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Technical Documentation

MTCS-C2

with

JENCOLOUR colour sensors



µC Version 0.12 PC SW Version. 1.67

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1. Introduction

Industrial colour detection, measurement and monitoring are becoming easier. Notably, where it is claimed that colours are to be detected, measured or compared "like human eyes" in a highly dynamic working environment and with little technical effort, MAZeT's JENCOLOUR OEM colour sensor design provides the optimal solution, both technically and economically.

Sensors of this type use the RGB Tri-Stimulus method, imitating the human eye's natural colour perception (MCS series), or, alternatively, a method according to DIN 5033, Part 2 – Colour Measurement; Standard Colorimetric Systems – CIE 1931 Tri-Stimulus 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 system testing, testing and function boards, software libraries).

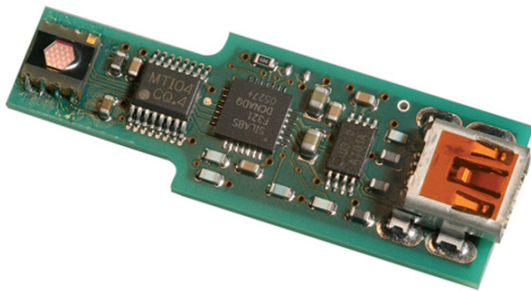


Figure 1: MTCS-C2 Board Colorimeter

In addition to its IC solutions, MAZeT offers a MTCS-C2 hardware solution based on the MTCS series, which will hereafter be referred to as "colorimeter 2" and will be described below. Alongside the colour sensor IC, the board integrates all signal processing resources, including interfacing and measuring control and can be adapted within a Design In project.

The MTCS-C2 kit includes PC software "colorimeter2.exe" under Windows XP™ to handle functions like sensor calibration and anything in connection with measured value representation and output, e.g. in the CIE Lab colour space. Furthermore an API Application Programming Interface (MTCSApi.DLL) with test software can also be supplied (optional).

If required, dedicated drivers and software libraries (tools for calculating the colour range and calibration) can be produced and supplied for necessary adjustments to the software.

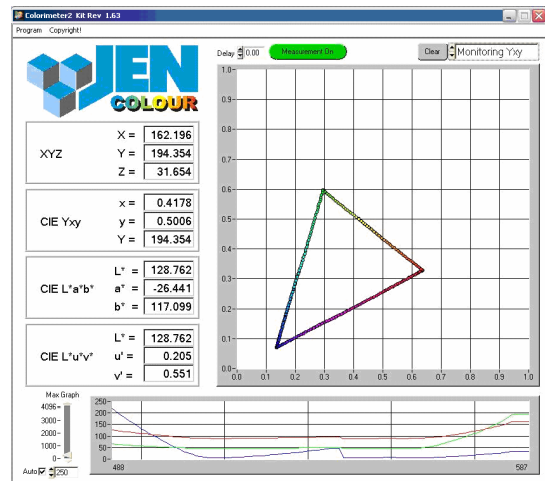


Figure 2: Operator interface mtcs-Software

Please do not hesitate to contact us for latest information about available components and scopes of delivery.

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

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2. Starting Up

2.1 Scope of Delivery

MTCS-C2 delivery includes²:

- MTCS-C2 (μ C Version 0.1x)
- Documentation
- optional³ USB cable
- Optional "colorimeter2.exe" PC software (with USB driver of SYS and MTCSApi.dll type)^{fn}
- Optional macro functions library
- Optional 10° optics consisting of shutter

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 / 2000

2.3 Components Hook-up

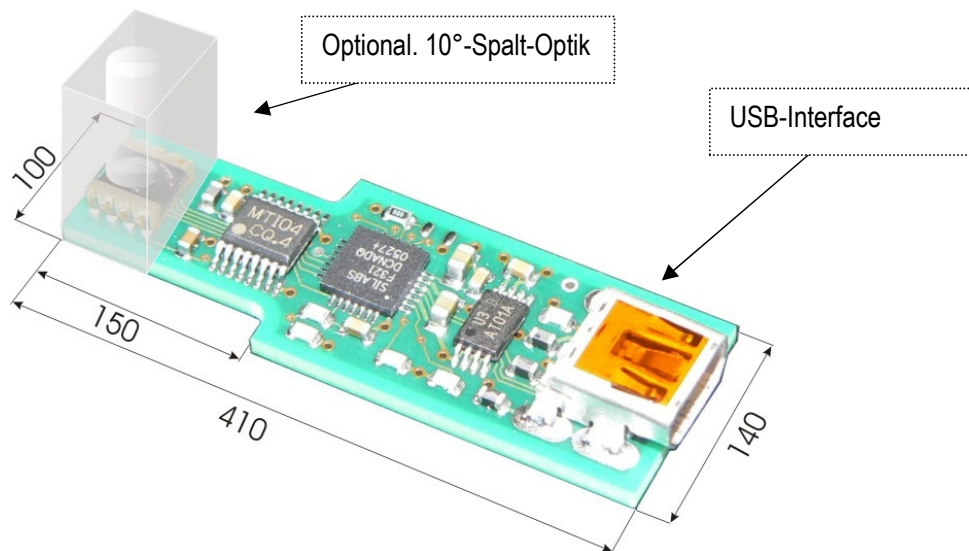


Figure 3; MTCS-C2 Board

² Please note, all components must be ordered as single positions.

³ Please specifically indicate when enquiring / ordering

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2.4 Software Installation

The "colorimeter2.exe" PC software (with USB driver of SYS and MTCSApi.dll type) is installed on your PC by using the setup.exe program.

For successful installation, the "usbcolor2.inf" and "usbio.sys" files must be copied to the "windows\inf" and the "windows\system32\drivers" directories, respectively. Use the USB cable (supplied) to connect the MTCS-C2 to one of your PC's free USB (2.0) ports. The device manager will output a "found new device" message on the screen.

