User Guide

Document Number

# AS7341 AquaSensor

## Measure Color and Spectrum in Liquid

AS7341 Application

v0-01 • 2022-Feb-25

# Content Guide

# 1 Introduction

The AS7341 EVK Aqua is a demo kit for inline measurement of liquids - with special sensor hardware in a plastic housing that can be carefully immersed in a liquid probe. Three interconnected boards form the light source, sensor, and signal electronics. The mainboard contains a NIR LED for indirect illumination and serves as the mechanical base for the sensor and LED board. By default, the sensor board contains the AS7341 spectral sensor chip. Alternative sensor options are available for customer projects. The primary LED board is equipped with VIS LEDs and a temperature sensor to control the LED temperature. The 3-board solution is arranged in a U-shape in a plastic housing that only allows careful immersion from the front without allowing liquid to enter the shell to the electronics. For this, the electronics in the shell would have to be sealed beforehand.

> Note that, (after delivery and without sealing), the electronics in the housing are not waterproof. Please ensure that the electronic components do not come in contact with water or other liquids. Otherwise, the sensor will be destroyed and a short circuit can cause damage.

**Figure 1:**
**Assembled AS7341 AquaSensor**

The sensor module is connected to the FTDI cable (I²C to USB dongle) which enables the use of the PC user interface. The LED driver and sensor functions are available by using the standard test software and the GUI from the AS7341 EVK.

The sensor module was developed to measure liquids under alternative conditions in the visible and near IR wavelengths, using the LED light sources in either direct or right-angle optical paths between the ‘LED’ and the ‘sensor’ through the plastic carrier and the liquid.

All components of the module represent a demonstration and reference design to show typical results for such measurements. It is recommended to use this reference as the first step in a feasibility project to check the application and verify external effects. Optimal results will be achieved by adjusting control parameters, to achieve the highest accuracy and dynamic range for each specific application and its specific conditions. The key areas of optimization include LED choices, spectral filter selections (using different **ams** multi-spectral sensors, conversion setup, and corrections for floating parameters. This document describes some typical aspects to help illustrate these.

# 2 Out of Box

The main components in the AquaSensor System part are:

1. Sensor solution with embedded LEDs
2. Plastic Carrier
3. FTDI-to-USB connecting cable
4. USB stick with software and documents

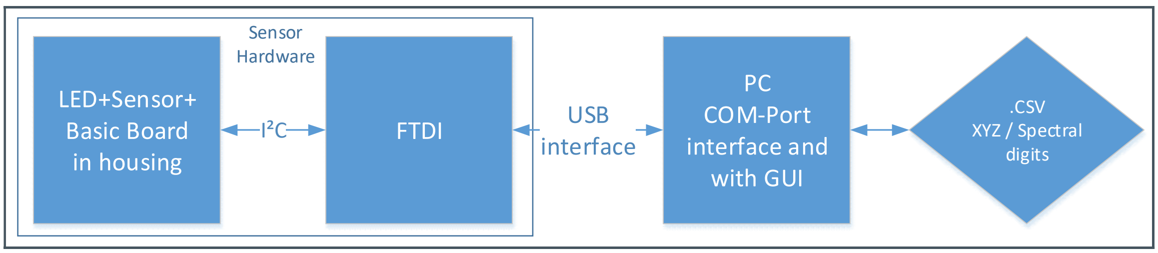
Please check if you have received all components before installation. Be careful by handling the blank electronic boards and consider all relevant ESD conditions. Electrical charges can destroy the electronics

# 3 Test System

The AquaSensor test system is for the demonstration of spectral liquid measurements by using the spectral sensor AS7341. The system includes all components that are necessary to directly measure the optical properties of liquids in an open container. A plastic housing surrounds the front of the AquaSensor assembly and is safe for use in most liquids.

Figure 2 shows a block diagram of the electronic components and their interfaces.

**Figure 2:**
**Block Diagram Showing the Connection Interfaces in AS7341 AquaSensor**




For accurate measurements, the sensor housing, with the two horns on the left and right, should be immersed in the liquid up to the end of each horn. Be careful not to dip the opened back of the housing into the liquids or it will result in damage.

Figure 3 shows the main components of the AS7341 AquaSensor test system. The plastic housing protects and fixes the hardware, and creates alternative optical paths from the LED to the sensor, including the diffuser function in front of the sensor. The sensor hardware consists of three interconnected boards, which need an FTDI adapter (I²C to PC via USB-connector and Com-Port Driver).

Figure 4 shows the optical axes 0°/90° in the standard AquaSensor module, which has to be adjusted by the application-specific requirements (limited/fixed optical axis from the LED to the sensor). Depending on the activated LED, the sensor with 0° optical axis in transmission measures turbidity as light decrease due to particle absorption or as light increase due to reflection of the light at the particle with 90° optical axis.

For example, color and/or turbidity can be measured excellent with a high concentration in transmission, whereas with a lower concentration, the 90° reflection achieves better results.

> **NOTE:** The AquaSensor GUI can control the LEDs separately because it is based on internal I²C programming. In custom-specific designs, it is not possible to control the LED with the usual AT commands, because the AS7341 pre-designed firmware was not prepared to address and control any bus participants. In such a case, use also I²C programming for extended bus configurations, beyond the network structure specified in the AS7341.

