MICRO-EPSILON

Instruction Manual

colorSENSOR WLCS-M-41

Color recognition sensor

CONTENTS

1. Welcome to MICRO-EPSILON Eltrotec GmbH

Dear customer,

we thank you for the purchase of the colorSENSOR WLCS-M-41 and congratulate you
for your decision. With the colorSENSOR WLCS-M-41 you acquired a color sensor, which is suitable by its fiber optics conductor link for a multiplicity of measuring and test functions in quality assurance and production plants. By its large field of application and its simple operation the colorSENSOR WLCS offers a high measurement of economy in almost any application.

The colorSENSOR WLCS-M-41 is a color sensor for the color recognition of surfaces and translucent media (reflex and through-beam operation).

The following characteristics distinguish the color sensor:

- High selectivity
- Modulated semiconductor lightsource
- High durability
- 4 reference colors can be stored
- Brightness independent recognition of color hue
- Manual and automatic tolerance adjustment for each channel
- Detection of grey colors
- Easy handling (plug&play)
- High switching frequency (1 kHz)
- High analog bandwidth (1.6 kHz)
- Easy handling with TEACH-IN
- Controlling possibility over control panel, digital inputs and optionally serial interface
- Galvanically isolated outputs
- Connection for high-quality fiber-optic cables from the whole FASOP program
- High-quality plug connectors
- Compact housing with IP 65
- Small current consumption
- Optimal price/effort relation

2. Technology

Operation principle
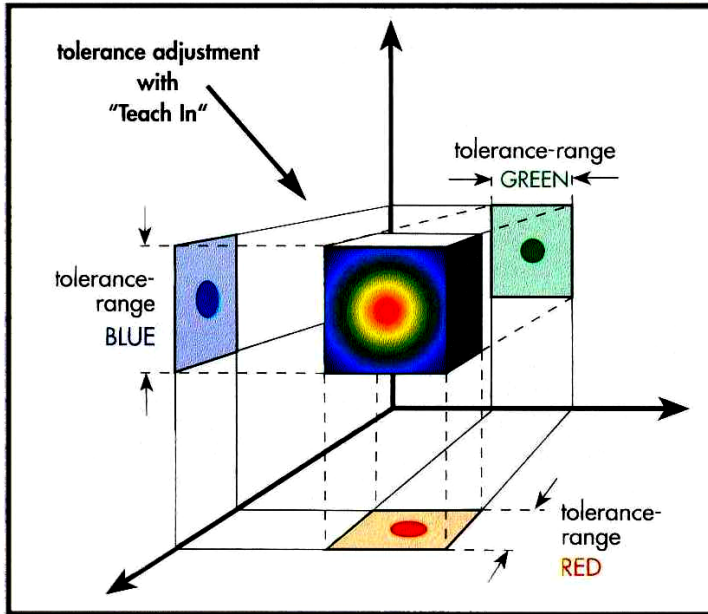
Color sensors of MICRO-EPSILON Eltrotec GmbH operate according to the principle of the human eye. All colors are described by a mixture of the basic colors RED, GREEN and BLUE.
The sensor illuminates the colored surface with a white light LED. The reflected light of the colored surface will be split up in the sensor into its basic colors and additionally an intensity signal develops.
As a result of standardisation of these values a distance independent color recognition arises. With this operational principle all visible color surfaces can be detected.
via "multiple-TEACH" distance -, angle and color changes can be stored.

Function principle of colorSENSOR WLCS-M-41
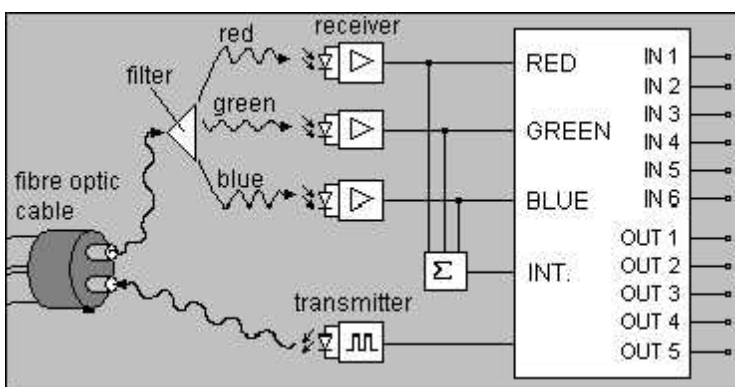
The colored surface of the test object is illuminated by the internal white light LED over a fiber optic cable. The reflected light from the surface is transmitted with a fiber optic cable on the receiver. A filter stage forms three spectral section light-currents, which are weighted by means of photo receiver elements. The digitized color proportional values are compared with the stored reference values and the outputs are switched accordingly. The status indication is made by LED's in the front plate.

3. Mounting / Wiring connections

Fix the housing with two M4 screws.
- Leave on the left side min. 50 mm free space to open the frame cover.
- Plug in the cable and tighten the screw strongly. Consider the coding.
- Close unused connectors.
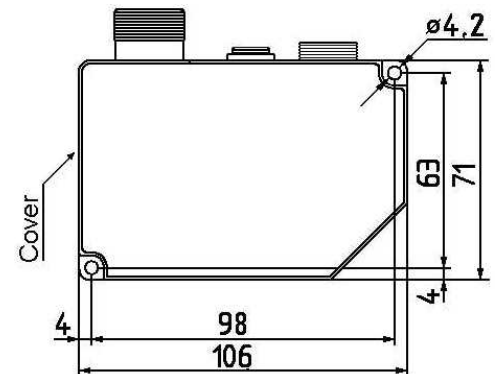
Note:
The optical link for the fiber-optic cable regards always duft proof locked!