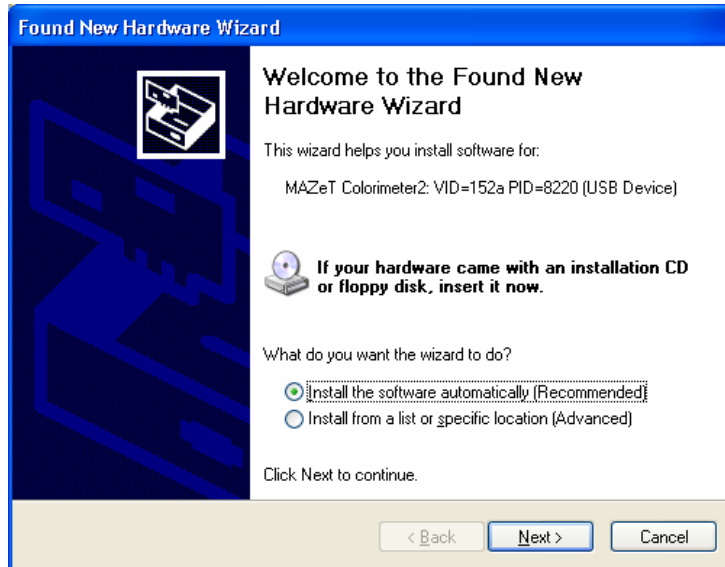


Figure 4 assistant for USB driver installation, 1. Page

In accordance with select the "Automatic software installation" function and then press "Next".

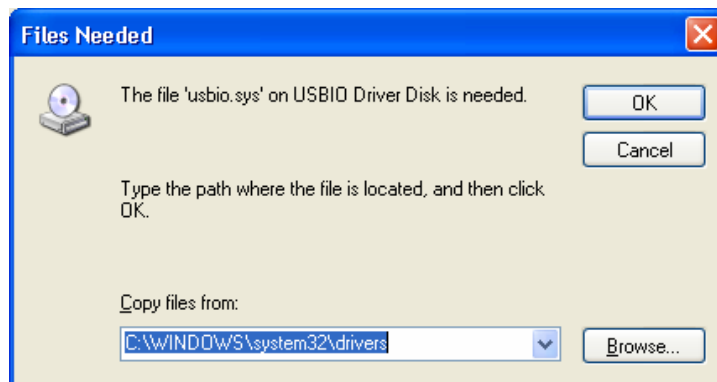


Figure 5; Microsoft assistant for USB driver installation

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In case the software does not install automatically (therefore, Windows does not locate the necessary files itself), you should enter the directories, in which you copied the .ini and .sys files (the default is \windows\inf and / or \windows\system32\drivers).

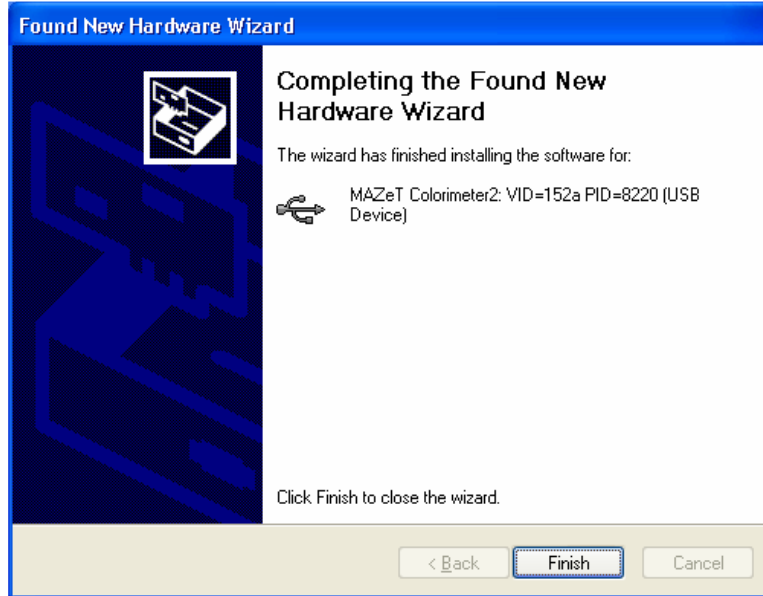


Figure 6 Assistant for USB driver installation, final page

After pressing "Finish" the USB driver installation is completed.

3. Hardware

3.1 MTCS-C2 Board

The following components are integrated on this board⁴:

- MTCSiCS True – Colour – Sensor
- MTI04CQ transimpedance amplifier
- C8051F321 micro controller with 10 bit AD converter and USB interface
- EEPROM - Free memory space for compensation and correction data

The board is supplied with voltage via the USB interface.

The micro controller has the following functions:

- Controlling and analysing of the colour sensor signals
- Activating the EEPROM for external memory space
- Communication via USB

⁴ The data sheets for the individual devices can be obtained from the MAZeT sales office.

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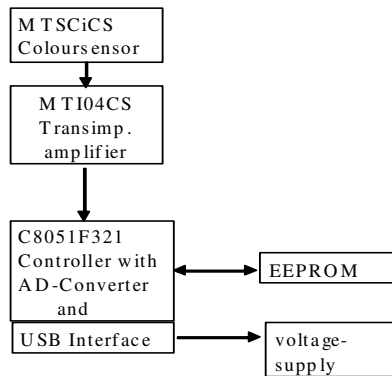


Figure 7; MTCS-C2 principle block diagram

The μ C C8051F321 firmware is designed to support communication via the USB interface, to handle all customized measuring algorithms, simple ADC access operations and averaging of multiple ADC access operation and to manage customised settings and data for calibrating the sensors.

