Product Document

Published by
ams OSRAM Group

high performance needs great design.

Coverpage: AS73210-AS89010-AB4 SET DK User Guide

Please be patient while we transfer this adapted former MAZeT document to the latest ams design.

User Guide
AS73210-AS89010-AB4 SET DK

Development Kit

Order No.: 220800004
Status: certified

INTRODUCTION

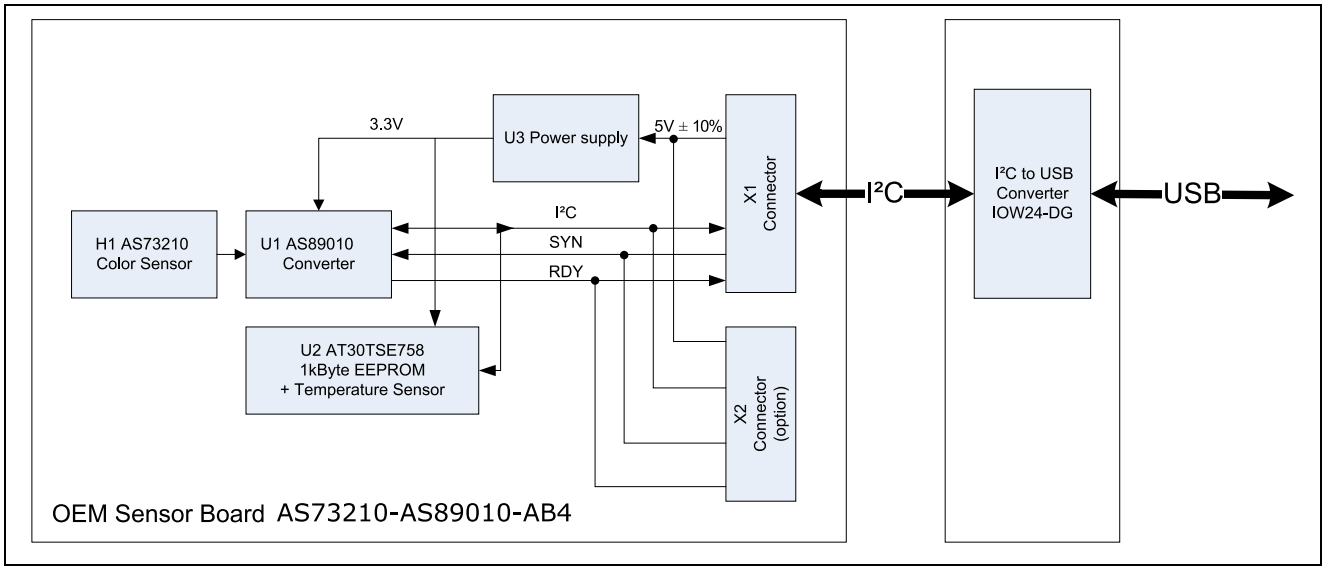
The family of AS73210-AS89010-AB4 based test systems of ams Sensors Germany, their housing, adapters and further information are described in this document.

The Test SETs include the OEM AS73210-AS89010-AB4 sensor board [5], optional (Development Kit) fitted into a metallic housing with optical interface, a standard I²C-to-USB converter as well as Windows PC test software.

The test software enables to control the converter, calibrate the sensor and allows data logging options including a print out of results. Please note, the development kit was designed to be a test system for system and application tests.

Please note, the development kit was designed to be a test system for using only in system and application tests.

Figure 1: Block Diagram AS73210-AS89010-AB4



The OEM sensor board AS73210-AS89010-AB4 is a small PCB for general color measurement and control applications, with a high bandwidth of light energy and handheld applications. The sensor board includes a True Color sensor AS73210 [2] based on the international CIE 1931 standard, a special analog-to-digital converter AS89010 [1] with a high dynamic range (1 : 1,000,000), an EEPROM for sensor data, an integrated temperature sensor, 2 LDO micro power regulators (LT1761ES5-3, Linear Technology) to manage the analog and digital supply voltage. I²C is used for external communication, configuration of the sensor, readout of the sensor data as well as writing and reading of the memory.

The OEM sensor board AS73210-AS89010-AB4 [5] uses a standard I²C-to-USB converter for initial testing reasons via USB and PC software. This converter IOW24-DG [4] is connected to the sensor board via cable and controls uncritical functions (not synchronized) of the sensor board via PC.

The standard software is only valid for Windows based systems (Minimum Windows 7). The I²C to USB converter [4,6] also supports LINUX and iOS based systems.

The description of the sensor, converter, OEM hardware and I²C communication is implemented in the reference documents [1] [2] [3] and [5]. For all details of the I²C converter, see [4].

The following chapters describe the development kit and especially the software setup and usage for a Windows PC. Please make sure to install all libraries and test software before you connect the development kit on PC via USB. Otherwise, the test software starts in a demonstration mode and does not make real measurements.

1 SCOPE OF DELIVERY

The AS73210-AS89010-AB4 product family includes alternative delivery forms with the following standard elements:

- Sensor board AS73210-AS89010-AB4 (housed or OEM PCB)
- Setup for PC test are including setup for MATLAB™ Compiler Runtime, not for OEM version
- I²C cable with USB converter (device from [4]) , not for OEM and/or optional
- Optical cover for realize angle of incidence, not for OEM and/or optional

Defined in [6] alternative IO-Warriors and libraries are available for customers wanting to integrate the kit into own software environments. For the scope of delivery of alternatives see the following table:

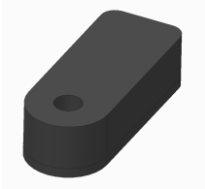
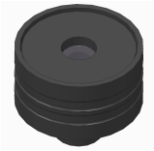
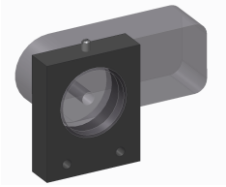
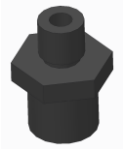
Table 1: Scope of delivery for AS73210-AS89010-AB4 product family (form of deliveries may be different)

Name	**AS73210-AS89010-AB4 SET DK JENCOLOR® Development Kit with USB-Interface**	**AS73210-AS89010-AB4 JENCOLOR® OEM Sensor Board with I²C-Interface**
		
Article	220800004	220800002
Sensor AS73210 + AS89010	O	O
Interface	I²C / USB via dongle	I²C
PC Windows Test software	O	---
Housing and adapter	O / O	O / -
USB cable	O	---
JCDK-Aperture-13.5	O	optional
Optical Cover	optional	O

The housed test system consists from a basic case which will be adapted customized and/or application specific by various parts and optical components (apertures).

The solid basic case was made of anodized aluminum, which protects the sensor board AS73210-AS89010-AB4 against mechanical stress as well as ESD and EMF. The sensor AS73210 is positioned in the basic case coaxial with a 3/8”-24 UNF internal thread and ready for the application of different optical accessories.

Table 2: Basic case and adapters for the DK AS73210-AS89010-AB4[1]

JCDK-Basic case	JCDK-Aperture-13.5	JCDK-Aperture-13.5 with IR-cut-off filter	JCDK-1/4"-Adapter	JCDK-SMA-Adapter
				

There are difference adapters "Aperture" available to adapt for the sensor in the package the angle of incidence and/or to fix the sensor system.

The JCDK-Aperture-135 is designed to limit the angle of incidence on the AS73210 to ±10°. It is an optional aperture of the JCDK assortment and characterized with a single groove outside. The outside diameter of 25mm makes it compatible with JCDK-1/4"-Adapter and opto-mechanical system parts (e.g. Linos). In front of the aperture is space for mounting a filter glass with outside diameter up to 22.2 mm and thickness up to mm.

JCDK-1/4"-Adapter is used for mounting the JENCOLOR® DKs on a camera tripod or equivalent holders. On the bottom side there is a centered 1/4"-20 UNC internal thread and 20mm below the optical axis there are two M4 internal threads for mounting the JCDK-1/4"-Adapter on a flat surface. For IR sensible applications order the JCDK aperture 13.5 with inserted IR blocking. For using the adapter with an alternative integrated filter please ask our sales team.

Via the JCDK-SMA-Adapter a fiber optic patch cable with F-SMA 905 plug can be connected to the JENCOLOR® Development Kit. The distance between fiber end and sensor is calculated to achieve an angle of incidence of at most 10° with a fiber core diameter up to 600µm. Minimum NA for illumination of the whole sensor area is 0.22 and to reduce the effect of stray light inside the adapter and the case NA should not exceed 0.39.

[1] For other adapters please contact our sales team.

2 SYSTEM REQUIREMENTS

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

- PC Pentium 1 GHz or higher
- 512 MB RAM
- 1x free USB (2.0) port
- 80 MB free hard drive memory (+ approx. 1.3 GB for MATLAB™ Compiler Runtime)
- Microsoft Windows™ 7 and above
- (optional[2] for import/export functions) Microsoft EXCEL™
- Internet Connection and administration right for runtime and software installation

3 SPECIFICATION OF AS73210-AS89010-AB4 FAMILY

Table 3: Specification of (SET) (DK) AS73210-AS89010-AB4

Spectral range	380nm … 700nm
Measuring Method	Based on XYZ CIE 1931 standard (user calibration necessary)[3]
Measuring values	ADC digit; ADC current; XYZ; Yxy; Yxy SDCM; Yuv
Gain (reference currents)	Selectable 20nA …5120nA (5 stages)
Integration time	Selectable 1ms … 1sec (11 stages)
Digital electronic resolution	16bit ADC output by using divider for 20 internal bits
LSB min lux	0.00005
FSR min lux	3.31
FSR max lux	13,576.43
Dynamic range	1 – 1,000,000
Power supply	USB powered
PC interface	USB 2.0 full speed
Weight	60 g plus adapter ca. 5…10g
Operating conditions	Temperature 0 ... 85 °C Humidity 85% relative humidity at 35°C

[2] E.g. recommend to use some special program functions like write protocol and others

[3] For more details for sensor response, sensitiveness and other parameters see the AS73210 datasheet

4 START-UP

4.1 Software/Driver Installation

This section of the document describes how to install and use the AS73210-AS89010-AB4 PC-software.