**Figure 3:**
**Concept and Main Electronically Components in AS7341 AquaSensor**

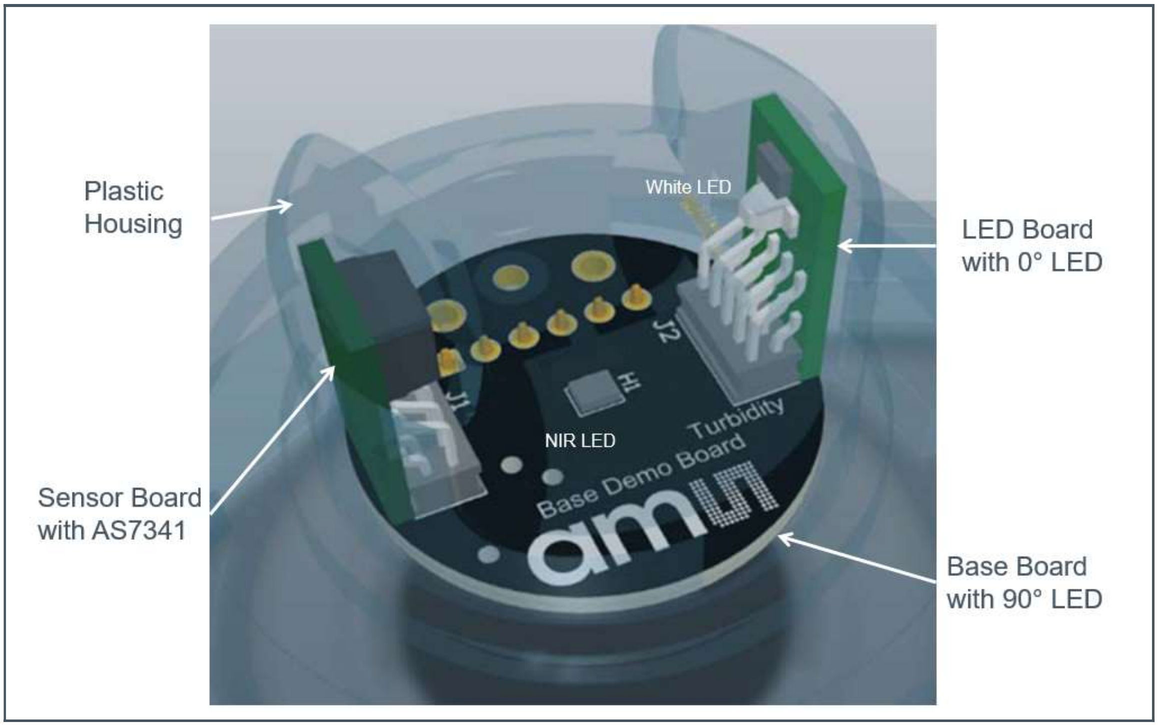
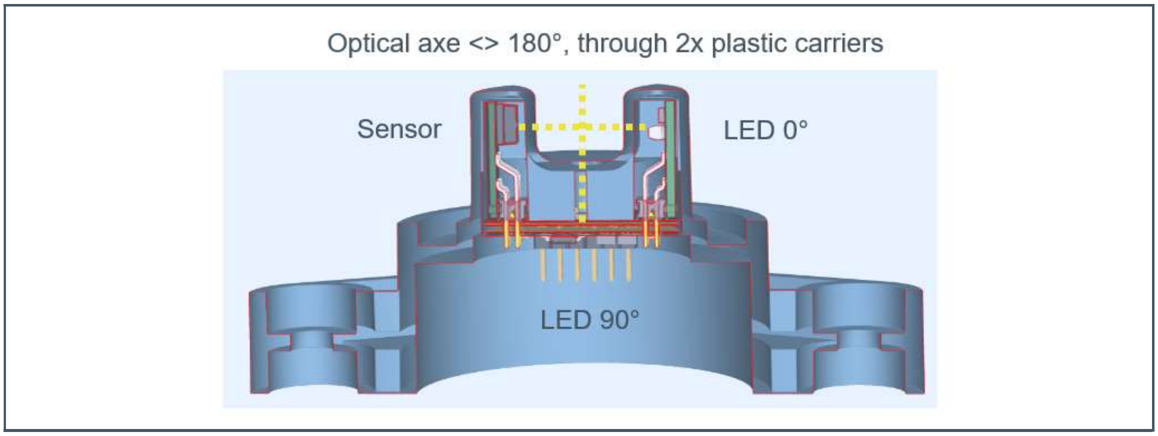



**Figure 4:**
**Optical Axes 0° and 90°**



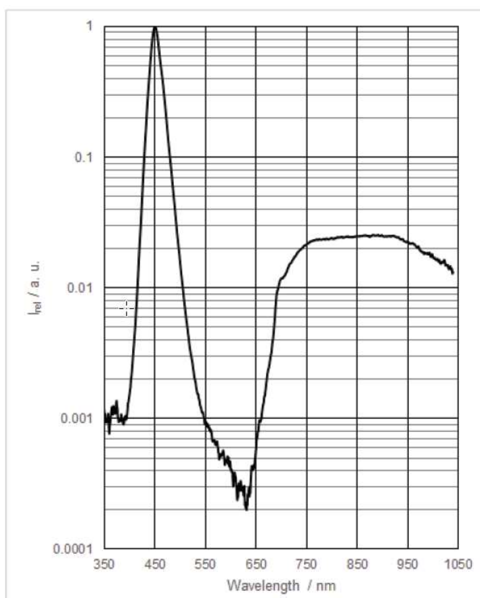
> **NOTE:** The plastic carrier was developed and manufactured as a demo tool for various alternative applications in liquid. The optical axes represent a compromise between accuracy and flexibility as well as the selected LED/sensor combination, which must be adapted to the requirements of the application. The housing material is a prototype material chosen as a diffuser without accuracy requirements for measurements. Therefore, the material, form, and all other conditions, which affect the measurements, must be adopted by the application-specific requirements.

The I²C to USB communication interface on the board makes the system compactable with PC and microcontroller applications. A special device Com Port driver on the PC is necessary, as well as the GUI software, which was adapted. The details regarding the Sensor system, in software and its functionalities, can be read from the datasheet and other documentation available on the USB sticks.

## 3.1 Base Board

The Baseboard is used to connect the LED/sensor board as well as the sensor unit in the housing. Further, it contains a NIR LED SFH4776 IR broadband emitter on board which useable as the indirect light source. Normally, the Baseboard is fixed in the plastic housing and must not be mounted by the customer. The same applies to the other hardware LED and Sensor Board. All electronic design documents and Gerber data, as well as the 3D printing data of the mechanical housing, can be found on the USB stick.

**Figure 5:**
**'NIR LED SFH4776 IR broad band emitter' [Source = Datasheet SFH4776][1]**

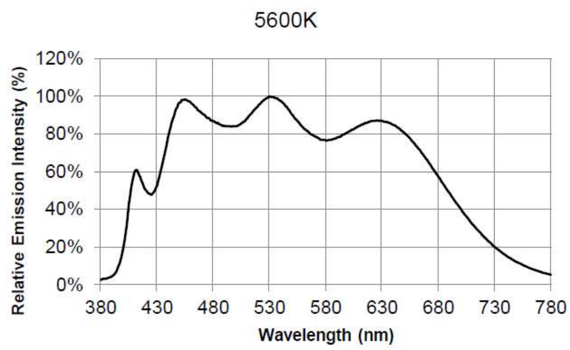



[1] SFH 4776 OSRAM Opto Semiconductors | Mouser Europe

## 3.2 LED Board

The LED board contains the LED VTC-2835 High CRI LED for VIS, plus an external temperature sensor to control possible temperature shifts of the LEDs.

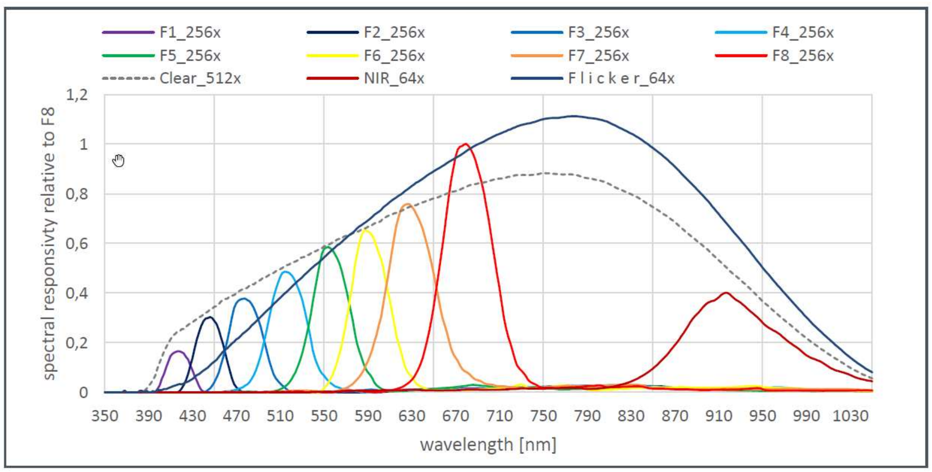
**Figure 6:**
**'TYPICAL SPECTRAL DISTRIBUTION GRAPHS VTC-2835 5600K' [Source = Datasheet YUJI LED][2]**




## 3.3 Sensor Board

The sensor board contains only the sensor and peripheral circuitry. The sensor, as well as the LED, is placed in the center of the LED board.