Pin configuration of plug M23

Pin	Colorcode	Designation	Function
1	GN	TS	Input, KEY RELEASE
2	GY	Int. OK	Output, INTENSITY OK
3	PK	-	N.C.
4	RD	OUT4	Output, COL.4
5	WH	OUT2	Output, COL.2
6	BU	-UB (0V)	Supply
7	VT	-	N.C.
8	GYPK	-	N.C.
9	RDBU	HOLD	Input, hold output
10	WHGN	TEACH 1	Input, TEACH COL.1
11	BNGN	TEACH 2	Input, TEACH COL.2
12	YE	PE	Protective earth
13	WHYE	Common	I/O supply
14	-	-	N.C.
15	BK	OUT1	Output, COL.1
16	YEBN	OUT3	Output, COL.3
17	WHGY	TEACH 3	Input, TEACH COL.3
18	GYBN	TEACH 4	Input, TEACH COL.4
19	BN	+UB (18-36 VDC)	Supply
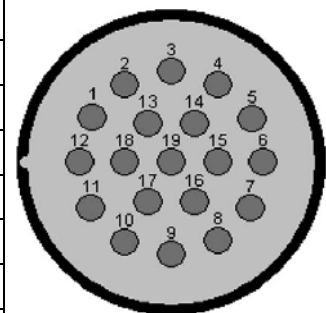
(Color code for connection cable No.:1123 2275)

Schematic circuit diagram

IN 1

IN2

IN 3

IN 4

IN 5

IN 6

GND

Sensor

COMMON

OUT 1

OUT 2

OUT 3

OUT 4

OUT 5
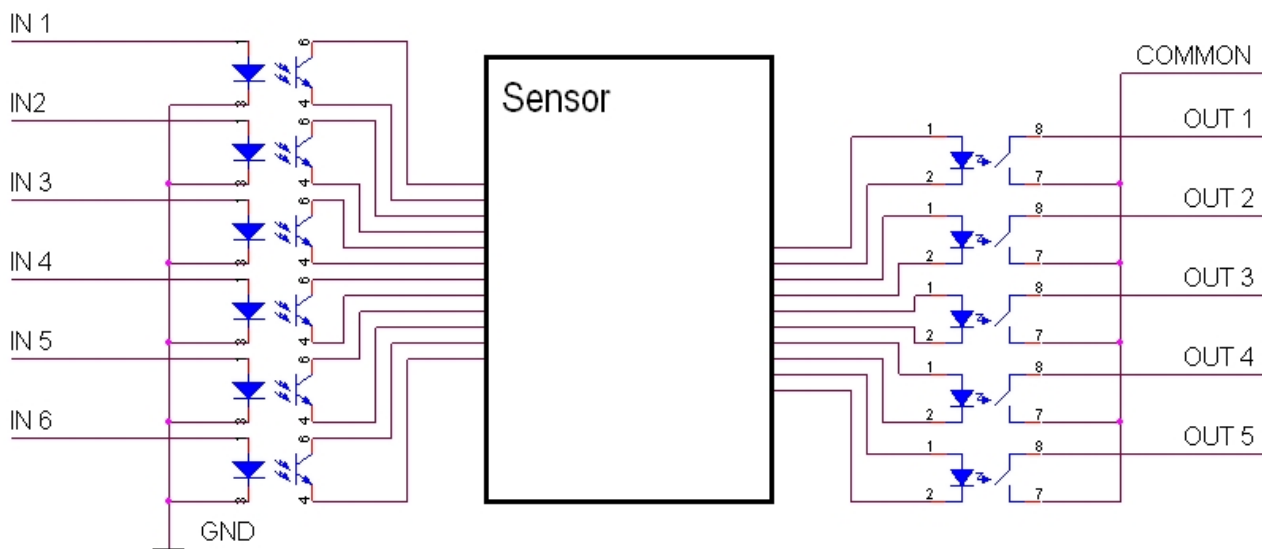
Inputs

Power consumtion   PNP, max 30 mA
Level: Low = GND up to +2 V
                          High = +10 V up to +30 VDC

Outputs

Current: max. 100 mA not inductive
Voltage: max. 30 VDC
Voltage drop: max. 2.5 V at 100 mA load

The outputs are short-circuits protected and galvanically isolated from the supply voltage.