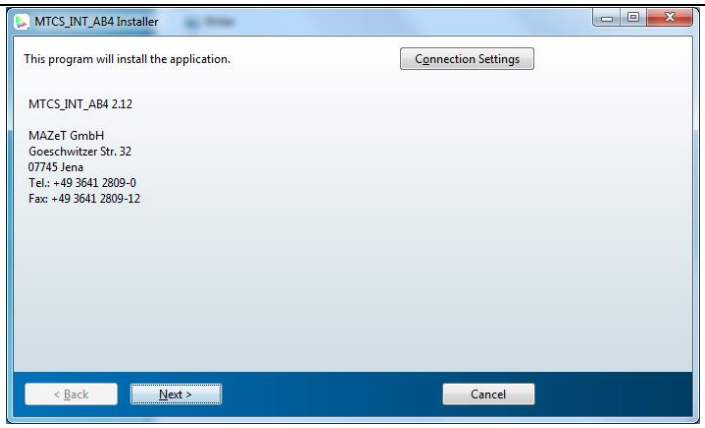
During process installation and work administration permission are needed. Note: The SETUP must be run with the special option "run with administration rights".

The installation process also requires a working internet connection to connect to MATLAB-specific system requirements. Please check your system configuration in Windows System Control for the Internet connection and right settings.

Before you start the SETUP file for the test software check whether the actual MATLAB Compiler Runtime (MCR) 8.2 version (standard installation by MCR_R2013b_win32_installer.exe) is installed on your PC[4]. If MATLAB Compiler Runtime library was not installed then follow the special instructions in the setup process for MATLAB.

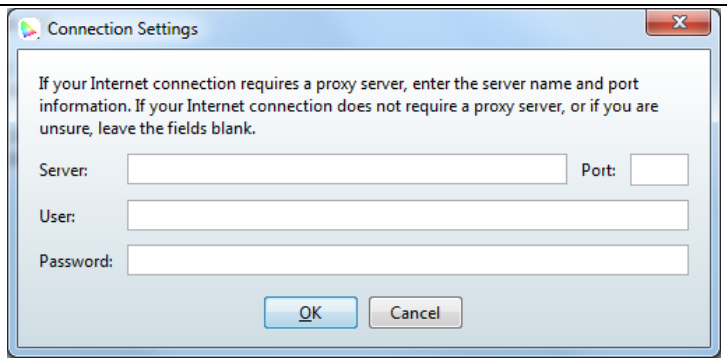
To start the installation of the AS73210-AS89010-AB4 test software simply execute the setup.exe file from the USB stick or other memory which you got and all required files are installed automatically. The setup opens in a window which guides the user through the installation step by step.

Figure 2: Setup - Welcome screen Setup



The setup software checks the installed MCR version. If the version is incorrect the setup attempts to download the correct MCR via internet. If your internet connection requires a proxy server, configure the server using the 'Connection Settings' button.

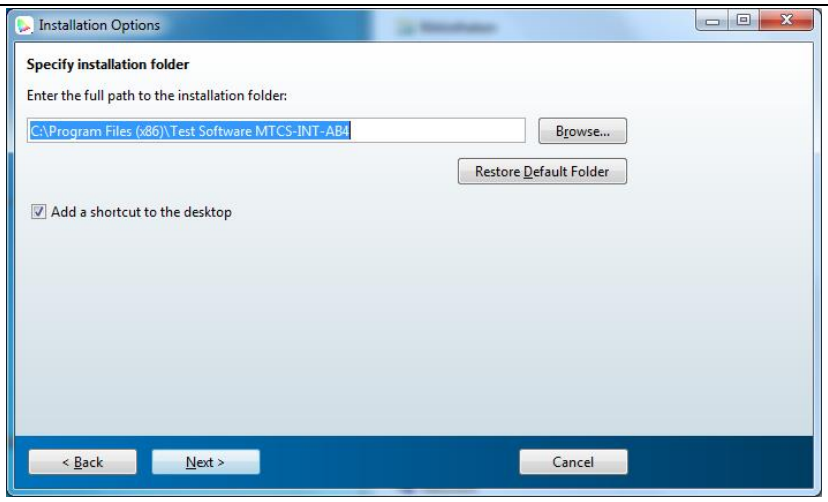
Figure 3: Setup - Connection settings



[4] The setup routine always check internally whether Setup Matlab was defined by the System variables $PROGRAMFILES. Normally that is the path C:\Program Files (x86)\MATLAB\MATLAB Compiler Runtime.

Click 'Next' to specify installation options, set the installation path and add a shortcut to the desktop. The installation folder will include the program and data files in several directories.

Figure 4: Setup - Destination Folder



After clicking 'Next' setup will check the installed MCR version. If the correct version was installed just click 'Next' at the following screen. Otherwise, setup attempts to download the correct version via internet and installs it.

Figure 5: Setup - MATLAB Compiler Runtime version already installed.

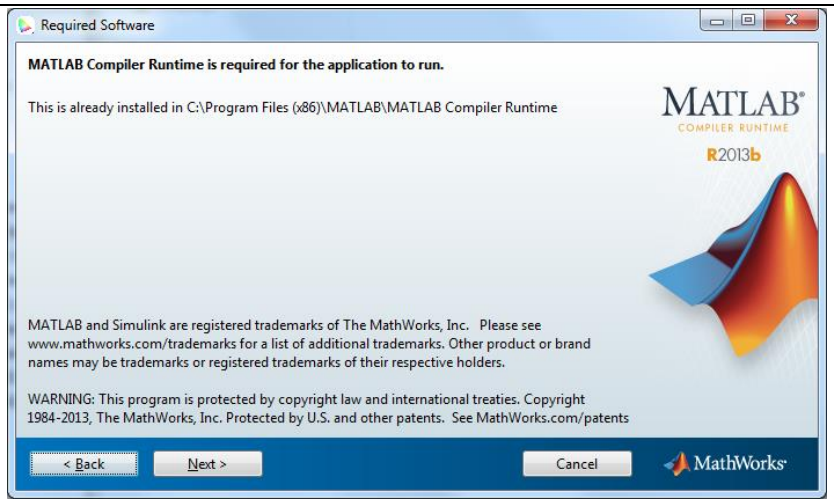
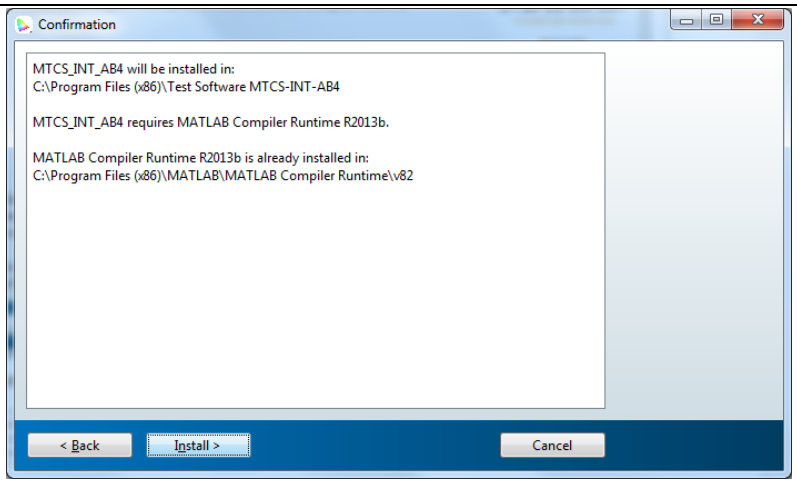


Figure 6: Setup - Download required Compiler Runtime and confirm MATLAB License Agreement

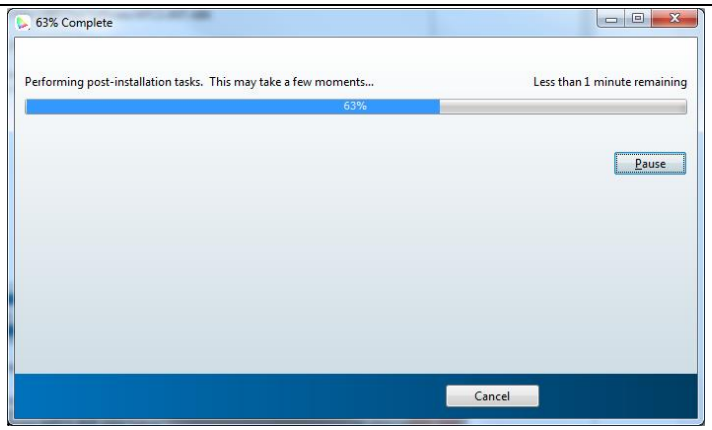
In the next screen, there is the option to confirm the MathWorks License Agreement.

Figure 7: Setup - Start installation



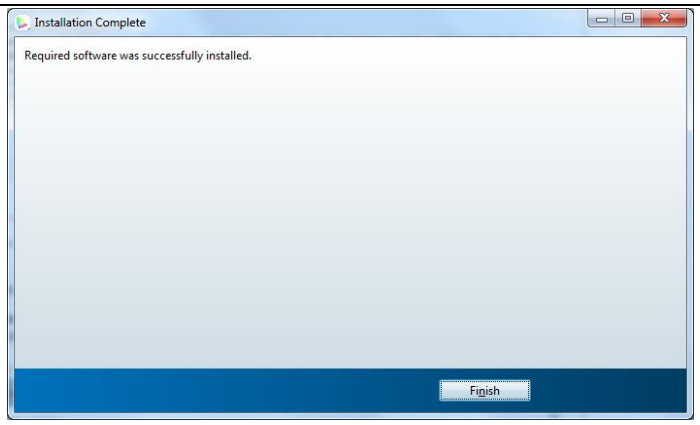
The software will be installed into the shown destination folders after confirming via 'Install' button.