4. Software

4.1 Software Start

Based on an Ini-file some functions and parameters are to be defined in the C2 software. Please do not change the details in the Ini-file without support by MAZeT or your distribution partner⁵. The Ini-file includes the following sections and parameters:

Ini-File: conf.ini

```

[section1]
// Boardtyp wechseln 0=modeva 1=col2
// change Boardtyp 0=modeva 1=col2
BoardTyp=0
DeviceAnzahl=1
Serial=0
Trennzeichen="."
// amplification adjustable in the main-panel
// Verstaerkungsfaktor im main-panel einstellbar
ShowVerstaerkung=0
// multiplikation with mti- amplification
Amplification=1
// at the starttime excel will be running
// beim Start wird excel geoeffnet
Excel=0
Column=12
//Wait =1 wait for confirmation and singlemeasurement
//Wait =1 auf Bestaetigen warten und Einzelmessung
Wait=0
    
```

⁵ Also do not change the values in the ini-File under [COLORIMETER2] und [modEVA].

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[COLORIMETER2]
 productid = 8220
 vendorid = 152a
 AnzeigeText=Colorimeter 2

[modEVA]
 productid = c35d
 vendorid = 400
 AnzeigeText=MTCS Mod Eva

DeviceAnzahl bigger as 1: some devices with the same ID's can be connected.
 Trennzeichen: “.” or “,” are possible. It is the description of the decimal point by saving.
 Serial=1 a connection to the serial port is possible.
 Excel=1 at the starttime excel will be running. All measurements will be writing to the excel-formulare.

A user software session can be triggered by selecting “mtcs.exe“. The window for USB System-Setup will open (Figure 8 or Figure 9). It contains standard entries for “Vendor_ID“ and “Product_ID“ representing specific Colorimeter conventions. These should not be changed.

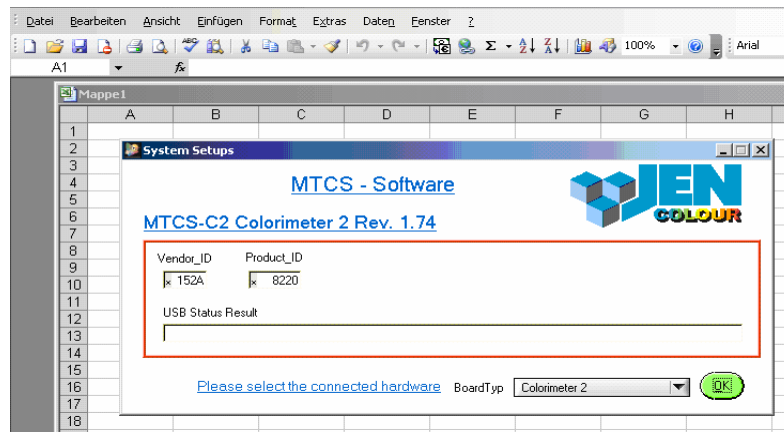


Figure 8; System Setups – Startup window with mit excel=1

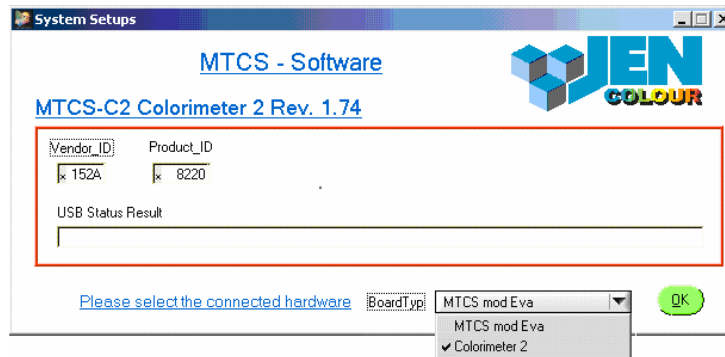


Figure 9; System Setups – Startup window

To check interface communication, click the OK button or the F8 function button.

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When the Colorimeter2 is correctly installed as a USB device, the firmware revision number 0.1x is read and displayed (**Figure 10; System setups – USB communication successfully established**).

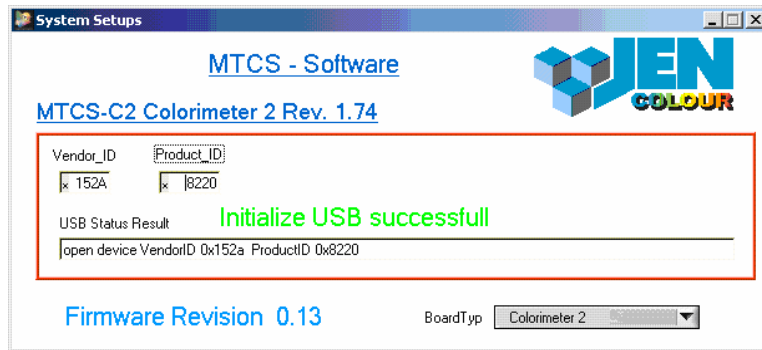


Figure 10; System setups – USB communication successfully established

After **Figure 10; System setups – USB communication successfully established** the window is automatically closed and the main window for carrying out measurements (see Section: : **4.2**) or the window for configuring the measuring environment on the erased memory space (see Section: 4.3) is opened.

If “....resetUSB“ appears in the “USB Status Result“ line, it is recommended to terminate the program, to split and rejoin the USB connection on the hardware side (Reset hardware) and to restart the PC software.

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4.2 Colour Detection and Measurement

Figure 11; Main window for colour measurement shows the main window for colour measurement visualisation.