Output connection examples

PNP   NPN

SENSOR
L+
COMMON
OUT
K1
A1
A2
L-

SENSOR
L+
A1
K1
A2
OUT
COMMON
L-

Getting Started

After connecting the supply voltage and the fiber-optic cable the sensor is ready for use.
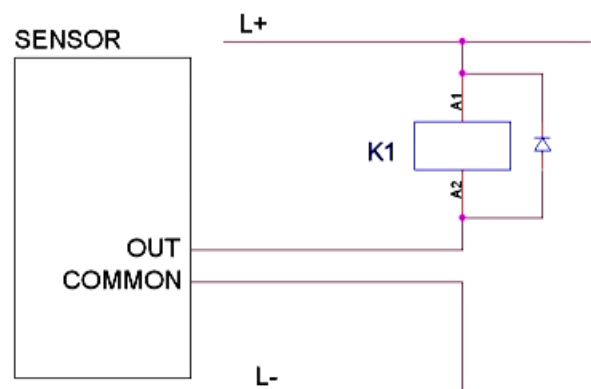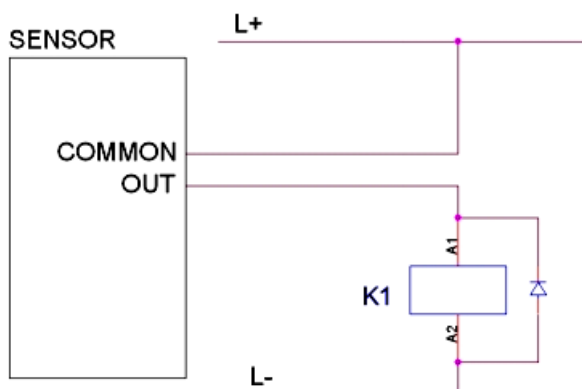
Sample part Teach In

1. Position the sample part in front of the fiber-optic cable and pay attention that the green LED „in range" is on.
2. Press the TEACH - key of the desired channel. The reference color is now stored with the manually adjusted tolerance (via poti´s) on the selected channel - LED "OUT" lights up green.
3. Remove the sample part - LED "OUT" goes out.

Extend position tolerance by „multiple teach"

1. Move the sample part within the detection area while keeping the TEACH - key pressed (max. 5 sec without interruption).
2. The difference will be added to the reference color
   (Reference color = teached color gamuts + manual tolerance adjustment)

Extend color tolerance by „multiple-teach"

1. Teach In sample parts with different colors, which should be detected as one, on the same channel.
3. The difference will be added to the reference color
   (Reference color = teached color spectrum + manual tolerance adjustment)

Delete stored color channel

1. Press and hold the Teach-Key of the channel you want to delete.
2. After 5 sec. the LED´s „<min" and „>max" starts blinking
3. After further 5 sec the LED's stop blinking and the color channel is deleted. Please release the key.

Delete all color channel

1. Press first TEACH - key 1, then TEACH - key 4 and keep both of them pressed. The LED's "< min" and "> max" starts blinking red for warning of the erasing process.
2. After 5 sec. the LED´s stop blinking and all 4 color channels are deleted. Please release both keys.

4. Control panel
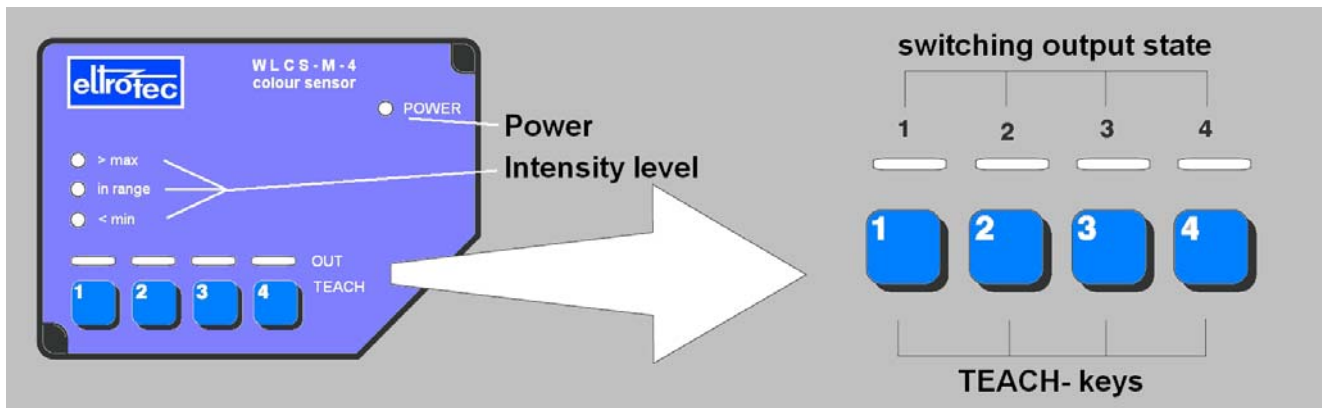
Brief description

LED Power   lights up green, if device is ready.

LED <min   lights up red, if recived light-level is to low.

LED In range   lights up green, if the value of the intensity is in range of the reciever.

LED >max   lights up red, if the recived light-level is to high.

LED OUT   switching state indicator lights up, if thevalue of the measured color is in the range of tolerance of the stored color and the output is set.

TEACH - keys   serve for storing and deleting of the color memorys, as well as for automatic extending of the range of tolerance (multiple-TEACH).

5. Further functions

The user can select between different operating modes and options, which affect the analysis of the measured values and the interface commands (RS 232).

Position of the Dill switches and Poti's under the frame cover
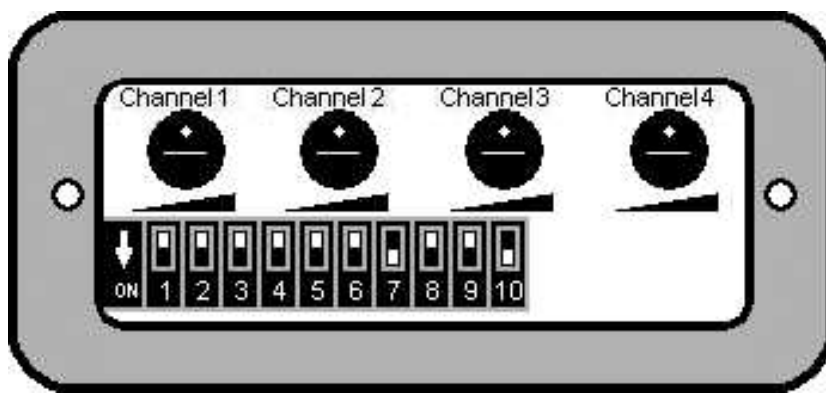
(left side of the housing)