Figure 8: Setup - Installing



The installation is completed after confirming via 'Finish' button.

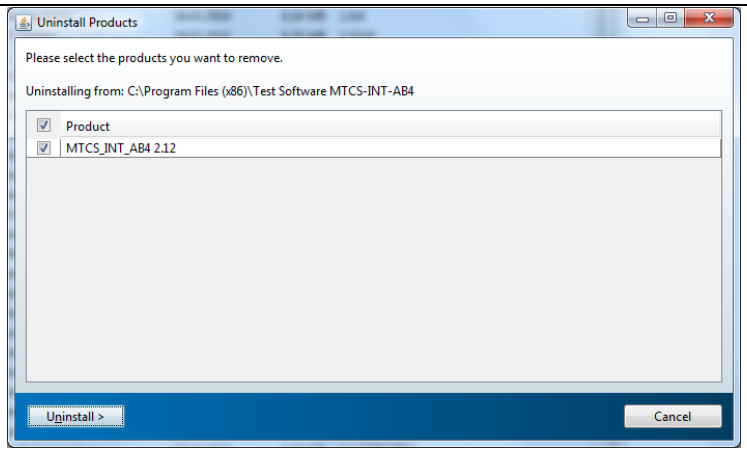
Figure 9: Setup - Installation finished



4.2 Remove

To uninstall the software use the Windows system setup “Add or remove programs”. Choose the programs to uninstall them in the following dialog.

Figure 10: Setup - Remove program



Press ‘Uninstall’ to delete the complete software package. You may be required to manually remove some files remaining in the installation of the software.

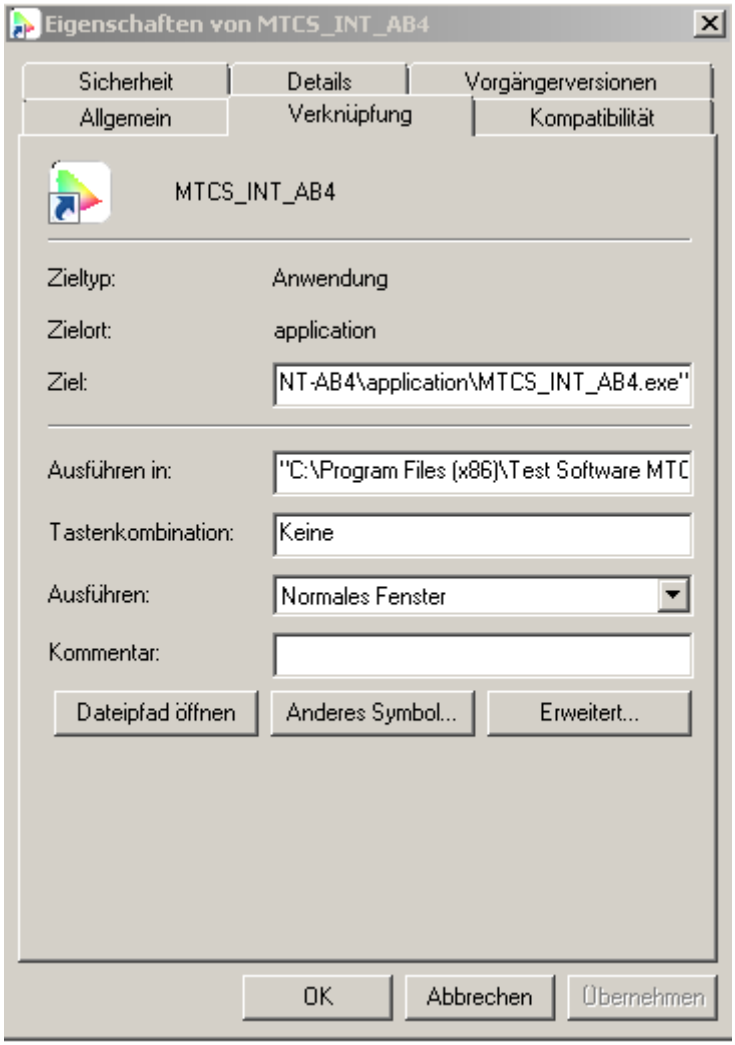
Attention: Create a backup of your own created files that are located within the installation folder.

5 SOFTWARE DESCRIPTION

5.1 Software start

Use the standard to start the AS73210-AS89010-AB4 software by the installed icon MTCS_INT_AB4 in the program menu. In the main user interface the specification for the measurements e.g. integration time, reference currents, divider and offset must be selected before the measurement process will be started (see chapter 0) or use the function "Load configuration file" to specify all the named parameters (see chapter 5.7). Some examples of such predefined specification files are installed in the directory "….Test Software AS73210-AS89010-AB4\application" (see chapter 5.8).

Figure 11: Standard properties of the installed AS73210-AS89010-AB4 software



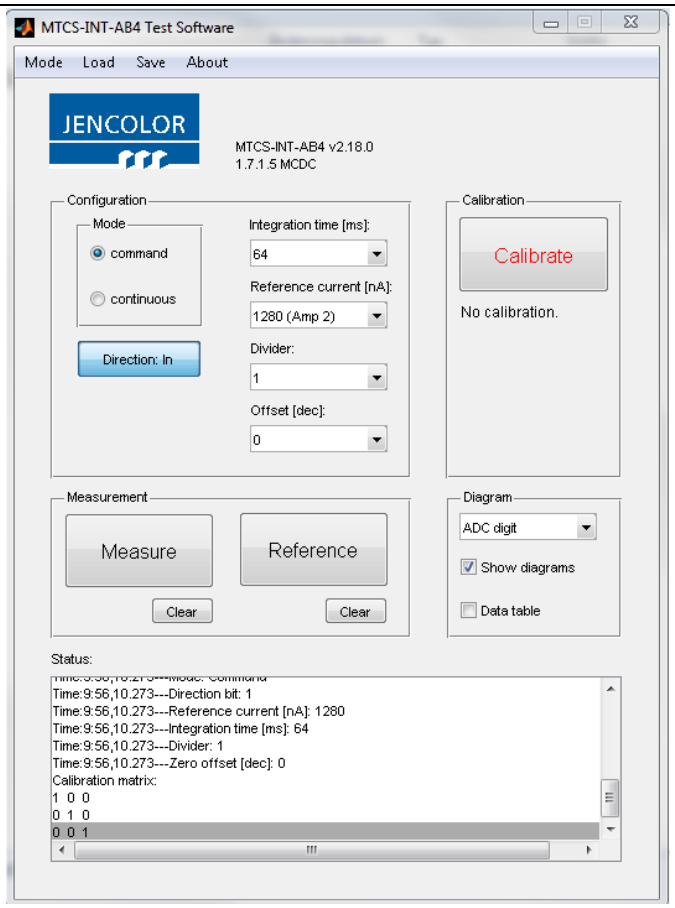
Another variant to start the software DK AS73210-AS89010-AB4 with specified parameters is to expand the start command in the property by a pre-defined configuration file. See the following example for a complete text in the target of the MTCS_INT_AB4 property to start the software:

"……. MTCS_INT_AB4.exe" "command example AS89010-EB1.csv"

5.2 Main User Interface Elements

After a successful installation and running the software the user interface always starts in ***Expert Mode*** (see chapter 5.4) and includes different possibilities (button, menu bar, dropdown menu) to change the parameters for measurements (***Configuration***), to select form of outputs (***Diagram***), and to control the next program steps (***Measurement, Calibration***).

Figure 12: Main User interface elements in Expert Mode



Configuration: The most important parameters can be changed direct by the user. It is possible to initialize and control the measurements (see also chapter 5.8). After pressing the ***Measure button*** the test software starts a measurement with the selected initialization. Based on the selected mode the measurement will be performed sequentially by ***command*** after each click and/or in ***continuous*** mode. By selecting the parameters of the converter like ***Integration Time, Reference Current, Divider*** and ***Offset*** parts of the gain of the sensor system can be directly controlled by the user. If an initialization via a *.csv-file (see chapter 5.8) was selected then ***Configuration*** shows the actual selected parameters of *.csv. For more details and parameters of ***Configuration*** please see chapter 5.5 and/or the datasheet of AS89010 [1].

Calibration: Use this button to start the calibration process (see also chapter 5.6). As long as no calibration is performed, the status of calibration is invalid and the button is highlighted in red. After completing a calibration the status is valid and the button is highlighted in green. A change in the configuration parameters changes the status of the calibration back to invalid (red) if the parameters differ from the setting used for the calibration.

Diagram: The representation of the measured data and a table for the data output of the measurements can be enabled / disabled and adjusted.

Measure / Reference: A (reference) measurement (see chapter 5.3 and/or 5.4) is started with the selected parameters.

The ***Clear*** button deletes all measurement values and closes the ***Color space*** window. It does not delete any register settings[5]. The following example shows the color space Yu'v'. (Figure 15)

[5] Please note that register settings only could be changed by new writing or after a hardware reset to default via USB disconnection/connection.

Status: The status window shows important steps performed by the program and I²C status is logged (see also chapter 5.4).

In the **Menu Bar** different functions for the initialization of the program, parameters and/or data input / output are listed.

Load/Save: In ***Load*** an initialization file for the gain parameters can be read ('Load Config', see chapter 5.7, 5.8). 'Load Config and measure data' will restore a saved session file (*.dat) with all gain parameters, calibration and measured data's of a last session. In ***Save*** the entry 'Save Config and measure data' saves all data of the actual session in a *.dat file and 'Export…' writes all configuration data's and the measured results in a *.xls[6] or *.csv file.

