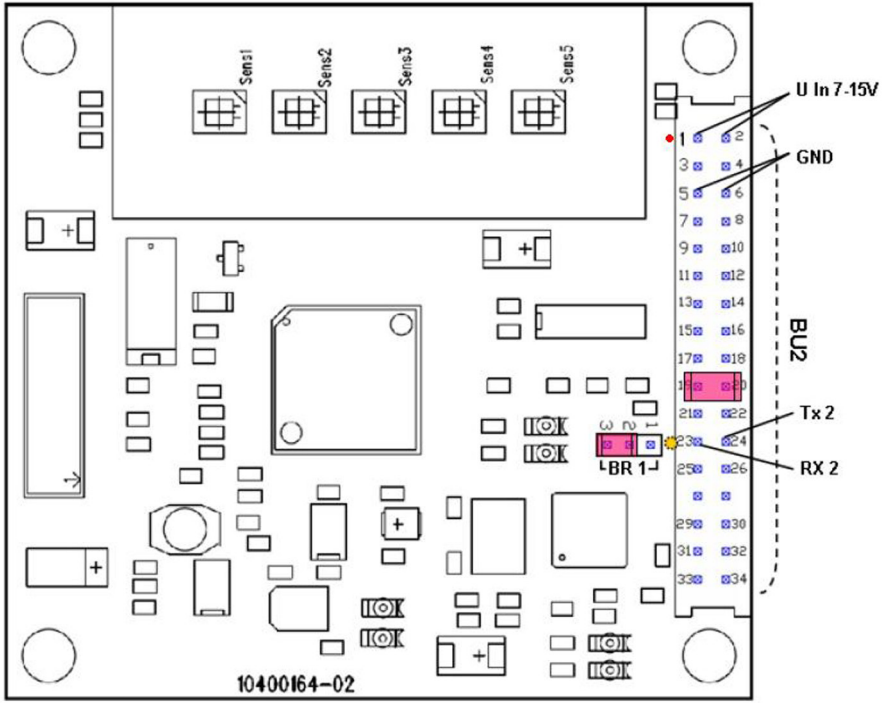


Fig. 11 Board with pin assignment for RS 232

i The jumper on BR1 must connect pin 2 with pin 3.

RS 232 connection		
Female connector 2	Pin	Description
	23	RX 2
	24	TX 2
	25	GND
	26	

RS 232 cable CAB-socket board-4P-co-fm-straight; 2.5m-PVC; RS232					
Socket (board) 4P	Pin	Description	RS232 Sub-D 9P female connector	Pin	Description
	1	RX 2 (yellow marking)		3	RX 2
	2	TX 2		2	TX 2
	3	GND		5	GND
				6	connected
				8	

Connector 2	Pin	Description
	19	Jumper
	20	

Attach the jumper only on the last board when using several boards.

You can order the RS 232 cable CAB-socket board-4P-co-fm-straight; 2.5m-PVC; RS232 as accessories, see Chap. A 1

Power supply		
Female connec-tor 2	Pin	Description
	1	+Ub 7 - 15 VDC
	2	
	5	GND
	6	

Power supply cable CAB-socket board-6P-co-fm-straight; 2m-PVC; 2P-open ends					
Power female connector	Pin	Description	open end	PIN	Description
	1	+7 - 15 VDC (red marking)		brown	+7 - 15 VDC
	5	GND		white	GND

BR 1	2	Jumper
	3	

You can order the power supply cable CAB-socket board-6P-co-fm-straight; 2m-PVC; 2P-open ends as accessories, see Chap. A 1

4.3.3 Synchronization

4.3.3.1 Synchronization with USB

The colorCONTROL MFA-5-P has a data bus (daisy chain), with up to 99 colorCONTROL MFA-5-P can be connected in series to check the 495 LEDs.

The supply of the 5 boards can be made via a power USB interface (5 x 80 mA = 400 mA), see Fig. 12.

If the power of the used USB interface is not sufficient or more than 5 boards are connected in series, a separate power supply of +7 - 15 VDC has to be applied depending to the power of the used interface.

i When using an external power supply, the jumper on BR1 must connect pin 2 with pin 3, see Fig. 13.

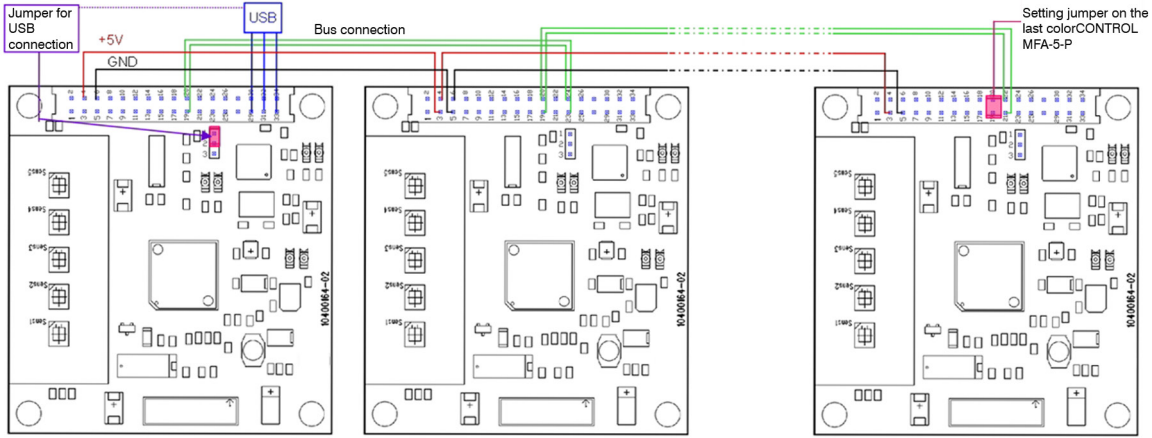


Fig. 12 Synchronization via USB

USB connection			USB cable CAB-socket board-6P-co-fm-straight; 1m-PVC; USB					
Male con-nector BU2	Pin	Description	Socket (board) 6P	Pin	Description	USB male con-nector	Pin	Description
	29	+5 V		1	yellow marking		1	+5 V
	30			2	n.c.		---	
	31	Data-		3	Data-		2	Data-
	32	Data+		4	Data+		3	Data+
	33	GND		5	GND		4	GND
	34			6	n.c.		---	

With a power consumption of 80 mA per board up to 5 boards can be operated via a power USB interface (total current consumption approximately 400 mA).

Data bus	Board 1	Pin	Description	Board 2	Pin	Description
		19	RX 4		24	TX2
		20	TX 4		23	RX2
		21, 22	GND		25, 26	GND

At the last board, the jumper must be set:

Female connec-tor 2	19	Jumper
	20	

4.3.3.2 Synchronization with RS 232 Connection

The colorCONTROL MFA-5-P can connect maximum 99 boards and can use this to test 495 LEDs, see Fig. 13.

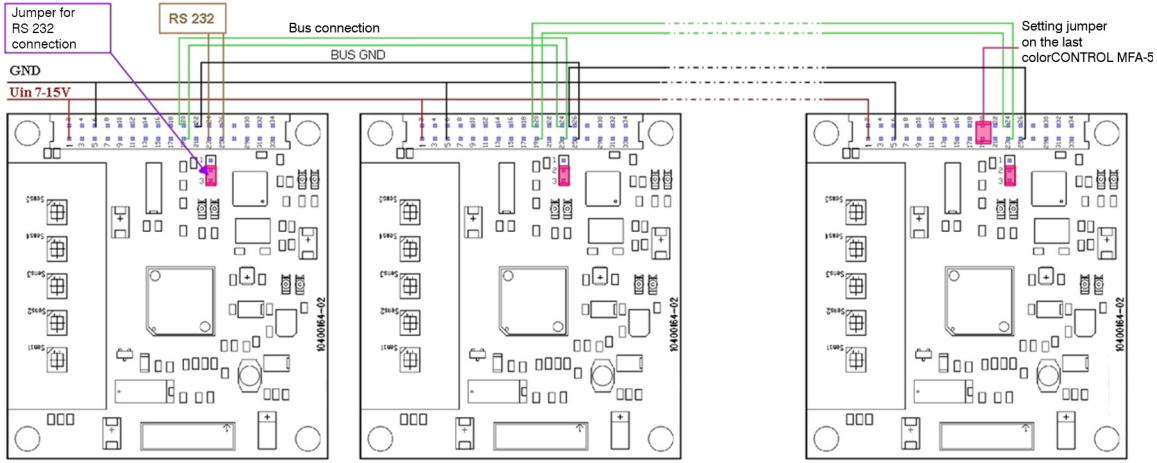


Fig. 13 Synchronisation via RS 232

RS 232 connection		
Female connec-tor 2	Pin	Description
	23	RX 2
	24	TX 2
	25	GND
	26	

RS 232 cable CAB-socket board-4P-co-fm-straight; 2.5m-PVC; RS232					
Socket (board) 4P	Pin	Description	RS232 Sub-D 9P female connector:	Pin	Description
	1	RX 2 (yellow marking)		3	RX 2
	2	TX 2		2	TX 2
	3	GND		5	GND
				6	connected
				8	

Data bus	Board 1	Pin	Description		Board 2	Pin	Description
		19	RX 4			24	TX2
		20	TX 4			23	RX2
		21, 22	GND			25, 26	GND

At the last board, the jumper must be set:

Female connec-tor 2	19	Jumper
	20	

Power supply		
Female connec-tor 2	Pin	Description
	1	U In 7 - 15 VDC
	2	
	5	GND
	6	

Each board contains a separate power supply and can be operated from +7 to 15 VDC (current consumption 80 mA).