DIL- switches allocation

No.	Designation	Function			
1	I1	Activates the intensity analysis for channel 1.			
2	I2	Activates the intensity analysis for channel 2			
3	I3	Activates the intensity analysis for channel 3			
4	I4	Activates the intensity analysis for channel 4			
5	HM	Activates the calibration mode			
6	MF	Activates the averaging.			
		Simple	Expanded	Remote	Not defined
7	BTR1	OFF	ON	OFF	ON
8	BTR2	OFF	OFF	ON	ON
9		Not used			
10	TF	Activates the key field continuously.			

Installed adjustment by distribution
Tolerance: 32 Inc., intensity analysis channel 1 - 4 off, measuring filter off, operating mode: Expanded, key panel on (see picture above)

Manual tolerance adjustment

The tolerance potentiometers serve the manual adjustment of the tolerance range. To each reference color, the tolerance which is adjusted at the potentiometer is added. 16 values of +/- 0 to +/- 59/1000 of the color proportional value are adjustable. The tolerance of the intensity is those of the color proportion x2.

Intensity analysis

According to standard the colorSENSOR WLCS-M-41 can differentiate colors by the red, green and blue parts. This method allows a larger distance of tolerance.
Through activation of the intensity analysis the measured color will be additionally compared with the adjusted intensity range of the reference color. This measurement, which is dependent on the distance, enables it to differentiate between the same colors with different intensity better.

Calibration mode

!ATTENTION!. **This operating mode serves the pointing alignment, please, leave always the DIL switch (5) on "OFF". The calibration is executed only by the manufacturer**

Precision filter (averaging)

While activating the precision filter, an average value of 32 valid measurements is calculated. The filter improves the recognition of colors on roughly structured surfaces (e.g. material, leather), however the measuring frequency is reduced.

Expanded mode

Multiple-Teach mode (standard mode)

Simple mode

In the operating mode "Simple", the reference channel while be overwritten by the operation of a teach-key or the setting of a teach-input (no multiple - teach possible). The tolerance can be adjusted manual over the Poti's (1-4).

Remote mode

This mode requires a serial interface binding. The colors can now not be learned by the teach-key or by a teach-input anymore, but only over the interface. Thereby wrong operations will be prevented. The switches I1 to I4 do not have any influence. The intensity will always be considered. If this is not desired, turn the the limit values of the intensity up: 000 (lower limit) or to set 999 (upper boundary).

Keylock

The DIL switch Tf (No.10) activates or deactivates the keys. In deactivated condition the keys can be activated by the input "key release" (pin 1 connector M23).

Hold input (see diagram P. 6)

All outputs are held (memory function), as long as the input "Hold" is set. In the deactivated condition the color values are updated continuously.

6. Serial Interface

Technical data

. Connecting type: Point to point
. Operation: Full-duplex
. Electrical specification: RS 232 C

Description of signal

TxD: Transmit Data
RxD: Receive Data
GND: Signal Ground

Transfer parameter:

- Start Bit: 1
- Stop Bit: 1
- Baud rate [BAUD]:   9600
- Parity: even
- Data bit: 8
- Report: none

Pin assignment of the interface plug M12

PIN	Color code	designation
1	Ws	Input RxD
2	Br	Output TxD
3	Sw	GND

Manufacturing the lead
- presents shielding on one side;
- RTS/CTS bridge (7,8)
- possible DTR/DSR/DCR bridge (1,4,6)
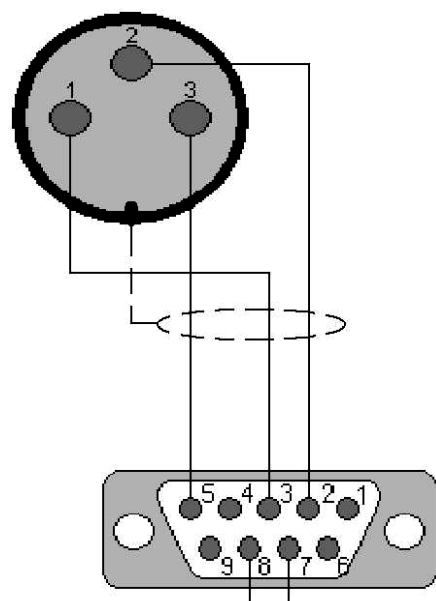
Command format

Each command must be finished with a terminator (< term >).
Possible terminators are:

	<CR>	ASCII-Code (decimal): <#013>
or	<CR><LF>	ASCII-Code (decimal): <#013><#010>

Line-Feed <LF> after Carriage-Return <CR> will be ignored.

