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Technical Documentation

MTCS-ME1

modEVA-Kit with JENCOLOUR Sensors

μC Version 2.07, PC SW Version 1.32

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1 Introduction

Industrial colour detection, measurement and monitoring is becoming easier. Notably, where colours are to be detected, measured or compared in a highly dynamic working environment and with little technical effort, MAZeT's JENCOLOUR sensor IC design lends itself to provide the optimal solution, both technically and economically.
These sensors use the RGB tristimulus method, imitating the human eye's natural colour perception (MCS series), and alternatively a method according to DIN 5033, Part 2 – Colour Measurement; Standard Colorimetric Systems – CIE 1931 Tristimulus Value Function (MTCS series)[1]. JENCOLOUR ICs are available in different styles and package versions and can be fitted with a broad range of accessory items (e.g. demonstrator of initial system testing).

In addition to its IC solutions, MAZeT offers a modular MTCS1-ME1 hardware solution based on the MTCS series, which will be described hereafter.

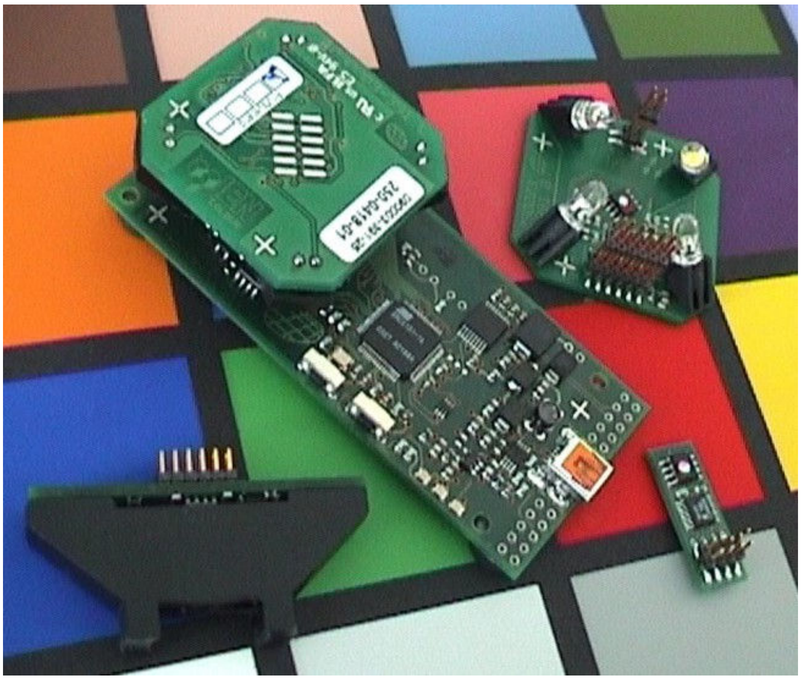


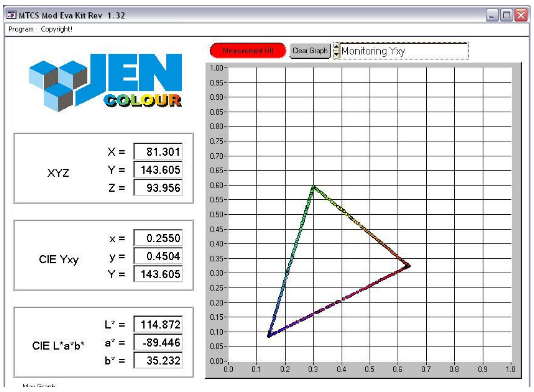
Figure 1: MTCS-ME1 mainboard with sensor module mounted

The modular MTCS-ME1 hardware solution consists of a mainboard that is configured with a plug module, optics and software as required for a particular application.

The mainboard integrates all signal processing resources, including interfacing and measuring control. Various componentry versions can be provided for customized adaptation to a given specific PCB functionality or connector shape to fit the plug modules (e.g. viewing direction of sensor).

[1] For data and application sheets, you should contact one of our sales offices.

Each plug module contains, besides the JENCOLOUR ICs, an alternative signal amplifier chain (dynamic, time integral) and different light sources (e.g. 4/2/0 white LED), using mechanical aperture blades to comply with 45/0 measuring geometry requirements under DIN 5033, Part 7.

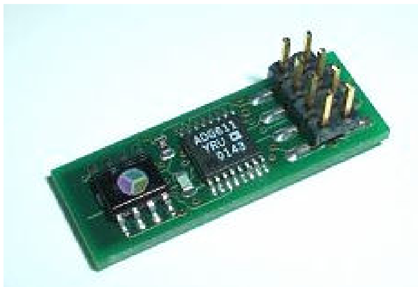


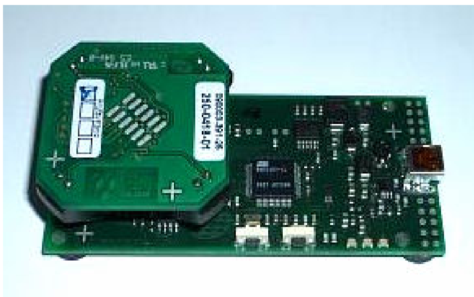
The standard modEVA kit with USB interface includes PC software under MS-Windows™ to handle functions like sensor calibration and anything in connection with measured value representation and output, e.g. in the CIE Lab colour space.

TOP plug module
(four LEDs with dynamic signal gain)

with optics mounted onto/removed from mainboard for reflective colour measurement

DARK plug module
mounted onto mainboard, e.g. for light measurement (colorimeter)





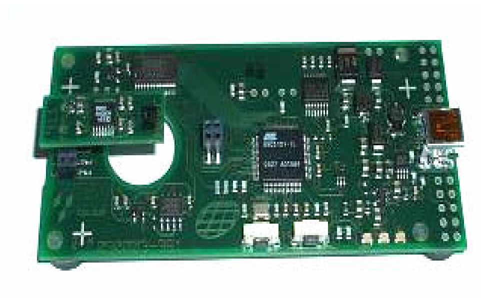


Figure 2: Sample configurations

The modEVA concept comprises a whole series of prefabricated components which can be combined into a package that will fit the given application scenario. Each package then undergoes system testing. All prefabricated modules have been developed and manufactured according to industrial requirements, i.e. they are immediately available in large batches and qualified for industrial use. The modEVA concept is being continuously extended, especially by new plug modules and accessory items.

Dedicated drivers and software libraries can be provided for necessary software (and firmware) matching, which also are subject to continuously ongoing development and extension. Please do not hesitate to contact us for latest information about available components and scopes of delivery.