Mode: The ***Easy Mode*** (see chapter 5.3) can be activated in this selection. This options is ideal to perform measurements after a calibration has been performed.

5.3 Easy Mode

The ***Easy*** Mode is designed to be as simple as possible using only limited functions. It can be set manually in menu bar as shown in the following picture in case the expert mode is active.

Figure 13: Menu bar - Easy mode

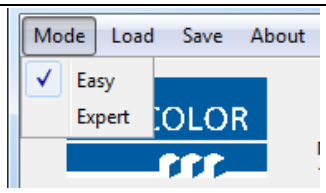
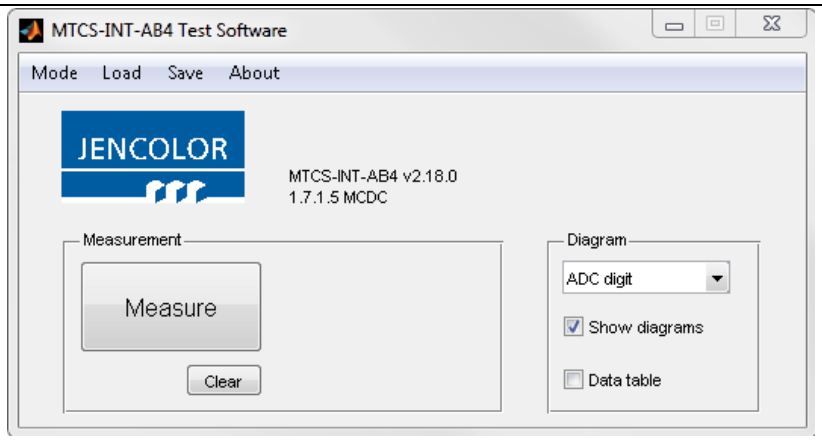


Figure 14: Main User interface elements in Easy Mode



To configure the device in the ***Easy*** Mode you can load a predefined configuration *.csv file or a full session file (*.dat) including configuration, calibration and measurements. To do this use the ***Load*** menu.

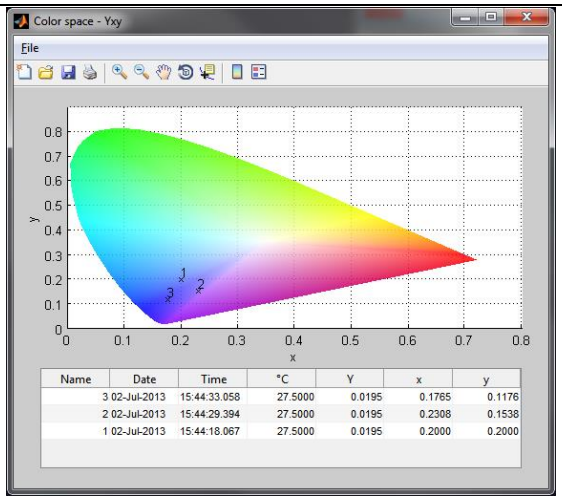
After pressing the ***Measure*** button a color chart appears with the selected diagram which shows the measured values of the sensors. Using a command based configuration file, clicking generates one new measurement value (in command mode) or continues measurements (in continues mode) until the stop button is pressed. The result(s) of the measurement(s) are shown in the selected diagram color space window as a figure, or, if activated, in a data table under the figure.

After starting the program this data table is not automatically activated to increase the speed of the measurements. If ***Data table*** is activated, please note the final result of the measurement is always displayed in the first line.

[6] Excel installation on PC is necessary

The number of measurements is always shown in row one - name.

Figure 15: Measurement values – with selected Yu'v' diagram and selected Data table



Name	Date	Time	°C	Y	x	y
3	02-Jul-2013	15:44:33.058	27.5000	0.0195	0.1765	0.1176
2	02-Jul-2013	15:44:29.394	27.5000	0.0195	0.2308	0.1538
1	02-Jul-2013	15:44:18.067	27.5000	0.0195	0.2000	0.2000

5.4 Expert Mode

The ***Expert*** Mode offers further options like a reference measurement, sensor calibration, and a detailed I^2C status report. The Expert Mode can be activated similar to the Easy Mode via menu button ***Mode***. The user interface changes automatically after choosing this option as shown in the Figure 16***.***

[Direction In: Only to use in combination with the AS89010 test board. Otherwise use it as "Direction In".]

Calibrate:The button ***Calibrate*** helps you to perform a sensor/application calibration to optimize the overall accuracy based on the CIE 1931 standard. Read section 5.6 for further information. If the Calibrate button is highlighted in red, it indicates that no calibration file is loaded and that the sensor only shows exact ADC values.

After the calibration has been performed and the Calibration button turns green all selected color points shown in the color space windows are shown exactly according to the calibration.

Status: The ***Status*** field provides information about the run time processes. This can be for example the ADC value, readings or settings of the configuration on the sensor board via I^2C or a specific calibration status.

Reference: Pressing the ***Reference*** button while color spaces are selected in the ***Diagram*** dropdown performs a comparison of the reference and measured values in the selected color space. Subsequently, pressing the ***Measure*** button allows to view the delta values between the reference and the measured values. To generate a new reference value, just press the ***Reference*** button again and the user interface will be updated with the new reference value.

Figure 16: Expert mode - User interface

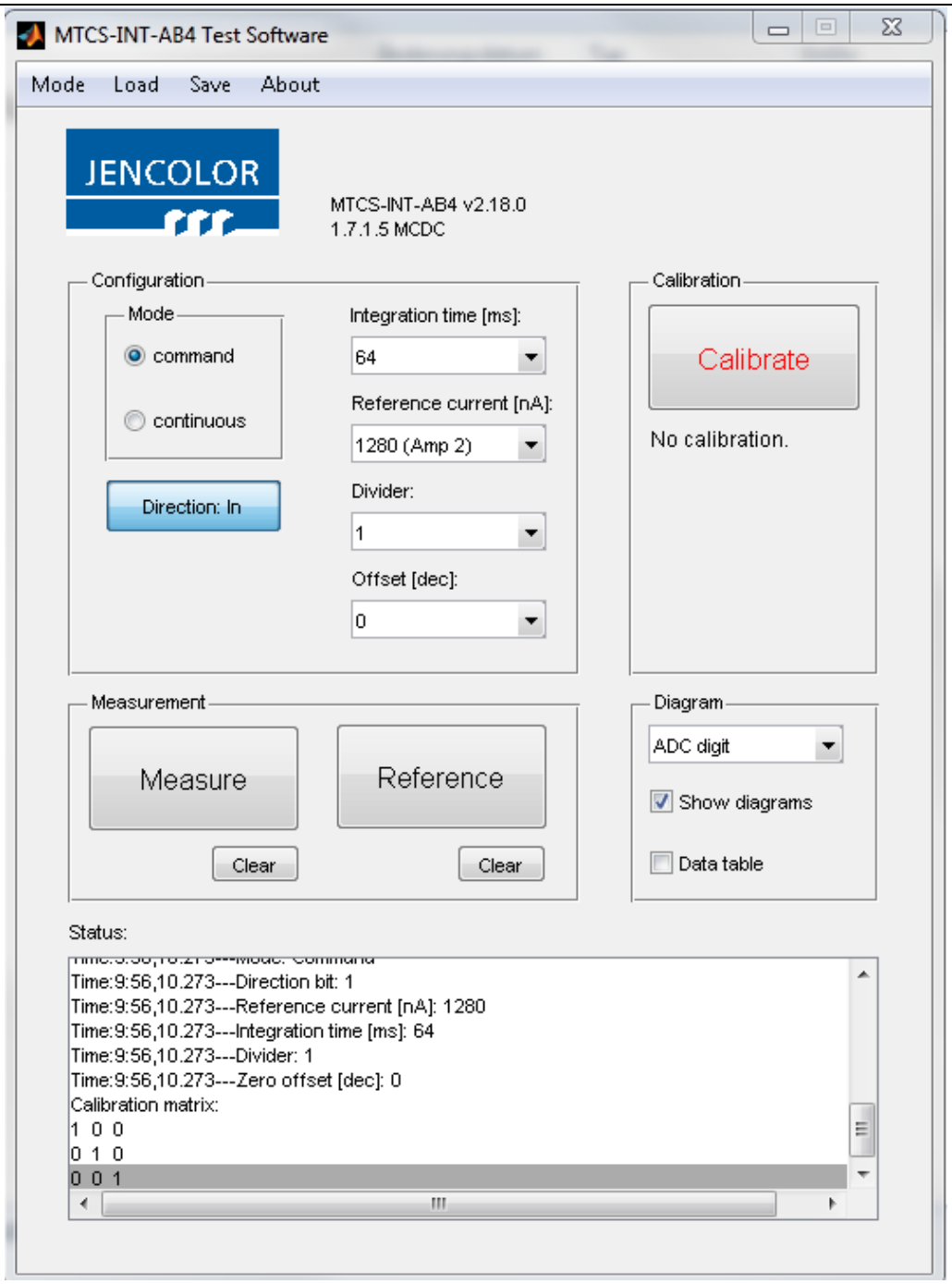
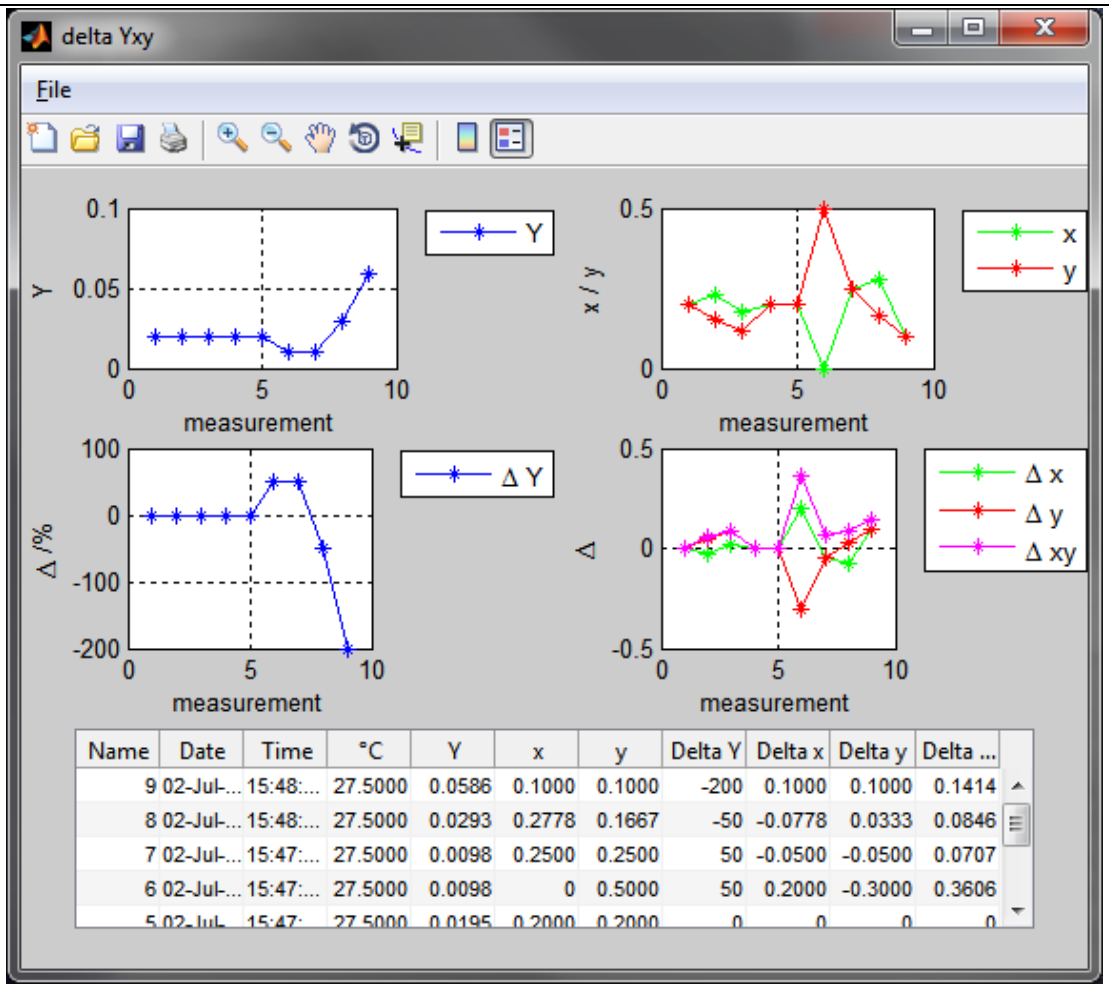