Description of command

Outline

Instruction   meaning

M   reading of measuring datas
C   reads the detected reference number
Rx   reads the limit values
Wx   writes the limit values (DILL-Schalter 8 ON)
Tx   teach   (DILL-Schalter 8 ON)
S   reads the status

M- Command

Syntax:	M<term>
Definition:	requests the current measuring data.
Answer:	M xxx xxx xxx xxx <CR><LF>
	(values are decimal ASCII coded)
	19 byte
Example:	M 563 215 222 037
	this corresponds to :
	56.3 % red, 21.5 % green, 22.2 % blue, 3.7 % intensity
Validity:	always valid

C- Command

Syntax: C<term>
Definition: requests the detected reference numbers of the current
             measurement .
Answer: Cx<CR><LF>
             (reference numbers hex- ASCII- coded)
             4 byte
             After the conversion of hex-ASCII in binary:
             Bit no. :

7	6	5	4	3	2	1	0
0	0	0	0	F4	F3	F2	F1

F1	0	color 1 not detected
	1	color 1 detected
F2	0	color 2 not detected
	1	color 2 detected
F3	0	color 3 not detected
	1	color 3 detected
F4	0	color 4 not detected
	1	color 3 detected

Example: C5<CR><LF>
             this corresponds to:
             channel 1 and 3 detected
Validitiy: always valid

R- Command

Syntax: Rx<term>
             (reference number decimal ASCII coded)
             value: 1, 2, 3, 4
Example: R2<term>
Definition: requests the limit values of a reference color
Answer: Rx xxx xxx xxx xxx xxx xxx xxx xxx<CR><LF>
             (values decimal- ASCII- coded)
             36 byte

Example: R2 484 516 184 216 284 316 084 116<CR><LF>
             this corresponds to:
             reference color 2= 48.4 – 51.6 % red 18.4 – 21.6 % green, 28.4
             – 31.6 % blue and 8.4 – 11.6 % intensity (without manual
             tolerance adjustment).
Validity: always valid

W- Command

Syntax: Wx xxx xxx xxx xxx xxx xxx xxx xxx\<term\>
               (reference number decimal ASCII coded)
               values: W1 - W4, 4X 000 – 999

Example: W1 484 516 184 216 284 316 084 116\<term\>

Definition: Writing of the limiting values of the reference color. These limit values are stored in the non volatile memory. Request the limit values of a reference color. While writing a reference color the upper boundary of a feature always has to be larger or equal lower limit of the same feature.

Exception: by the deletion of a color.
               Wx 999 000 999 000 999 000 999 000\<term\>

Answer: none

Validity: Remote mode

T- Command

Syntax: Tx\<term\>
               (reference number decimal -ASCII-coded)
               value: 1, 2, 3, 4

Example: T2\<term\>

Definition: To learn reference color x. A measurement is made and these measured values will be additional-learned to the appropriate reference color. The new limit values are stored in the non volatile memory.

Answer: none

Validity: Remote mode

S- Command

Syntax: S<term>
Definition: requests the status of colorSENSOR WLCS-M-41.
Answer: Sxxxxx xxx xxx xxx xxx<CR><LF>
                (status information hex- ASCII- coded)
                (Tol. values decimal-ASCII-coded)
                24byte

Contents of individual byte of the status information after conversion in binary:

byte2:   Switch adjustment of the switches 1 - 4

Bit no.7	bit no.6	bit no.5	bit no.4	bit no.3	bit no.2	bit no.1	bit no.0
0	0	0	0	I4	I3	I2	I1

I1	0: Intensity is not considered with channel 1. 1: Intensity is considered with channel 1.
I2	0: Intensity is not considered with channel 2. 1: Intensity is considered with channel 2.
I3	0: Intensity is not considered with channel 3. 1: Intensity is considered with channel 3.
I4	0: Intensity is not considered with channel 4. 1: Intensity is considered with channel 4.

byte 3:   Switch adjustment of the switches 5 - 8

bit no.7	bit no.6	bit no.5	bit no.4	bit no.3	bit no.2	bit no.1	bit no.0
0	0	0	0	HM	MF	BTR1	BTR2

BTR1	BTR2	Operating mode
0	0	Simple
0	1	Remote
1	0	Expanded
1	1	Not definite
MF		0: Measuring values will not be filtered. 1: Measuring values will be filtered.
HM		0: Standard- Mode 1: CALIBRATION MODE!!!

byte 4:   Error status

bit no.7	bit no.6	bit no.5	bit no.4	bit no.3	bit no.2	bit no.1	bit no.0
0	0	0	0	SE	UE	-	-

UE	0: no error occurred 1 1: Uart- Error (Interface error): - Receive buffer overflow - parity-Error
SE	0: no error occured 1: system-Error bit is reset during the reading.
-	Reserved

byte 5:   reserved.
byte 6:   reserved.
example: SF505F
               = C+I for all channels, operating mode REMOTE, measuring
               values will be filtered, no error.
               24 byte
validity: always valid

Extension of reference colors in the host

First the new reference color must be teached into the colorSENSOR WLCS-M-41. In the next step the reference color with Rx can be read and stored in the host.

The host selects the new valid reference color and sends these with the command of limit values, writes (Wx…) to the sensor. The limit values do not have to be checked or processed.

Delete a reference color in remote operation

The limit values of a reference color can be deleted with the command "write limit values". For this the upper limits be set to the smallest value (000) and the lower limits have to be set to the highest value (999).