2 Starting up

2.1 Scope of Delivery

MTCS-ME1 delivery includes:

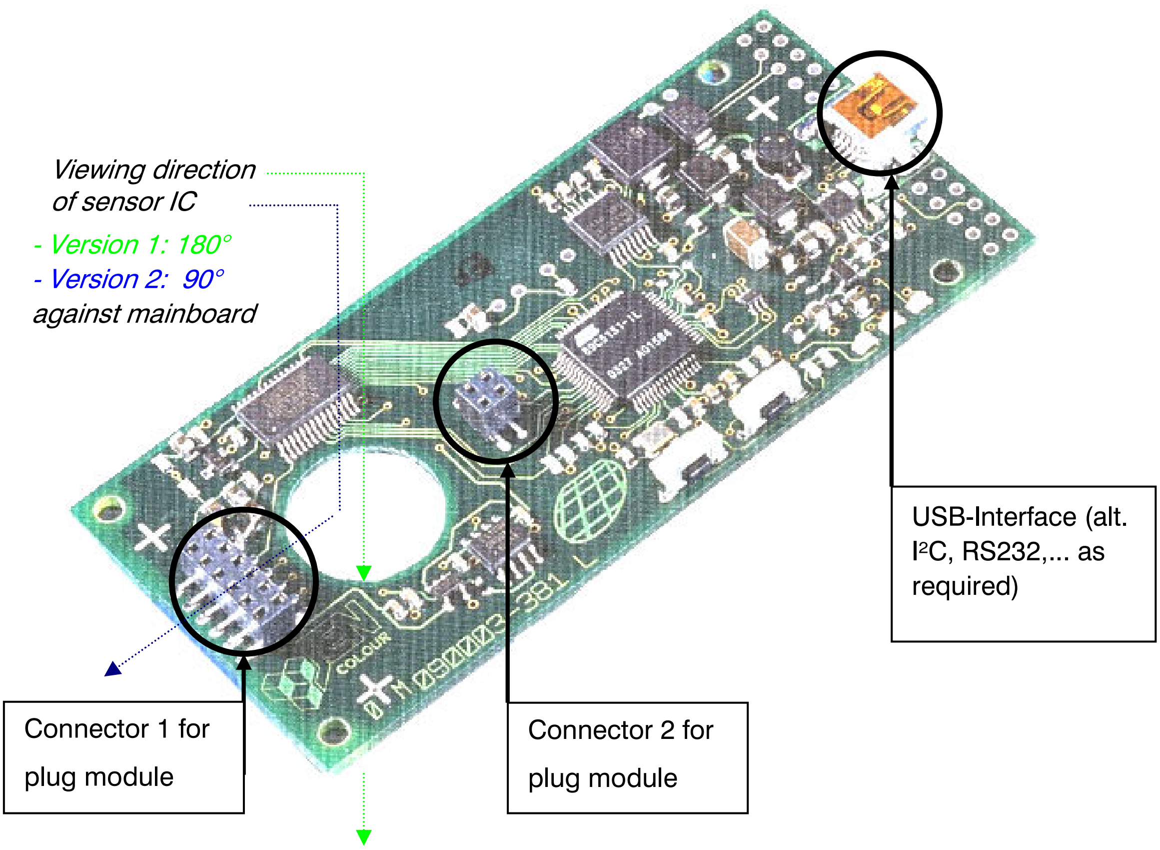
- One MTCS-ME1 mainboard 090003-382/383 (μC version 2.07)
- One ME sensor board (TOP 090003-391/FRONT 090003-401/DARK 090003-411/412)
- USB cable
- Test software (optional USB driver of SYS and DLL type)
- Documentation

2.2 System Requirements

For start-up procedures, the following system resources are required:

- PC Pentium 150 MHz or higher
- 8 MB RAM
- 5 MB free hard drive memory
- One free USB(2.0) port
- MS Windows™ XP

2.3 Components Hookup



2.4 Software Installation

The “setup.exe“ file will install the user interface on your PC.

On successful installation, the “oem7.inf“ and “usbio.sys“ files are to be copied to the “windows\inf“ directory and the “windows\system32\drivers“ path, respectively.

Having done this, use the USB cable (supplied) to connect the MTCS-ME1 to a free USB (2.0) port of your PC. The device manager will output a “Found new device“ message.

Select “Automatic software installation“, then press “Continue“.

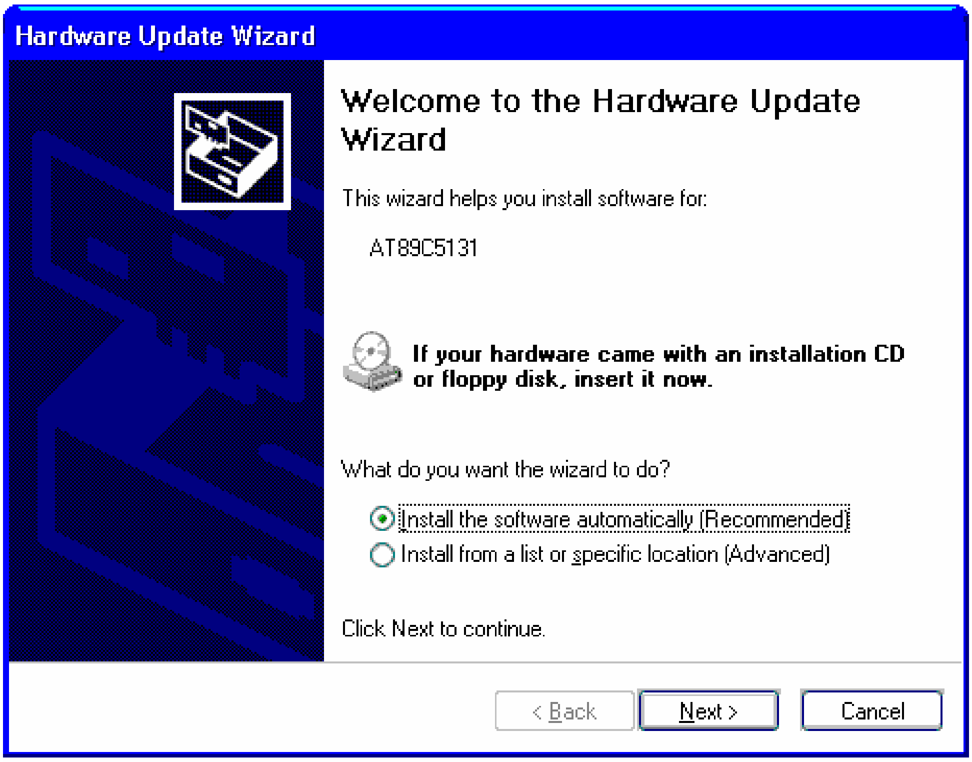


Figure 3: Microsoft assistant for USB driver installation

In case the software does not install automatically, enter the paths you copied the .ini and .sys files to.

3 Hardware

The hardware of a modular Eva kit can be configured to meet the particular application requirements.

The modular design concept provides for a separation into analogue sensor parts on the one and digital processing and interface electronic components on the other hand. It allows a number of sensors to be lined up in a cascadable chain with a minimum pitch of 10mm, i.e. the complete MTCS-MEK system or a customized signal evaluation branch can be cascaded.

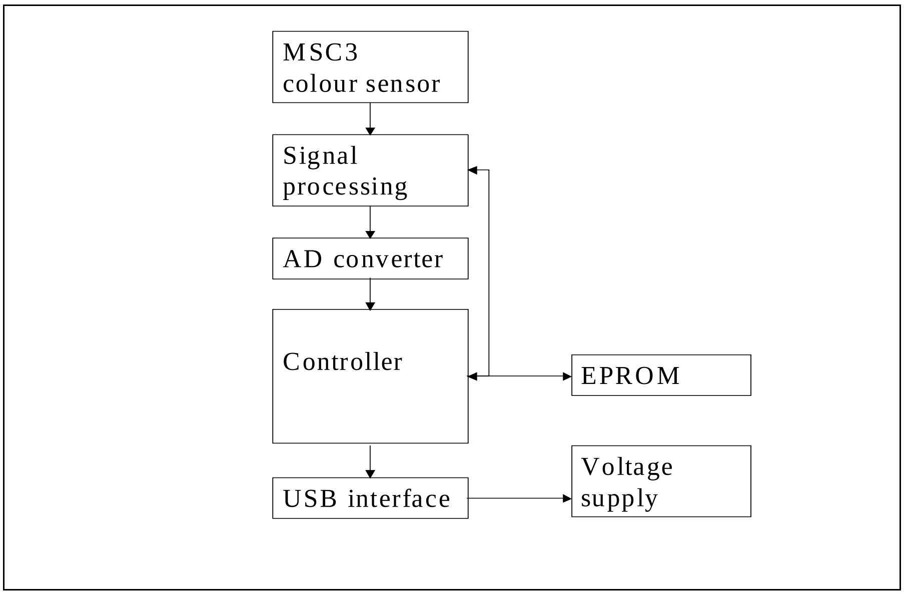


Figure 4: Block diagram of MTCS-MEK

Basically, three sensor modules are available at the moment[2]. They will be commented on their possible applications in the following sections:

- modEVA-TOP
- modEVA-FRONT
- modEVA-DARK

3.1 MTCS-ME1 Mainboard

The MTCS-ME1 mainboard is the basic signal preprocessing and postprocessing tool. It performs necessary digitization processes, contains the μC and the firmware, handles digital signal preprocessing and provides various interfaces.