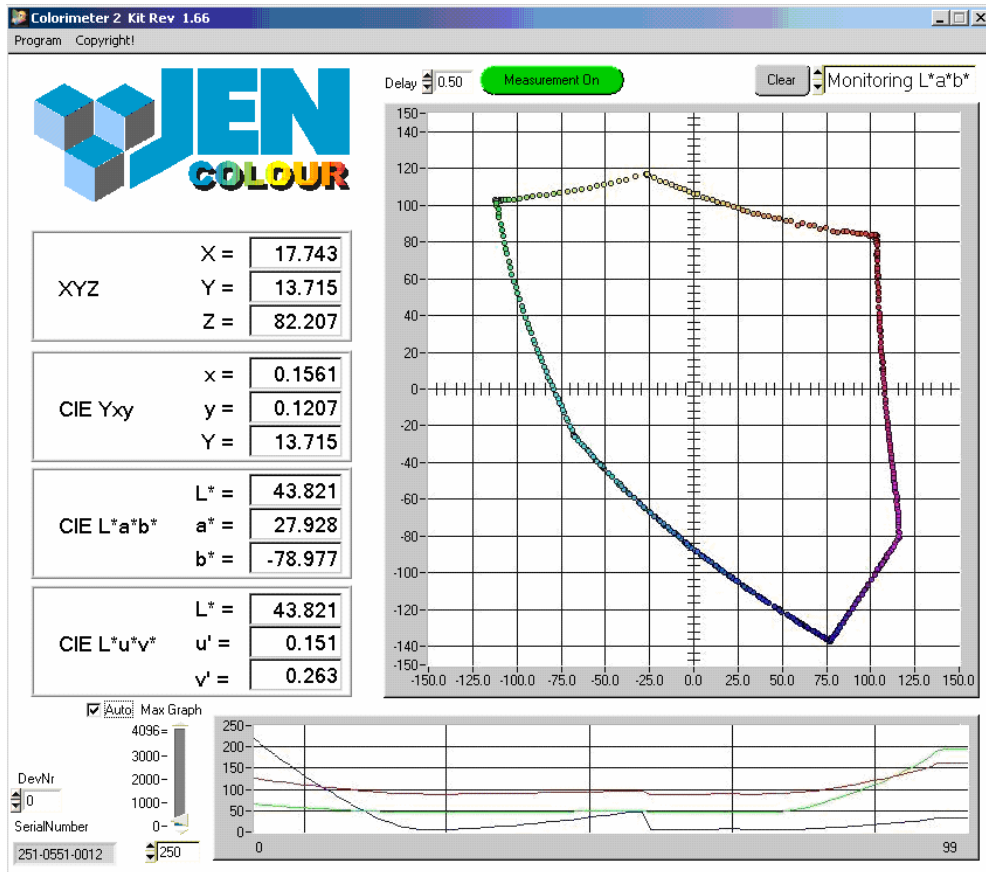


Figure 11; Main window for colour measurement

The measured results are represented graphically as XYZ standard Tri-Stimulus values, in a standard chromaticity chart of CIE 1976 L*a*b* and as L*u*v colour space. Please ensure that the colour values can only be interpreted more or less in the sense of the colour measurement when the board is calibrated to a measurement standard.^{fn}

A measurement can be triggered and cancelled by clicking the green "Measurement On / Off" or "ENTER" button (if the focus is non the "Measurement On / Off" button). By variation of the "delay" time (next to "Measurement On / Off" - input in seconds), a desired waiting time between two measurements can be changed. The "delay" time also changes the measurement time provided that the other values set in the program (e.g. averaging) and the computing power of the data processor allow this.

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For graphical display, you may choose between Yxy, L*a*b* or L*u*v* from the list in the top right. A given graphic can be deleted with the "Clear Graph" button or the "DELETE" key. At the bottom of the window there is an additional area in which the progression of recent values is displayed

(Figure 12; Graph of the variation over time of measured values). On the left, the display scale can be adjusted by setting a maximum value for the y-axis. If no progression gauge is displayed for continuous measurement it may be necessary for the area to be adapted. Selecting "Auto" automatically adjusts the area. On the left side you can read the serialnumber of the actually device. DevNr is for the selection of the device. It is only visible, if

- in the ini_File conf.ini the DeviceAnzahl is bigger then 1
- more as 1 device with the same VendorID and ProduktID are connected

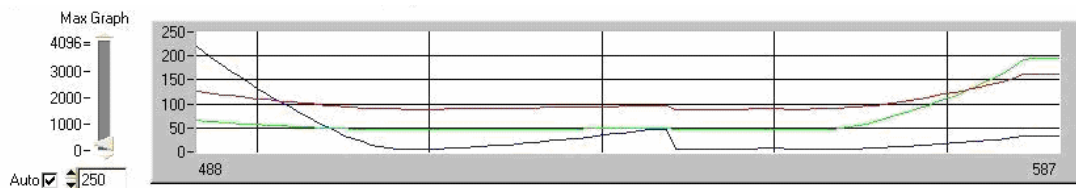


Figure 12, Graph of the variation over time of measured values

4.3 Menu

A variety of actions ("Program", **Figure 14**) can be selected by using the menu next to the program information ("Copyright", **Figure 13; Copyright**). This is described below.



Figure 13; Copyright

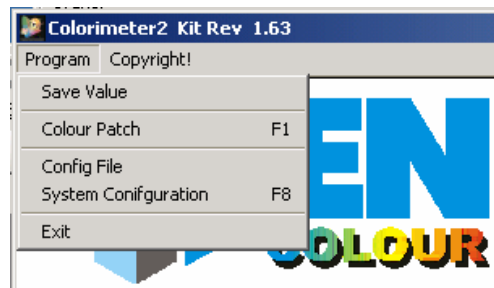


Figure 14; Menue

4.3.1 Save Value

Selecting "Save Value" from the "Program" menu enables you to save the measurement data

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as individual values or as a continuous list of all of the measurements as a measurement report in an external file.

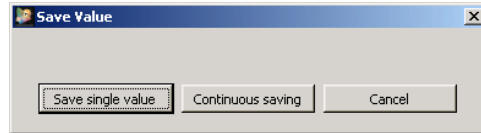


Figure 15; Save option: individual data or continuous saving

“Save single value“ saves the last measurement in a file. This function can also be carried out directly by pressing the F10 button.

If “Continuous saving“ is selected, data is saved according to all measurement specifications. By adjusting the time intervals, measurements can be carried out in succession by entering the delay time in seconds in the “delay” field.

A file name must be entered before the data can be saved (Figure 30).