Example: W1 999 000 999 000 999 000 999 000<term>

C instead of C+I in remote operation

(The intensity of a reference color in the operating mode REMOTE is not considered)
Fo this the limit values of the intensity the desired reference color for the wished reference colors can be set with the help of the command "write limit values":
Lower limit for the intensity: smallest value (000)
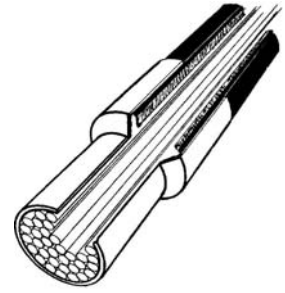Upper limit for the intensity: highest value (999)

Example:

: R1<term>
Possible Answer: R1 300 350 200 250 400 450 200 300
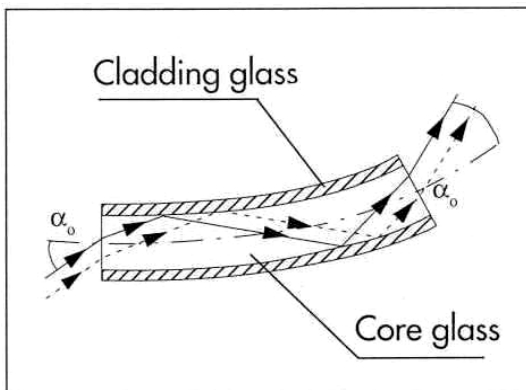Writing of new limiting values: W1 300 350 200 250 400 450 000 999
As a check and synchronisation the new limit values with "R 1" can now be read and checked.
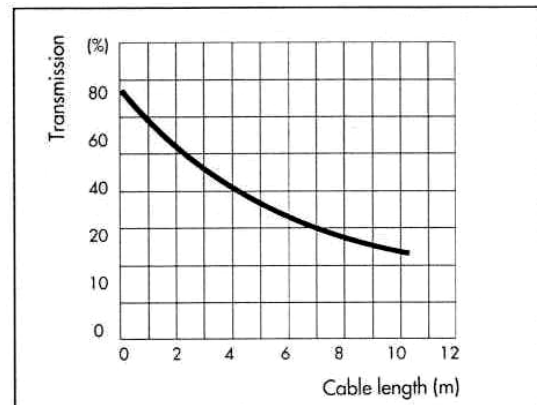
7. Fibre optics

Technical data
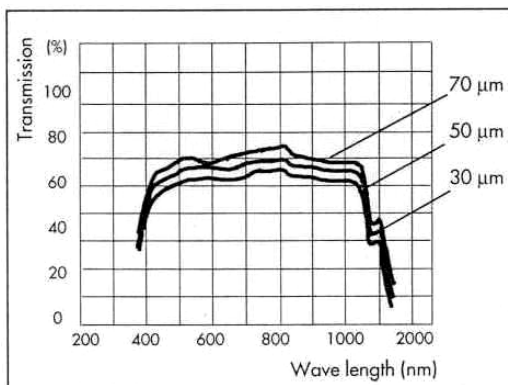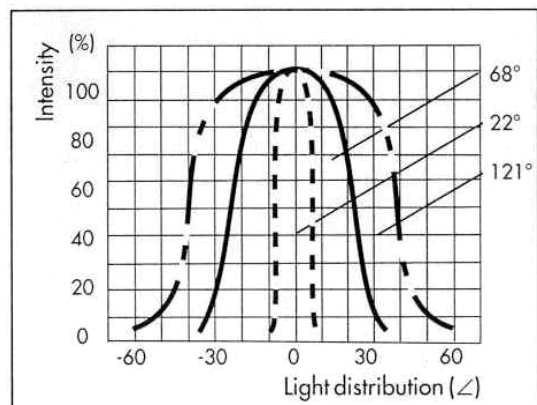
Operational Principle

Permeability

Spectral Permeability
length: 1 m, generating angle: 68 °

Curve of light distribution

Standard Fibre optics

Fibre bundle diameter 0.6 to 3.5 mm
Stable temperatur to: 80.180 or 400 °C
Outlet light angle: 22 °, 68 ° and 121 °
Standart length: 600 and 1200 mm

Setup

Reflex arrangement

With this arrangement the color can be detect by non-transparent objects. Transmitters and recivers of the outlet are statistically mixed.

Color and angle

With shining surfaces the color saturation can be increased by tipping the fibre-optic cable and reducing with it the arranged reflection (gloss). With some surfaces the angle affects also the received color.
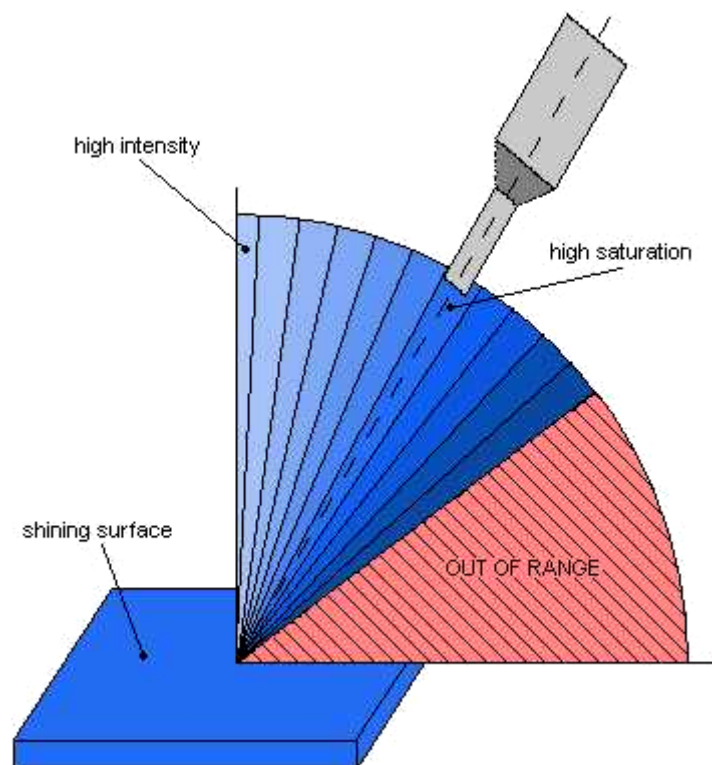
Through-Beam Version

This arrangement is assigned to detect the color of transparent objects (e.g. liquid, glass, foils…).