BR 1	2	Jumper
	3	

5. Operation

5.1 Commissioning

Make the following settings after the MICRO-EPSILON LED Check software has been installed and the color-CONTROL MFA-5-P has been connected:

5.1.1 Configuration: Port (Interface)

The USB port is configured as virtual COM port and is designated as Com5, Com6 etc.

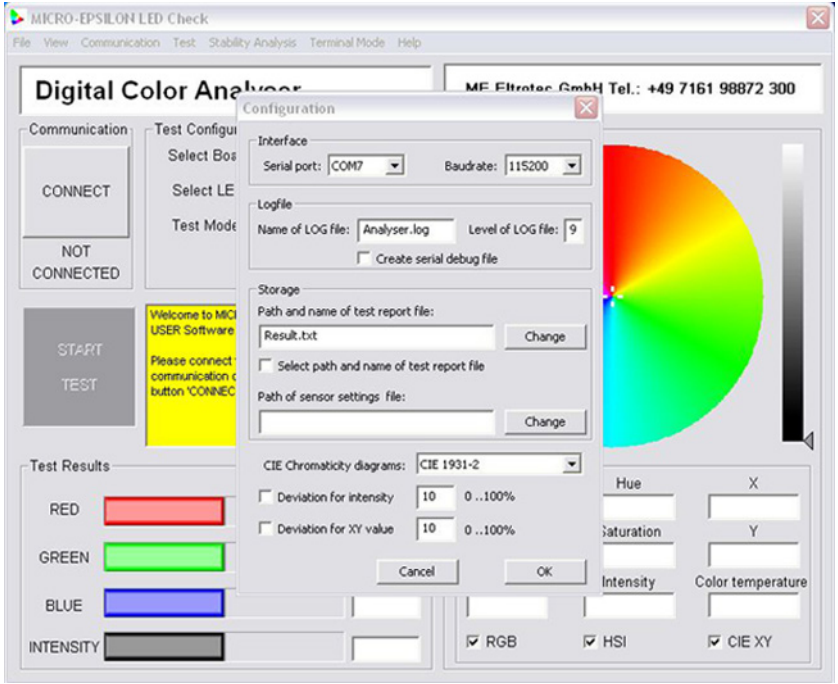
The sensor is shipped with a baud rate of 115200, see Chap. A 2

➡ Set the serial port to `Auto` and the baud rate to 115200.

The COM port can be between 1 and 256 from firmware version 2.0.0.1.

ℹ The COM port must be between 1 and 8 for firmware versions older than 2.0.0.1.

The baud rate can be set between 9600 and 115200.



The colorCONTROL MFA-5-P test program is a graphical tool which can send commands to and receive results from the colorCONTROL MFA-5-P.

The LEDs are tested individually. The results are saved in a file (e.g. TestReport.txt).

The program specifies the optimum setting for the LED to be tested. For operation of the colorCONTROL MFA-5-P program, see Chap. 5.2.3.

Alternatively, a customer-specific program can also be generated which sends commands, see Chap. 6. and evaluates the result data at the USB port or the RS232 interface.

5.1.2 Color Chip of the colorCONTROL MFA-5-P

In order to enable a test over a wide range of illuminance, the sensitivity of the color chip can be adjusted in two levels:

- High Sensitivity Mode
- Low Sensitivity Mode.

The active photo-diode area receives the light. It is dependent on the selected sensitivity in the center of the color chip:

- High Sensitivity Mode with 9x9 elements or
- Low Sensitivity Mode with 3x3 elements

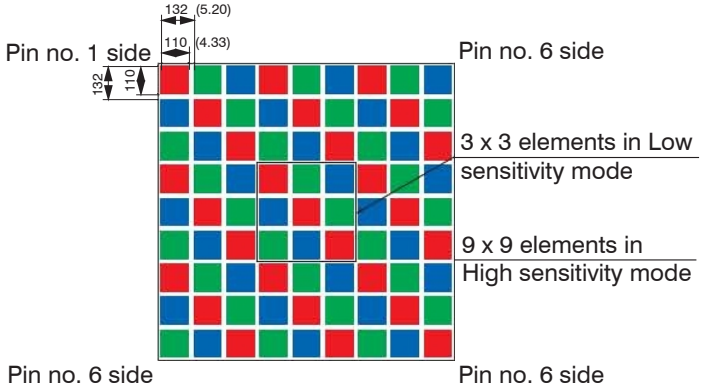


Fig. 14 Color chip of the colorCONTROL MFA-5-P with High and Low Sensitivity Mode

In addition to both the High Sensitivity Mode and Low Sensitivity Mode, the light intensity can also be influenced via the measuring time of 1 ms to 10000 ms. The most important settings are shown under "Manual Capture" test modes. Very dark or very bright LEDs can thus be tested without having to operate additional mechanical filters.

The color chip tests the colors and the intensity of the LED to be tested in RGB format.

The presentation can be shown in RGBI, HSI and xy or CIE Chromaticity diagram.

5.1.3 Setting an Offset for the Calculation of the x any y Chromaticity Coordinates

There are three ways to store an offset for the calculation of the x and y chromaticity coordinates:

1. MICRO-EPSILON Eltrotec GmbH provides a calibration service for the colorCONTROL MFA-5-P. In doing so, your LEDs to be tested are tested on our premises using a verifiably calibrated spectrometer in a standardised process.

In the next step, the chromaticity coordinates tested by the colorCONTROL MFA-5-P are adjusted to the test values of the spectrometer. This can be done during the installation of the firmware using a non-volatile stored offset.

2. It is also possible to integrate the colorCONTROL MFA-5-P in an existing test system via initialisation of the COM port and a command set, see Chap. 6.

An offset for each LED to be tested can also be stored in this application case using the commands `setxoffset#+-0.xxxx b` or `setyoffset#+-0.xxxx b`.

i Volatile stored offset which is lost after switching off the power supply or after the command `setdefault b`.

3. An offset can also be stored using the supplied MICRO-EPSILON LED Check software.

This memory, as in point 2, is also a volatile memory and is lost after switching off the power supply or after a `Reset Board` command in the software.

The following steps explain how an offset is stored using the software in the colorCONTROL MFA-5-P:

It should be emphasised for the MICRO-EPSILON LED Check software that the display of stored offsets and modifications in the menu window `Measurement settings` or `Settings for Sensor` is not applied and displayed until performing a test for the software. For further details about setting and modifying an offset, see Chap. 5.2.4.2.

Offset setting

- Open the `Communication` pop-up menu and select `Configuration.`
- Clear the checkbox `Don't allow any changes to the XY offset values.`
- Open the `Test` pop-up menu and then `Measurement settings`

All adjustment parameters of the individual checkpoints of the colorCONTROL MFA-5-P are displayed.

- Now select the required sensor / required checkpoint by double clicking on the line.

Now you can change the settings.

The menu window `Settings for sensor is displayed, see` `Fig. 15`

i Clear the `Don't change XY offset` checkbox to be able to input an offset for the x any y chromaticity coordinates.

- Now, input the required offset.
- Confirm with the button `OK`.

The menu window closes.

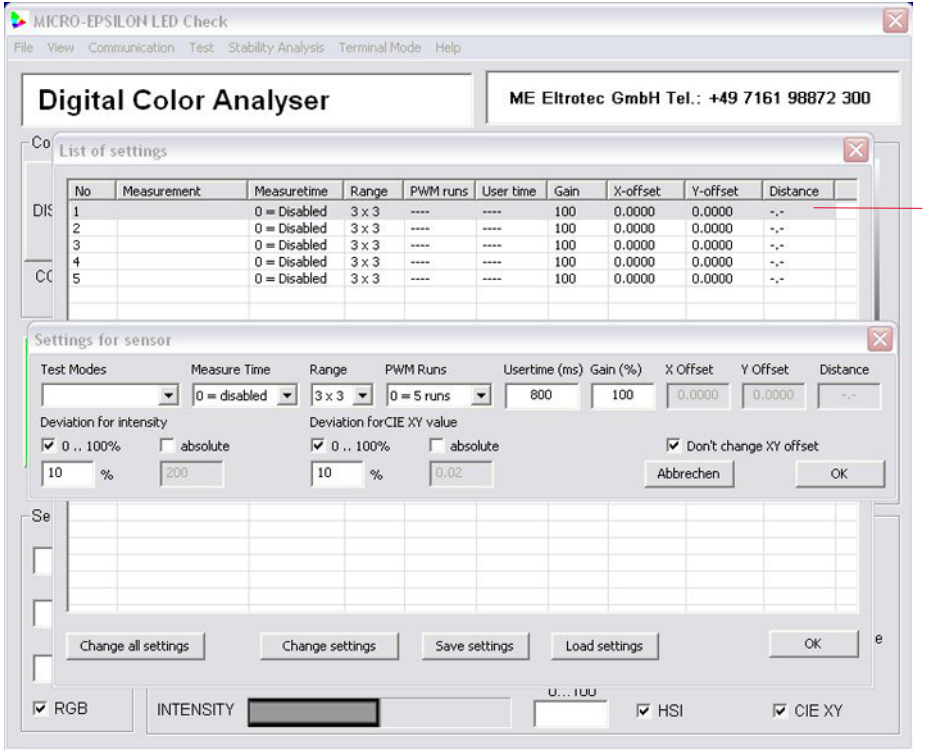


Fig. 15 Settings for test sensitivity

5.2 Software Description of MICRO-EPSILON LED-Check

5.2.1 User interface, Settings

After the MICRO-EPSILON LED Check software has been started, the start screen is displayed, see Fig. 16. All required functions and control elements are reached using this start screen.