The following function modules are integrated on this board:

- Digitization with 12 bit resolution
- μC-controlled signal detection
- USB interface (default) plus RS232 and I^2C[3]
- Free memory space for compensation and correction data
- Two pushbuttons for manual triggering of measurement
- Three event indication LEDs
- Interrupt and IO terminal pin(s) for integration into control sequences
- Voltage supply via USB
  (separate operating voltage can be supplied for RS232 and I^2C)
- Programmable voltage source to control target illumination sources.

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[2] Are continuously upgraded. Contact us for latest information: sales@mazet.de Phone +49 3641 2809-0.

[3] Assembly hardware available on demand; software adaptation on request

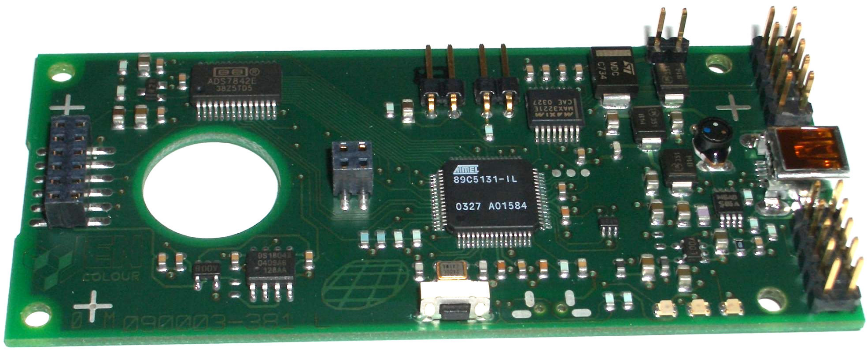

Figure 5: modEVA mainboard

The standard microcontroller firmware is designed to support communication via a USB interface and handle all customized measuring algorithms:

- Simple ADC access operations
- Averaging of multiple ADC access operations
- Measured value logging using stray light compensation
- Smart control for signal integration (modEVA-DARK with current-to-charge conversion)
- Brightness control of illuminator LEDs
- Management of customized settings and calibration data

The mainboard is available in two different componentry versions:
- 090003-382 with vertical pin jack for modEVA-TOP and modEVA-DARK
- 090003-383 with angled pin jack for flat design shape with modEVA-FRONT.

The signals of both sensor board versions share a double line 12-pole pin bar jack interface (with 2mm pin pitch). Figures 6 and table 3-1 show the various signal assignments.

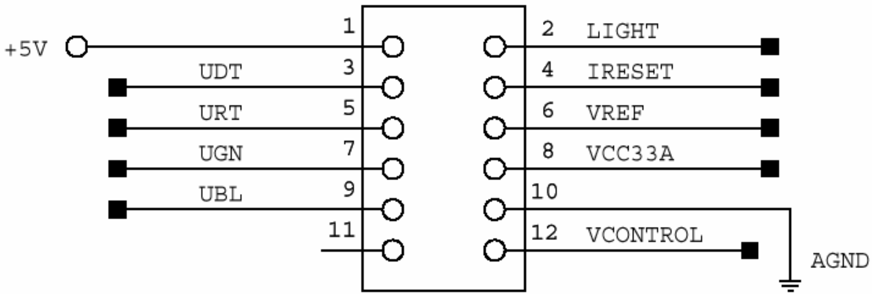

Figure 6: Signal assignments of sensor interface

Table 3-1: Signal assignments of sensor interface

PIN	I/O	NAME	DESCRIPTION
1	E	+5V	Analogue operating voltage for target illuminator
2	E	LIGHT	Turns target illuminator on
3	A	UDT	Signal level of isolating diode (not used)
4	E	IRESET	Resets/discharges current-to-charge converter
5	A	URT	Red signal level
6	E	VREF	Reference voltage
7	A	UGN	Green signal level
8	E	VCC33A	Analogue operating voltage for signal gain
9	A	UBL	Blue signal level
10	E	AGND	Analogue frame ground
11		n.c.	
12	E	VCONTROL	Control voltage for target illuminator

Pins 1, 2, 11 and 12 are not used for the modEVA-DARK sensor board (8-pole connector).

3.2 modEVA-TOP

The configuration set of a modEVA mainboard and a modEVA-TOP allows for colour measurement of flat reflective targets by setting the mainboard (preassembled with the modEVA TOP) upon the target to be measured.

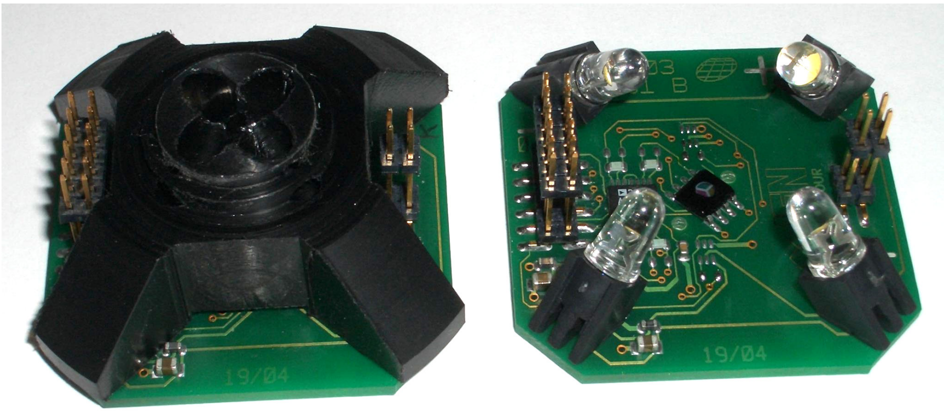

Figure 7: modEVA-TOP

The modEVA-TOP is mounted onto the modEVA mainboard, using the 12-pole and the 4-pole connector, in upright position such that target illumination and reflected light measurement both take place through the circular opening (15 mm) in the modEVA mainboard.

The modEVA-TOP sensor module contains a MTCSiCS colour sensor[4] along with a four-position white illuminator LED pad. Its plastic top ensures compliance with 45/0 measuring geometry requirements under DIN 5033, Part 7.

[4] Alternatice MTCS/MCS series sensors are available on request

3.3 modEVA-FRONT

The configuration set of a modEVA mainboard and a modEVA-FRONT allows for colour measurement of reflective targets by holding the mainboard (preassembled with the modEVA-FRONT) in front of the target to be measured.

