Application Note

AN000660

AS7341 Demo for Fast Measurement Using Unicom Board

Quick Start Guide for Fast Measurement with AS7341 Spectral Sensor

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Content Guide

1 Introduction 3

2 Hardware Description 4

3 AS7341 Fast Measurement GUI Software 6

3.1 Spectral Tab 7
3.2 Flicker Tab 10
3.3 Spectral/Flicker Tab 11

4 Appendix 14

4.1 Basics for Flicker Detection 14
4.2 Limitations of Flicker Detection 17
4.3 Example for Detection Flicker and Duty Cycle from Log File 17

5 Revision Information 24

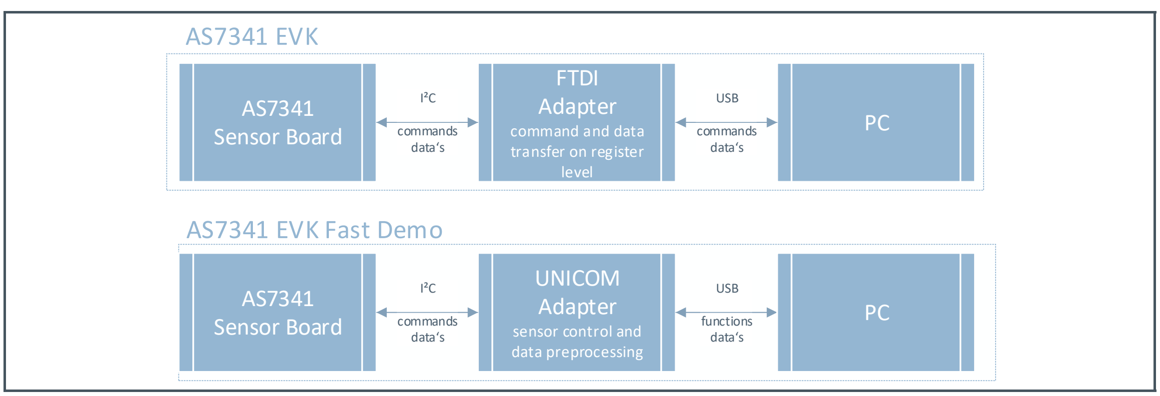
6 Legal Information 25

1 Introduction

AS7341 EVK exists from the sensor and FTDI cable to connect the I²C interface to PC via USB. This interface with FTDI cable, USB and Windows consumes more time and this leads to a reduced speed for the I²C communication for measurements. Therefore, some use cases are not testable for its speed or frequency. E.g., the frequency range of Ambient Light Sensing ALS flicker detection is limited due to the reduced speed of communication when using FTDI cables. Various customer applications require fast and real time measurements using AS7341. Therefore, **ams** offers a solution as demo in parallel to its EVKs via FTDI for fast measurement of AS7341 by using a special digital board solution. This digital board is named AS7241 EVK Fast Demo (with Unicom boar) and is a special demo solution where a higher speed of the measurement is an important factor. It includes only limited functions, which are necessary to realize a faster measurement than the standard EVK with the speed limited USB adapter.

It is recommend to use for all dynamical application tests the AS7341 Fast Demo solution and for accuracy tests the AS7341 EVK standard. The future development kits as well as a later customer series can consider the speed and accuracy in one sensor hardware and software. The current variants into two kits is only due to the used PC adapters. The standard kit uses a direct connection between USB and I²C for sensor access, which is limited by the adapters speed and Windows handling. The Fast Demo collects data from the sensor at I²C level and presents it to the PC as data packets in the GUI. Therefore, this solution is faster. Nevertheless, both solutions are based on the same I²C sensor board.

Figure 1:
Useful Caption



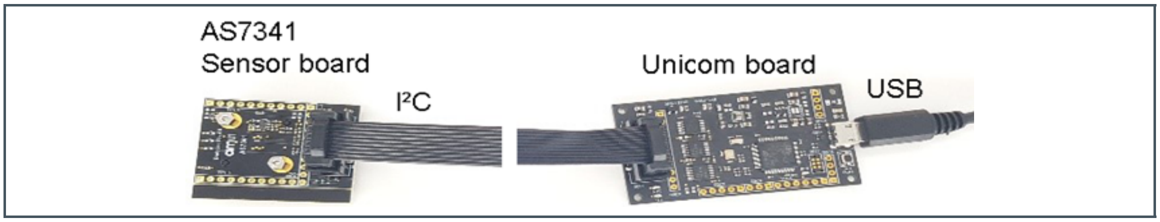
The following chapters describe the complete solution as kit, and parts of hardware and software to control it. At this time, this solution is only an **ams** internal demo and not available in the **ams** web shop.

2 Hardware Description

AS7341 EVK Fast Demo exists from AS7341 Sensor Board with LED and Diffuser, Unicom Board, Flat band cable and Software.