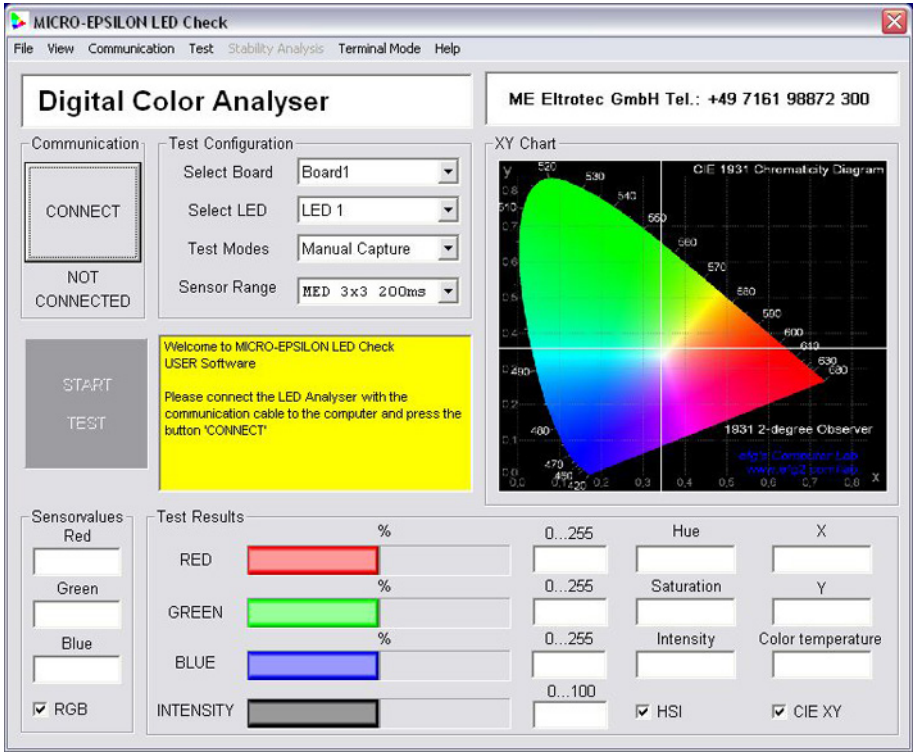


Fig. 16 Start screen

There are several pop-up menus in the top line which are briefly explained below and in detail in the following chapters:

File	You close the software using this menu.
View	Here, you can change between the color spaces which are displayed in the right-hand half. The HSI Color Wheel, the RGB Color Palette and the CIE color space are available for the user here. Three displays can be selected between for the CIE 1931 color space using the menu `Communication` and then `Configuration`. The respective test values for the individual color spaces can be found in the right-hand half of the `Test Result` window.
Communication	- The colorCONTROL MFA-5-P is connected to or disconnected from the LED Check software here. - The configuration settings of the colorCONTROL MFA-5-P are opened here using the menu, see Chap. 5.2.2.
Test	- The application for the test and the comparison of several LEDs can be opened here, see Chap. 5.2.4. - You can also save and open test reports. - The `Reset Board` function is used if offsets have been set during operation and the initial situation should be restored. The software must always be restarted after a `Reset Board, see Chap. 5.2.4`.
Terminal Mode	After opening a terminal, you can communicate with the colorCONTROL MFA-5-P using the command list, see Chap. 6.
Help	You obtain information here about the MICRO-EPSILON LED Check software version used.

The functions of the individual control elements are explained in the following steps, see Fig. 17.

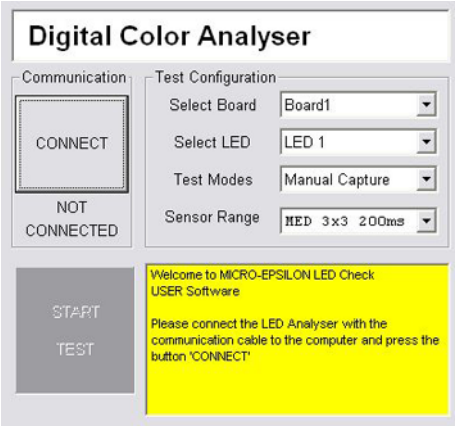


Fig. 17 Start screen extract

Connect Button	The colorCONTROL MFA-5-P is connected to the software after pressing the `Connect` button. In doing so, the button label changes to `Disconnect`. The colorCONTROL MFA-5-P is disconnected after pressing the button again.
Not Connected label	Shows the respective connection status of the colorCONTROL MFA-5-P.
Start Test button	The software performs a test using the current test configuration.
Select Board	Enables the selection of the connected colorCONTROL MFA-5-P sensors.
Select LED	Enables the selection of a specified checkpoint / specified color chip on the colorCONTROL MFA-5-P.

Test Modes	There are different test modes available for the user depending on the application. - The Manual Capture mode enables selection of predefined exposure times and a color chip range (adjustable area 9x9 or 3x3) using the `Sensor Range` menu. The correct selection of the exposure time and sensor area depends on the light intensity of the test object. - With the User Capture mode, the user can freely decide about the exposure time and color chip range using `Sensor Configuration`. The software permits exposure time values from 1 ms to 1000 ms. - The PWM Capture mode is ideally suited for determining the color values of pulsed LEDs. This mode adopts the checkpoint settings concerning exposure time and color chip range from the last test performed. The user defines the number of tests to be performed by selection of the `Average Factor` which is displayed after selection of the PWM mode. As soon as the colorCONTROL MFA-5-P captures the LED in the ON state during the number of automatically performed tests, the color parameters are saved and displayed after completion of the complete test process.
Information Screen	The information window with yellow background gives the user information about the MICRO-EPSILON LED Check firmware used and the number of connected colorCONTROL MFA-5-P sensors. It also informs the user about any occurring errors.

All light parameters tested and calculated by the colorCONTROL MFA-5-P are displayed to the user in the window `Test Results, see` Fig. 18.

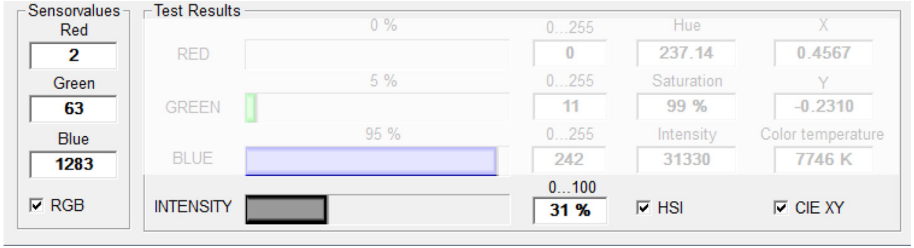


Fig. 18 Start screen extract Test Results

The tested color values are displayed to the user in three different color spaces:

- The RGB values are displayed in the left-hand area.
- Next to this on the right are the HSI values (Hue - Saturation - Intensity).
- On the far right, the CIE 1931 color space with the x and y chromaticity coordinates.

The Correlated Color Temperature (CCT) is also displayed on the bottom right.

5.2.2 Configuration

Before you can perform any test with the colorCONTROL MFA-5-P, you must first make the following configuration settings, see Fig. 19.

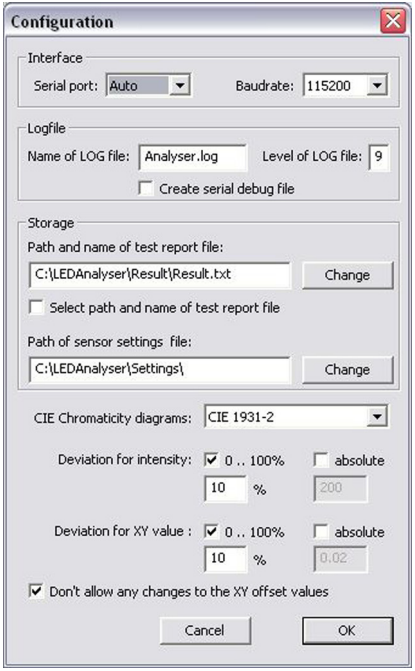


Fig. 19 Configuration window

Serial Port

Using this pull-down menu, you select the COM port which is assigned to the colorCONTROL MFA-5-P by Windows. Using the `Auto` selection, the program searches for the assigned COM port automatically. If you want to determine the assigned COM port manually, go to the ports (COM & LPT) using the Control Panel and Device Manager.

Baud rate	Set the baud rate here. The baud rate is 115200 for the newer devices.
Log file window	The log file is defined in this window. This section is not important for usual use. It is only needed for error analysis for the MICRO-EPSILON LED Check program.
Storage window	The storage locations for the test report file and sensor settings file are defined here.
CIE C. diagrams	Different CIE color spaces can be selected using this window which are displayed on the start screen if the CIE color space has been selected using the View pop-up menu.
Deviation for intensity	A tolerance window is defined using these selection options which is taken into account for the comparison tests of LEDs. The LED is assessed as good if the test value is within the tolerance window of the reference value. The tolerances for individual LEDs can also be changed in the `Measurement settings` window, see Chap. 5.2.4.
Deviation for xy values	Behaves analogously to `Deviation for intensity`.
Don‘t allow any changes ...	This checkbox is equivalent to a confirmation question if an xy offset should be changed by the user via the `List of Settings` window. There is no possibility to change the offset of an inspection point / color chip while the check mark is set. The state of the checkbox is saved when the software is closed and adopted again when the software is restarted.

5.2.3 Color Test Using the Function Elements of the Start Screen

After all required settings have been made using the `Configuration` window, you must now find the correct test mode and the correct checkpoint settings for your application.

i We recommend testing with largest possible light intensity.