Focus Optics

With this, the light-current arriving at the recipient can be strengthened, or the range can be increased. However with reflex light conductors the reflections at the lens will weaken the color saturation.

Sensing head   Optic with adapter   Object
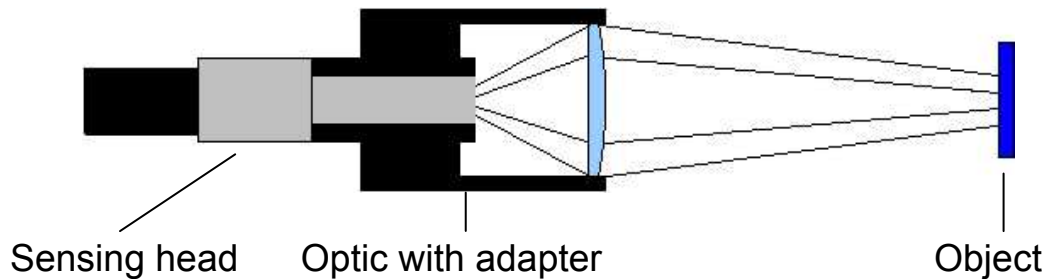
Standart focus optic: FLF.B-35, distance 55 mm, spot diameter 6 mm.
(see **FASOP- fibre optic data sheet**)

V- Reflex order

The senders and recipients can be arranged seperatly in order to use reflex measurements with optics, without weakening the color saturation.
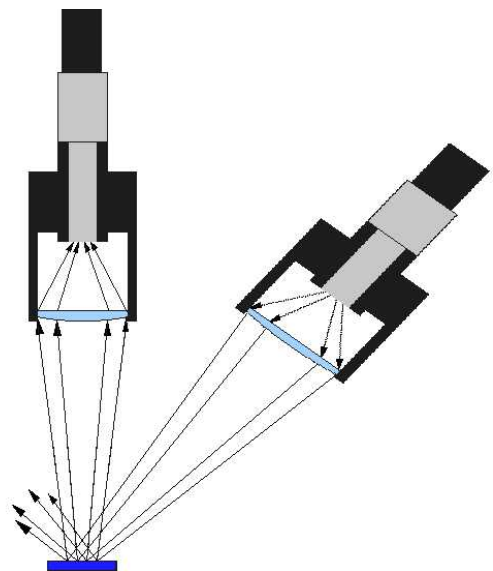
8. Delivery

Contain in the scope of delivery:

1. Color sensor colorSENSOR WLCS-M-41
2. Instruction manual

The following components are available optional:

- Connection cable 2 m with 19 pin plug connector   (1123 4089)
- Connection cable 5 m with 19 pin plug connector   (1123 4097)
- 3-pin RS 232 connection cable 2 m   (1123 4090)
- 3-pin RS 232 connection cable 5 m   (1123 4098)
- Fiber-optic cable and accessories (look at color catalogue)

NOTE:

- *Pay attention to intact contents. In case of damages, please inform the post office or conveyance and the manufacturer.*
- *Check the scope of delivery on the basis of your order and delivery documents for completeness.*
- *Keep the original packaging for the case that the device must be stored or sent away at a later point in time.*

9. General safety notes

- The intended use is described in this manual.
- A not intended use questions the security and function of the color recognition sensor, and is therefore inadmissible.
- Link and maintenance may take place only by technically experienced personnel.
- Repairs may take place only directly with the manufacturer or with a MICRO-EPSILON Eltrotec service partners. Interventions and modifications in the device are inadmissable and make all warranty claims futile.
- The operator is responsible for the adherence of locally valid regulations.

Non-liability

We checked the content of the block letters for agreement with the described hardware. Nevertheless deviations cannot be excluded, so that we do not take over guarantee for the complete agreement. The specification in this block letters is regularly checked, and necessary corrections are contained in the following editions.

Technical care and service

For questions or problems, which occur with the installation or line-up, please contact us. Our team is available from Monday to Fryday from 8:00 am to 5:00 pm.

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10. Technical data

__General__

Designation	colorSENSOR WLCS-M-41
Type of sensor	Color recognition sensor
Transmitter	High power LED, modulated 20 kHz
Receiver	PIN Photodiods for red green and blue light
Durability	type 20 000 at 25 ° C
Resolution	10 bit
Dynamic range (color)	12 bit
Environment light	Up to 5000 lux
Working distance (reflex)	≤ 70 mm / 40-100 mm (with focus optic)
Working distance (through beam)	10 - 140 / 50 - 1200 mm (with focus optic)
Size of object	type >1 mm²
Response time/Analog bandwidth	0.6 ms/1600 Hz
Measuring frequenzy	1000 Hz
Operating voltage	18 VDC – 30 VDC polarity fail protected
Remaining ripple	max 200 mV
Power consumption	Typ. 240 mA
Outputs	4x color detected 1x intensity OK max 100 mA short circuit protected, galvanically isolated
Inputs	4 x color TEACH 1 x hold 1 x key lock PNP max 30 mA
Status indication	Supply voltage OK Intensity at recipient <min/OK/>max channel 1 – 4 color detected
Interface (optional) Type of connection Operation Parameter	RS 232 C Point to Point Full-duplex 1 Startbit, 1 stopbit, 9600 baud, 8 databits
Type of protection	IP 65
Working temperature range	0 to +50 °C (up to 55 °C with reduced durability of the light source)
Housing	Aluminium black anodized
Size (without plug connector)	71 mm x 106 mm x 40 mm
Weight	ca. 360 g
Connection for PLC	19 pin. (16+3)
Connection for RS 232	3 pin.
Connection for fibre-optic cable	FA – Adapter