**Figure 7:**
**Spectral Sensitivities 11-Channel Spectral Sensor AS7341**



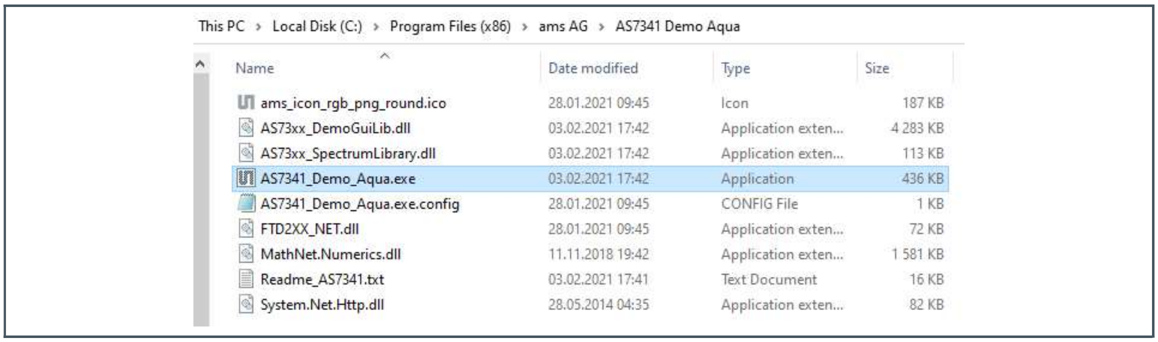

[2] www.yujiintl.com

## 3.4 Test Software

The GUI of the AS7341 EVK is used as test software. The software installation and the use of the GUI are described in principle in the manual for the AS7341 EVK. The document is included on the USB stick for the AS7341 AquaSensor.

Software and sensor data use different directories after installation. The executable file .exe is normally located in "*C:\Program Files (x86)\ams AG\AS7341 Demo Aqua*" (Figure 8). Do not change or delete any files from this directory without a request to **ams**.

**Figure 8:**
**.EXE Directory with Executable File**



This PC > Local Disk (C:) > Program Files (x86) > ams AG > AS7341 Demo Aqua

| Name | Date modified | Type | Size |
|---|---|---|---|
| ams_icon_rgb_png_round.ico | 28.01.2021 09:45 | Icon | 187 KB |
| AS73xx_DemoGuiLib.dll | 03.02.2021 17:42 | Application exten... | 4 283 KB |
| AS73xx_SpectrumLibrary.dll | 03.02.2021 17:42 | Application exten... | 113 KB |
| AS7341_Demo_Aqua.exe | 03.02.2021 17:42 | Application | 436 KB |
| AS7341_Demo_Aqua.exe.config | 28.01.2021 09:45 | CONFIG File | 1 KB |
| FTD2XX_NET.dll | 28.01.2021 09:45 | Application exten... | 72 KB |
| MathNet.Numerics.dll | 11.11.2018 19:42 | Application exten... | 1 581 KB |
| Readme_AS7341.txt | 03.02.2021 17:41 | Text Document | 16 KB |
| System.Net.Http.dll | 28.05.2014 04:35 | Application exten... | 82 KB |

Initialization files and protocols are saved in a special data directory in the user area *C:\Users\xxx\AppData\Roaming\ams AG\AS7341 Demo Aqua*. Figure 9 shows the directory with all installed initialization files.

**Figure 9:**
**Data's Directory With Initialization Files**

This PC > Local Disk (C:) > Users > fkru > AppData > Roaming > ams AG > AS7341 Demo Aqua

| Name | Date modified | Type | Size |
|---|---|---|---|
| AS7341_Demo.config | 08.02.2021 14:51 | CONFIG File | 1 KB |
| AS7341_Script.txt | 28.01.2021 09:45 | Text Document | 2 KB |
| CM_L1_v1_0_0#spectral.csv | 28.01.2021 09:45 | Microsoft Excel C... | 67 KB |
| init_file.txt | 08.02.2021 14:10 | Text Document | 2 KB |
| Mask_L_v1_0_0.csv | 28.01.2021 09:45 | Microsoft Excel C... | 132 KB |
| Readme_AS7341.txt | 03.02.2021 17:41 | Text Document | 16 KB |
| TC_v1_0_0.csv | 28.01.2021 09:45 | Microsoft Excel C... | 7 KB |

Figure 10 shows the meaning of the files in the initialization directory.

**Figure 10:**
**Meaning of Initialization Files[3]**

| File | Comment |
|---|---|
| AS7341_Demo.config | Flag file for internal software control – do not change anything without request. |
| AS7341_Script.txt | Example to control GUI via tracer (batch file). |
| init_file.txt | Specification of different application specific inputs and correction values. |
| Mask_L_v1_0_0.csv | Example with spectral masks for the MaskCompare function. |
| Readme_AS7341.txt | General information and about the GUI’s history. |
| TC_v1_0_0.csv | Example syntax for temperature compensation. |

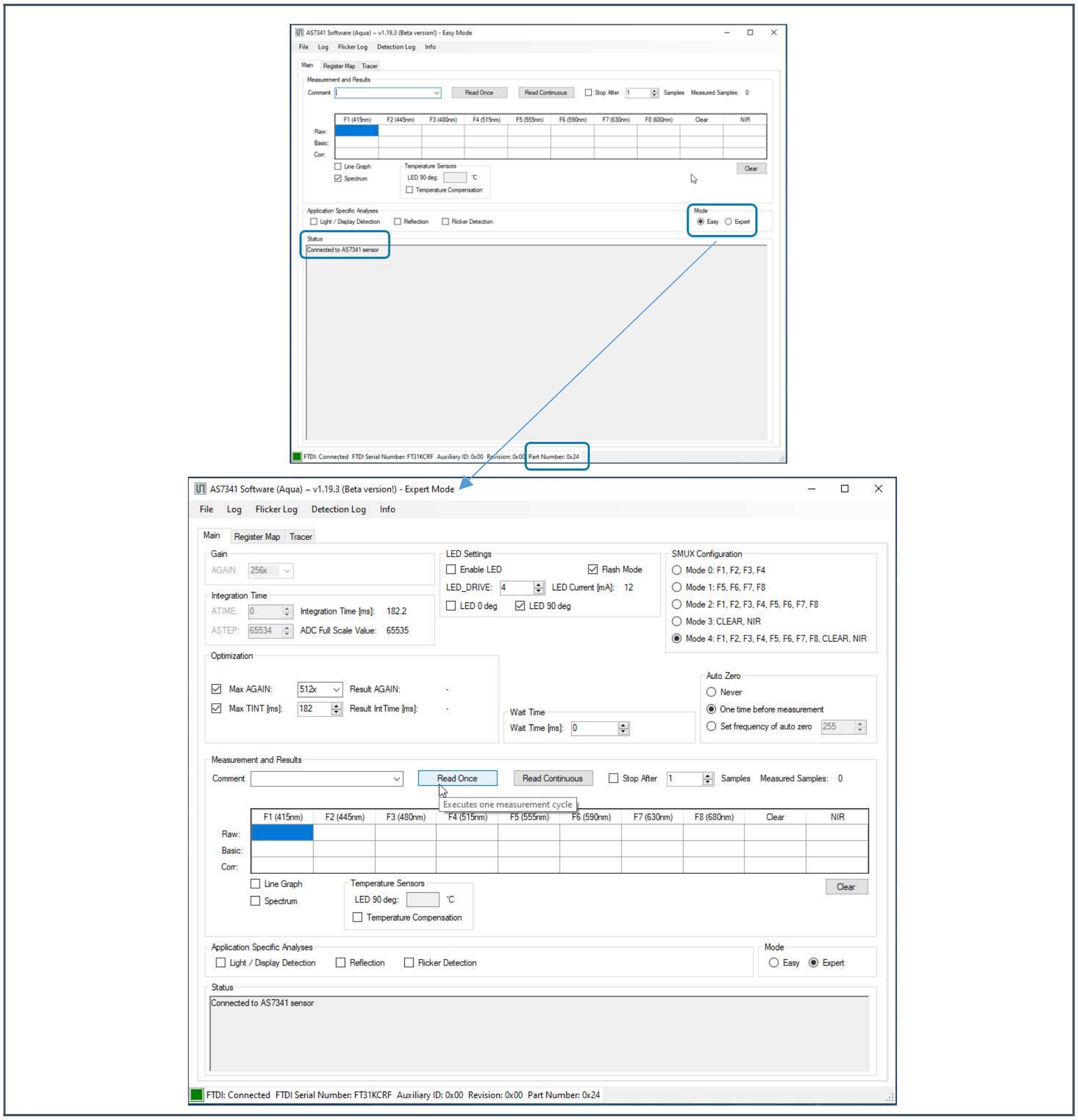
The Base functions for the GUI and its special functions for operating the AS7341 AquaSensor are described below.