Figure 17: Reference measurement – with selected Yxy diagram and selected data table



Name	Date	Time	°C	Y	x	y	Delta Y	Delta x	Delta y	Delta ...
9	02-Jul-...	15:48:...	27.5000	0.0586	0.1000	0.1000	-200	0.1000	0.1000	0.1414
8	02-Jul-...	15:48:...	27.5000	0.0293	0.2778	0.1667	-50	-0.0778	0.0333	0.0846
7	02-Jul-...	15:47:...	27.5000	0.0098	0.2500	0.2500	50	-0.0500	-0.0500	0.0707
6	02-Jul-...	15:47:...	27.5000	0.0098	0	0.5000	50	0.2000	-0.3000	0.3606
5	02-Jul-...	15:47:...	27.5000	0.0195	0.2000	0.2000	0	0	0	0

5.5 Basics for Measurements

Each ADC value (Analog-Digital Converted value) is calculated to a photocurrent ("photocurrent_nA") under consideration of dark current ("zero"), reference current ("refCurrent_nA") and integration time ("nClck"). These steps are performed before this value is used for any calibration or colorimetric functions. The following virtual code is used for each sensor channel value - whereas the ADC is the 16bit read out value:

```
% Correction ofbit shift (register CREGH)
% divider = 1 (off), 2, 4, 8 or 16
Adc = Adc * divider;

% Calcualtion of the maximum number of clocks nClck
% intTime_ms is the integration time in milliseconds (register CREGL)
bit = 10 + log2(intTime_ms);
nClck = 2^bit;

% Check of saturation
sat = nClck - 1;
if sat > 65535
 sat = 65535;
end
if Adc >= sat
 % Error! Sensor channel is saturated!
```

```
else
 % Measurement is ok.
end

% Correction of zero offset (register OPTREG)
% zero = 0 (disabled), 15, 31 or 63
Adc = Adc - zero;

% Calculation of photo current in nano ampere
photocurrent_nA = Adc * refCurrent_nA / nClck;
```

A detailed description of the sensor signal calculation is included in the datasheets of JENCOLOR® key components, white papers or application notes. Please ask our sales team for further information.

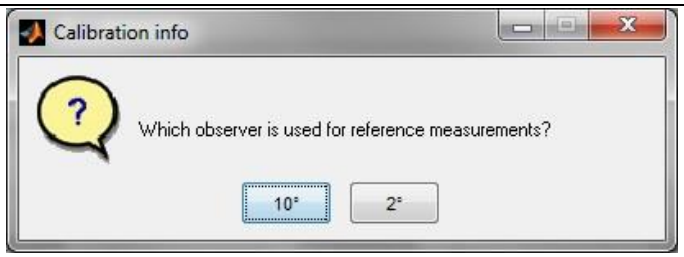
To perform absolute color measurements or for further evaluation of the results in any color space, the sensors system DK AS73210-AS89010-AB4 must be calibrated to the specific application or test setup. Please ensure that all continuous processes, measurements and the calibration procedures are performed based on same conditions. These aspects refer to the DUT (device under test), distances between DUT and sensor as well as all initialization and environment conditions. The sensor, selected illumination and target are used in a closed system for calibration and measurement procedures. A new calibration is required if you change any conditions inside this closed system.

5.6 Calibration

The calibration option is used to create an application and sensor specific calibration via calibration targets measured by a reference device like a spectrometer. The standard calibration simply uses an identity matrix which approximates the color space values. Therefore it is recommended to calibrate the sensor/application to get accurate results and coordinates in any color spaces. This section describes how to calibrate the device.

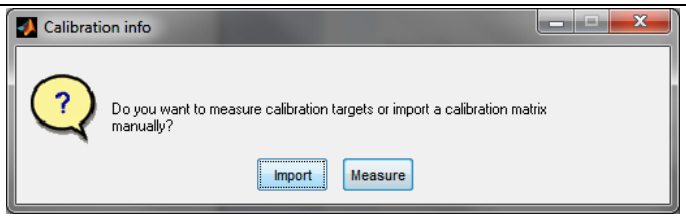
First set the observer with which the reference values are measured (see colorimetric settings of your reference device alike a spectrometer or others).

Figure 18: Calibration - Observer



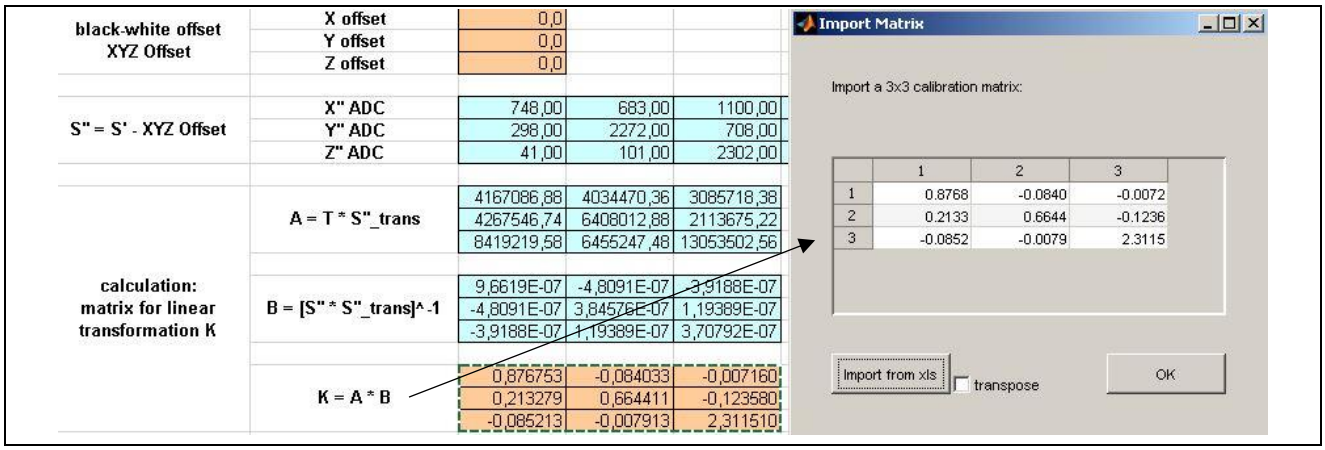
Then choose whether the calibration matrix should be inserted manually or to measure it.