The intensity refers to the originally tested RGB values of the color chip, see Fig. 20. The value for the light intensity should be between 30 % and 80 %.

This prevents the color chip operating outside the linear sensitivity function in relation to the color parameters. An optimum test result is thus achieved.

Now, note the following steps:

- First select the required checkpoint / required color chip.
- Now start your test with a sensor range of 9x9 and a large exposure time.
- Reduce the exposure time in the next steps while you are in the light intensity range 10 % to 80 % .
- If the reduction of the exposure time is not sufficient, change the color chip range from 9x9 to 3x3 and repeat the determination of the optimum exposure time as described above.

If you have an application in which you test several LEDs per test, we recommend determination of the optimum setting for each checkpoint / each color chip using the main screen.

- Using the pop-up menu `Test`, now change to the window `Measurement settings` and `Measurements, see Chap. 5.2.4`.

The settings for the exposure time and sensor range are adopted here.

In the case of an application with several LEDs with the same light intensity, it is sufficient to determine the setting of the color chip range for one LED in this way. Afterwards, this setting can be transferred to the other checkpoints / color chips using the `Measurements` window, see Chap. 5.2.4.

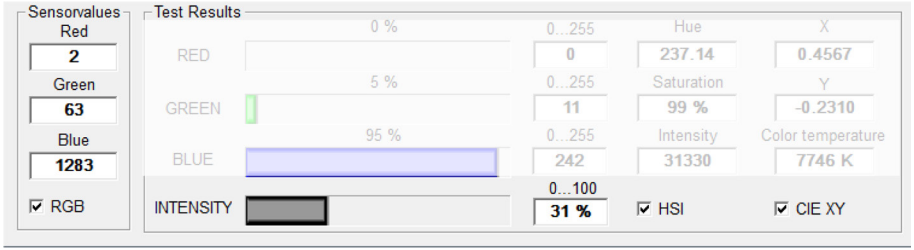


Fig. 20 Sensor values and intensity section

5.2.4 Color Test and Comparison of Several LEDs

5.2.4.1 Test and Comparison of LEDs with Different Light Intensities

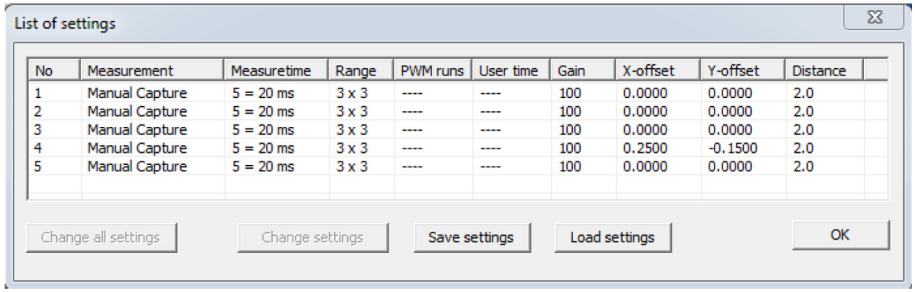
In order to compare LEDs with each other, you use the `Measurement` window in combination with the `Measurement settings` window, see Fig. 21, see Fig. 22, see Fig. 23.

It is recommended to first determine the optimum settings of the checkpoints via the start screen, see Chap. 5.2.3. These are adopted when the `Measurement settings` window is opened.

It is displayed at the same time during the adoption of the exposure time and color chip range whether a checkpoint / color chip has an offset.

Example:

In the following example, see Fig. 21, 5 checkpoints / color chips have been set using the main screen. Thereby, the checkpoint 4 (color chip 4) has a permanently stored offset.



No	Measurement	Measuretime	Range	PWM runs	User time	Gain	X-offset	Y-offset	Distance
1	Manual Capture	5 = 20 ms	3 x 3	----	----	100	0.0000	0.0000	2.0
2	Manual Capture	5 = 20 ms	3 x 3	----	----	100	0.0000	0.0000	2.0
3	Manual Capture	5 = 20 ms	3 x 3	----	----	100	0.0000	0.0000	2.0
4	Manual Capture	5 = 20 ms	3 x 3	----	----	100	0.2500	-0.1500	2.0
5	Manual Capture	5 = 20 ms	3 x 3	----	----	100	0.0000	0.0000	2.0

Fig. 21 List of settings window

When opening the `Measurements` window, the color values are displayed for the 5 specified checkpoints / color chips which have been determined using the start screen, see Fig. 22.

List of measurements

U	No	Red	Green	Blue	Hue	Satur.	Intens.	X	Y	C.Temp.	Mode	Range
☑	1	0	11	242	237.14	99 %	31330	0.1567	0.0686	---	MAN-ULT	3 x 3
☑	2	1	215	37	130.14	98 %	22124	0.3179	0.5869	5774 K	MAN-ULT	3 x 3
☑	3	33	79	142	214.57	62 %	9597	0.2142	0.2153	---	MAN-ULT	3 x 3
☑	4	127	127	0	60.00	100 %	561	0.6887	0.3519	---	MAN-ULT	3 x 3
☑	5	254	0	0	0.08	100 %	17802	0.6484	0.3309	---	MAN-ULT	3 x 3

Perform measurement | Save as reference | Load reference | Save Test Report | OK

Fig. 22 List of measurements window

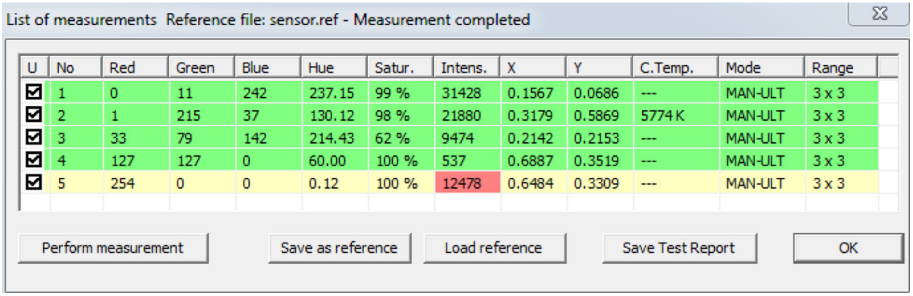
If you would like to compare LEDs with each other, you can save the color values in the software as reference values and compare them.

- Save the determined vales for this using the `Save Reference` button. Load the determined vales using the `Load Reference` button.
- Now test again using the `Perform Measurement` button without changing the test environment.

The color values are displayed in green. This means that the software has recognised the values as reference values. It is also recommended to save the settings using `Save Settings` otherwise they have to be entered again when the software is restarted.

When you replace the reference LEDs with the LEDs to be tested, and perform a new measurement using the `Perform Measurement` button, the program compares the test values with the reference values, see Fig. 23. If any difference occurs in doing so, this is displayed in red.

- Archive the test result using the `Save Test Report` button.



U	No	Red	Green	Blue	Hue	Satur.	Intens.	X	Y	C.Temp.	Mode	Range
☑	1	0	11	242	237.15	99 %	31428	0.1567	0.0686	---	MAN-ULT	3 x 3
☑	2	1	215	37	130.12	98 %	21880	0.3179	0.5869	5774 K	MAN-ULT	3 x 3
☑	3	33	79	142	214.43	62 %	9474	0.2142	0.2153	---	MAN-ULT	3 x 3
☑	4	127	127	0	60.00	100 %	537	0.6887	0.3519	---	MAN-ULT	3 x 3
☑	5	254	0	0	0.12	100 %	12478	0.6484	0.3309	---	MAN-ULT	3 x 3

Fig. 23 Comparison test

5.2.4.2 Changing Tolerances, Checkpoint Settings and an Offset

The user has the following possibility to define a tolerance range with respect to the test values for a comparison test or an offset:

➡ Double click on the required test line in the `Measurement settings` window.

The `Settings for Sensor` window is displayed, see Fig. 24 Tolerances concerning the intensity and the x and y chromaticity coordinates can be input using this window.

These are taken into account for the comparison of the test values with the reference values.

Any checkpoint settings concerning the test mode, the exposure time and the range can also be changed during running operation.

➡ In order to be able to input an offset for the x and y chromaticity values, deactivate the checkbox `Don't allow any changes to XY values` in the `Configuration` window and confirm with OK.

➡ Now activate the checkbox in the window `Settings for sensor`.

➡ Now input the x and y offsets and confirm with `OK`.

Changes made here will not be applied until the next test using the `Measurements` window.

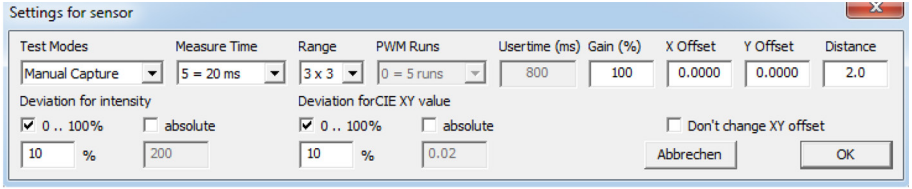


Fig. 24 Settings for sensor window

5.2.4.3 Test and Comparison of Several LEDs with the Same Light Intensity

If you want to compare LEDs with the same light intensity, it is sufficient to determine the optimum checkpoint settings for one LED using the main screen.

➡ Go to the `Measurement settings` window.

➡ Then select the checkpoint whose parameters you want to apply by clicking on the test line.

➡ Now press the `Change all settings` button to apply the checkpoint settings.

➡ Perform a test using the `Measurement` window to determine the reference values.

ℹ Particularly pay attention during the adoption of the settings whether you want to apply the offset or not.