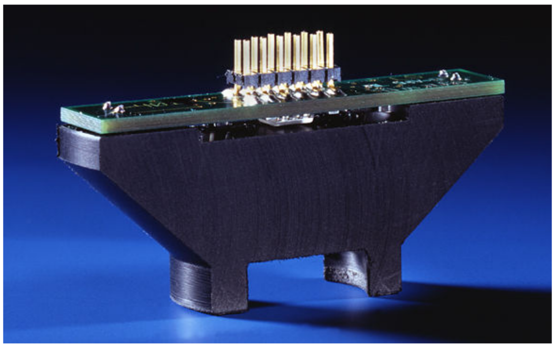

Figure 8: modEVA-FRONT

The modEVA-FRONT is mounted onto the modEVA mainboard in horizontal position via an angled 12-pole connector.

The modEVA-FRONT sensor module contains a MTCSiCS colour sensor along with a two-position white illuminator LED pad. Its plastic top ensures compliance with 45/0 measuring geometry requirements under DIN 5033, Part 7, plus a defined target distance.

3.4 modEVA-DARK

The configuration set of a modEVA mainboard and a modEVA-DARK allows for colour measurement of luminous targets, e.g. LEDs or displays, and can be operated in connection with alternative light sources, respectively (e.g. halogen or neon, not integrated in modEVA).

Figure 9: modEVA-DARK

Apart from the sensor IC the modEVA-DARK sensor module solely contains sensor signal amplification circuitry.

This amplifier is available in two different configurations:

- Configured with current-to-charge converter for integration of photo currents from temporally varying light sources (e.g. CRT monitors) and
- Configured with transimpedance amplifier for measurement of temporally stable light sources as well as of reflective surfaces with separate illumination.

The modEVA-DARK is mounted onto the modEVA mainboard in center-aligned horizontal position using the 12-pole connector, at which Pins 1, 2, 11 and 12 are unused.

4 Software

4.1 Software Start

The application software is started by running “mtcs_mod_eva.exe“. The window for USB configuration will open (Figure 10). It contains standard entries for “Vendor_ID“ and “Product_ID“ representing specific MTCS-ME conventions, which should not be changed.

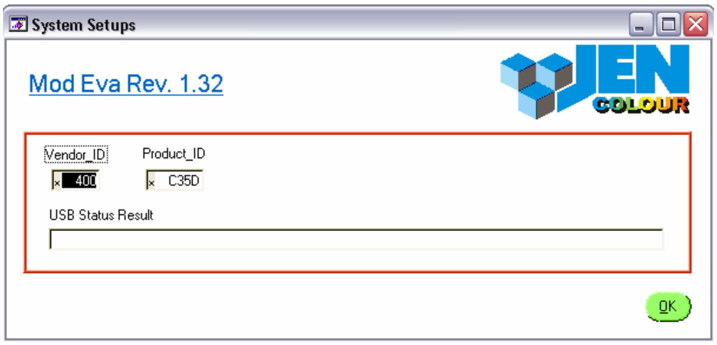

Figure 10: System setups starting window

To check interface communication, click the OK button.

Once communication has been successfully established, a respective message will appear along with the firmware revision number. (Figure 11).

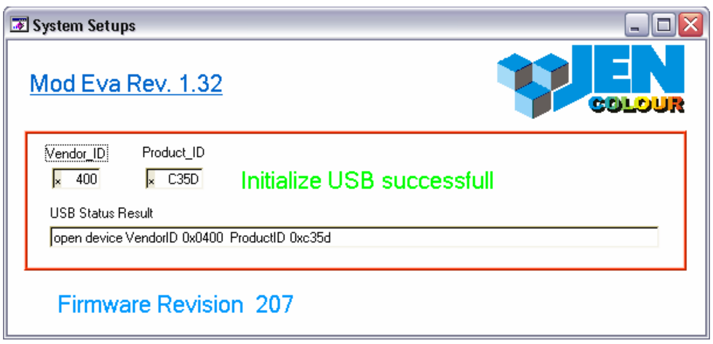

Figure 11: System Setups – USB communication successfully established

The current window then automatically closes and the main window for colour measurement (see section: 4.2) opens. If no saved configuration is available the measuring environment configuration window (see section: 4.4) opens instead.

If the software responds "....resetUSB" in the "USB Status Result" line, it is recommended to terminate the program session, to shortly disconnect the USB hardware and to restart the software.

4.2 Colour Measurement

Figure 12 shows the main window for colour measurement visualisation.

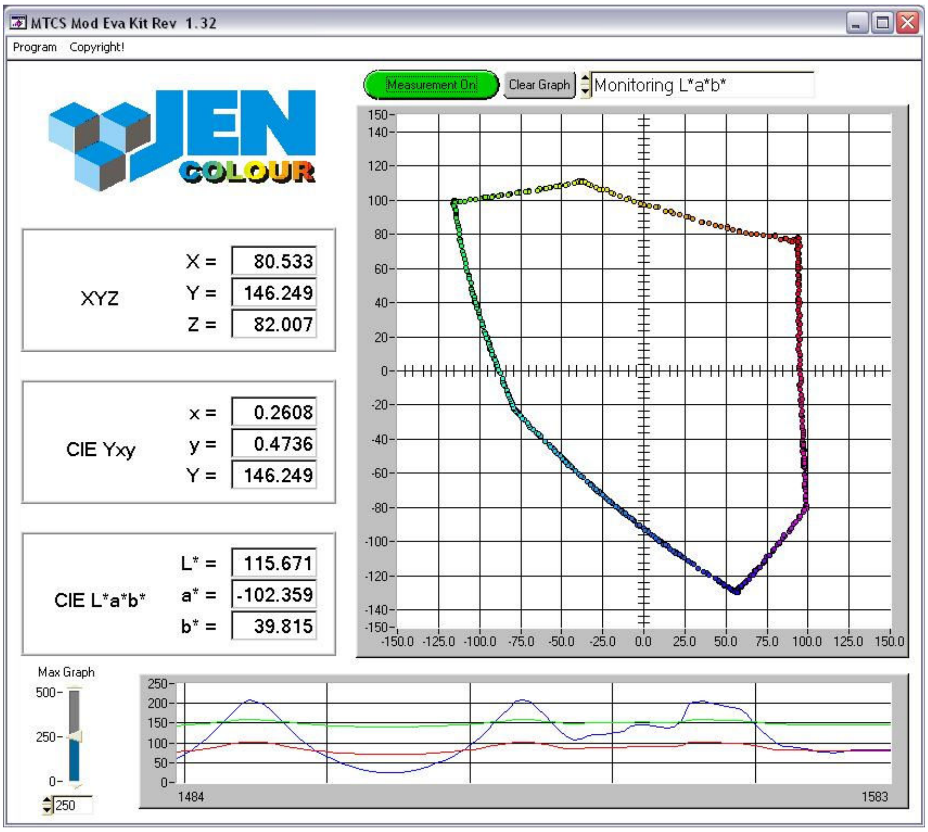

Figure 12: Main window for colour measurement

The measurement results are represented as XYZ standard tristimulus values, in a CIE Yxy standard chromaticity chart and a CIE 1976 L*a*b* colour space.

A measurement can be triggered and cancelled by clicking the "Measurement On / Off" button.

For graphical display, you may choose between "Yxy" and "L*a*b*". A given graphic can be deleted with the "Clear Graph" button.

At temporally varying measured values, an extra area at the bottom of the window displays the progression of recent values (Figure 12.1). On the left, the display scale can be adjusted by setting the maximum value for the y-axis.