Figure 19: Calibration - Targets measure or manually -



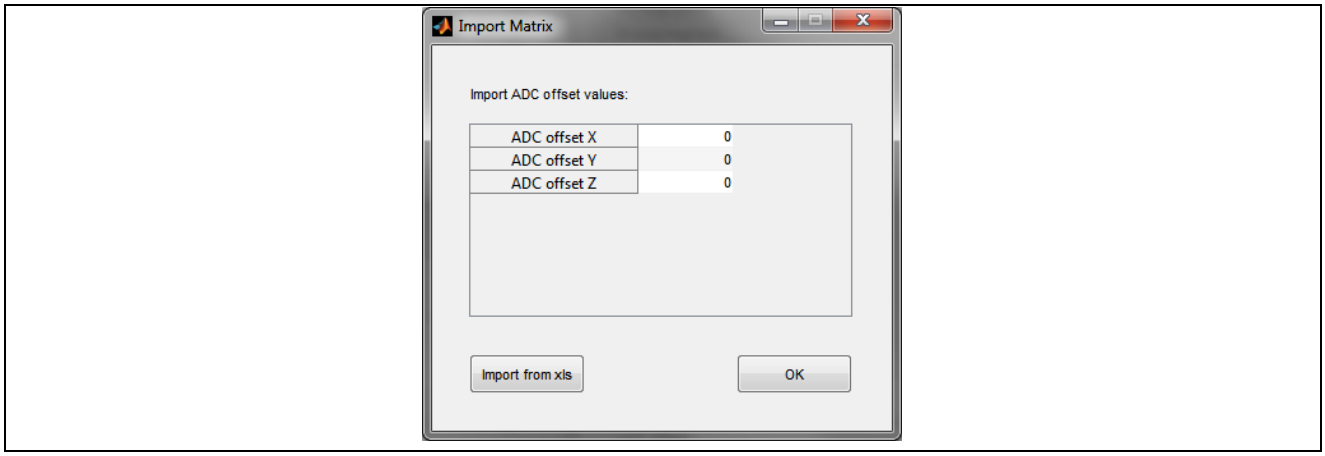
After choosing ***Import*** the calibration matrix and offset values must be inserted e.g. from an Excel sheet like shown in the following figure. Just select the cells for import and press the button ***Import from xls***.

Figure 20: Calibration - Manual, insert matrix



In the next step the offset values for the sensor must be imported.

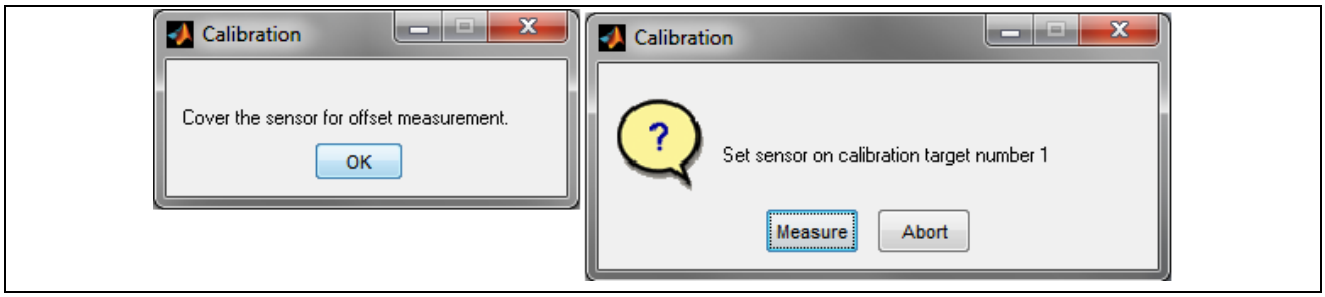
Figure 21: Calibration - ADC offset values



After choosing the ***Measure*** option, it is required to enter the amount of calibration targets those want to be measured. The minimal amount of targets is the number of sensor channels. The DK AS73210-AS89010-AB4 uses at least 3 channels.

Next, the software requests to cover the sensor for an offset measurement. After this following the software performs measurements for each target and guides the user through the process step by step.

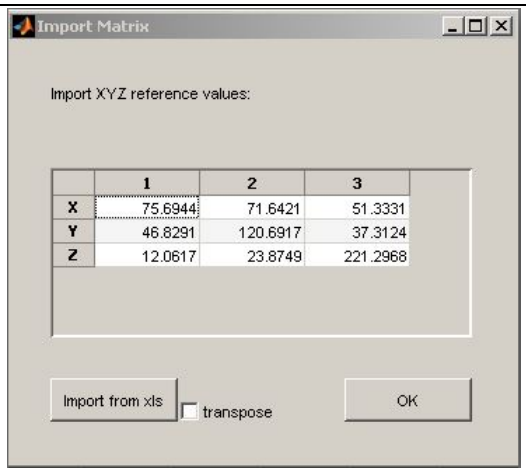
Figure 22: Calibration - Measurement steps Dark measurement and measurements of targets -



In the final step, the software requests to insert XYZ values measured from the reference device. It is possible to save the results of the calibration process into a special owner configuration file.

If any support during the sensor calibration is needed, please contact our sales team.

Figure 23: Calibration - Input XYZ reference values -



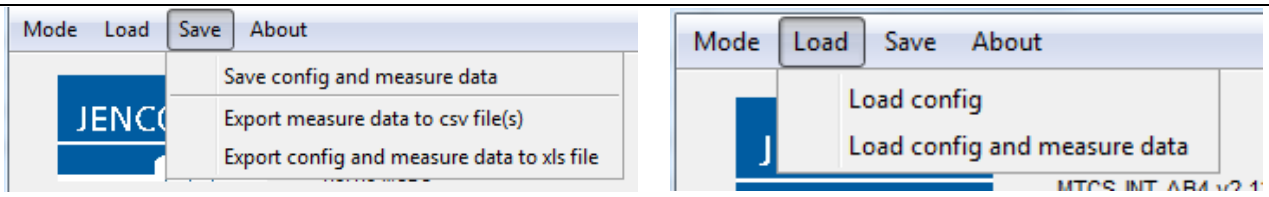
A calibration is valid for the used system and must not be re-calibrated until not relevant system configurations or parameters for measurement were changed (e.g. integration time). After changing the configuration file the software always tests the specified parameters if a re-calibration is necessary and shows the message "No calibration loaded" or "Calibrated with different settings". In this case the calibration must be performed again to achieve exact results. Please note, the software only tests known parameters of the test software and cannot check if any external conditions in the test system were changed. Ask our sales team for support during the calibration process or if you will not get the specified results after calibration.

5.7 Load/Save menu

The ***Load*** and ***Save*** menus provide the option to load and save the configuration, calibration and measurement values in a file with the extension *.dat ('Load config and measure data'; 'Save config and measure data'). To simply load a configuration of the sensor use the ***Load config*** menu entry. This allows you to load a *.csv (*.csv – comma separated values) configuration file (see chapter 5.8).

The ***Save*** menu also offers an extra feature to export measurement values to *.csv files or the actual sensor configuration and measurement values to an Excel file (*.xls) for further usage. This data can be used for comparison or for statistical calculations. Note: The export to Excel is only available if Excel is properly installed on your local PC.

Figure 24: Menu - Load and Save



5.8 Configuration Files (*.csv)

The Configuration Files (*.csv – comma separated values) contain all important information about the measurement and configuration behavior. The files are used for application-specific adjustment of the test board AS73210-AS89010-AB4 and/or compatible boards. In the installation path of the test software you find several examples for a configuration file like "command example.csv" or "command example AS89010-EB1.csv"[7]. Processing these *.csv-files is possible with a text editor, Open Office Software or MS Excel. Please note, however compliance with the syntax and the extension *.csv when saving. Other-wise, errors

[7] This file is an example for a software adaptation for an alternative and AS73210-AS89010-AB4 compatible test board AS73210-AS89010-EB1. This board represents an evaluation kit for ams Sensors Germany's ADC AS89010 and I²C in interface.

will occur during software operation. Table 1 indicates all relevant syntax, columns and register commands. All grey highlighted columns are comments or user information with no conditions for syntax except for the use of the separation of characters like "," or ";". In case of using JENCOLOR® sensors a changing of the line with the keyword "ChannelOrder" is not necessary because the filter set was pre-defined. On the other side by using alternative sensor boards the ChannelOrder must be adapted based on the any special configuration. Check the installation or support files like readme.txt or datasheet for more details.

To use a configuration file, select the file and load it by mouse click. Then the parameters inside the files specified will be used.

Table 4: Command example.csv - in includes not a scenario for measurement but different alternative examples to show structure and coding

STATE	INFO REGISTER	INFO DATA	COMMENT	R/W	I²C ADDRESS	REGISTER	DATA		
ChannelOrder			specifies the number and reference of the filters .e.g. JENCOLOR® sensor			1	3	2	
Init	OSR	Set config mode	Access to config registers	W	E8	0	2		
Init	OSR	No power down mode	Wake up MCDC (wait 500 µs before measurement)	W	E8	0	0		
Init	CREGL	R=20 nA T=1 ms	R=reference current T=integration time	W	E8	6	128		
Init	CREGL	R=20 nA T=1024 ms	R=reference current T=integration time	W	E8	6	138		
Init	CREGL	R=5.12 µA T=1 ms	R=reference current T=integration time	W	E8	6	192		
Init	CREGL	R=5.12 µA T=1024 ms	R=reference current T=integration time	W	E8	6	202		
Init	CREGL	R=1.28 µA T=128 ms	R=reference current T=integration time	W	E8	6	183		
Init	CREGH	CMD Div=off	Command mode and digital divider off	W	E8	7	8		
Init	CREGH	CMD Div=2	Command mode and digital divider 2	W	E8	7	9		
Init	OPTREG	Zero=63	Set offset of 63 digits (recommend)	W	E8	8	3		

STATE	INFO REGISTER	INFO DATA	COMMENT	R/W	I²C ADDRESS	REGISTER	DATA		
Init	OSR	Set address to register	Set address point to register	W	E8	0			
Init	OSR	Read 11 byte	Read all config registers (if access = R*)	R	E9		11		
Measure	OSR	Start measure	Begin single measurement	W	E8	0	131		
Measure	OUT0	Set address to register	Set address to first output register	W	E8	0			
Measure	OUT0	Read 8 byte	Read OUT0 to OUT3	R	E9		8		

All commands and data refer to the I²C communication and register settings of the Sensor signal ASIC AS89010. For more details please check the description in the datasheet of the AS89010 [1].