There are checkboxes for this in the `Configuration` window and in the `Settings for Sensor` window whose function is explained in further detail below:

Example 1:

If you only want to assign the parameters without offset from one checkpoint / one color chip to all other checkpoints / color chips, the checkbox `Don't allow any…` in the `Configuration` window must be activated and confirmed with `OK`.

➡ Select the checkpoint whose parameters should be applied.

➡ Press the `change all settings` button.

The parameters are applied to the other checkpoint lines.
The changes become effective after performing a test using the `Measurement` window.

Example 2:

If you want to assign the offsets of one checkpoint only partially or completely for the other checkpoints, you must deactivate the checkbox of the `Configuration` window.

➡ At the same time, deactivate the checkbox in the `Settings for Sensor` window for each checkpoint for which you want to assign the offset.

The checkbox in the `Settings for Sensor` window must remain activated for the checkpoints where the old offset setting should be retained.

- Now select the checkpoint whose parameters should be applied by clicking on it.
- Check whether the checkbox in the `Settings for Sensor` window is also deactivated.
- Then press the `Change all settings` button after selecting the checkpoint.
- Now perform a test using the `Measurement` window to apply the reference values.

i Changes relating to the offset and checkpoint settings are always not applied until after performing a new test using the `List of measurements` window.

5.2.4.4 Reset of Offset Settings to the Factory Settings

- Use the `Reset Board` command on the `Test` pop-up menu to restore the factory settings of the colorCONTROL MFA-5-P.
- Now disconnect the colorCONTROL MFA-5-P using the `Disconnect` button.
- Restart the software to apply the condition as delivered.

5.2.5 Use of the Terminal Mode

The MICRO-EPSILON LED Check software also provides a terminal mode.

You can test the ASCII communication commands and retrieval of the color values using this terminal mode. This is used for simplified integration of the colorCONTROL MFA-5-P in your test system. The detailed command overview can be found, see Chap. 6.

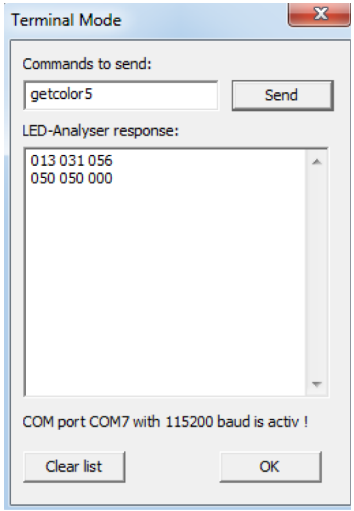


Fig. 25 Terminal Mode window

6. Commands

6.1 Commands Overview

Group	Chapter	Command	Short description
General			
	Chap. 6.2.2.1	testcon	Connectivity test
Checking			
	Chap. 6.2.2.1	capture	General check
	Chap. 6.2.2.2	capturexyz	Manual check
	Chap. 6.2.2.3	capturepwm	General check of pulsed LEDs
	Chap. 6.2.2.4	capturepwm## zb	Manual check of pulsed LEDs
Output			
	Chap. 6.2.3.1	getrgbi# b	Read saved RGB values and intensity
	Chap. 6.2.3.2	getcolor# b	Read saved RGB color components and intensity
	Chap. 6.2.3.3	gethsi# b	Read saved hue values, saturation and intensity
	Chap. 6.2.3.4	getxy# b	Read saved x and y chromaticity coordinates
	Chap. 6.2.3.5	getctemp# b	Read saved temperature values
	Chap. 6.2.3.6	getintensity# b	Read value for intensity
	Chap. 6.2.3.7	getintgain# b	Read saved gain
	Chap. 6.2.3.8	getranges b	Read intensity ranges
	Chap. 6.2.3.9	getusertime b	Read user-defined test time
	Chap. 6.2.3.10	getxoffset# b	Read offset of the x chromaticity coordinate
	Chap. 6.2.3.11	getyoffset# b	Read offset of the y chromaticity coordinate
	Chap. 6.2.3.12	getdistance# b	Read distance between LED and colorCONTROL MFA-5-P

Group	Chapter	Command	Short description
Input			
	Chap. 6.2.4.1	setcaptimexyz b	Set the test time without test
	Chap. 6.2.4.2	setaverage## b	Set the average factor without test
	Chap. 6.2.4.3	setintgain# xxx	Set gain for intensity
	Chap. 6.2.4.4	setusertime##### b	Set user-defined test times
	Chap. 6.2.4.5	setxoffset#+-0.xxx b	Set X chromaticity offset value
	Chap. 6.2.4.6	setyoffset#+-0.xxx b	Set Y chromaticity offset value
	Chap. 6.2.4.7	setdistance#xxx.x b	Set distance between LED and optical fiber
	Chap. 6.2.4.8	setdefault b	Set colorCONTROL MFA-5-P to default values
Hardware and software			
	Chap. 6.2.5.1	getserial	Read serial number of the colorCONTROL MFA-5-P
	Chap. 6.2.5.2	getversion	Read firmware version number
	Chap. 6.2.5.3	gethw	Read hardware version number
Baud rate			
	Chap. 6.2.6.1	setbaudratexxxxxx	Set baud rate
Example			
	Chap. 6.2.7		Checkpoint query

6.2 Commands

6.2.1 General

6.2.1.1 Connectivity Test

`testcon`

Command	Description	Received	Example	Note
testcon	Connectivity test	OK or xOK	testcon 2 OK	X = number of sensors / colorCONTROL MFA-5-P

This command is used for checking the connection between the test system / PC and the colorCONTROL MFA-5-P.

If only one colorCONTROL MFA-5-P sensor is connected to the sensor and the connection is present, the "OK" response is received.

If several colorCONTROL MFA-5-P sensors are connected, the number of the colorCONTROL MFA-5-P sensors is also indicated, e.g. "2 OK".

i This command must be sent as the first command so that all connected colorCONTROL MFA-5-P sensors are detected.

6.2.2 Check

6.2.2.1 General Check

`capture`

Measures and saves the color and intensity of the LEDs.

Command	Description	Received	Example	Note
capture	Start color, saturation, intensity check	OK	capture OK	Check of all colorCONTROL MFA-5-P and their checkpoints with current settings.

This command tells the colorCONTROL MFA-5-P to check and save the colors and intensity of all connected LEDs at the same time.

The test time and the color chip sensitivity range (9x9; 3x3) can be set before the actual test using the command setcaptimexyz b, see Chap. 6.2.4.1 .

6.2.2.2 Manual Check

```
capturexyz b
```

Measures and saves the color and intensity of the individual LEDs with the specified test time.

Command	Description	Received	Example	Note
capturexyz b	x = test time preselection 1 = 600 ms 2 = 200 ms 3 = 120 ms 4 = 60 ms 5 = 20 ms 6 = 10 ms 7 = 2 ms 8 = can be programmed by the user 9 = current setting will be applied 0 = sensor off y = 0 color chip Low (3x3) preselection y = 1 color chip High (9x9) preselection z = preselection channel 1 ... 5 or 1 ... n b = preselection board 1 ... n, only if z = 1 ... 5	OK	capture 215 3 OK capture 31 OK capture 3117 capture 312 4 OK	x = test time 200 ms y = color chip High (9x9) Z = channel 5 b = board 3 x = test time 120 ms y = color chip High (9x9) for all channels and colorCONTROL MFA-5-P x = test time 120 ms y = color chip High (9x9) Channel 17 or channel 2 on board 4

This command enables optimum setting for every LED to be tested.

Dark LEDs are checked with a longer test time (e.g. 600 or 200 ms) and the Sensor High setting is used (in doing so, all 9x9 segments of the color chip are used).

For very bright LEDs, the Sensor Low setting is selected (only 3x3 segments of the color chip are used) and the test time is reduced accordingly (e.g. 10 or 2 ms).

Board = colorCONTROL MFA-5-P
Channel = checkpoint

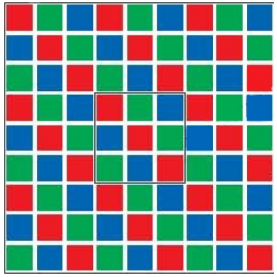


Fig. 26 Color chip of the colorCONTROL MFA-5-P test system

A color chip consists of 9x9 = 81 segments for the colors red, green and blue.
All segments are used and a long exposure time is selected for dark LEDs.

Only the middle 3x3 = 9 segments are used for very bright LEDs and depending on the brightness, the exposure time is reduced until any overload of the segments is prevented.

6.2.2.3 General Check of Pulsed LEDs

`capturepwm`

Measures and saves the color and intensity of pulsed (PWM) LEDs.

Command	Description	Received	Example	Note
capturepwm	Start PWM color, intensity check	OK	capturepwm OK	Check of all colorCONTROL MFA-5-P and sensors with current settings.

PWM LED = Pulse Width Modulated LED

This command tells the colorCONTROL MFA-5-P to check and save the colors and intensity of all connected LEDs.

Thereby, a default setting is used which is sufficient for most LEDs.

However, it is recommended to set the preselection manually to achieve better results for different LEDs, see Chap. 6.2.2.4.

6.2.2.4 Manual Check of Pulsed LEDs

`capturepwm## zb`

Measures and saves the color and intensity of pulsed (PWM) LEDs with the specified test time.