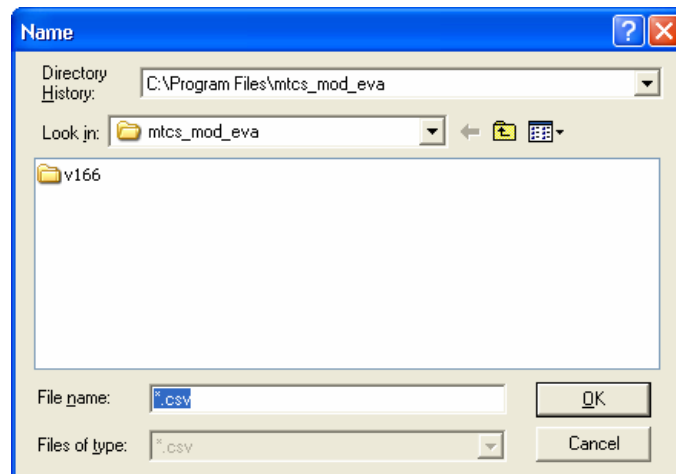


Figure 16; Enter a file name in order to save the data

Enter a name and press OK – the data will be saved in this *.csv file.

The entry “Stop Save value“ is in the “Save Value“ menu.

When activating the saving of data via the menu, there is the possibility to add new measurement data to the most recently used file or to put it in a new file. The request is carried out in accordance with figure 31.

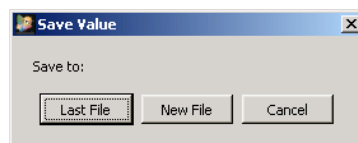


Figure 17; Save option: save in the most recent or a new file

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The .csv file has the following format.

- Line 1: JENCOLOUR Colorimeter2 Kit Revision 1.67
date and time of creation
- Line 2: data file No.;; X;Y;Z;; x;y;Y;; Lab;; Date ;
Time, separated with semicolons
- The data appears from line 3 onwards
The choice of separator (decimal point or comma in real numbers) is recorded in the ini file (see below).

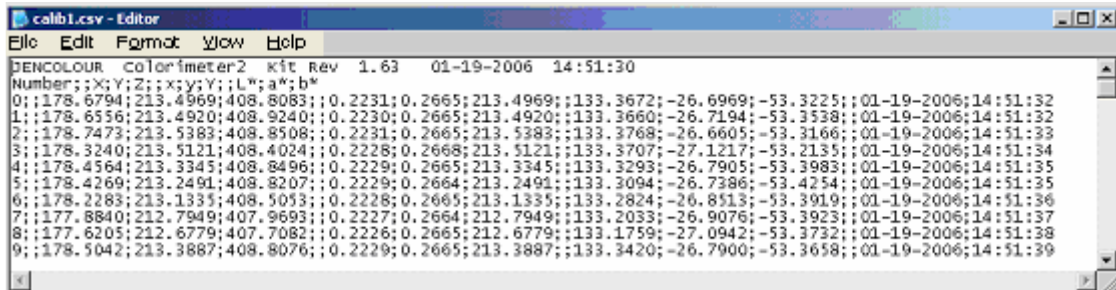


Figure 18; Organisation of saved data

Continuous data saving can be terminated when measurement ceases or by selecting "Stop Save value" from the "Program" menu.

4.3.2 Colour Patch

Selecting "Colour Patch" from the menu enables the measured colours to be visualised as a corresponding coloured window on the user interface. In addition, RGB values are indicated (Figure 19).

An evident matrix for the calculation of the RGB monitor values from the ADC raw data is a prerequisite for enabling the correct colours to be displayed (see section 4.5).

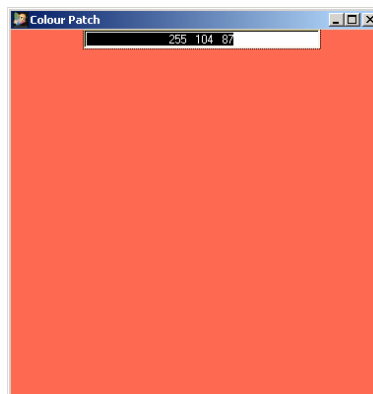


Figure 19; Colour Patch display

Attention!

Clear differences may occur in the colour reproduction of the measured targets due to different display types or different settings in the colour management of the PC and graphics card.

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4.3.3 Config File

Selecting “Config File” from the “Program” menu enables application-specific system configurations and calibration data to be loaded and stored (see section 4.5; Configuration of the application (measuring mode)).

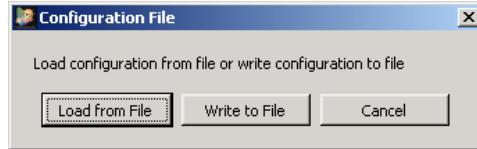


Figure 20; Accessing the system configuration file

The data is stored in a *.cfg file, organised in the following way:

Line	Contents	Example
1-2	SW Revision / Date / Time	
3	Type of configuration	
4	0	
5-7	Offset measurement value	
8-10	X, Y, Z for type of illumination	
11	0	
12	Max. Number of integration intervals	
13	Intensification	
14-22	Matrix raw data => XYZ	
23-31	Matrix raw data => RGB monitor	

4.3.4 System Configuration

The sensor system is set to corresponding types of measurement with specific parameters by using System Configuration. There is a detailed description in section 4.4.

4.3.5 Exit

Selecting “Exit” from the “Program” menu terminates the PC software.

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4.4 Changing the System Configuration

It is only necessary to change the system configurations during initial operation or when changing the measurement type.

The window for changing the system configuration is opened by going to the "Program/System Configuration" menu or by pressing the F8 button. When the program is run, this user interface is automatically loaded if no configuration data is stored (initial operation).