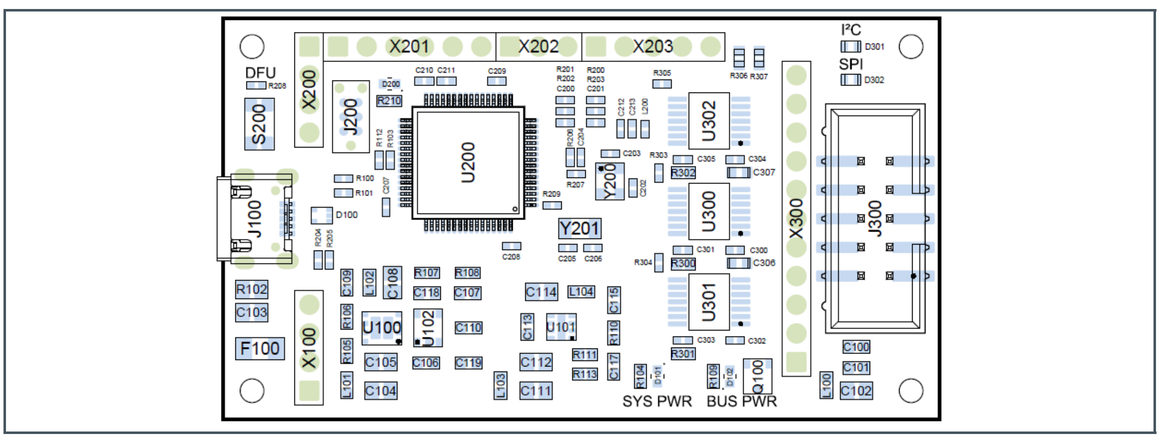
The AS7341 Sensor board and all components on board are described in the manual of the AS7341 EVK (UG000400).

Figure 2:
AS7341 Connection to PC via Unicom Board



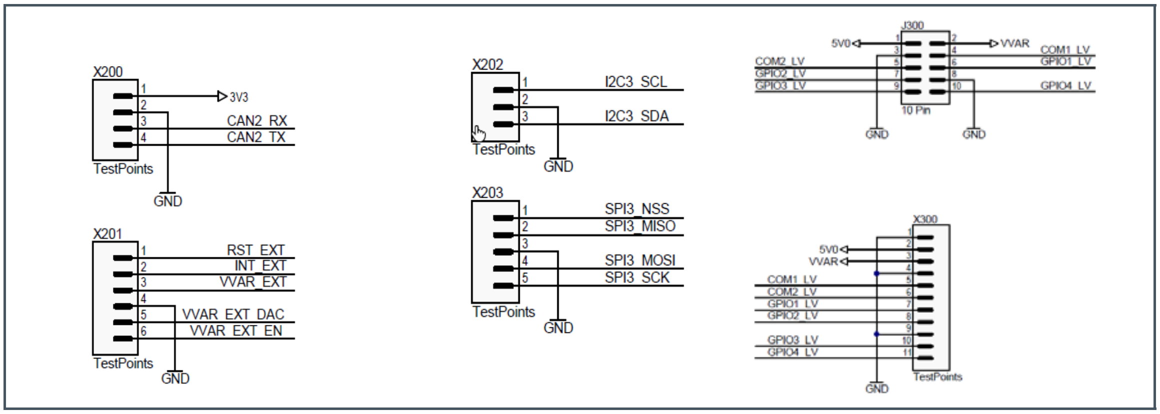
The Unicom board derived from microcontroller STM32F413 provides generic interface like USB to I²C, SPI, and UART etc. The I²C (inter-integrated circuit) bus interface handles communications between the microcontroller and the serial I²C bus. It supports Standard-mode (Sm), Fast-mode (Fm) and Fast-mode Plus (Fm+). Unicom board supports the connection with AS7341 via I²C bus. The firmware is configured and coded for Fast-mode (which supports up to 400 kHz clock frequency) connection with AS7341 sensor board (part of the AS7341 EVK).

Figure 3:
Top Side Unicom Board (Scale 2:1)



In Figure 3, the top side of Unicom board is shown with its interfaces, which are defined in Figure 4.

Figure 4:
Interfaces Unicom Board



All components are ready for measurements after completion. Connect the AS7341 EVK Sensor board to the Unicom board and USB to PC as shown in Figure 2.

3 AS7341 Fast Measurement GUI Software

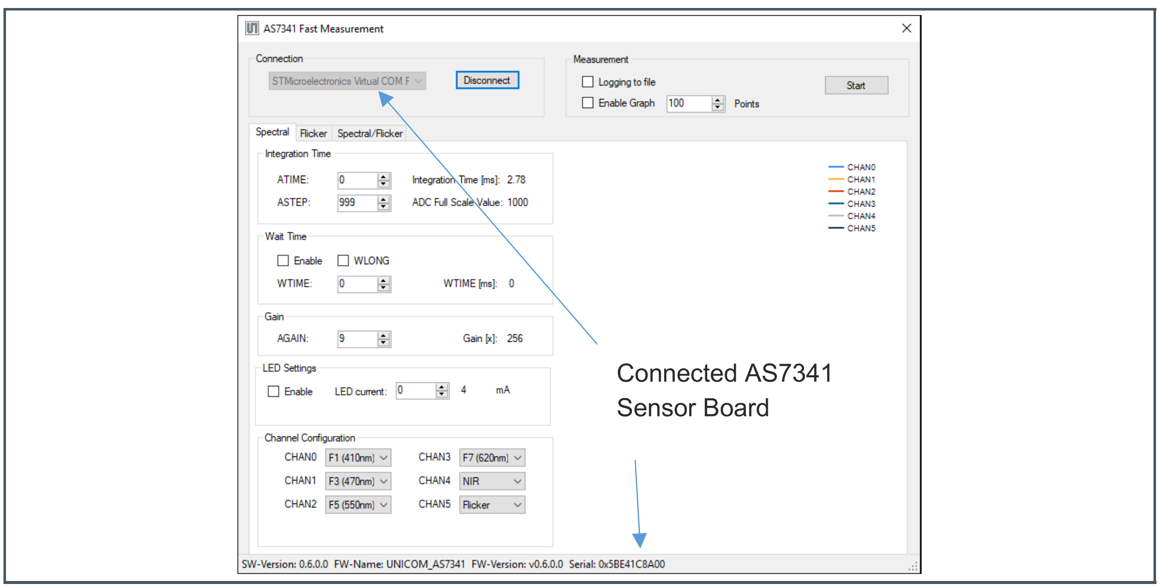
The GUI AS7341 for Fast measurement is for Windows 10 based systems where .net Framework 4.5.2 or later versions are preinstalled.