4.3 Menu Bar

Several functions can be accessed through the "Program" item in the menu bar:

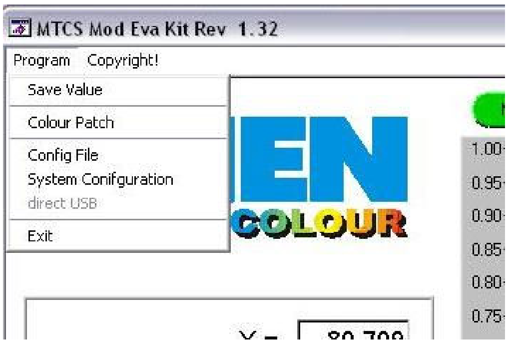

Figure 13: Menu bar

4.3.1 Save Value

Selection of "Save Value" in the "Program" menu bar allows to save your measured data as single values or to dump all measured values continuously into a log file.

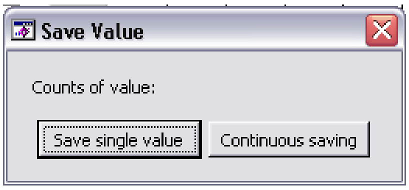

Figure 14: Selection options for saving: single value or continuous saving mode

When "Continuous saving" is selected, another window appears (figure 14.1) in which the termination condition (total number of measurements – Line 3) and the measurement rate can be selected. Here, the number of measurements (Line 1) per time unit (hour, minute, second – Line 2) has to be entered.

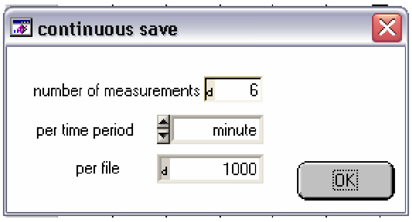

Figure 14.1: Selection options for continous measurement

Before data can be saved, a file name must be specified (figure 15).

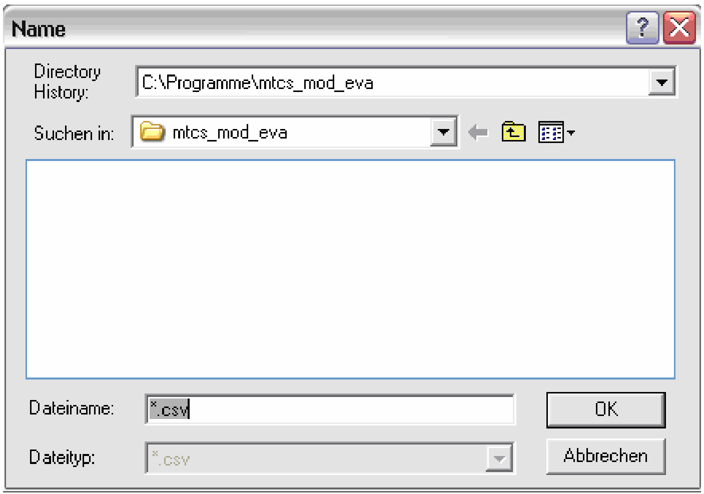

Figure 15: Assignment of file name for measurement data saving

Once a name has been entered and confirmed with OK, the data will be saved to this file.

Continuous data saving can be aborted by clicking “Stop saving“ in the “Program“ menu bar.

In single value saving mode, new measurement data can be added to the most recently used file. A query box as shown in figure 16 will appear.

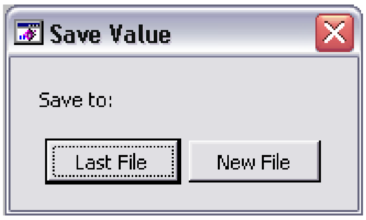

Figure 16: Option box for saving in latest file or a new file

File organization data contains date and time information and sequential value saving number, XYZ, xyY and Lab, separated by semicolon, in line two.

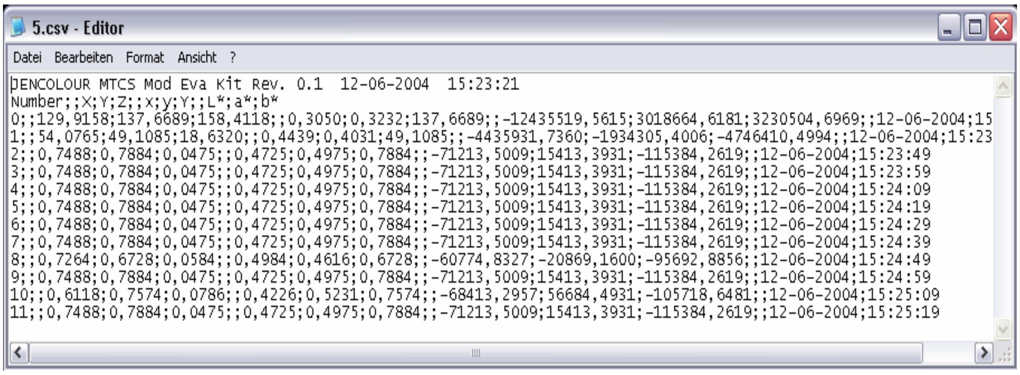

Figure 17. Organization of data saving

4.3.2 Colour Patch

“Colour Patch“ allows to display a particular measured colour in an accordingly coloured desktop window with RGB value indication (figure 18).

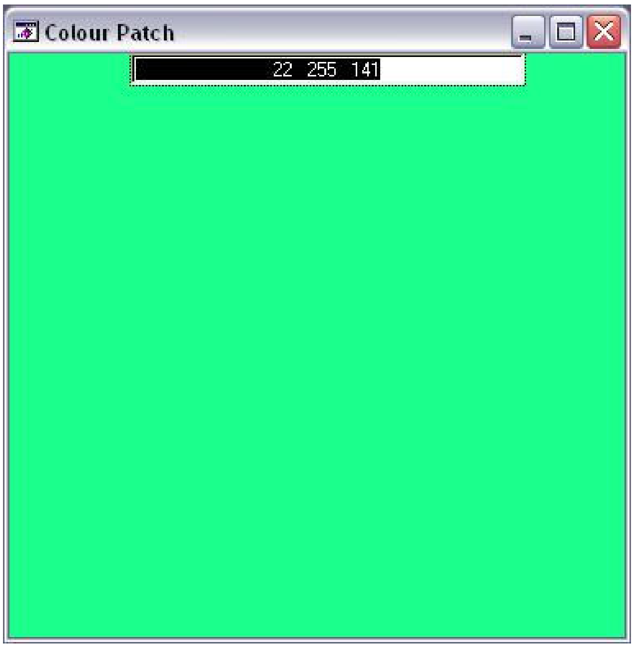

Figure 18: Colour patch display

> ***Caution!***
> Due to a certain variance in display types and differing PC and graphic card settings for colour management, there may, in some cases, be a notable deviation in the colour reproduction of a measured target.

4.3.3 Config File

Selection of “Config File“ in the “Program“ menu bar allows to load or save application specific system configurations and calibration data (see also section 4.4).

Figure 19: File access options for system configuration

4.3.4 System Configuration

The sensor system can be set to appropriate measuring modes with specific parameters using the system configuration. Refer to section 4.4 for a detailed description.

4.3.5 Exit

Clicking “Exit“ in the “Program“ menu bar will terminate the software session.

4.4 Changing System Configuration

A change in the system configuration is only necessary during the initial start-up procedure or following a change in the hardware configuration.

The measuring environment configuration window can be opened by selecting “Program > System Configuration“ in the menu bar. It also opens automatically when the software is started and no saved configuration data is available.