Figure 21; Reference to empty EEPROM

The following tasks are carried out via the „Application Setups“ dialogue box:

- Application requirement (measurement type)
- Adjustment of measurement conditions (integration time, mean values, etc.)
- Definition of colorimetric ambient conditions (offset, type of standard light, gamma correction)
- Determination of the gain matrix for colour range transformation due to target-specific comparison
- Memory allocation on the board

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If no configuration is saved (“no saved configuration”), the notification in Figure 21 appears directly after the USB initialisation and then the user interface appears, shown in Figure 22.

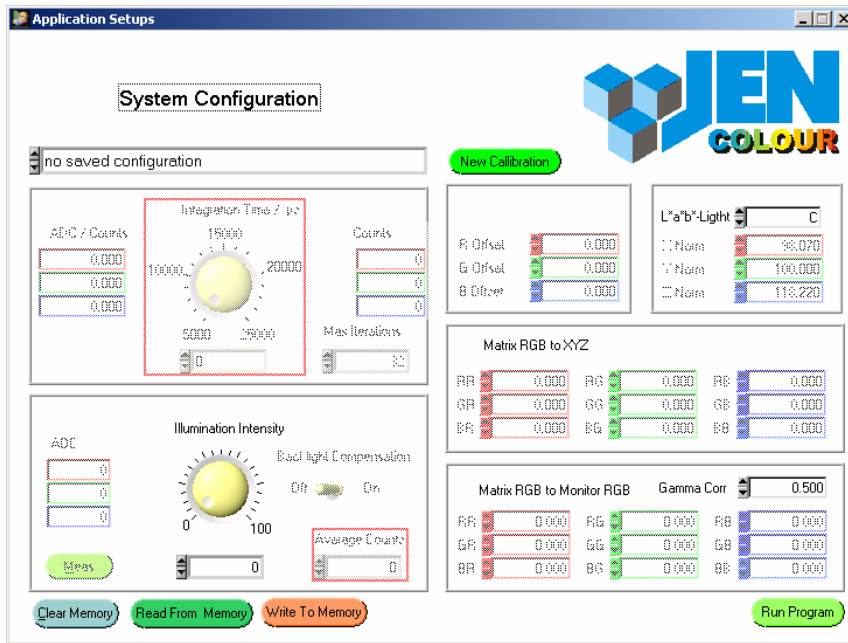


Figure 22; Example of configuration

The choice of application complies with the measurement type used and is selected from the list at the top left.

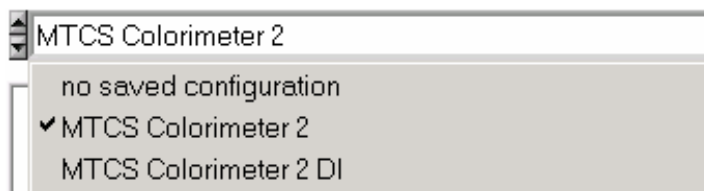


Figure 23; Application configuration (measurement type)

Depending on the application selected, the fields permitted for change are activated.

The configuration data is handled using the “Clear Memory”, “Read From Memory” and “Write To Memory” buttons in the memory on the main board.

After the configuration is changes, the “Run Program” remains inactive until the data is saved, using “Write To Memory” or reset, using “Read From Memory”.

Once the system in successfully configured, you can return to measuring mode by pressing the “Run Program” or F8 button (Main window for colour measurement, Figure 22).

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4.4.1 MTCS-C2 Configuration MTCS-C2

In the MTCS-C2 configuration, “Average Counts” determines the number of measurement values by averaging. For example, the MTCS-C2 board can be set to measure light sources, e.g. LEDs or TFT monitors.

An adjustment of the 10 bit ADC value can be entered in the “Shift” field and transmitted via the firmware.

The “Amplification” rotary knob adjusts the intensification on the MTI. There are 8 intensification levels.

If the intensification=0, the intensification is automatically determined. In order to do this, the tolerance value is required.

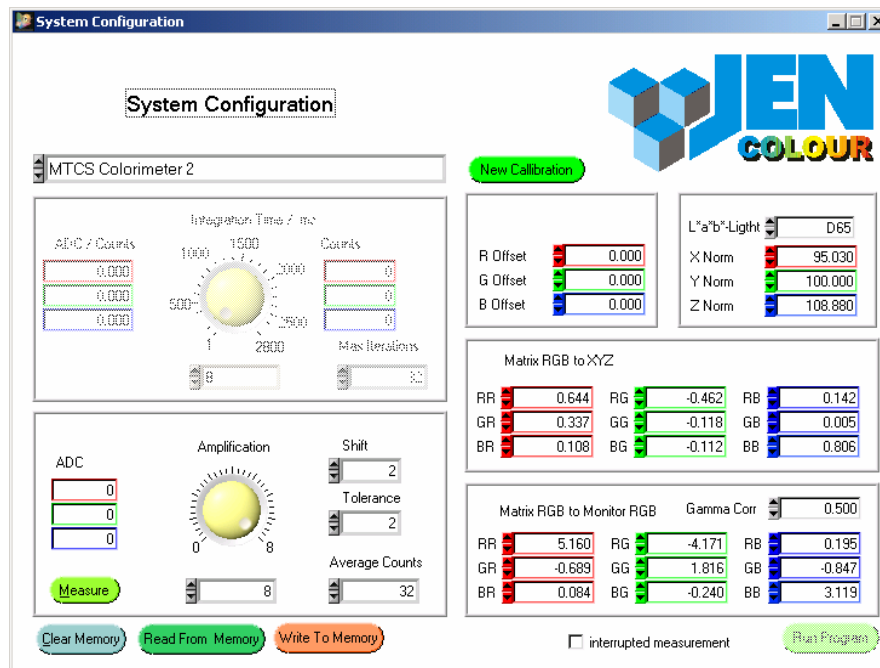


Figure 24; Example of configuration for MTCS-C2

In order for the system to be configured, the sensor must be directed at a white surface. With TFT monitors, it can be carried out on the screen with an appropriate light background.

Pressing the “Measure” button triggers a measurement and the corresponding measurement values (ADC values with fixed adjustment “Shift”) of the three measuring channels are displayed.