Start the software application by clicking on the file "AS7341_FastMeasurement by double-clicking the.exe" icon.

An application window pops up as shown in Figure 5. This window contains basic setup functions and three tabs with specific functions for alternative use cases. The basic functions are to connect the sensor, enable/disable the log file/graph, and to start/stop the measurements. The tabs are Detections of Spectral, Flicker, and combined Spectral/Flicker.

The connection list box fills with the Unicom board connected Com port. Pressing 'connect button' adjacent to the list box initiates the connection of AS7341sensor. The serial number of the detected board is shown in the footnote if the sensor board was detected successful.

Figure 5:
AS7341 Fast Measurement GUI



Once the connection is successful, there is possibility to navigate to three of the operational tabs- *Spectral, Flicker and Spectral/Flicker tab*.

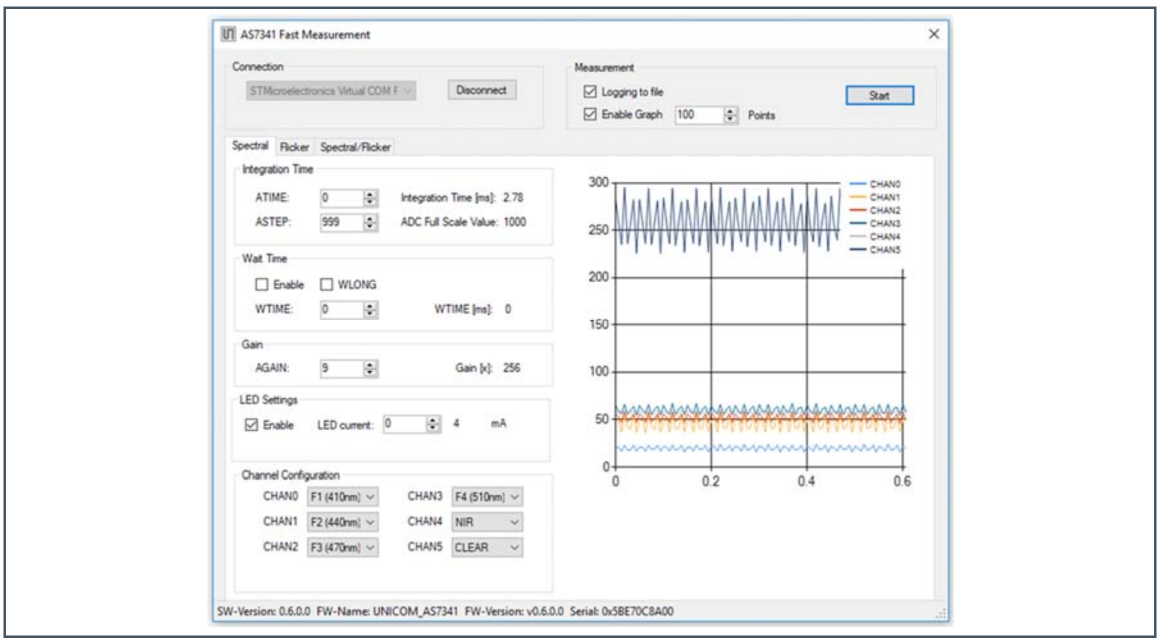
Activating the *Enable Graph* displays the measured ADC values graphically. After checking, the *Logging to file* and *Enable Graph* checkbox, pressing *Start* button starts the measurement continuously until the *stop* is pressed.

3.1 Spectral Tab

In the tab Spectral, most of the parameters can be selected in limited but variable ranges. The setups for the parameters **Integration Time, Wait Time, Gain, LED** and the **Channel configuration** can be set based on the application specific requirements.

Channel Configuration: AS7341 has eight optical channels cover the visible spectrum, one channel is used to measure near infrared light and another one channel is a photo diode without filter ("clear"). The device also integrates a dedicated channel to detect ambient light flicker. On the other side, AS7341 contains only a limited number of ADC channels and the number of optical channels is higher than the ADC channels on chip. Therefore, select in the *Channel configuration* the interest channel for the test setup based on the application specific requirements and the function Spectral tab considers all these channels. Their counts as results are printed in the log file and diagram. The Channel Configuration is done by on chip integrated multiplexer (SMUX) and mapping of available photo diodes to one of the six available ADC converters (ADC0 to ADC5). Operator can select six ADC channels with any of the 11 available channels: F1, F2, F3, F4, F5, F6, F7, F8, Clear, NIR, and Flicker.