Command	Description	Received	Example	Note
capturepwm ## zb	## Average factor 0 = 5 test processes 1 = 10 test processes 2 = 15 test processes 3 = 20 test processes ----- 15 = 80 test processes z = channel b = board	OK	capturepwm 1032 OK	10 = 55 test processes z = channel 3 b = board 2

PWM LED = Pulse Width Modulated LED
This command enables optimum setting for every pulsed (PWM) LED.
The first two factors refer to the average factor of minimum 5 and maximum 80 test processes.
z refers to the channel and b identifies the colorCONTROL MFA-5-P used.
The Average Factor is divided in 15 ranges, factor 2 relates to 15 test processes.
The settings of the test time and the color chip range are based on the previous settings for this checkpoint, e.g. using the command `setcaptime, see Chap. 6.2.4.1.`

Board = colorCONTROL MFA-5-P
Channel = checkpoint

6.2.3 Output

6.2.3.1 Read Saved RGB Values and the Intensity from Memory

`getrgbi# b`

Command	Description	Received	Example	Note
getrgbi# b # = channel number 1 ... 5 b or # = 1 ... 495	Read saved RGB values and intensity r,g,b = 0 ... 4095 (4095 / 16 = 255) i = 0 ... 99999	rrrr gggg bbbb iiiii	getrgbi3 5 getrgbi23 Output format: 0060 2301 0185 06383	# = 1 ...5, if b = board # = 1 ... 495 for max. 99 boards, b not specified

In the specified case, the data of LED 3 are read from the colorCONTROL MFA-5-P/ 5 (no. 5 in series) or LED numbered 23.
The values are for

Red	0060
Green	2301
Blue	0185
Intensity	06383

This corresponds to 6.383 %.

Board = colorCONTROL MFA-5-P
Channel = checkpoint

6.2.3.2 Read Saved RGB Color Components in Percent from the Memory

`getcolor# b`

Command	Description	Received	Example	Note
getcolor# b # = channel number 1 ... 5 or # = 1 ... 495	Read saved RGB color components in percent	rrr ggg bbb	getcolor 3 getcolor13 getcolor3 2 Output format: 010 068 022	# = 1 ...5, if b = board # = 1 ... 495 for max. 99 boards, b not specified

6.2.3.3 Read Saved HUE values, Saturation and Intensity from Memory

`gethsi# b`

Command	Description	Received	Example	Note
gethsi# b # = channel number 1 ... 5 or # = 1 ... 495	Read saved hue values, saturation and intensity	hhh.hh sss iiiii	gethsi3 5 gethsi23 Output format: 123.47 089 04383	# = 1 ... 5, if b = board # = 1 ... 495 for max. 99 boards, b not specified

Board = colorCONTROL MFA-5-P
Channel = checkpoint

6.2.3.4 Read Saved XY Chromaticity Values from the Memory

`getxy# b`

Command	Description	Received	Example	Note
getxy# b # = channel number 1 ... 5 or # = 1 ... 495	Read saved XY chromaticity values	0.xxxx 0.yyyy	getxy 1 4 getxy16 Output format: 0.6461 0.3436	# = 1 ... 5, if b = board # = 1 ... 495 for max. 99 boards, b not specified

6.2.3.5 Read Saved Temperature Values in Kelvin from the Memory

`getctemp# b`

Command	Description	Received	Example	Note
getctemp# b # = channel number 1 ... 5 b or # = 1 ... 495	Read saved values for temperature	xxxxx.x	getctemp1 Output format °Kelvin: 05679.9	00000 = calculation not possible # = b values see getrgbi

Board = colorCONTROL MFA-5-P
Channel = checkpoint

6.2.3.6 Read Value for Intensity

`getintensity# b`

Command	Description	Received	Example	Note
getintensity# b # = channel number 1 ... 5 b or # = 1 ... 495	Read value for intensity	iiiii	getintensity1 Output format 06734	0000.0 = under range 99999 = over range # b values, see Chapter 6.2.3.1 (`getrgb`)

6.2.3.7 Read Saved Gain

`getintgain# b`

Command	Description	Received	Example	Note
getintgain# b # = channel number 1 ... 5 b or # = 1 ... 495	Read saved gain	xxx	getintgain1 Output format 100	Standard = 100 % # b values, see Chapter 6.2.3.1 (`getrgb`)

Channel = checkpoint

6.2.3.8 Read Ranges of the Intensities for all Optical Fibers

`getranges b`

Command	Description	Received	Example	Note
getranges b # = channel number 1 ... 5 b or # = 1 ... 495	Read ranges of the intensities of a colorCONTROL MFA-5-P system for all channels	m-f m-f m-f m-f m-f	getranges 2 Output format 2-0 2-0 3-1 1-0 6-1	Chapter 6.2.2.2 m = test time (0-8) f = sensor area (0/1) 0 = 3x3, 1 =9x9 b = board

6.2.3.9 Read User-defined Test Time

`getusertime b`

Command	Description	Received	Example	Note
getusertime b	Read user-defined test time	xxxxx	getusertime (of board 1) Output format 01000	Time in ms, b = board. If specified, otherwise board 1

Board = colorCONTROL MFA-5-P
Channel = checkpoint

6.2.3.10 Read Offset of the x Chromaticity Coordinate

`getxoffset# b`

Command	Description	Received	Example	Note
getxoffset# b # = channel number 1 ... 5 or # 1 ... 495	Read saved x chromaticity offset value	+-0.xxxx	getxoffset1 getxoffset2 3 Output format +0.0550	# = 1 ...5, if b = board # = 1 ... 495 for max. 99 boards, b not specified.

6.2.3.11 Read Offset of the y Chromaticity Coordinate

`getyoffset# b`

Command	Description	Received	Example	Note
getyoffset# b # = channel number 1 ... 5 or # 1 ... 495, b = board	Read saved x chromaticity offset value	+-0.xxxx	getyoffset1 getyoffset2 3 Output format -0.0015	# = 1 ...5, if b = board # = 1 ... 495 for max. 99 boards, b not specified.

Board = colorCONTROL MFA-5-P
Channel = checkpoint

6.2.3.12 Read Distance between LED and colorCONTROL MFA-5-P

`getdistance## b`

Command	Description	Received	Example	Note
getdistance## b # = channel number 1 ... 5 or # 1 ... 495, b = board	Fetch saved distance value in mm	xxx.x	getdistance4 Output format 003.5	# = 1 ...5, if b = board # = 1 ... 495 for max. 99 boards, b not specified.

6.2.4 Input

6.2.4.1 Set the Test Time without Test

`setcaptimexyz b`

Command	Description	Received	Example	Note
setcaptimexyz b	x = test time preselection 1 = 600 ms 2 = 200 ms 3 = 120 ms 4 = 60 ms 6 = 10 ms 7 = 2 ms 8 = can be programmed by the user 0 = off without test - only preselection	OK	setcaptime2115 or setcatime215 3 Output format: OK	x = 2 200 ms y = 1 Sensor High 9x9 z = 15 Sensor 5, Board 3 z = 1 Sensor 1-5 or 1 ... 495 b = board, if z = 1-5

Board = colorCONTROL MFA-5-P
Channel = checkpoint

6.2.4.2 Set the Average Factor without Test

`setaverage## b`

Command	Description	Received	Example	Note
setaverage## b	Average factor 0 = 5 ... 15 = 80 runs without test - only pre-selection	OK	setaverage10 or setaverage10 2 Output format: OK	# = 0 ... 15 b = board

6.2.4.3 Set Gain for Intensity

`setintgain#xxx b`

Command	Description	Received	Example	Note
setintgain#xxx b # = channel number 1 ... 5 b or # = 1 ... 495	Set gain for intensity	OK	setintgain1095 setintgain23095 Output format: OK	Set channel 1 to 95% Set channel 23 to 95% # = sensor xxx = value, b = board

Board = colorCONTROL MFA-5-P
Channel = checkpoint

6.2.4.4 Set User-defined Test Times

`setusertime###### b`

Command	Description	Received	Example	Note
setusertime##### b	Set user-defined test time	OK	setusertime01000 Output format: OK	1 ... 100000 ms b = board

6.2.4.5 Set X Chromaticity Offset Value

`setxoffset#+-0.xxx b`

Command	Description	Received	Example	Note
setxoffset#+-0.xxx b # = channel number 1..5 b or # = 1..495	Set X chromaticity offset value	OK	setxoffset1+0..050 Output format: OK	Set channel 1 x offset to +0.050 # = sensor, xxx = value b = board

6.2.4.6 Set Y Chromaticity Offset Value

`setyoffset#+-0.xxx b`

Command	Description	Received	Example	Note
setxoffset#+-0.xxx b # = channel number 1..5 b or # = 1..495	Set Y chromaticity offset value	OK	setyoffset1+0..050 Output format: OK	Set channel 1 y offset to -0.050 # = sensor, xxx = value b = board

Board = colorCONTROL MFA-5-P
Channel = checkpoint

6.2.4.7 Set Distance between LED and Optical Fiber

`setdistance#vxxx.x b`

Command	Description	Received	Example	Note
setdistance#xxx.x b # = channel number 1..5 or # = 1..495	Set distance to light source in mm, default = 2 mm Range: 000.0 - 999.9 mm	OK	setdistance4003.5 Output format: OK	Set channel 4 distance to 3.5 mm, # = sensor, xxx.x = value, b = board

6.2.4.8 Set colorCONTROL MFA-5-P to Default Values

`setdefault b`

Command	Description	Received	Example	Note
setdefault b	Set default values	OK	setdefault Output format: OK	Reset to factory settings, b = board if specified, otherwise board 1

Board = colorCONTROL MFA-5-P
Channel = checkpoint

6.2.5 Hardware and Software

6.2.5.1 Read Serial Number of the colorCONTROL MFA-5-P

`getserial`

Command	Description	Received	Example	Note
getserial	Read serial number of the colorCONTROL MFA-5	xxxx	getserial Output format: 75A6	4 positions

6.2.5.2 Read Firmware Version Number

`getversion`

Command	Description	Received	Example	Note
getversion	Read firmware version number	xxxx	getversion Output format: 1034	4 positions

6.2.5.3 Read Hardware Version Number

`gethw`

Command	Description	Received	Example	Note
gethw	Read hardware version number	xxxxxxx	gethw Output format: GPS 5-1	7 positions

6.2.6 Baud Rate

6.2.6.1 Set Baud Rate

`setbaudratexxxxxx`

Command	Description	Received	Example	Note
setbaudratexxxxxx	Set baud rate Default: 57600	OK	setbaudrate019200 Output format: OK	9600, 19200, 38400, 57600, 115200, 230400 Only applicable for the colorCONTROL MFA-5-P <-> PC connection

i The baud rate between the colorCONTROL MFA-5-P and the MFA-5-P connected in series is 115200 and cannot be changed.
The baud rate between the first colorCONTROL MFA-5-P and the PC can be set individually.