After the measuring conditions are adjusted, the system can be calibrated by generating a target-oriented gain matrix. This is explained in more detail in section 4.5.

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4.4.2 MTCS-C2 DI Configuration

DI stands for Digital Integration, which means that the ADC values (with fixed adjustment “Shift”) are added up over a fixed period of time.

The configuration is carried out by means of the active fields, as in Figure 25. The integration time is entered into the “Integration Time / ms” field. It can vary between 0ms and 2800ms.

A measurement is carried out in the given integration time. The measurement value (“ADC/Counts”) represents the integral deviation of the signal lever divided by the number of integration intervals (“Counts”).

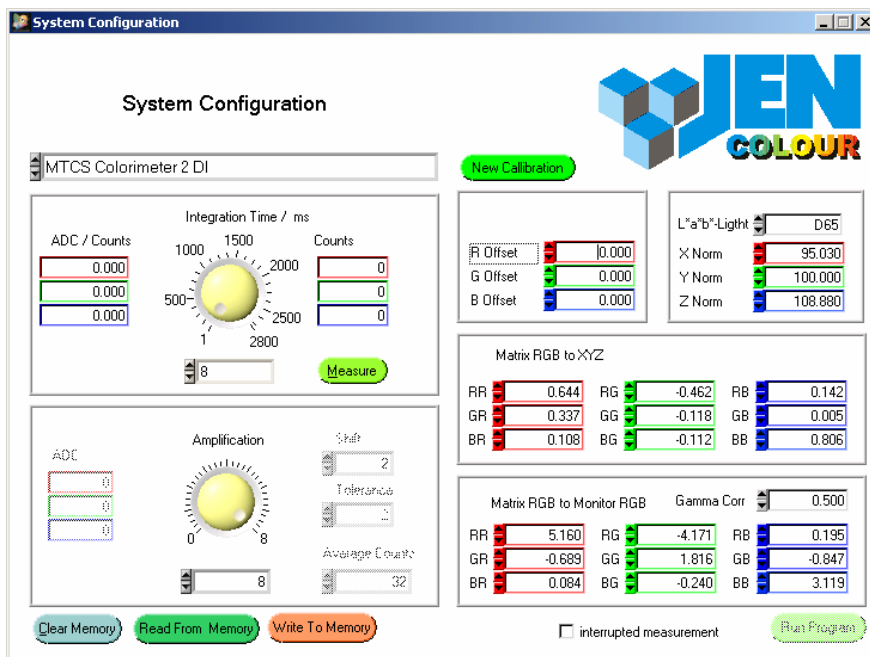


Figure 25; Example configuration for MTCS-C2 DI

The integration time is adjusted using the top rotary knob. The intensification is adjusted using the bottom rotary knob.

The intensification is adjusted on the MTI in the “Amplification” field.

A measurement is triggered when the “Measure” button is pressed and the corresponding measurement values (ADC/Counts-Values) are displayed on the three measuring channels.

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4.5 Target-oriented Calibration

The system comparison (Figure 26) is carried out on a known target set when the “New Calibration“ button is pressed. In the process, the actual system values are calculated to the targets with known XYZ values and, as a result, the offset values and the gain matrix are calculated. The comparison starts with the following window:

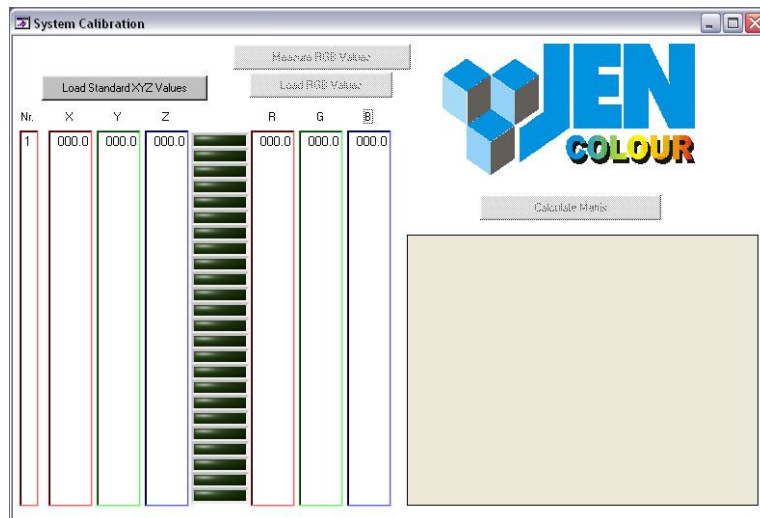


Figure 26; Start of System Calibration

The data for a known and measured target set is loaded by pressing the "Load Standard XYZ-Value" button. This dataset consists of a minimum of 3 (24 recommended) target XYZ and RGB values for the monitor display.

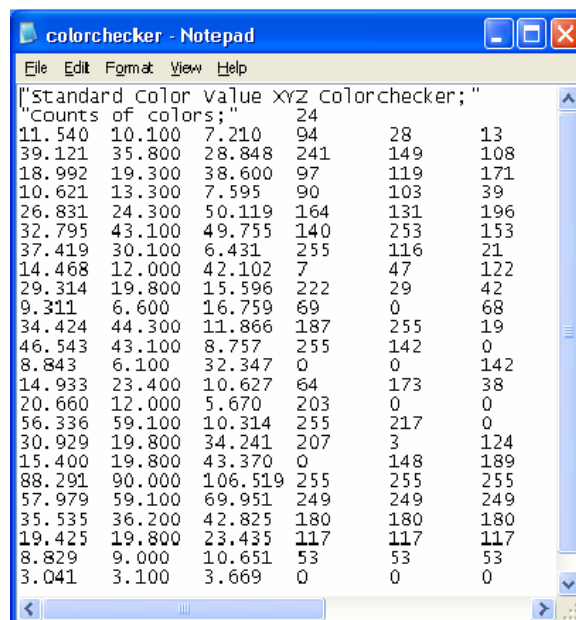


Figure 27; Target Dataset

The dataset can be calculated using the radiance measurement, for example from the colour range data provided from a colourchecker from the company, GretagMacbeth (Figure 28).