Figure 6:
Spectral Measurement Tab



Integration Time (TINT) and ADC Value: The Integration Time is set, using ATIME (0x81) and ASTEP (0xCA, 0xCB) registers. The Integration Time [millisecond] calculated using the following

Equation 1:

$$tint = (ATIME + 1) \times (ASTEP + 1) \times 2.78\ \mu s$$

Integration Time is one parameter to affect the sensor digital counts or raw value. ADC Full scale value for a particular setting calculated as –

Equation 2:

$$\text{ADC Full Scale Value} = (ATIME + 1) \times (ASTEP + 1)$$

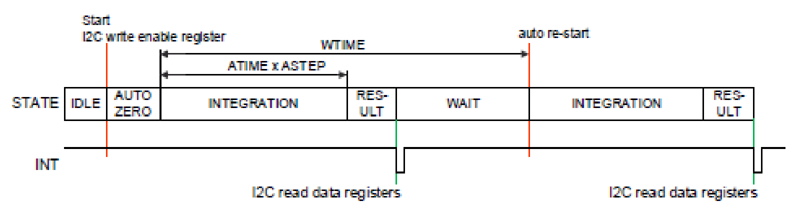
Sensed raw values exceeds the ADC full-scale value results in saturation.

Wait Time: Enable check box enables or disables the WEN bit in ENABLE register (0x80). When it is checked, the wait time is added to the integration time for one measurement cycle.

Equation 3:

$$\text{WTime} = \text{Tint} + \text{Wait Time}$$

Figure 7:
SPM Mode Timing Description



WLONG: Enables or disables the WLONG bit (bit 2) in 0XA9 register. When asserted, WTIME is increased by a factor 16x.

Gain (AGAIN): The gain amplifies the six integrated ADCs signal to increase sensitivity. The AGAIN consists of 11 possible gain selections between 0.5x and 512x.

LED Settings (LED Current): If LEDs are mounted on the Sensor board, Checkbox Enable enables the LED and sets LED currents. Enabling or disabling the LED_ACT bit (bit 7) of register 0x74. The current can be set using the up-down control on LED_DRIVE bits (6:0) of register 0xB1. It has a range from 4 mA to 258 mA[1].

Enable Graph activates the diagram and digital output of the results.

Enabling Logging to file activates the logging of the measured data to *SpectralLoggingData.csv* in the .exe directory. The logfile contains the setup and sensor results per line for each measurement.

[1] Function LED current and light intensity and/or maximal driver current is depending on the used LEDs and connected power supply. Check the LED data sheet before using this LED setting. A too high LED current can destroy LEDs.

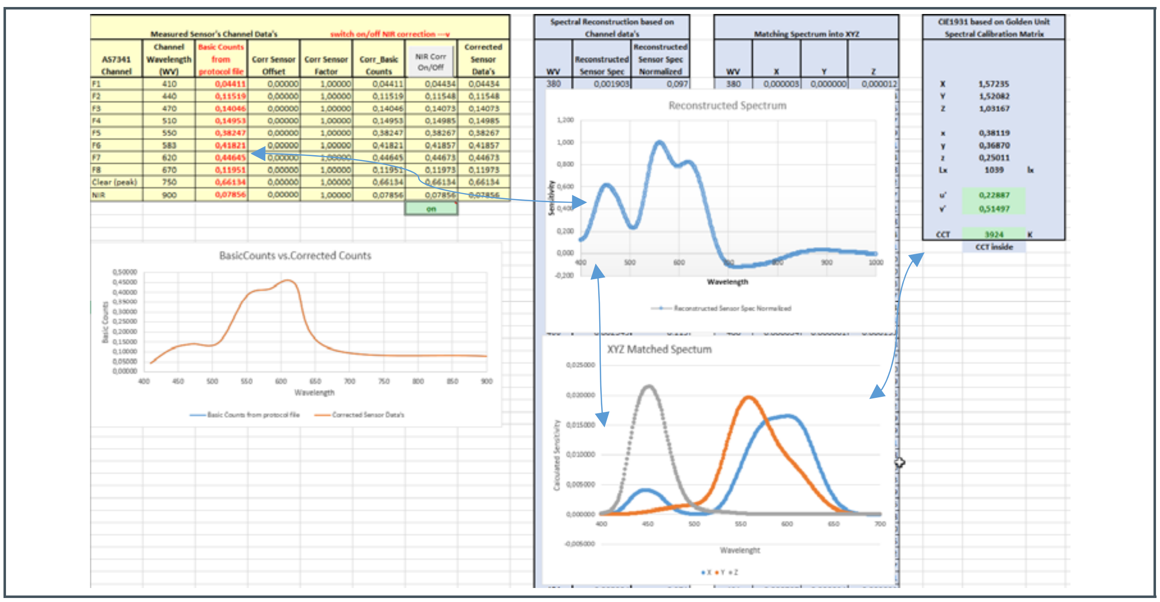
Figure 8:
SpectralLoggingData.csv Includes Setup and Results for Pre-Selected Channels