[3] See the detailed description in the AS7341 EVK manual [8].

# 4 Software Operation

Figure 11 shows the startup window after the software installation and the start of the AS7341 AquaSensor Demo. The status window and footer line confirm (see Figure 11) the successful sensor connection. Check the AS7341 EVK manual in case of any issue and error message, or contact the **ams** support team. Select the expert mode (see Figure 11) to start initial preparations with the sensor.

**Figure 11:**
**Startup Window – Sensor Control - from Easy to Expert Mode**



## 4.1 LED Test

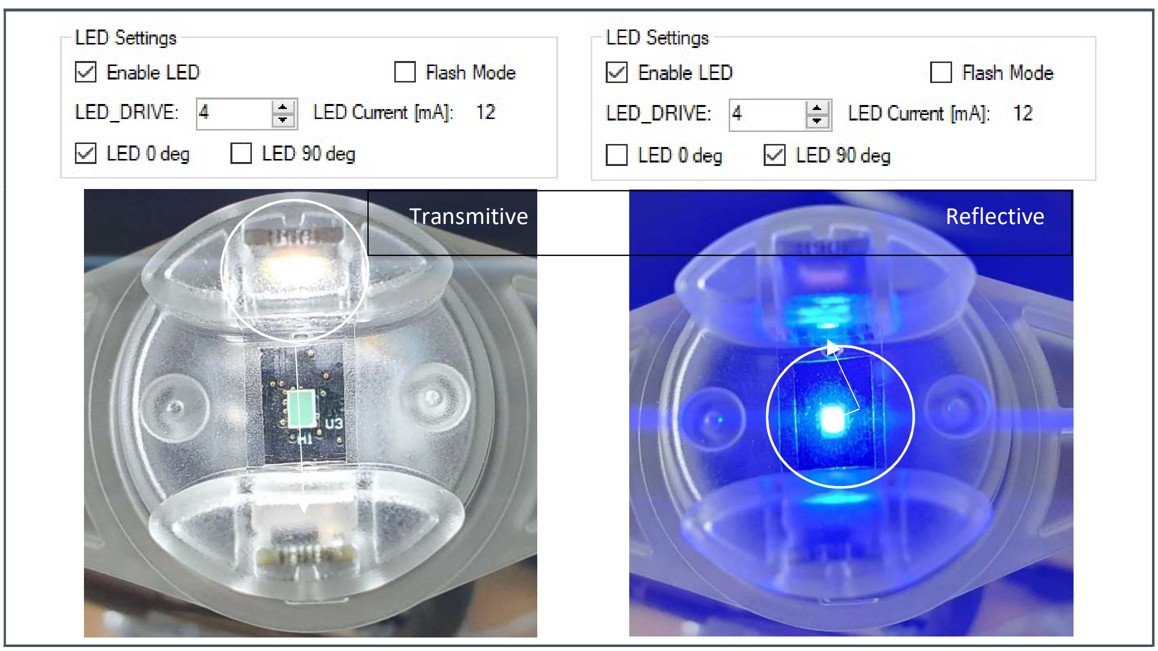
Generally always applies. Do not measure noise and avoid saturation. In between is the dynamic range of the sensor with the highest possible counts in the Full-Scale Range FSR of 16bit, in the case of the highest accuracy. Exposure is a parameter to bring the Sensor/LED combination into an optimal working range.

The luminous intensity of the LEDs can be influenced by the LED current parameter, within the limits of the maximum flux intensity. Darker liquids require a higher luminous intensity, but a higher LED current naturally generates more heat, drift in the LED, and leads to faster wear.

The LEDs can be tested by setting 'LED' Enabled in Expert Mode in the GUI in the main window at LED Settings, with 'Flash Mode' not active. With '0 deg LED' selected, the White LED (VTC-2835 High CRI LED, 5600K, **max. 40mA LED current**) on the LED board should shine and with '90 deg', the NIR LED (SFH4776 IR broadband emitter, **max. 1A LED current**) on the baseboard (see Figure 12).

> Operate the LEDs only in the parameters as specified in the data sheet. The GUI does not consider the maxima of datasheets and always starts with the minimum, which must be adjusted. The user is responsible for the optimal setting.

**Figure 12:**
**Switched On LEDs (Left LED Board 0° – Right Base Board 90°)**




Before the first measurements, the LEDs should burn for hours. It should also be noted that LEDs are subject to constant temperature drifts. Therefore, the following are recommended during operation for measurements:

1. Warm up the LEDs to operating temperature before measurements.

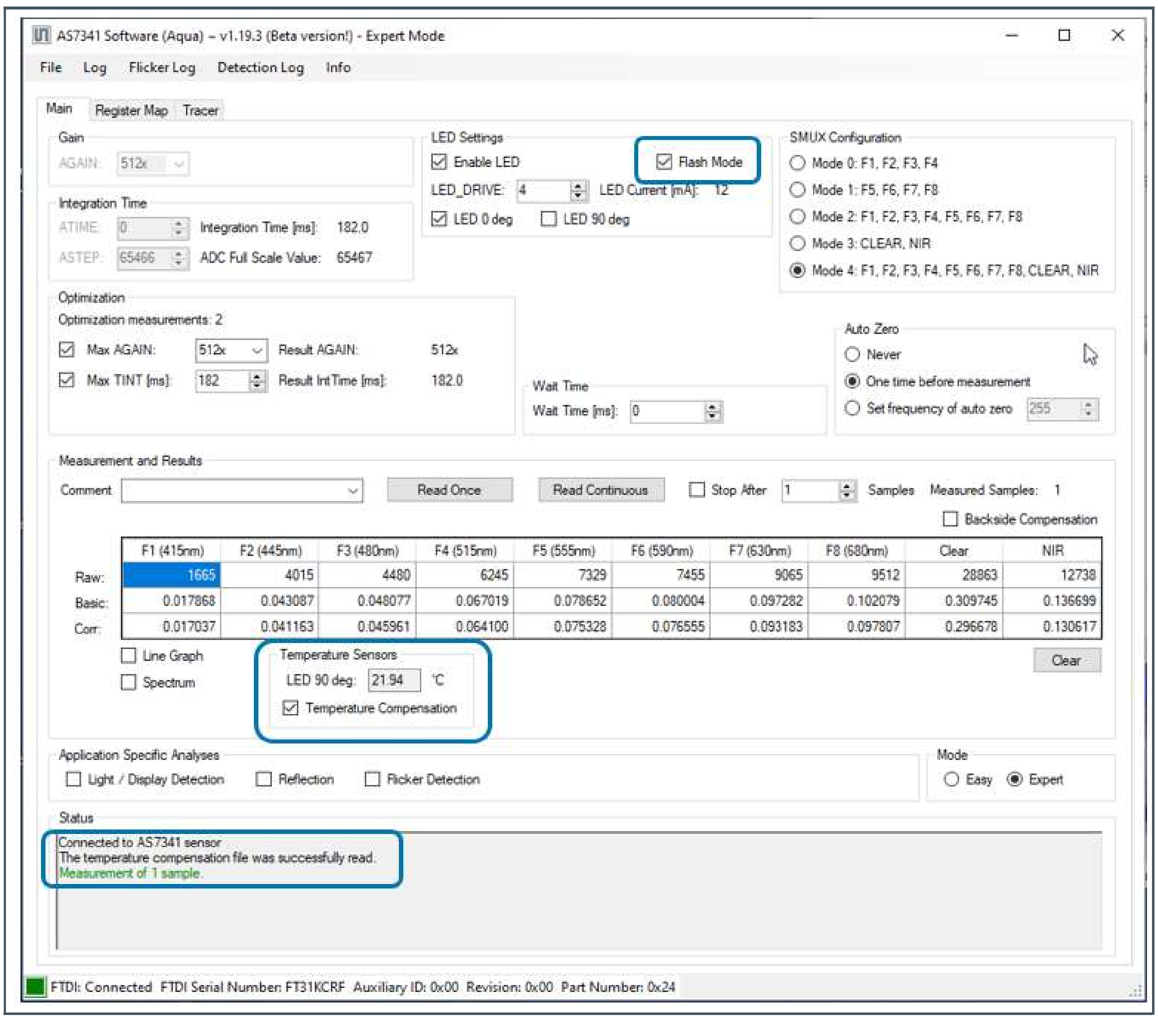
2. Use “FlashMode” to avoid large temperature drifts.

In any case, the temperature should be monitored with an external temperature sensor, and the values corrected if necessary.

It should also be noted that the ambient temperature in the liquid could affect both the LED and the measurements in the sensor.

However, the correction requires a temperature compensation file, which must be measured beforehand with the system under real temperature changes. The file used after the software installation is only to illustrate the syntax and does not contain any meaningful correction.

**Figure 13:**
**Activated LED Flash Mode and Temperature Compensation**



## 4.2 Sensor Settings

If the LED current is set optimally, for the time being, the optimal parameters gain and integration time must be found for the required working range of the application. The darkest and the brightest sample are used to test the minimum and maximum of the counts (=ADC outputs) when determining the sensor dynamics. A change of the integration time and the gain leads linear to the change of the counts considering the FSR Full-Scale Range. The following table shows the correlation between integration time, maximum achievable counts before saturation, FSR, and LSB.

**Figure 14:**
**Correlation FSR, LSB[4] and Counts from Integration**

| TINT (ms) | f (kHz) | Resolution (bit) | Counts | FSR high gain (µW/cm²) | FSR low gain (µW/cm²) | LSB high gain (nW/cm²) | LSB low gain (nW/cm²) | FSR high gain (lux) | FSR low gain (lux) |
|---|---|---|---|---|---|---|---|---|---|
| 0,00556 | 180,00000 | 1,00 | 2,00 | 55,19001 | 56 514,57 | 27 595,00465 | 28 257 284,766 | 376,9478 | 385 995 |
| 0,01111 | 90,00000 | 2,00 | 4,00 | 55,19001 | 56 514,57 | 13 797,50233 | 14 128 642,383 | 376,9478 | 385 995 |
| 0,02222 | 45,00000 | 3,00 | 8,00 | 55,19001 | 56 514,57 | 6 898,75116 | 7 064 321,192 | 376,9478 | 385 995 |
| 0,04444 | 22,50000 | 4,00 | 16,00 | 55,19001 | 56 514,57 | 3 449,37558 | 3 532 160,596 | 376,9478 | 385 995 |
| 0,08889 | 11,25000 | 5,00 | 32,00 | 55,19001 | 56 514,57 | 1 724,68779 | 1 766 080,298 | 376,9478 | 385 995 |
| 0,17778 | 5,62500 | 6,00 | 64,00 | 55,19001 | 56 514,57 | 862,34390 | 883 040,149 | 376,9478 | 385 995 |
| 0,35556 | 2,81250 | 7,00 | 128,00 | 55,19001 | 56 514,57 | 431,17195 | 441 520,074 | 376,9478 | 385 995 |
| 0,71111 | 1,40625 | 8,00 | 256,00 | 55,19001 | 56 514,57 | 215,58597 | 220 760,037 | 376,9478 | 385 995 |
| 1,42222 | 0,70313 | 9,00 | 512,00 | 55,19001 | 56 514,57 | 107,79299 | 110 380,019 | 376,9478 | 385 995 |
| 2,84444 | 0,35156 | 10,00 | 1 024,00 | 55,19001 | 56 514,57 | 53,89649 | 55 190,009 | 376,9478 | 385 995 |
| 5,68889 | 0,17578 | 11,00 | 2 048,00 | 55,19001 | 56 514,57 | 26,94825 | 27 595,005 | 376,9478 | 385 995 |
| 11,37778 | 0,08789 | 12,00 | 4 096,00 | 55,19001 | 56 514,57 | 13,47412 | 13 797,502 | 376,9478 | 385 995 |
| 22,75556 | 0,04395 | 13,00 | 8 192,00 | 55,19001 | 56 514,57 | 6,73706 | 6 898,751 | 376,9478 | 385 995 |
| 45,51111 | 0,02197 | 14,00 | 16 384,00 | 55,19001 | 56 514,57 | 3,36853 | 3 449,376 | 376,9478 | 385 995 |
| 91,02222 | 0,01099 | 15,00 | 32 768,00 | 55,19001 | 56 514,57 | 1,68427 | 1 724,688 | 376,9478 | 385 995 |
| 182,04444 | 0,00549 | 16,00 | 65 536,00 | 55,19001 | 56 514,57 | 0,84213 | 862,344 | 376,9478 | 385 995 |
| 364,08889 | 0,00275 | 16,00 | 65 536,00 | 27,59500 | 28 257,28 | 0,42107 | 431,172 | 188,4739 | 192 997 |
| 728,17778 | 0,00137 | 16,00 | 65 536,00 | 13,79750 | 14 128,64 | 0,21053 | 215,586 | 94,2369 | 96 499 |
| 800,00000 | 0,00125 | 16,00 | 65 536,00 | 12,55879 | 12 860,20 | 0,19163 | 196,231 | 85,7766 | 87 835 |
| 1 456,35556 | 0,00069 | 16,00 | 65 536,00 | 6,89875 | 7 064,32 | 0,10527 | 107,793 | 47,1185 | 48 249 |
| 2 912,71111 | 0,00034 | 16,00 | 65 536,00 | 3,44938 | 3 532,16 | 0,05263 | 53,896 | 23,5592 | 24 125 |
| 5 825,42222 | 0,00017 | 16,00 | 65 536,00 | 1,72469 | 1 766,08 | 0,02632 | 26,948 | 11,7796 | 12 062 |
| 11 650,84444 | 0,00009 | 16,00 | 65 536,00 | 0,86234 | 883,04 | 0,01316 | 13,474 | 5,8898 | 6 031 |
| 23 301,68889 | 0,00004 | 16,00 | 65 536,00 | 0,43117 | 441,52 | 0,00658 | 6,737 | 2,9449 | 3 016 |
| 46 603,37778 | 0,00002 | 16,00 | 65 536,00 | 0,21559 | 220,76 | 0,00329 | 3,369 | 1,4725 | 1 508 |
| 93 206,75556 | 0,00001 | 16,00 | 65 536,00 | 0,10779 | 110,38 | 0,00164 | 1,684 | 0,7362 | 754 |