6.2.7 Checkpoint Capture Example

Example: capture215 3	capture	=	start test
	2	=	test time -> 200 ms, MED
	1	=	sensitivity -> High, 9x9 color chip matrix
	5	=	sensor -> 5. Sensor
	Space character		
	3	=	MFA-5-P/ number 3 -> 3. MFA-5-P in series

A carriage return CR (0x0d) must be sent after every command.
Every received character string is terminated with CR

i A space character must be sent between the command and the number of the colorCONTROL MFA-5-P.
If you use several colorCONTROL MFA-5-P, the command `testcon` must be sent before the test value recording, see Chap. 6.2.1.1.

7. Instructions for Operation

7.1 Cleaning

We recommend cleaning the protective covers regularly.

Dry cleaning

You can use an anti-static brush for lenses, or blow down the covers using dehumidified, clean, oil-free compressed air.

Wet cleaning

Use a clean, soft, lint-free cloth or a lens cleaning tissue and pure alcohol (isopropanol) to clean protective covers.

Never use commercial glass cleaners or other cleaning agents.

8. Warranty

All components of the device have been checked and tested for perfect function in the factory. In the unlikely event that errors should occur despite our thorough quality control, this should be reported immediately to MICRO-EPSILON Eltrotec.

The warranty period lasts 12 months following the day of shipment. Defective parts, except wear parts, will be repaired or replaced free of charge within this period if you return the device free of cost to MICRO-EPSILON Eltrotec. This warranty does not apply to damage resulting from abuse of the equipment and devices, from forceful handling or installation of the devices or from repair or modifications performed by third parties.

No other claims, except as warranted, are accepted. The terms of the purchasing contract apply in full. MICRO-EPSILON Eltrotec will specifically not be responsible for eventual consequential damages. MICRO-EPSILON Eltrotec always strives to supply the customers with the finest and most advanced equipment. Development and refinement is therefore performed continuously and the right to design changes without prior notice is accordingly reserved. For translations in other languages, the data and statements in the German language operation manual are to be taken as authoritative.

9. Service and Repair

If the sensor or the optical fiber is defective, please send the affected parts back for repair or exchange. Where the cause of a fault cannot be precisely defined, always send the entire test system to:

MICRO-EPSILON Eltrotec GmbH
Manfred-Wörner-Straße 101
73037 Göppingen / Germany

Tel. +49 (0) 7161 / 98872-300
Fax +49 (0) 7161 / 98872-303

eltrotec@micro-epsilon.de
www.micro-epsilon.com

10. Decommissioning, Disposal

Disconnect the power supply cable and all output cables from the sensor. Disconnect the fiber optics from the sensor.

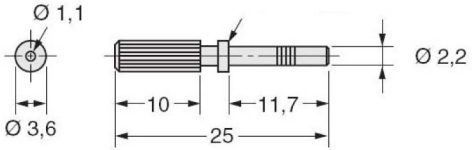
colorCONTROL MFA-5-P is produced according to the 2011/65/EG RoHS directive. The disposal is done according to the legal regulations (see directive 2002/96/EC).

Appendix

A 1 Accessories

Designation	Description	Order number
CAB-socket board-6P-co-fm-straight; 2m-PVC; 2P-open ends	Power supply cable; length 2 m	11294203
CAB-socket board-6P-co-fm-straight; 1m-PVC; USB	USB cable; length 1 m	11294054
CAB-socket board-4P-co-fm-straight; 2.5m-PVC; RS232	RS232 cable; length 2.5 m	11294204
Threaded ferrule; LWL; M4		11251112
Mounted lens	ø 6 mm for threaded fitting	11251113
Threaded ferrule; 3 mm lens; LWL; M4		11253931
POF 2.2 mm fiber optic cable (available by the meter)		10814105
POF 2.2 mm fiber optic cable (FOC)	0.5 m cut	10814189
POF 1.1 mm fiber optic cable (FOC) (available by the meter)		10813842
Reducer adapter 2.2/1 mm POF	for use with POF 1 mm	11253959
Guide sleeve 1 mm	for POF 1 mm	11253906

Clamping collet



Clamping collet E39-F9

A 2 Factory Settings

Baud rate 115200

A 3 Frequently Asked Questions about the colorCONTROL MFA-5-P

A 3.1 Overview

Chap. A 3.2	Which types of LEDs and colors can be tested?
Chap. A 3.3	What is RGB?
Chap. A 3.4	What is hue?
Chap. A 3.5	What is the CIE color system?
Chap. A 3.6	How precise is the colorCONTROL MFA-5-P from Micro-Epsilon?
Chap. A 3.7	How long does the measurement of LEDs take?
Chap. A 3.8	How long does the test of 25 and more LEDs take?
Chap. A 3.9	Can flashing or pulse width modulated (PWM) LEDs be tested?
Chap. A 3.10	Can 7-segment displays be measured?
Chap. A 3.11	Can bi-color or tri-color LEDs be tested?
Chap. A 3.12	Can bar graph displays be tested?
Chap. A 3.13	Can several LEDs be tested simultaneously?
Chap. A 3.14	Which output formats can be provided by the colorCONTROL MFA-5-P?
Chap. A 3.15	How can the colorCONTROL MFA-5-P be connected to a PC?
Chap. A 3.16	What distance should the optical fiber be from the LED to be tested?
Chap. A 3.17	What is the smallest bending radius for an optical fiber?
Chap. A 3.18	How long is the optical fiber permitted to be?
Chap. A 3.19	How high is the power requirement?

A 3.2 Which Types of LEDs and Colors can be Tested?

The colorCONTROL MFA-5-P records the complete spectrum of visible light (390 - 780 mm) from light emitting diodes (LEDs). All sizes and forms and very bright or very dark LEDs can be tested. As well as standard LEDs, bi-color and tri-color LED displays and luminous bar displays can also be tested.

A 3.3 What is RGB?

The RGB (red green blue) color space is an additive color model where the base colors add up to white (light mixture). A color is specified by three values: the red, the green and the blue proportion. Depending on the color component, all possible tone value steps (mixed colors) can be displayed.

A 3.4 What is hue?

Hue is the color tone. The HSV / HSI color space is the color space of the color model where the color is defined using the hue, the saturation and the grey value or intensity.

The HUE Color Wheel is frequently used for determination of the color because the color can be represented in the HUE system using a number.

The color tone is specified as hue angle H on the color wheel (e.g. 0 ° = red, 120 ° = green, 240 ° = blue).

The saturation is specified as vector S from 0 - 100 % from the center of the wheel to the outside.

The brightness is specified as vector V/I from top to bottom with 0 - 100 %.

A 3.5 What is the CIE Color System?

The CIE color system graphically represents a color tone similarly to the RGB and HSV color space. The CIE color system shows the correlation between a measured wavelength (in nm) and the xy value which explains the mixed color.

The CIE color system is only exactly defined by the originally experimentally determined relative sensitivities of the three color receptors of human color perception (the so-called "standard observer") for every visible spectral color.

The CIE color system is particularly suitable for the determination / display of white LEDs.

A 3.6 How Precise is the colorCONTROL MFA-5-P?

The color chip used enables a color depth with 12 bit resolution for each color; this corresponds to 236 = 68,719,476,736 representable colors. The colorCONTROL MFA-5-P therefore achieves an unsurpassed repeatability of the color and intensity.

CIE color system:	White x = ± 0.0015, y = ± 0.0015
RGB color:	Red (630 nm) ± 3 nm
	Green (540 nm) ± 4 nm
	Blue (630 nm) ± 3 nm

A 3.7 How Long Does the Measurement of LEDs Take?

The "Standard Capture" command takes approx. one second. However, there are many capture modes available; the exposure can be freely set between 1 ms and 10,000 ms to guarantee optimum testing. Very short exposure times are sufficient for very bright LEDs while longer exposure times must be provided for dark LEDs.

A 3.8 How Long Does the Test of 25 and More LEDs Take?

All the LEDs to be tested are captured simultaneously with the "Capture" command. The time actually needed is basically specified by the darkest LED. Up to 99 colorCONTROL MFA-5-P can be connected via a data bus (daisy Chain), that means up to 495 LEDs can be tested simultaneously, see Chap. 4.3.3.1.

A 3.9 Can Flashing or Pulse Width Modulated (PWM) LEDs be Tested?

Yes, see Chapter 6.2.2.3, command "Capturepwm".

A 3.10 Can 7-segment Displays be Tested?

Yes, provided you treat each segment as an individual LED and mount an optical fiber over each segment. The displayed numerals from 0 to 9 can thus also be tested.

At least 7 checkpoints are needed for this (1x colorCONTROL MFA-5-P).

A 3.11 Can Bi-color or Tri-color LEDs be Tested?

Yes. Each color must be tested separately.

A 3.12 Can Bar Graph Displays be Tested?