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Figure 28; GretagMacbeth Colourchecker

The use of other targets presumes knowledge of the XYZ values. By monitoring with a spectrometer, an appropriate file can be created for luminescent objects.

The loaded target file is displayed with the XYZ numerical values and the combination colour of the monitor in tabular form (Figure 29).

The actual values are entered automatically during a comparison on a calibrated monitor. For this, the sensor is positioned in the middle of the coloured surface or in the separate colour patch field and the comparison is started by clicking on “Measure RGB Values”. The RGB monitor values deposited in the file are successively adjusted and the corresponding actual values are recorded.

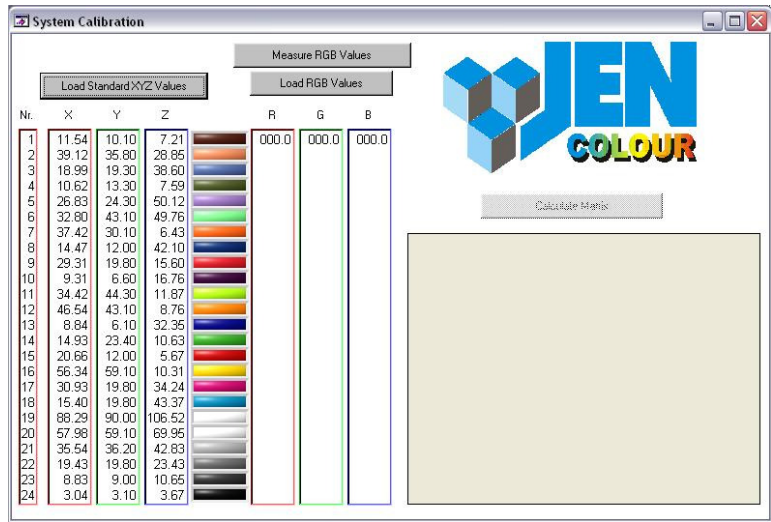


Figure 29; System Calibration: Required Values

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When the comparison is carried out on a reflecting target set, the sensors are successively adjusted to measured target colours and the respective actual value is entered when “Measure” is activated (Figure 30).

In the case of incorrect measurements, the last measurement can be deleted and repeated by pressing the “Repeat” button.

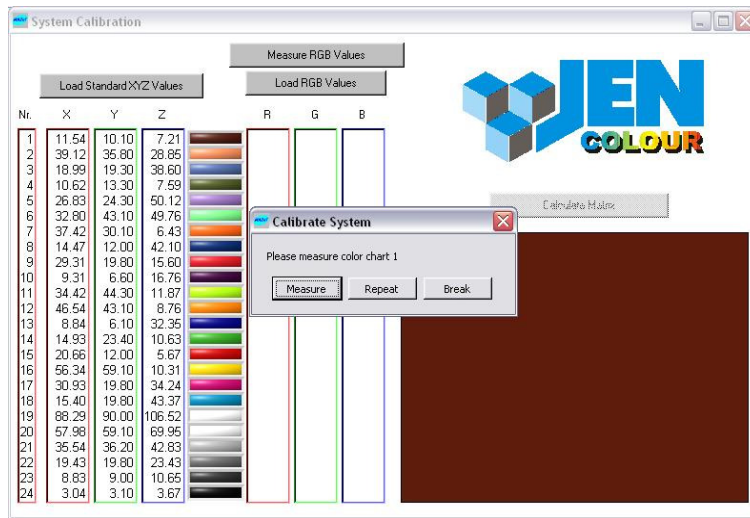


Figure 30; System Calibration: Entering the actual values

Use the “Break” button to cancel the calibration and return to the “Application Setups” dialogue box.

Once all 24 actual values have been entered, the file is saved and the offset values are calculated. A pre-prepared actual value file can be loaded by pressing “Load RGB Values”.

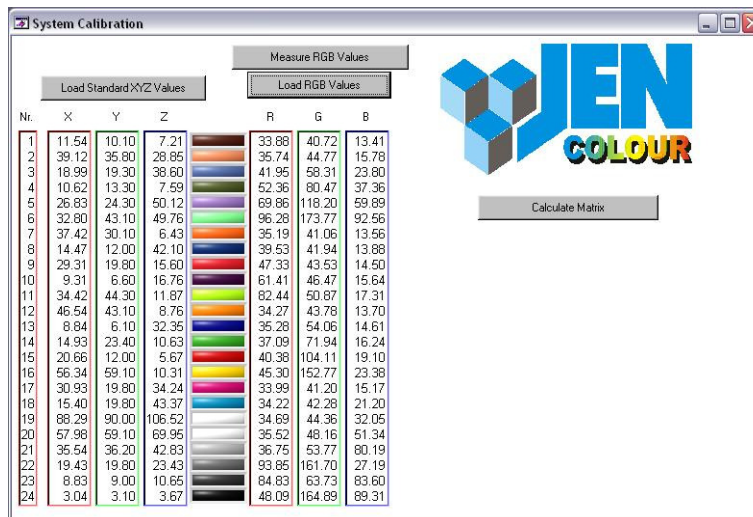


Figure 31; System Calibration: Matrix Calculation

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If the offset-corrected actual values are available, the “Calculate Matrix” button is activated (Figure 31). You can click to calculate the gain matrices, complete the comparison and revert the software back to the “Application Setups” dialogue box, in which the determined offset values and matrices are displayed.

For the lab values calculated in the measurement, it is still necessary to enter the type of illumination, for which the calibration was carried out (“L*a*b*Light“ in Figure 25).

The determined calibration data is deposited into the onboard memory when the “Write to Memory” button is pressed. It becomes available automatically after the system is rebooted, without the need to carry out a new comparison.

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