For example, 16 bits are reached as maximum with 65536 counts, with a minimum integration time of 182ms. Another example is that the sensor at TINT = 23ms would already be in saturation with counts > 8192. Therefore, the integration time is not only to be selected according to a possible frequency of the measuring intervals but also influences the number of possible bits, thus the resolution but also the saturation.

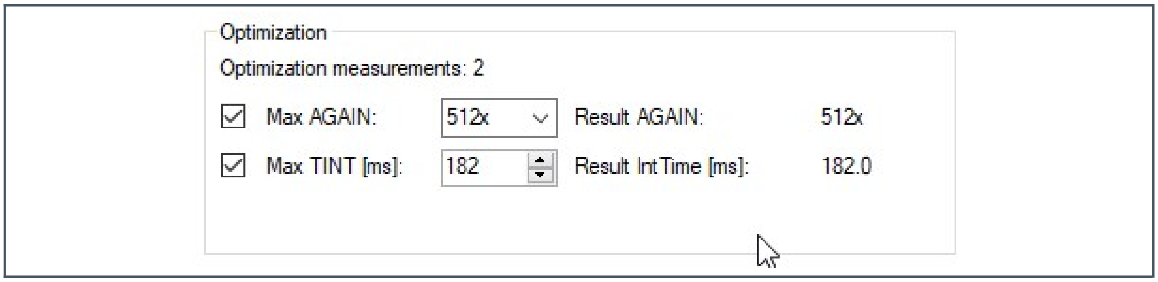
The ADC responds linearly to changes in integration time, but the gain has some small linearity errors. These can be corrected if the planned accuracy requires it. It is better to achieve the dynamics of the application with one gain, if necessary because in this case the so-called gain error is omitted.

Select an optimal TINT based on the required timing and determine a gain, which results in 'minimum' and 'maximum' acceptable counts (not noise and not saturation). It should not go above or below about 90% saturation for the maximum and 10% to 20% for the minimum to cover the full dynamics of the application with a gain. If this is not possible, then the dynamic gain is recommended, where the GUI

[4] Least Significant Bit

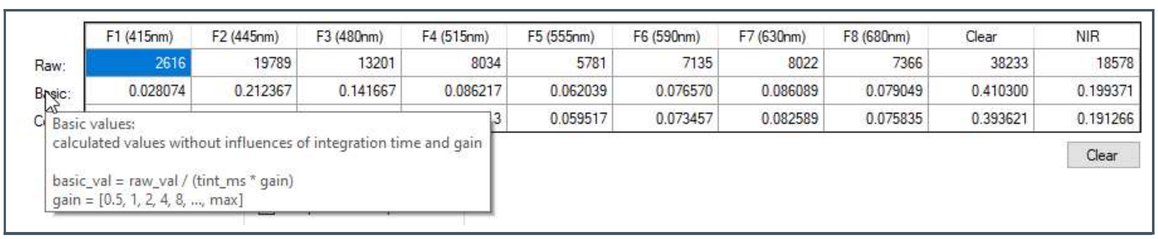
independently changes TINT and gain within defined limits ('Max' – see Figure 15 ) so that maximum counts are always achieved.

**Figure 15:**
**Define Maximum Sizes for Gain and TINT for Dynamic Conversion**




In case Gain or TINT are changed during the measurement series, the resultant count of the ADC 'Gain corrected' should be used. Furthermore, it should be calculated in a form that is independent of the setup quantities TINT and Gain. The GUI defines the so-called 'Basic_Counts', which are described in the manual of the AS7341 EVK [8]. This also applies to the 'Corrected_Counts', which are the result of the corrected 'Basic_Counts'. Correction here means that the GUI can consider offset as well as balancing of the 'Basic_Counts' according to the correction values in the INIT file (offset, gain correction, balancing – see [8]), if these are agreed by the user. After the software installation, the correction values contain a default '0' for offset and '1' as balance vector (=no change of the 'Basic_Counts'). When moving the mouse over the labels in the results table in the GUI, the user also gets the information about the meaning (Figure 16).

**Figure 16:**
**Result Table in AS7341 GUI with Help**




## 4.3 First Test – from ADC Value to Corrected Sensor Counts

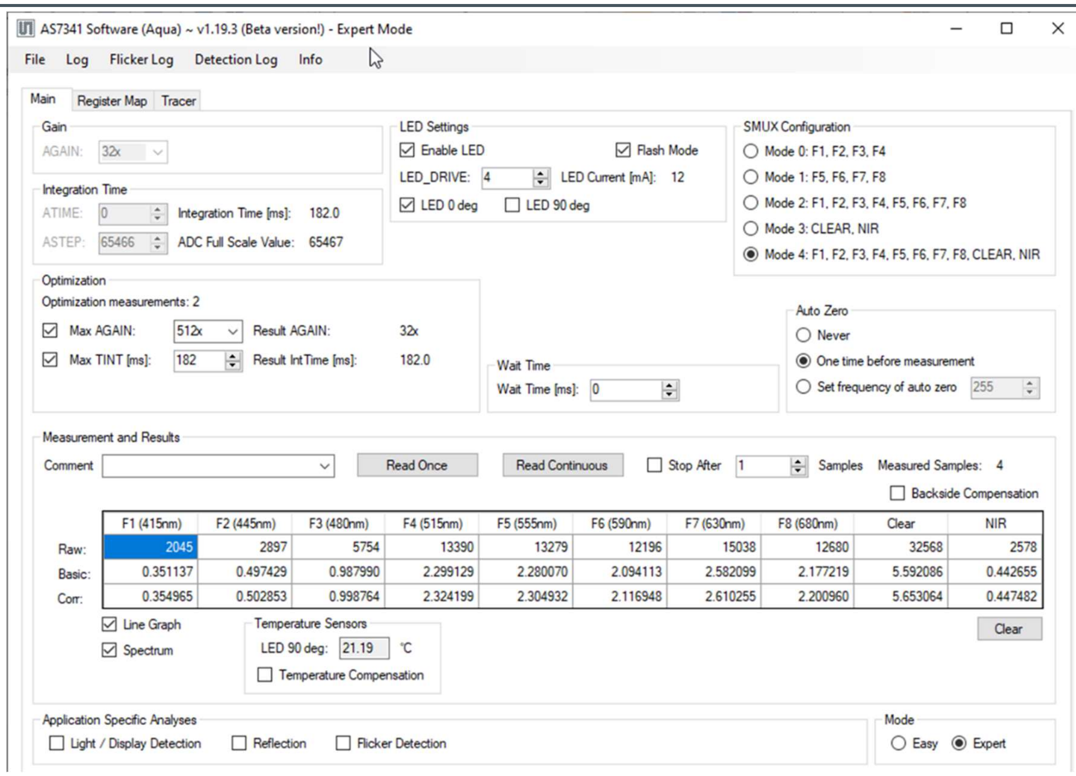
The measurements with hardware and parameter setup are application-specific. A simple fictitious example shall show the next steps here.