Serial: 0x!	ATIME: 0	ASTEP: 999	AGAIN: 10	WTIME: 0	WLONG: Fal!	WEN: False	LED_ACT: Tru	LED_DRIVE: 12		<=== parameters
timestam	error code	F1 (410nm)	F3 (470nm)	F5 (550nm)	F7 (620nm)	NIR	Flicker			<=== header
0	0	52	122	173	217	171	1000			<=== measurement result per li
0,006231	0	53	119	167	211	171	1000			
0,012461	0	52	119	169	213	171	1000			
0,018692	0	52	120	172	215	171	1000			
0,024922	0	52	118	166	207	170	1000			
0,031155	0	52	120	172	217	171	1000			

Column A in the log file includes a timestamp in seconds where '0' of the first line is the start time of logging. Each following line contains the time difference between the start '0' and the time of the current measurement. In chapter **Error! Reference source not found.**, an example is shown how to use these data's to find out flicker frequency and duty cycle with an Excel spreadsheet.

The spectral interpretation, verification of spectral footprints, calibration/correction of spectral data's and color matching for AS7341 signals are described in special application notes (e.g. AN000633 Spectral Sensor Calibration Methods), user manual for the standard EVK and Excel spread sheets (see Figure 9).

Figure 9:
Part of Excel Spreadsheet - From Sensor's RAW Counts to XYZ Based Results



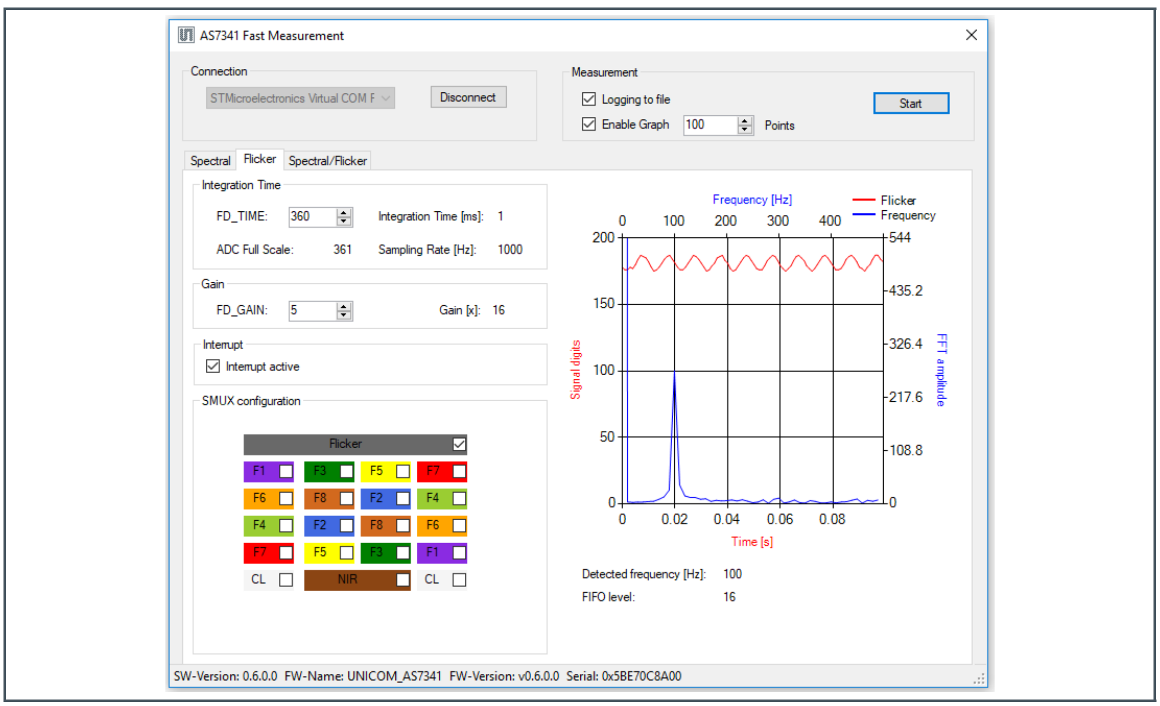
3.2 Flicker Tab

The AS7341 device is integrated ambient light flicker detection. The fully processing is similar to the Spectral tab.

- Enable *Logging to file* activates the logging of the FIFO flickering sample data to *FlickerLoggingData.csv*. Checking in the *Enable Graph* displays the flickering data values graphically.
- Pressing *Start* button starts the flicker measurement continuously until the *Stop* is pressed.
- The corresponding flickering frequency calculated from the measured flicker samples are displayed as detected frequency in the Flicker tab. The FIFO flickering data is represented as red color in graph and corresponding, calculated fast Fourier transformation (FFT) in blue color.
- *Interrupt active* button is to enable and disable Interrupt pin on the AS7341 sensor board.

SMUX Configuration: Similar to the spectral data, the Flicker tab can use alternative channels to detect flicker. The standard channel is enabled Flicker (see Figure 10). Adding other channels by the SMUX configuration means, activation and add-up of the counts of all selected channels. The higher are the numbers of counts, the higher is the sensitivity and better the accuracy.

Figure 10:
Flicker Tab



FD Integration Time and FD Gain: Select the configuration for flicker detection by choosing the FD_TIME, FD_GAIN and number of sample in points. The sampling rate is determined by inverse of the integration time.