CE

Housing dimensions
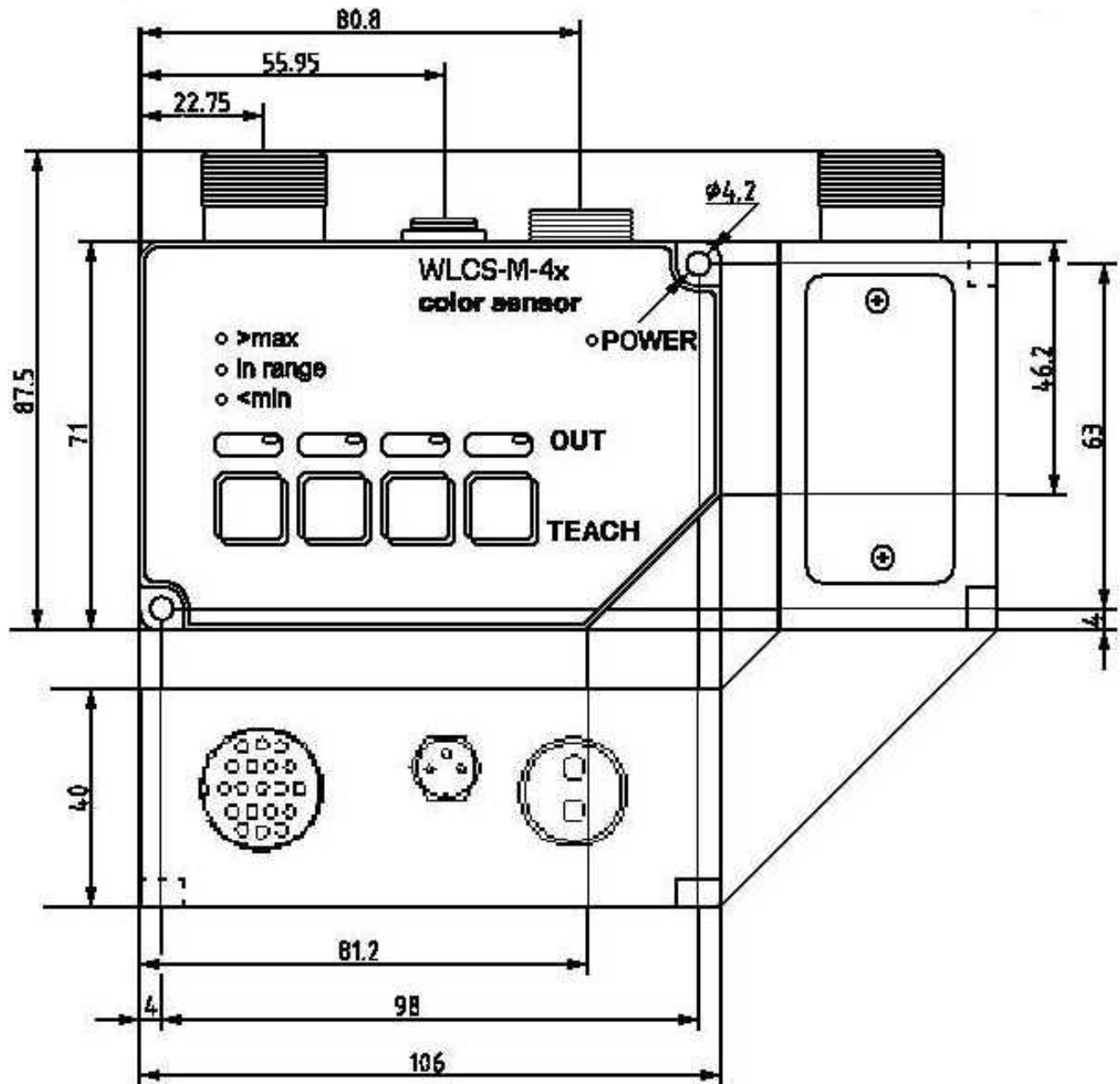
11. Definitions

Color distance	Measurement for the difference of two colors (defines e.g. according to DIN, CIE or ANSI).
Color type	Colors, which differ only by the brightness, have the same color type, i.e. the same color proportional values.
Color selectivity	Measurement for the smallest detectable color distance.
Color proportional	relatively proportions of the three color values. The total values of the color proportional values are always constant.
Color potentials	Measurement for the light-current after the spectral evaluation. Defined for each of the three spectral evaluation curves.
Gloss	Impression by arranged reflection at the surface develops.
Lightness (INT)	Measurement for the entire light-current
Inc.	Increment (Step)
Reference color	color range, whose limit values US and OS of the proportional color values lightness are stored in the color detection device.
Reference channel	Internal storage space for reference color.
Saturation	Colors with the highest saturation are spectrally pure colors and are in the standard color chart on the spectral color course. Close to the uncolored spot the saturation decreases.

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