Different colors in the water are to be measured with the demo, where the channel values should correspond to the color (not the mix of illumination and color). Practically this means, the difference between the LED spectrum and the color in the water per channel is the result.

**Figure 17:**
**Simple Example to Present Aqua Demo**


Figure 18 shows the GUI configuration. The automatic conversion was selected and the maximum for each parameter was specified. SMUX was determined to mode 4 to get all the channels as result. An LED current of 12mA was enough to get stable results.

**Figure 18:**
**Main Window with Parameter Setup**

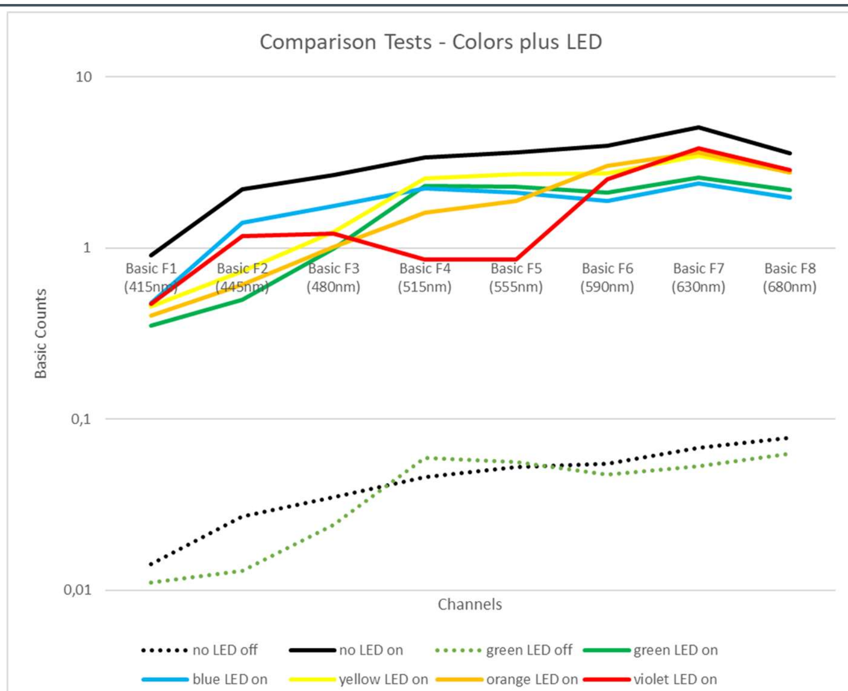


To exclude disruptions and drifts, the configuration was tested beforehand. Gain correction and automatic gain control were activated with typical correction values from the AS7341 datasheet [1]. Figure 19 shows a table (Figure 20 as diagram) with the results of the 'Basic_Counts' of the measured targets as RAW spectrum[5] - colored water (blue, green, yellow, orange, and violet) plus the values for the single LED (in pure water), and only for testing the value for the ambient light.

**Figure 19:**
**Table - Measured Results as Basic_Counts for the Probes - Colored Water**

| | Basic F1 (4 | Basic F2 (4 | Basic F3 (4 | Basic F4 (5 | Basic F5 (5 | Basic F6 (5 | Basic F7 (6 | Basic F8 (6 | Basic Clea | Basic NIR |
|---|---|---|---|---|---|---|---|---|---|---|
| no LED off | 0,014187 | 0,027044 | 0,035006 | 0,045545 | 0,052241 | 0,054946 | 0,067523 | 0,077997 | 0,230997 | 0,111662 |
| no LED on | 0,905572 | 2,196793 | 2,673446 | 3,371255 | 3,598936 | 3,947153 | 5,065296 | 3,562534 | 14,39883 | 0,751037 |
| green LED off | 0,011054 | 0,01291 | 0,023964 | 0,059603 | 0,056148 | 0,047176 | 0,052885 | 0,06293 | 0,208439 | 0,108668 |
| green LED on | 0,351137 | 0,497429 | 0,98799 | 2,299129 | 2,28007 | 2,094113 | 2,582099 | 2,177219 | 5,592086 | 0,442655 |
| blue LED on | 0,475108 | 1,403516 | 1,754653 | 2,230104 | 2,116778 | 1,879826 | 2,374679 | 1,964648 | 6,147895 | 0,452443 |
| yellow LED on | 0,454846 | 0,728887 | 1,237477 | 2,548445 | 2,691647 | 2,713625 | 3,440108 | 2,779903 | 7,033893 | 0,557011 |
| orange LED on | 0,400759 | 0,611613 | 1,016665 | 1,613511 | 1,889956 | 3,033511 | 3,601168 | 2,753117 | 6,185499 | 0,552718 |
| red LED on | 0,469441 | 1,165877 | 1,218247 | 0,851141 | 0,857666 | 2,507922 | 3,824556 | 2,865069 | 5,814616 | 0,519407 |

**Figure 20:**
**Diagram - Measured Results as Basic_Counts for the Probes - Colored Water**



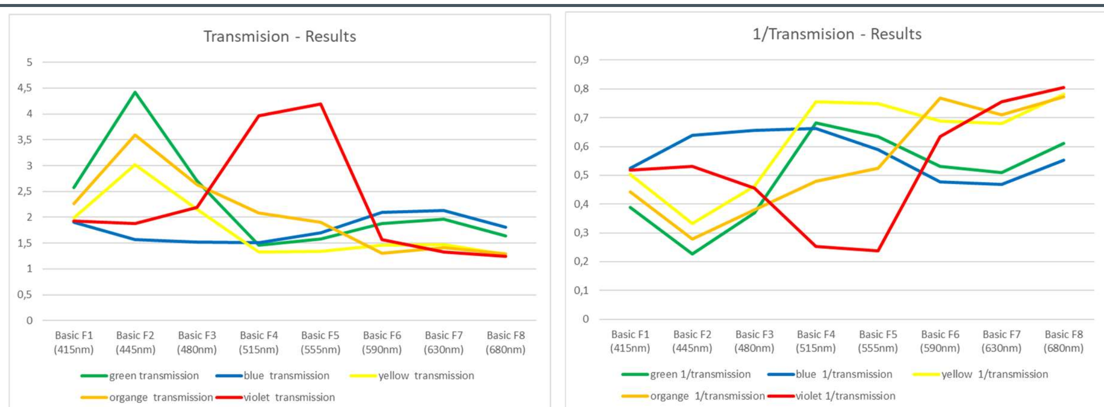

[5] Do not correspondence with the real spectrum measured by a spectrometer because spectra are distorted based on filter sensitivities and filter bandwidths. However, these distortions are taken into account during matching.

The results in Figure 21 represents per channel the overlay and mixing from the LED spectrum (wideband LED 5600K), as well as the transmission spectrum from the colored water. The next step is to calculate the channel results by dividing the single spectra from each other to eliminate light and filter effects. Figure 21 shows the results as a table, Figure 22 as a diagram. The Basic_Counts represent the transmission spectra however, they are illuminated by the LED and acquired by the AS7341 filter configuration.