The *FD Integration Time [ms] = (Fd_time +1) * 2.78*[2]

ADC Full Scale = Fd_time +1

The measured samples exceeding the ADC full scale value results in saturation of FIFO sample data.

The one of the FD_Gain- 0.5x, 1x, 2x, 4x, 8x, 16x, 32x, 64x, 128x, 256x, or 512x selected from the selection list.

3.3 Spectral/Flicker Tab

This tab combines the spectral and flicker detection measurements in a serial/parallel mode with automatic settings and in a shortest time. This gives the benefit of measurement of spectral data from all 10 channels and flickering FIFO sample measurement simultaneously. The results of these measurements are the spectral RAW values and an AS7341 sensor based flicker detection in a minimum of time.

Figure 11:
Spectral/Flicker Tab Measurement Cycle

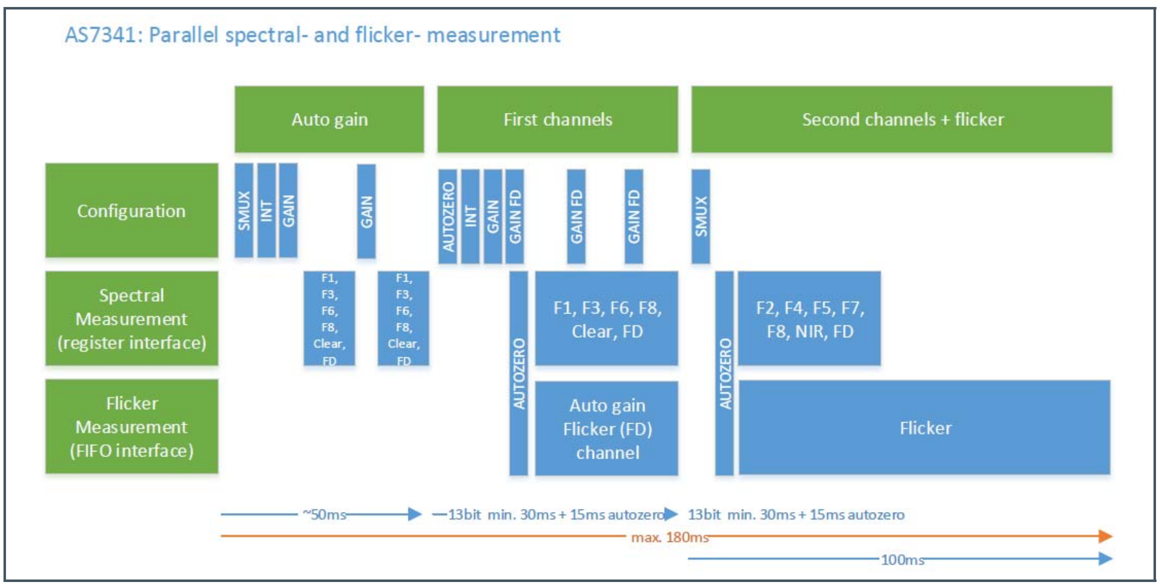


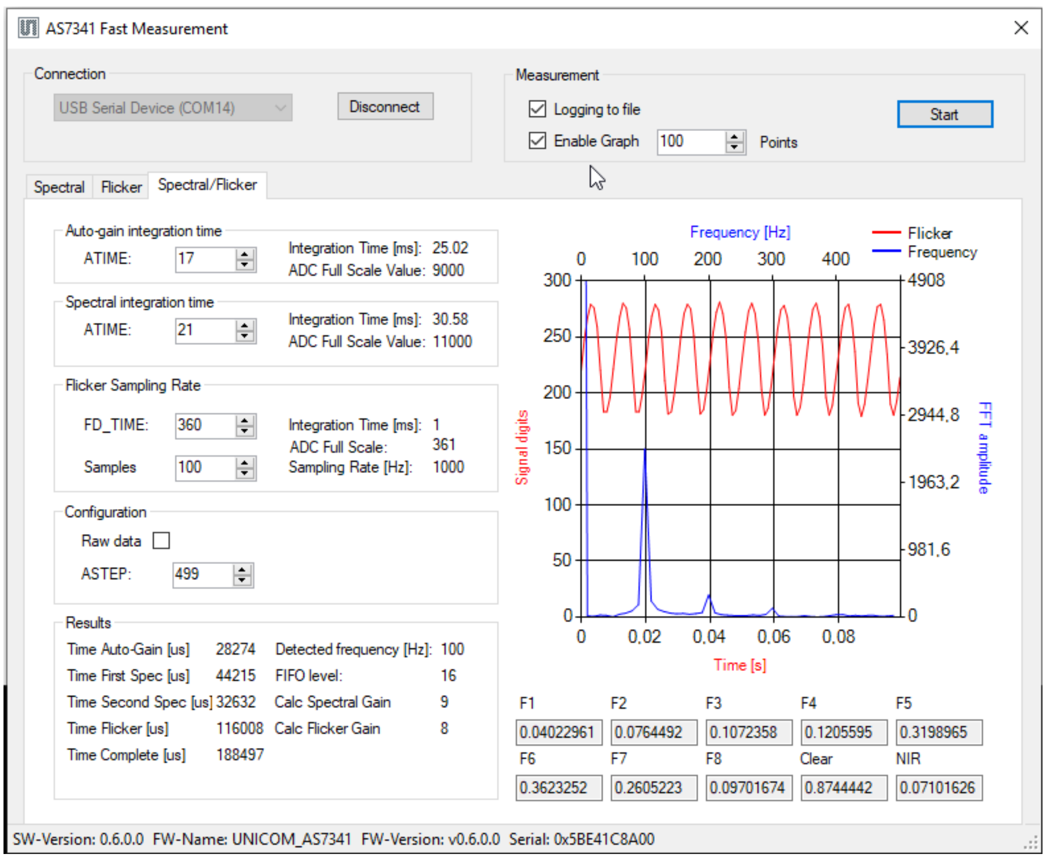
Figure 11 shows the single steps of the simultaneously flicker and spectral detection within a maximum of time of 180 ms (= cycle time) under following conditions:

- The spectral measurement is based on TINT < 30 ms (max. 13-Bit). If integration time is increased, the cycle time changes as well.
- All optical channels plus flicker are reading out.

[2] Better to calculate with result of ‚2000/720‘

- Autogain is used and needs as minimum one reading to tune it.
- The complete cycle for measurement shall not be longer than 180 ms.
- The time for flicker is depending on the target frequency, which must be detected. Lower frequencies need longer times, and higher frequencies higher sampling rates. Depending on the configurable integration time for the flicker diode, the sensor's internal buffer needs to be fetched more often.

Figure 12:
Spectral/Flicker Tab



Auto-Gain Integration Time: Set the integration time for the detection of Auto gain detection. During this time, the SMUX is configured and the optimized gain is calculated with the provided integration time.

Time Auto-Gain [µs]: Time taken for the SMUX configuration and to find the optimized gain at a given Auto-Gain Integration time.

Spectral Integration Time: This defines the actual integration time used for the measurement cycle.

Time First Spec [µs]: Time taken for the first measurement cycle of channels – F1, F3, F6, F8, Clear and FD. Flicker auto gain calculated during this period.

Time second Spec [µs]: Time taken for the second cycle of measurement for channels F2, F4, F5, F7, F8, NIR and FD. A new SMUX configured and the parallel measurement of flicker samples.

Flicker Sampling Rate: This block defines the parameter for the flicker detection. FD_Time assigned similar to the Flicker tab. Sampling rate is calculated as reciprocal of FD Integration Time. FD_Gain adjusted automatically upon saturation of sample values.

Time Flicker [µs]: Each sample takes one FD_Integration time. Time Flicker is the time taken for measuring all the flicker samples in a cycle. This time has other overheads for configuring. This cycle starts along with the second spectral measurement.

Configuration: Configuration sets the ASTEP for Auto-gain and Spectral integration time. Raw Data checkbox allows selecting between raw and basic count values.

Equation 4:

$$\text{BasicCounts} = (\text{RawCounts})* \text{Gain\_Correction} \;/\; (\text{gainx} * \text{tint\_ms})$$

// corresponding gain correction for 0.5x,1x,2x,4x,8x,16x,32x,64x,128x,256x,512x -

Gain_Correction=1.024;1.024;1.024;1.040;1.000;1.000;1.000;1.000;1.000;0.9875;0.9688

Time Complete [µs]: Time taken for entire measurement cycle that includes the – Time for Auto-Gain, first measurement cycle, second measurement cycle, flicker measurement cycle and other overheads.

4 Appendix

4.1 Basics for Flicker Detection

A flicker detection is essentially determined by 2 parameters. The sampling rate must be fast enough and the number of digits must be sufficient to identify the different periods.

The sampling rate must be must be at least twice or higher as high as the detectable frequency (Nyquist Shannon Sampling Theorem). The smallest impulse in a period determines the detectable frequency. For example, in a PWM based LED light are needed different sampling rates if in a constant PWM are different duty cycles are used. Figure 13 shows different sample rates in case of alternative duty cycles of a given PWM LED light.

It should also be noted that the sample rate (corresponds to the integration time of the AS7341) influences the digits. The higher is the integration time, the higher are the counts (linear). However, as known, an increase of the integration time reduces the detectable frequency of the flicker. This opposite effect can only be compensated by the parameter gain. With gain, the digits can be increased or decreased (linear). Depending on the application, gain should be selected in such a way that the FFT algorithm can detect the flicker periods without errors by using the digits 'as high as necessary'.

Figure 13:
Different Sample Rates T and f for a 400 HZ PWM in Case of Alternative Duty Cycles

PWM Hz	pulse ms	duty	factor duty %	T ms	f scan Hz	min FDTIME
400	2,50	**90%**	10	**0,25**	**4000**	**1440**
400	2,50	**80%**	5	**0,50**	**2000**	**720**
400	2,50	**75%**	4	**0,63**	**1600**	**576**
400	2,50	**50%**	2	**1,25**	**800**	**288**
400	2,50	**25%**	4	**0,63**	**1600**	**576**
400	2,50	**20%**	5	**0,50**	**2000**	**720**
400	2,50	**10%**	10	**0,25**	**4000**	**1440**

Figure 14 shows an example of a detected 100Hz flicker where the parameter setting Gain and FD_Time as integration time result in digits between 160 and 280 with which the 0-1 periods and flicker can be identified very clearly. Figure 15 shows the results of a positive detected flicker function and its frequency of 100 Hz with a sampling rate of 1000Hz. The blue line in the diagram represents the frequencies with amplitudes as FFT result(s). In this case, the results include more or less a unique result in kind of one frequency with a maximum of amplitude. Such a clear result refers to an optimized setup under normal application specific conditions, far away from any limitations.