Description of *.csv columns:

"State"	All rows containing "Init" are send to the AS73210-AS89010-AB4 to initialize the AS89010 after choosing a configuration . Important: Do only use the commands "ChannelOrder", "Init" and "Measure" (case sensitive)! Do not mix "Init" and "Measure" rows!
"Info Register", "Info Data", "Comment"	Columns are not relevant for a functional use.
"Read/Write"	Insert "W" for write I^2C data or "R" for read I^2C data.
"I^2C Address"	Insert "E8" for write and "E9" for read I^2C data.
"Register"	For write I^2C: Insert the register address which should be written to. Important: Only insert decimal values 0...255! For read I^2C: Leave it empty.
"Data"	For write I^2C: Insert the data which should be written. Important: Only insert decimal values 0...255! For read I^2C: Insert the amount of bytes which should be read.

Attention:

The JENCOLOR® AS73210-AS89010-AB4 Evaluation Software is designed like as a simple terminal program. This means that each write and read command (each row of configuration file) is written or read via I^2C without checking the validation of data. For detailed description of all registers check the datasheet of AS89010 [1]. The JENCOLOR® AS73210-AS89010-AB4 Evaluation Software can only be used in Command and Continuous mode (compare register CREGH of AS89010).

After software installation in the software directory "application" some samples of *.csv files show several examples to set the system, write/read registers and measure in different modes.

6 QUICK START GUIDE

STEP	ACTION	BASICS	RESULT	COMMENT / DESCRIPTION
Initializing Test system and start the software	• Install software and drivers • Connect sensor boards via USB • start the software	Software and hardware are available, all system requirements are fulfilled	Installed software	See chapter 4.1 See chapter 5.1
Setting / control parameters	Set ***Reference current***	In/Decrease until the digits are in a range with an excellent ratio between noise (digits) and brightness digits (several thousands, max. without saturation, in case of saturation consider also divider)	Optimal digits = high accuracy	Specify it as low as possible but so high as necessary (see chapter 5.2
	Set ***IntegrationTime***	An ideal ratio between noise (digits) and brightness digits needs to be found (several thousands)	Optimal (max) digits = high accuracy	Specify it as low as possible but so high as necessary (see chapter 5.2)
	Set ***Divider***	To prevent the risk of saturation increase divider as long as the sensor is not in saturation otherwise decrease gain or IntegrationTime	Optimal (max) digits = high accuracy	If possible decrease amplification to prevent saturation, consider the divider in the signal calculation (see chapter 6.2)
Sensor calibration	**Dark measurement**	Consider electronically noise – needed to increase accuracy	I_{Dark} which correct sensor result ADC digit	see chapter 5.6
	Calibration - Option #1 Known target values	Use known XYZ values for the calibration target	Possible calibration for the existing target	see chapter 5.6
	Calibration - Option #2 Trial & Error	Use a virtual calibration via simple calibration matrix $\begin{matrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{matrix}$	No existing reference values and spectrometer	No absolute measurement, estimation values for relative color measurement (see chapter 5.6)

7 EXAMPLE FOR MEASUREMENT

The AS73210-AS89010-AB4 test system is ideal to detect and measure colors, color temperatures or brightness of lighting signals[8]. Typical applications are LED control and measurement and/or calibration of video walls and monitors.

Please note, the results was achieved by a standard and application specific calibrated test system (by using spectrometer and sensor, measured one by one, nearly at the same position). Measurements and calibration were done with a standard display under laboratory conditions. The following tables show the calculation of the calibration matrix and the results of the spectrometer, sensor and evaluation by using the set iref = 20nA, Tint = 1024ms and a RGB calibration.

Table 5: Example for calculation of the calibration matrix (calibration for RGB / target = 3)

		red	green	blue	white	grey 191	grey 127	grey 63	grey 31	yellow	magenta	cyan	black
Target data T	X	101,811295	89,8851089	44,6216393	241,16815	144,72527	73,803055	25,08864	7,8187065	192,6158	148,16277	136,15387	0,3010196
	Y	53,5799675	180,218567	19,6138611	259,89822	156,35645	80,397415	27,329342	8,4692755	235,91702	73,913986	202,53325	0,2844719
	Z	4,00652361	28,3652859	232,759201	272,6904	166,04439	85,696915	30,100254	9,0750713	32,101482	241,40384	264,61588	0,6896413
Sensor data S	X ADC	0,44342449	0,44284238	0,1933091	1,0995358	0,6618579	0,3389045	0,1158219	0,0363662	0,8936063	0,6407872	0,643008	0,0014194
	Y ADC	0,23132649	0,81560093	0,10905106	1,1812601	0,7130977	0,367776	0,1255672	0,039099	1,0597086	0,3420032	0,9330936	0,0012544
	Z ADC	0,02219289	0,06843875	0,43715331	0,5444769	0,3300425	0,1706812	0,0598643	0,0181949	0,0904617	0,4671361	0,5125724	0,0012142
electronical offset XYZ ADCOffset	X ADCOffset	0,002											
	Y ADCOffset	0,00089											
	Z ADCOffset	0,00122											
S' = S - XYZ ADCOffset	X' ADC	0,44142449	0,44084238	0,1913091	1,0975358	0,6598579	0,3369045	0,1138219	0,0343662	0,8916063	0,6387872	0,641008	-0,000581
	Y' ADC	0,23043649	0,81471093	0,10816106	1,1803701	0,7122077	0,366886	0,1246772	0,038209	1,0588186	0,3411132	0,9322036	0,0003644
	Z' ADC	0,02097289	0,06721875	0,43593331	0,5432569	0,3288225	0,1694612	0,0586443	0,0169749	0,0892417	0,4659161	0,5113524	-5,83E-06
black-white offset XYZ Offset	X offset	0,0											
	Y offset	0,0											
	Z offset	0,0											
S'' = S' - XYZ Offset	X'' ADC	0,44	0,44	0,19	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
	Y'' ADC	0,23	0,81	0,11	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
	Z'' ADC	0,02	0,07	0,44	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
calculation: matrix for linear transformation K	A = T * S''_trans	93,1036902	101,517741	27,6293008									
		106,851803	161,294271	21,7881287									
		58,8021521	49,2082394	103,458197									
	B = [S'' * S''_trans]^-1	10,8037949	-6,68471892	-3,1159837									
		-6,68471892	5,6283685	1,11105134									
		-3,11598367	1,11105134	6,4742213									
	K = A * B	241,163157	-20,295170	1,560052									
		8,306641	217,757058	-12,681089									
		-16,030909	-1,166386	541,257597									

[8] Note, the accuracy is depend on the system conditions, calibration and interferences. Therefore in application specific systems the sensor system must be optimized to increase accuracy. E.g. IR lighting will reduce the signal noise ratio dramatically. An add-on IR g will correct that.

Table 6: Calculations of sensor results

	Number of targets											
Spectrometer	1	2	**3**	4	5	**6**	7	8	**9**	10	11	12
	red	green	blue	white	grey 191	grey 127	grey 63	grey 31	yellow	magenta	cyan	black
X	101,811295	89,8851089	44,6216393	241,168152	144,725266	73,8030548	25,0886402	7,81870651	192,615799	148,162766	136,15387	0,30101958
Y	53,5799675	180,218567	19,6138611	259,898224	156,356445	80,3974152	27,3293419	8,46927547	235,917023	73,9139862	202,533249	0,2844719
Z	4,00652361	28,3652859	232,759201	272,690399	166,044388	85,6969147	30,1002541	9,07507133	32,1014824	241,403839	264,615875	0,6896413
sensor ADC	red	green	blue	white	grey 191	grey 127	grey 63	grey 31	yellow	magenta	cyan	black
X	0,44342449	0,44284238	0,1933091	1,09953579	0,66185785	0,33890448	0,11582195	0,03636625	0,89360629	0,64078719	0,64300798	0,00141943
Y	0,23132649	0,81560093	0,10905106	1,1812601	0,71309767	0,367776	0,1255672	0,03909899	1,0597086	0,34200324	0,93309362	0,00125439
Z	0,02219289	0,06843875	0,43715331	0,5444769	0,33004246	0,17068117	0,05986427	0,01819494	0,09046171	0,46713612	0,51257241	0,00121417
Sensor XYZ after calibration												
	X	102,277	90,351	45,088	242,043	145,658	74,533	25,477	8,005	194,139	148,322	136,932	0,319
	Y	53,775	180,414	19,809	259,457	156,595	80,737	27,546	8,585	237,035	73,873	202,029	0,270
	Z	4,634	28,993	233,386	275,698	167,196	86,521	30,399	9,220	33,402	242,170	266,037	0,633
DIFF	**X**	**-0,466**	**-0,466**	**-0,466**	**-0,875**	**-0,933**	**-0,730**	**-0,388**	**-0,186**	**-1,523**	**-0,159**	**-0,778**	**-0,018**
	Y	**-0,195**	**-0,195**	**-0,195**	**0,442**	**-0,238**	**-0,339**	**-0,217**	**-0,116**	**-1,118**	**0,041**	**0,504**	**0,015**
	Z	**-0,627**	**-0,627**	**-0,627**	**-3,007**	**-1,152**	**-0,824**	**-0,299**	**-0,144**	**-1,300**	**-0,766**	**-1,421**	**0,057**
Spectromete	x	0,639	0,301	0,150	0,312	0,310	0,308	0,304	0,308	0,418	0,320	0,226	0,236
	y	0,336	0,604	0,066	0,336	0,335	0,335	0,331	0,334	0,512	0,159	0,336	0,223
	z	0,025	0,095	0,784	0,352	0,355	0,357	0,365	0,358	0,070	0,521	0,439	0,541
Sensor	x	0,637	0,301	0,151	0,311	0,310	0,308	0,305	0,310	0,418	0,319	0,226	0,261
	y	0,335	0,602	0,066	0,334	0,334	0,334	0,330	0,333	0,510	0,159	0,334	0,221
	z	0,029	0,097	0,782	0,355	0,356	0,358	0,364	0,357	0,072	0,522	0,440	0,518
DIFF	**delta Y (WP)**	**0,075%**	**0,075%**	**0,075%**	**0,170%**	**0,092%**	**0,130%**	**0,083%**	**0,045%**	**0,430%**	**0,016%**	**0,194%**	**0,006%**
	delta xy	**0,003**	**0,002**	**0,001**	**0,002**	**0,001**	**0,001**	**0,002**	**0,002**	**0,002**	**0,000**	**0,002**	**0,025**
Spectromete	u'	0,444	0,125	0,172	0,195	0,194	0,192	0,191	0,193	0,201	0,299	0,137	0,181
	v	0,526	0,564	0,170	0,472	0,471	0,471	0,468	0,470	0,555	0,336	0,459	0,386
Sensor	u'	0,443	0,125	0,173	0,195	0,194	0,193	0,192	0,195	0,202	0,299	0,138	0,204
	v	0,524	0,563	0,171	0,471	0,470	0,470	0,468	0,470	0,554	0,335	0,459	0,387
Diff	**u'v'**	**0,00122**	**0,00059**	**0,00123**	**0,00125**	**0,00091**	**0,00102**	**0,00134**	**0,00181**	**0,00072**	**0,00050**	**0,00122**	**0,02230**
Number of targets		3											

See the in the lines "Delta"values the results as Delta Y, Delta xy or Delta u'v' for the single colors, measured by the calibrated test system.