The system configuration screen allows the following settings:

- Determination of application (depending on utilised sensor board; also refer to sections 3.2 to 3.4)
- Setting measurement conditions (integration time, average values, illumination LEDs, etc.)
- Definition of colorimetric environmental conditions (offset, CIE illuminant, gamma correction)
- Determination of correction matrix for colour space transformation by target specific calibration
- On-board memory management

In case no configuration data is stored on-board, (“no saved configuration“), a screen as shown in figure 20 will appear immediately after USB initialization.

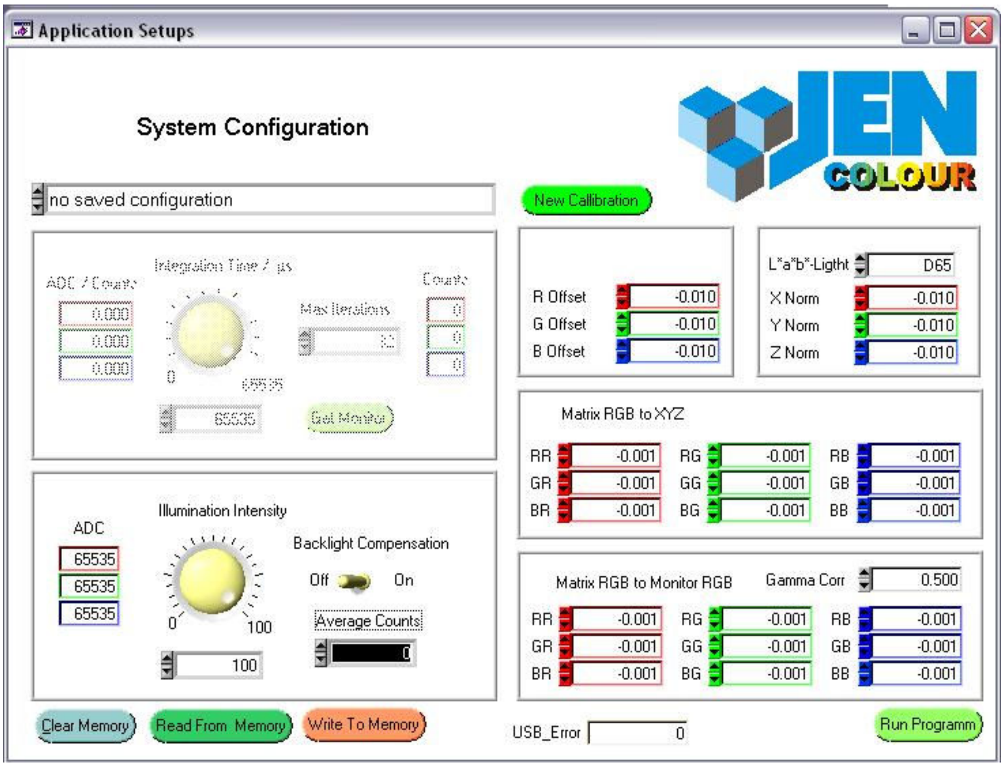

Figure 20: System configuration starting screen

The appropriate application choice depends on the currently installed sensor board. It is set in the top entry field.

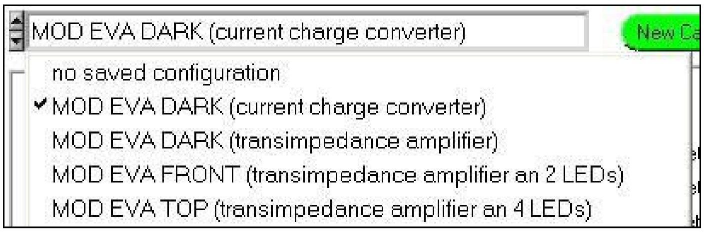

Figure 21: Configuration of application

Depending on the selected application, particular fields will be enabled for setting changes.

Configuration data management in the on-board memory takes place through the three buttons “Clear Memory“, “Read From Memory“ and “Write To Memory“.

On successful system configuration, click “Run Program“ to return to measuring mode.

4.4.1 Configuration for modEVA-DARK (Current-To-Charge Converter)

The modEVA-DARK (current-to-charge converter) sensor board is primarily used for measurement of light sources, e.g. illuminator LEDs or monitors, too. For integration of sources with a potential variance over time (e.g. CRT monitors), integration time can be set to a value from 1000μs to 65535μs. Accurate synchronisation of the integration time setting to the frequency of the light source being measured is crucial for achieving a colour detection duly matched to the human eye’s inertia.

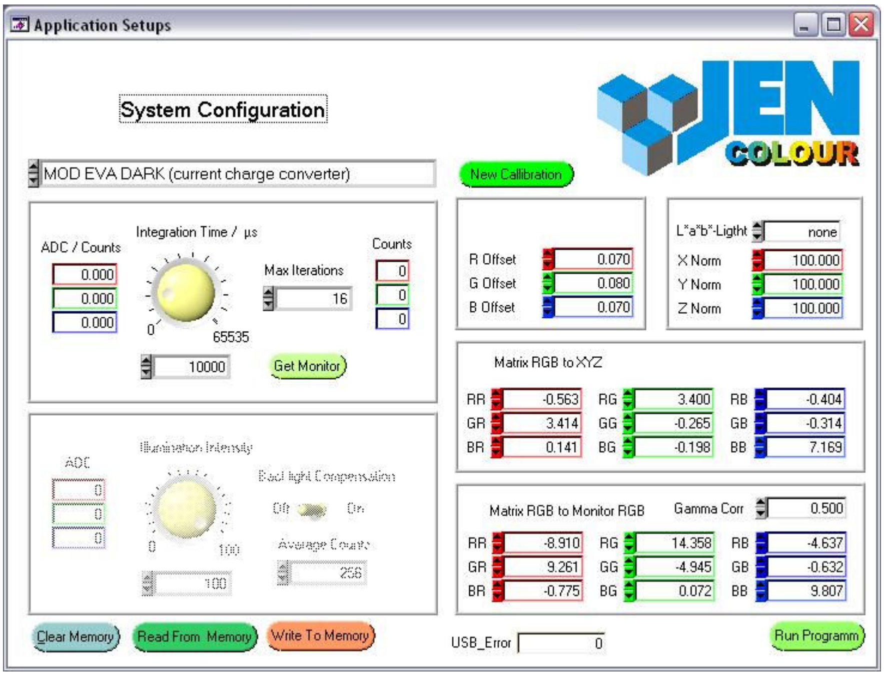

Figure 22: Sample configuration for modEVA-DARK (current-to-charge converter)

For system configuration direct the sensor at a white surface. When measuring monitors, the screen with an appropriately bright background colour can be used.

By clicking the “Get Monitor“ button, you can determine the refresh rate and, hence, the optimal integration time for temporally varying sources.
For example, a response value of 11765µs corresponds to a monitor frequency of 85Hz. A “0“ or “1“ response value indicates a non-varying source, i.e. a steady illuminator (e.g. TFT monitor). Integration time can be randomly selected.

A measurement lasts for a multiple of the specified integration time. The measured value (“ADC / Counts“) represents the integral signal level excursion, divided by the number of frame refresh cycles (counts).

On selection of “Max Iterations“, the termination condition - the maximum number of frame refreshs to be performed - is determined for a measuring cycle. A change in a parameter will immediately trigger a measurement with the current set of measuring conditions and display the measured values (“ADC / Counts“) and the number of required iterations (“Counts“) accordingly.

When all measurement settings have been made, the system can be calibrated with the help of a target-matched correction matrix. For a more detailed description, refer to section 4.4.2.