Yes, bar graph displays can be tested. However, each segment of the bar graph display must be captured directly using an optical fiber (test position).

A 3.13 Can Several LEDs be Tested Simultaneously?

All the LEDs are actuated simultaneously with the "Capture" command.

Up to 495 checkpoints can be connected via a data bus (daisy chain) with each other and tested simultaneously using 99 colorCONTROL MFA-5-P, see Chap. 4.3.3.1.

A 3.14 Which Output Formats can be Provided by the colorCONTROL MFA-5-P?

The colorCONTROL MFA-5-P can provide the data both via a USB or RS232 interface. The results can be output both as RGB, HSI or CIE values as well as the color temperature in Kelvin.

A 3.15 How can the colorCONTROL MFA-5-P be Connected to a PC?

The colorCONTROL MFA-5-P can be connected via a serial or USB port. The appropriate cables can be ordered as accessories, see Chap. A 1

A 3.16 What Distance should the Optical Fiber be from the LED to be Tested?

The distance between LED and optical fiber should be 2 to 8 mm, see Chap. 4.2.1. A larger distance can also be selected for very bright LEDs.

A 3.17 What is the Smallest Bending Radius for an Optical Fiber?

The minimum bending radius of 25 mm should not be undercut, see Chap. 4.1. Smaller radii are possible, but the light loss as a result is increased and the optical fiber can be damaged.

A 3.18 How Long is the Optical Fiber Permitted to be?

The length of the optical fiber can be adjusted in the adapter to the required length of 0.5 to 2 m without large losses. The damping per metre for 650 nm is approx. 0.18 dB. This corresponds to damping of 2 %.

A 3.19 How High is the Power Requirement?

The colorCONTROL MFA-5-P with 5 channels has a current consumption of approx. 80 mA.

The colorCONTROL MFA-5-P can be operated both via an RS232 as well as via a USB port.

In USB operation, the power for a colorCONTROL MFA-5-P is supplied via the USB interface. An external power supply must be connected for a system network with more than one colorCONTROL MFA-5-P (total current consumption approx. 400 mA for 20 checkpoints), see Chap. 4.3.1.

A power supply must also be connected for RS232 operation, see Chap. 4.3.2.

A 4 Software Description

A 4.1 Introduction

This quick reference guide provides help for programming with Labview™ for the colorCONTROL MFA-5-P.

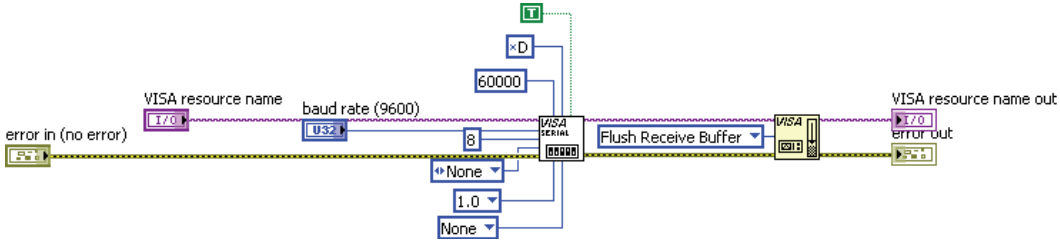
The programming is based on the contents of the operating manual of the colorCONTROL MFA-5-P and its command list.

The programs have been created with Labview™ 2010 Base Development System.

A 4.2 Programs

The programs (SUB-Vis) are presented according to their hierarchy

RS232 READ	RS232 Read.vi	Read the responses of the colorCONTROL MFA sensors.
RS232 WRITE	RS232 Write.vi	Write the commands for the colorCONTROL MFA sensors
RS232 MSG	RS232 Message.vi	Read and write the commands for the colorCONTROL MFA sensors

RS232 OPEN	RS232 Open.vi	Enables the preset of the port using which the colorCONTROL MFA-5-P communicates. The associated COM port can be selected for the input using `VISA resource name`. The current baud rate setting is 115200 and applies for all sensors from firmware version 1005. The baud rate should be set to 57600 for sensors with firmware older than version 1005. 
RS232 GET SERIAL	RS232 GetSerial.vi	Fetch 4-position serial number of the sensor (example "0149")
RS232 GET HW	RS232 GetHw.vi	Fetch 7-position hardware version number (example "MICRO-EPSILON 5-1")
RS232 GET VERSION	RS232 GetVersion.vi	Fetch 4-position firmware version number (example "2001")
RS232 GET TESTCON	RS232 testCon.vi	Connection test response "OK" Response "Number of connected sensors" This command must be sent as the first one so that all connected sensors are detected.

RS232 CAPTURE STD	RS232 CaptureStandard.vi	The colorCONTROL MFA-5-P is told to capture and save the colors and the intensity of all connected LEDs simultaneously. Response "OK"
RS232 CAPTURE MANUAL	RS232 CaptureManual.vi	Using the color chip range, the image range of the color chip can be set to 3x3 or 9x9 and different test times can also be selected:
		DISABLE UTH 3x3 10 ms ULT 3x3 20 ms SUP 3x3 60 ms HGH 3x3 120 ms MED 3x3 200 ms LOW 3x3 600 ms ULT 9x9 20 ms SUP 9x9 60 ms HGH 9x9 120 ms MED 9x9 200 ms LOW 9x9 600 ms Response "OK"

RS232 GET RGBI	RS232 GetRGBi.vi	Fetch saved values for RGB and intensity. RGBI Red 16 Green 39 Blue 66 Intensity 26202
RS232 GET XY	RS232 GetXY.vi	Fetch saved value for XY chromaticity. data XY Chromacity X 0,6265 Y 0,3454
RS232 GET HSI	RS232 GetHSI.vi	Fetch saved values for HUE, saturation and intensity. data HSI Hue 212,56 Saturation 60 % Intensity 26202

RS232 GET CTEMP	RS232 GetCTTemp.vi	Fetch saved value for color temperature. data Color Temperature 210889
RGB:x	RS232 Convert RGBi to RGB Percent.vi	Converts the received RGB values to percent. data RGB Red 28 Green 68 Blue 141 Intensity 55409 data RGB % [R] 11,8 % [G] 28,7 % [B] 59,5 %

A 4.3 Strict Type Def

Strict type definitions are customer-controlled files in which changes can be made easily.

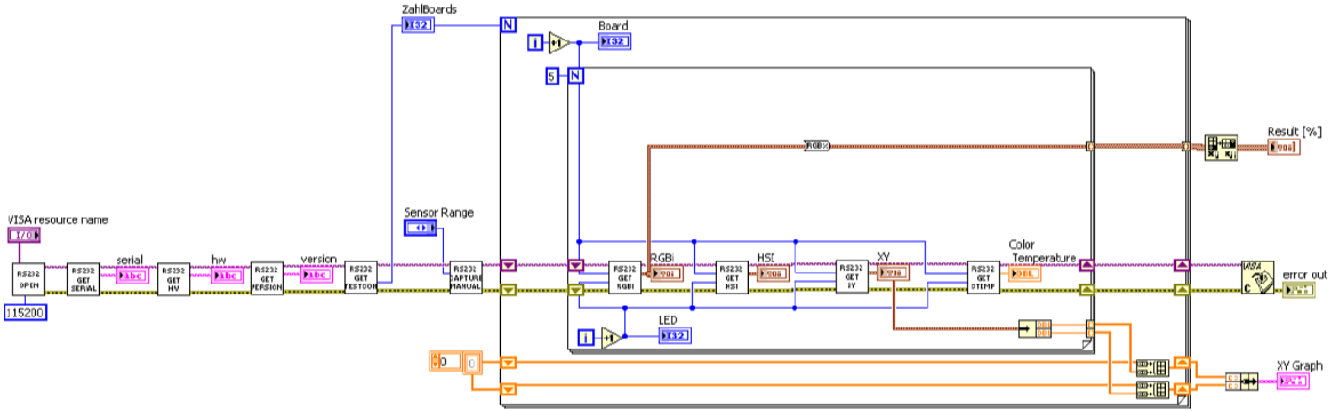
If the file (*.ctl) is changed, this affects all elements in the programs and their subprograms; thus not every VI has to be changed individually.

Type Sensor area selection.ctl	Enum from 3 elements	Color chip area preselection: 3x3, 9x9 or n/a (not available)
Type Sensor range selection.ctl	Enum from 12 elements	Color chip area and measurement time preselection (see RS232 CaptureManual.vi)
Type Time range selection.ctl.	Enum from 10 elements	Test time preselection: from 2 to 600 ms
Type Measurement selection.ctl.	Enum from 4 elements	Test type preselection: XY data RGBI HSI color temperature
Type RGBi.ctl	Cluster from 4 elements	Red, green, blue, intensity
Type RGB Prozent.ctl	Cluster from 3 elements	Red in %, green in %, blue in %
Type XY.ctl	Cluster from 2 elements	X value and Y value Value range 0-1 with 4 decimal places
Type HSI.ctl	Cluster from 3 elements	Hue, saturation and intensity
Type Main status.ctl	Enum from 5 elements	Main - state ->init - idle - Getdata - error - stop
Type Queue Msg.ctl	Cluster from 2 elements	Element data type for the data exchange of the communication loop with the test loop

Type Pieces of Boards.ctl	Ring from 20 elements	Selection of the sensors which are ready for the communication. Currently, up to 20 sensors can be addressed. Up to 99 sensors can be implemented.
Type Number of LED.ctl	Ring from 5 elements	Selection of the checkpoints of a selected sensor. Up to 5 checkpoints per sensor can be addressed.

A 4.4 Test.vi

All relevant Sub.vis are integrated in Test.vi. All connected sensors and 5 checkpoints each are passed through using a For loop.



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