8 SOFTWARE LICENSE AGREEMENT

MATLAB®. © 1984 - 2012 The MathWorks, Inc.

9 REFERENCE DOCUMENTS

[1] AS89010 Converter datasheet
http://www.mazet.de/en/english-documents/english/data-sheets/as89010/download

[2] AS73210 Sensor datasheet
http://www.mazet.de/en/english-documents/english/data-sheets/as73210/download

[3] EEPROM AT30TSE752 8751D–DTS–8/2012 Atmel datasheet
http://www.atmel.com/Images/doc8751.pdf

[4] IOW24DG Converter I²C to USB - www.codemercs.com

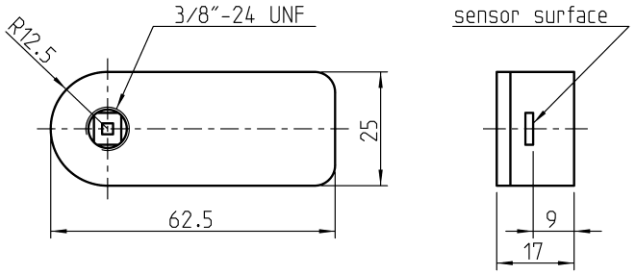
[5] AS73210-AS89010-AB4 datasheet OEM Sensor board

[6] IO-Warrior Software
http://www.codemercs.com/index.php?id=337&L=1

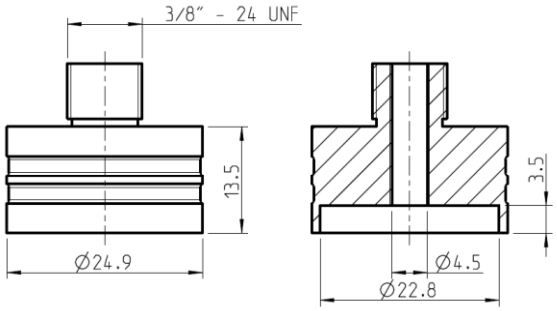
10 MECHANICAL SIZES

Figure 25: Dimensions of the package and adapters

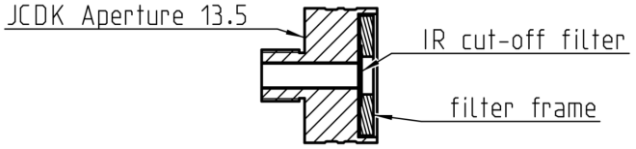
JCDK-Basic



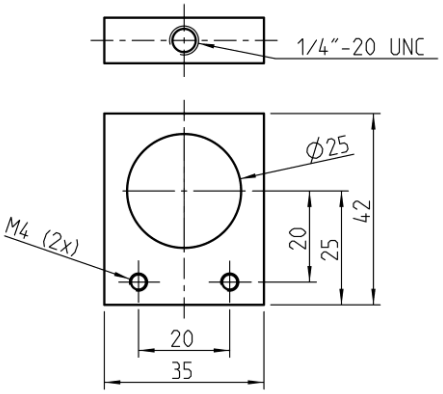
JCDK-Aperture-13.5



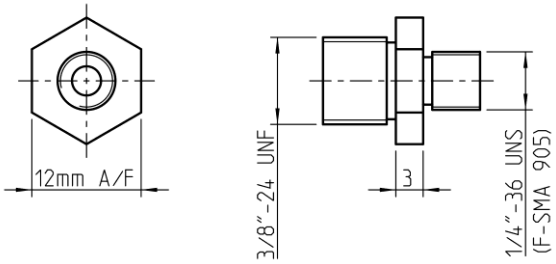
with IR-cut-off filter



JCDK-1/4"-Adapter



JCDK-SMA-Adapter



ORDERING INFORMATION

NAME	STATUS	ARTICLE
AS73210-AS89010-AB4 SET DK	Development Kit	220800004
AS73210-AS89010-AB4	Series	220800002
JCDK-Aperture-13.5 with IR-cut-off filter	Accessories	on request
JCDK-1/4"-Adapter	Accessories	on request
JCDK-SMA-Adapter	Accessories	on request

The Development Kits and OEM modules described here are only to be used for compatibility-, qualification tests, and verification procedures or as demonstrators. They are not designed to be used in series products.

Please note, the OEM sensors and kits were designed to be a test system for usage in laboratories only. They are not suitable for outdoor applications or to as series devices for inline measurements. Do not use the device in any process control or in any other series applications!

Before using engineering samples for anything other than system tests, please ask our sales team for status and availability of series or customized system solutions.

For more information please contact:

ams Sensors Germany GmbH:
Göschwitzer Straße 32
07745 JENA | GERMANY
Phone: +49 3641 2809-0
Fax: +49 3641 2809-12
sales-europe@ams.com
www.ams.com

LEGAL NOTES AND WARNINGS

Failure to comply with these instructions could result in death or serious injury.

Misuse of documentation – The information contained in this document is the property of ams Sensors Germany. Photocopying or otherwise reproducing any part of the catalog, whether electronically or mechanically is prohibited, except where the express permission of ams Sensors Germany GmbH has been obtained. In general, all company and brand names, as well as the names of individual products, are protected by brand, patent or product law.

State of document - The information provided in this document is for reference only. Do not use this document as product installation guide since products can be under development to improve performance or any other purpose. Before you start any development or place an order please contact your supplier or ams Sensors Germany for the latest version of this document. ams Sensors Germany explicitly reserves the right to make technical changes to information described in the document.

Information and Disclaimer – The information provided in this document is based on the knowledge of the ams Sensors Germany GmbH as of the date of publication. The ams Sensors Germany GmbH cannot give warranty regarding the accuracy of information provided by third parties. ams Sensors Germany may not have conducted testing or chemical analysis on all incoming material or chemicals. ams Sensors Germany GmbH performs and continues to perform reasonable measures to provide the most accurate data at the given time. Additional efforts to integrate information provided by third parties are performed and continue to be performed. Certain supplier information may be proprietary or limited and not available at release.

Personal Injury: All products are conform to the specifications in accordance with the terms and conditions of ams Sensors Germanys standard warranty. Production processing does not necessarily include testing of all parameters.

RoHS Directive 2011/65/EU /REACH INFORMATION - RoHS compliance and PB free: The products of ams Sensors Germany fully comply with the current RoHS-directives. The ams Sensors Germany semiconductor products do not contain any of the six substance chemical categories, for example including the restriction on lead usage (lead weight may not exceed 0.1% in homogeneous materials). RoHS compliant products are suitable for the usage in lead-free specified processes, when designed to be soldered at high temperatures.

REACH information: ams Sensors Germany products do not contain any of the latest REACH Substances of Very High Concern (SVHC) regarding the Europe Union (EU) Regulation 1907/2006. The latest 155 substances restricted per the REACH Regulation were last updated on June 16, 2014. Please refer to the following for the most current candidate list of substances: http://echa.europa.eu/candidate-list-table.

ams Sensors Germany solutions are not designed or intended for use in critical applications, in which the failures or malfunctions of the product may result in personal injury or death. Use of ams Sensors Germany products in life support systems is expressly unauthorized and any use by customer is completely at their own risk. In the case of a restricted use of the product described here, an application of the product outside of this limitation is at your own risk.

Warranty disclaimer – The warranty expressed herein shall be in lieu of any other warranties, expressed or implied, including, without limitation, any implied warranties or conditions of merchantability and fitness for a particular purpose., which are expressly disclaimed, and is in lieu of any and all other obligations or liability on supplier's part- For the avoidance of doubt, supplier shall not be liable for any special, incidental, indirect or consequential loss or damage, including loss pf revenue or profit, of any kind of nature, arising at any time, from any cause whatsoever resulting from the use or operation of the products or any breach of this limited warranty.

Legal liability - ams Sensors Germany assumes no responsibility for the use of any foreign products or circuits described in this document or customer product design, conveys no license, either expressed or implied, under any patent or other right, and makes no representation that the foreign circuits are free of patent infringement. ams Sensors Germany further makes no claim as to the suitability of its products for any particular purpose, nor does ams Sensors Germany assume any liability arising out of the use of any product or circuit, and specifically disclaims any and all liability, including without limitation consequential or incidental damages.

ESD Warning: Sensor handling precautions should be observed to avoid static discharge.

WEEE Disposal: - The product should be disposed in to according the Directive 2002/96 / EC of the European Council on Waste Electrical and Electronic Equipment [WEEE] and the German electoral law [ElektroG] of 16 March 2005. Please contact our technical support if you need more details.