4.4.2 Configuration for modEVA-DARK (transimpedance Amplifier), -Front and -Top

modEVA-DARK (transimpedance amplifier), -FRONT and -TOP configurations are employed to measure reflective samples or constantly bright sources. Configuration settings can be made using the active fields shown in figure 23.

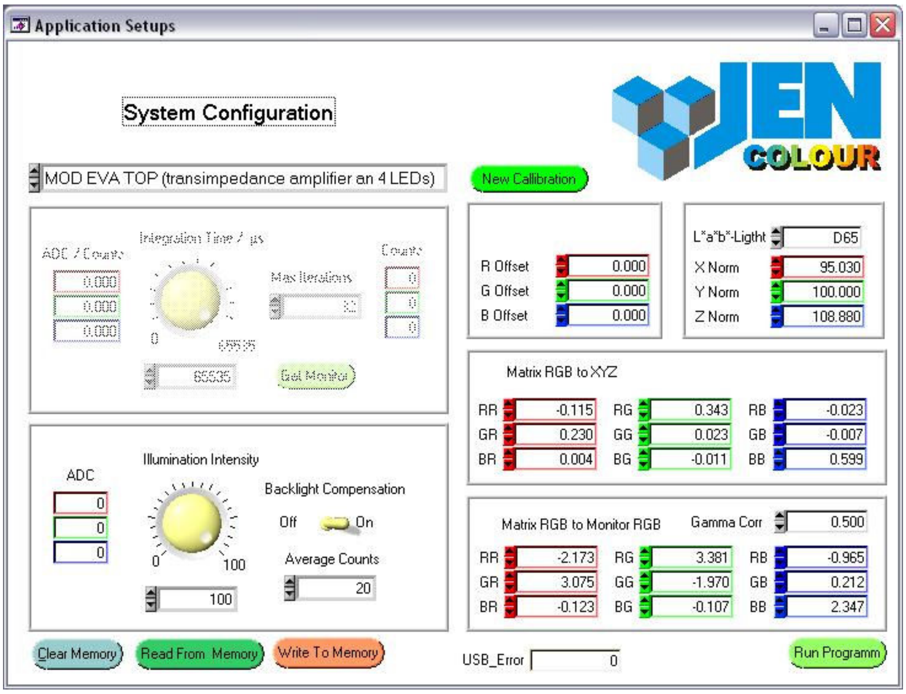

Figure 23: Sample configuration with modEVA-TOP

The brightness of the LED illuminator is adjusted using the “rotary control knob“ (only for modEVA-FRONT and modEVA-TOP).

“Backlight Compensation“ allows for a dynamic background and stray light suppression and “Average Counts“ determines the number of measured values to be included in averaging.

Entering a measuring condition parameter will immediately trigger a measurement and display the measured values (“ADC“) of all three channels accordingly.

4.5 Target-Matched Calibration

By clicking the “New Calibration“ button, the system can be calibrated to a known set of targets (figure 24). There, the actual system values are determined for targets with known XYZ values, from which the offset values and finally the correction matrix are calculated.

Calibration starts with this screen:

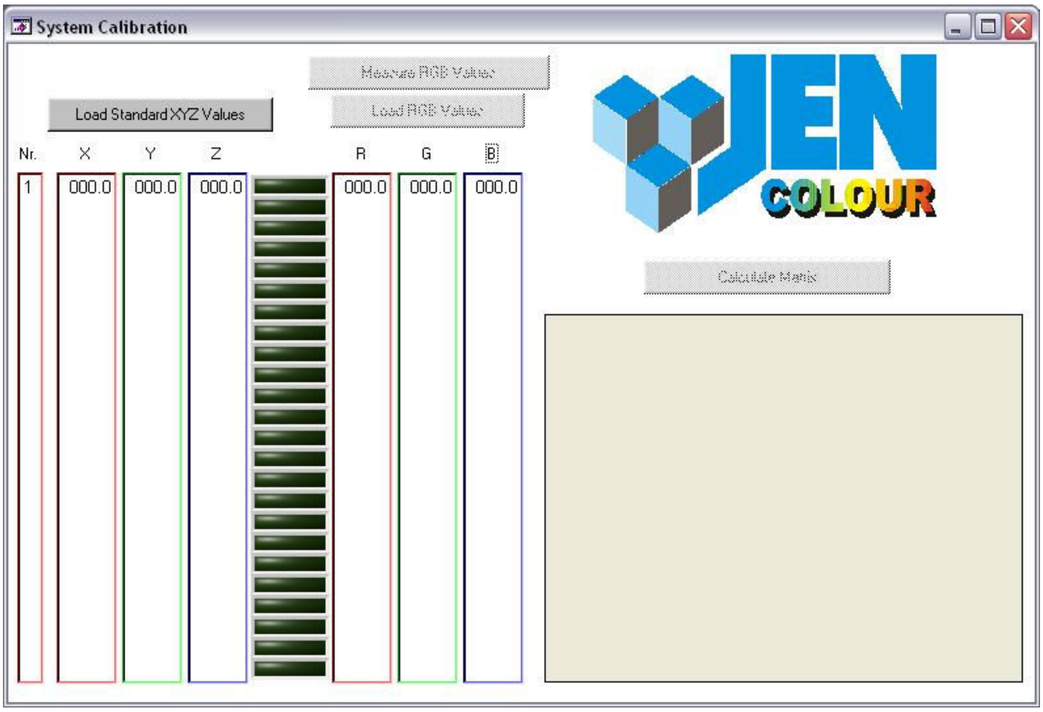

Figure 24: System calibration starting screen

Clicking the “Load Standard XYZ-Value“ button loads a known and measured target data set. This data set comprises 24 XYZ and RGB target values to be shown on the monitor.

colorchecker.gmb - Editor

Datei Bearbeiten Format Ansicht ?

```
"Standard Color Value XYZ Colorchecker;"
"Counts of colors;"     24
11.540  10.100  7.210   94      28      13
39.121  35.800  28.848  241     149     108
18.992  19.300  38.600  97      119     171
10.621  13.300  7.595   90      103     39
26.831  24.300  50.119  164     131     196
32.795  43.100  49.755  140     253     153
37.419  30.100  6.431   255     116     21
14.468  12.000  42.102  7       47      122
29.314  19.800  15.596  222     29      42
9.311   6.600   16.759  69      0       68
34.424  44.300  11.866  187     255     19
46.543  43.100  8.757   255     142     0
8.843   6.100   32.347  0       0       142
14.933  23.400  10.627  64      173     38
20.660  12.000  5.670   203     0       0
56.336  59.100  10.314  255     217     0
30.929  19.800  34.241  207     3       124
15.400  19.800  43.370  0       148     189
88.291  90.000  106.519 255     255     255
57.979  59.100  69.951  249     249     249
35.535  36.200  42.825  180     180     180
19.425  19.800  23.435  117     117     117
8.829   9.000   10.651  53      53      53
3.041   3.100   3.669   0       0       0
```

Figure 25: Target data set

For reflectance measurement, a data set can be calculated, for example, using the provided colour space data of a colour checker from GretagMacbeth (figure 26).

Figure 26: Colour checker from GretagMacbeth

The use of other targets requires prior knowledge of their XYZ values. For luminous objects, a corresponding target file can be created by performing a metrological test run with a spectrometer.

A loaded target file is displayed in tabular form including all XYZ values as well as the RGB monitor colour (figure 27).