**Figure 21:**
**Table - LED Corrected_Counts from Colored Water**

| | Basic F1 (4 | Basic F2 (4 | Basic F3 (4 | Basic F4 (5 | Basic F5 (5 | Basic F6 (5 | Basic F7 (6 | Basic F8 (6 |
|---|---|---|---|---|---|---|---|---|
| green transmissic | 2,578971 | 4,416295 | 2,705944 | 1,466318 | 1,578432 | 1,884881 | 1,961697 | 1,636277 |
| blue transmissior | 1,906034 | 1,565207 | 1,523632 | 1,511703 | 1,700195 | 2,099744 | 2,133045 | 1,813319 |
| yellow transmiss | 1,990942 | 3,013901 | 2,160401 | 1,322867 | 1,337076 | 1,454568 | 1,472424 | 1,281532 |
| organge transmis | 2,259642 | 3,591802 | 2,629623 | 2,089391 | 1,904243 | 1,301183 | 1,40657 | 1,294 |
| violet transmissic | 1,929043 | 1,884241 | 2,194502 | 3,960865 | 4,196198 | 1,573874 | 1,324414 | 1,243437 |

**Figure 22:**
**Diagram - Corrected_Counts Transmission (Left) and 1/Transmission (Right)**




Thus, they do not have a high similarity with the real transmission and remission spectra, i.e. compared when measured with a spectrometer. The reasons for this are:

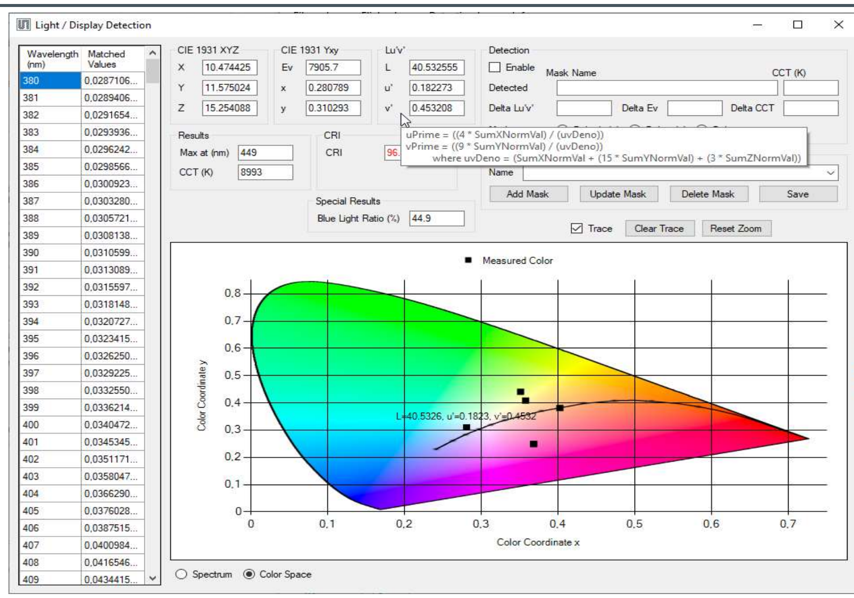
- The light source and Sensor are not calibrated and standard devices like a spectrometer or standard illumination like D65, D50, etc.
- The real filter curves of the sensor, which are too broadband and cover wavelength ranges, and also have different sensitivities.
- The emission spectrum of the LED, which distorts the Transmission spectrum of the color in the water.
- Other spectral disturbances, such as the transmission spectrum of the plastic housing, which has already been approximately eliminated as an offset.

- Tests were not done in a laboratory and were not free of disruptions (temperature, environmental light, etc.).

The AquaDemo AS7341 uses the GUI and partly corrected data of the AS7341 EVK ALS Ambient Light Sensing because hardware and application are similar. Therefore, using the correction matrix of AS7341 ALS can be useful to transform the spectral mix from ‘LED lighting’ + ‘color in water’ into a reconstructed spectrum and/or CIE1931 based units like XYZ or color coordinates. The way from ‘counts’ to ‘spectrum and CIE1931’ is described in [9].

Figure 23 shows the sensor results of the colored water as color dots in the CIE1931 xyY standard after calibration with the AS7341 ALS Golden Device Matrix from the Ambient Light Measurement application, where light spectra are measured and displayed as a reconstructed spectrum to measure their real CCT and lux.

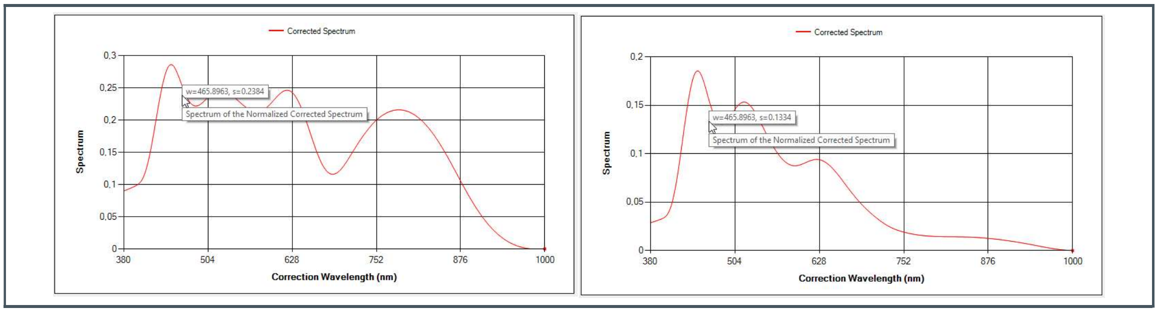
**Figure 23:**
**ALS Window with Traced Sensor Results in XYZ Diagram**




Now the coordinates, if they are compared with a spectrometer, are not very accurate. But, they are logically correct.

The same picture emerges for the reconstructed spectra. Left in Figure 24 is the spectrum of the LED, right with violet water. Here the spectra of the violet transmission are missing now.

**Figure 24:**
**Reconstructed Spectra – Left Only LED + Water – Right LED + Violet Water**



# 5 Additional Documents

The following list includes a selection of available documents with more technical details for the Sensor and AS7341 Evaluation Kit. This list is not fixed and it is constantly changing. Ask us for new details.

**For further information, please refer to the following documents:**

1. ams AG, *AS7341 11-Channel Spectral Sensor Frontend* (DS000504),datasheet.
2. ams AG, *AS7341 Details for Opto-Mechanical Design*, application note.
3. ams AG, *AS7341 Eval Kit Flicker Detection* (AN000605), application note.
4. ams AG, *SMUX configuration* (AN000666), application note.
5. ams AG, *Schematic a0013a_CSS Evalboard AS7341*.
6. ams AG, *AS7341 Eval Kit – Spectral Balance and Calibration* (QG000139), quick start guide.
7. ams AG, *AS7341 Demo for Fast Measurement Using Unicom Board* (AN000660), application note.
8. ams AG, *AS7341 EVK Manual* (UG000400), user guide.
9. ams AG, *Calibration* of spectral sensors (AN000633), application note.

# 6 Revision Information

| Changes from previous version to current revision v0-01 | Page |
|---|---|
| Initial version | all |
| | |
| | |
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| | |

- Page and figure numbers for the previous version may differ from page and figure numbers in the current revision.
- Correction of typographical errors is not explicitly mentioned.

# 7 Legal Information



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**Headquarters**
ams AG
Tobelbader Strasse 30
8141 Premstaetten
Austria, Europe
Tel: +43 (0) 3136 500 0

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