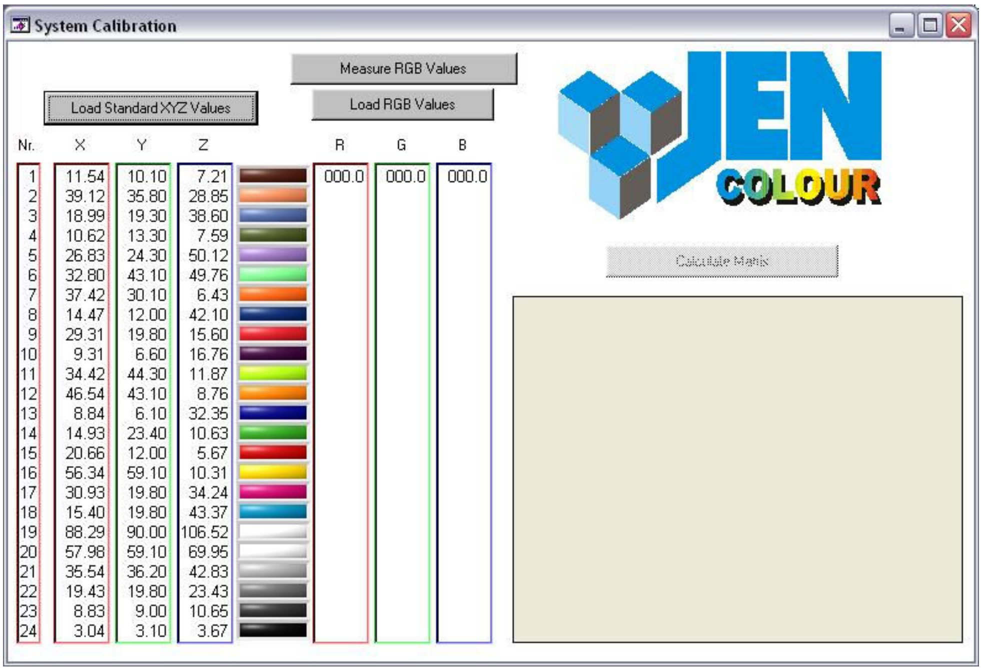

Figure 27: System calibration nominal value

If calibration is performed using a calibrated monitor, the actual values are determined automatically. The sensor must be positioned in the middle of the colour area or in front of the separate colour patch field for this purpose. Calibration can then be triggered via “Measure RGB Values“. During calibration, the monitor’s RGB values, which are saved in the file, are set consecutively and their corresponding actual values are determined.

For calibration to a reflective target set, the sensor must be successively placed onto each target colour to be measured. By pressing “OK“, the respective actual value will be determined (figure 28).

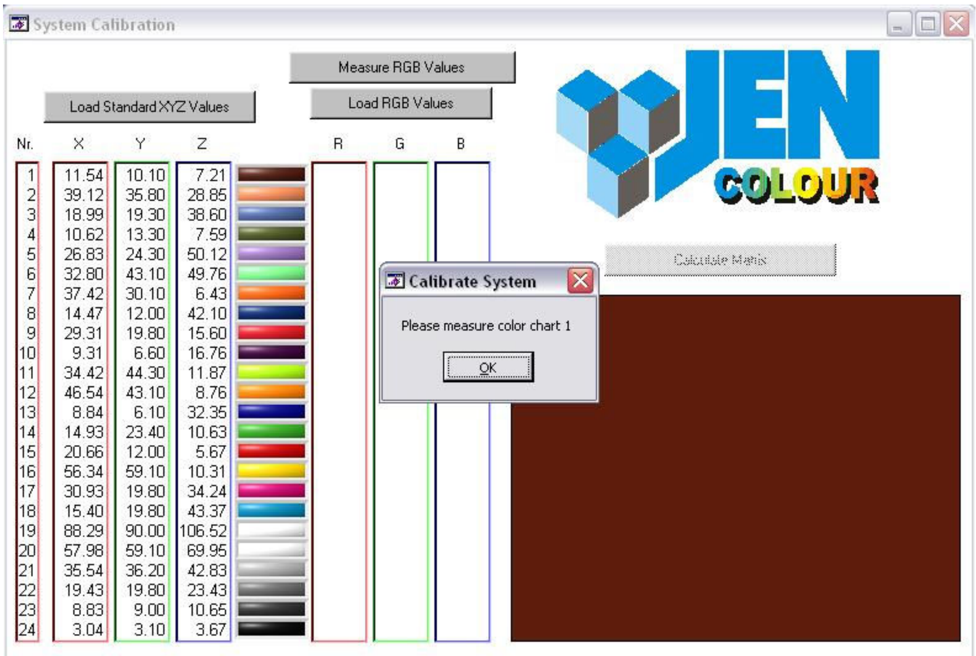

Figure 28: System calibration – determination of actual values

After all 24 actual values have been recorded, their data is saved and the resulting offset values are calculated.

An already existing file of actual values can also be loaded via “Load RGB Values“.

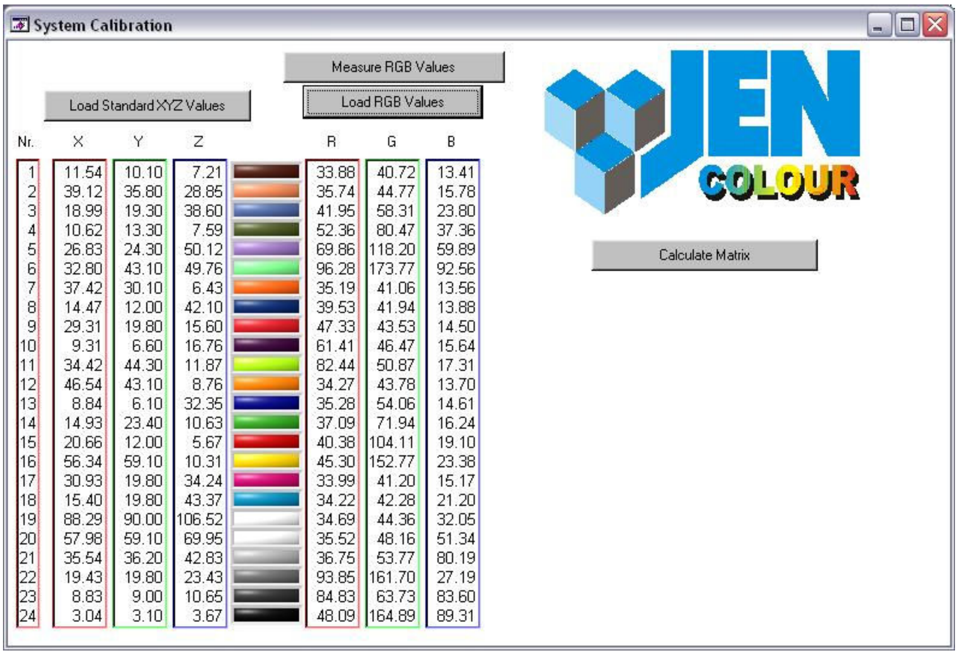

Figure 29: System calibration – calculation of matrix

As soon as offset-corrected values are available, the “Calculate Matrix“ button will be enabled (figure 29). By clicking this button, the required correction matrices will be calculated, designating the end of calibration. The software returns to the “Application Setups“ screen, displaying the determined offset values and matrices.

The Lab values which have been calculated during the measurement remain to be specified by the type of illumination source for which calibration was performed (“L*a*b*Light“ in figure 23).

Subsequently, clicking “Write to Memory“ saves the newly obtained calibration data set to the on-board memory. It will automatically be restored with each restart without having to perform another calibration procedure.

For further information, please contact:

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