Figure 14:
Example of Flicker with Recognized Digital Function (Gain = 10; FD_Time = 360)

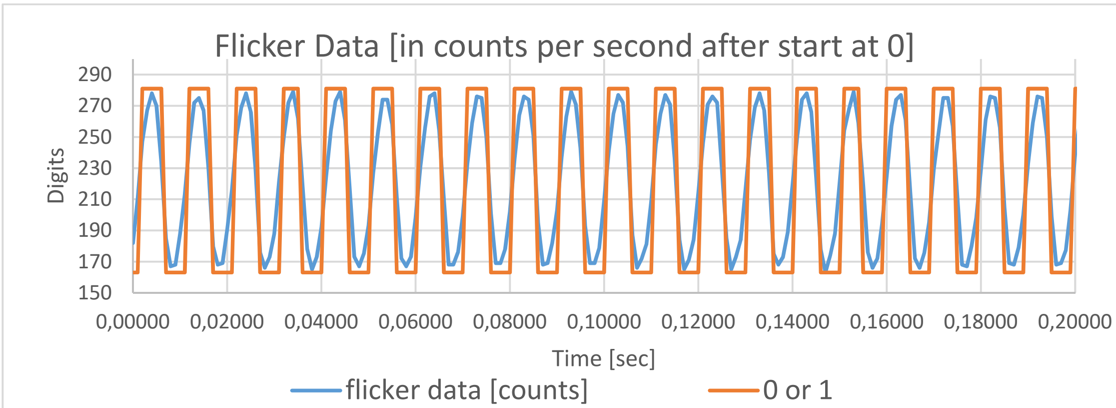
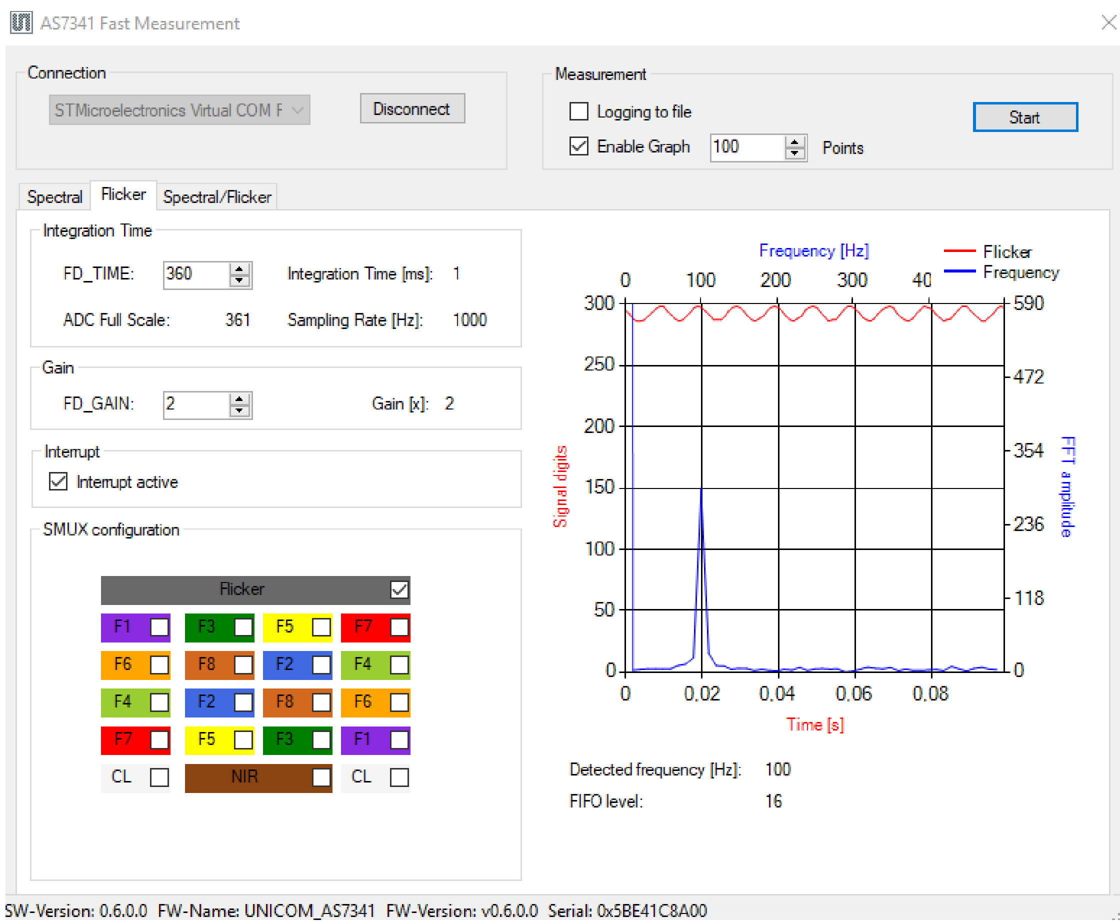
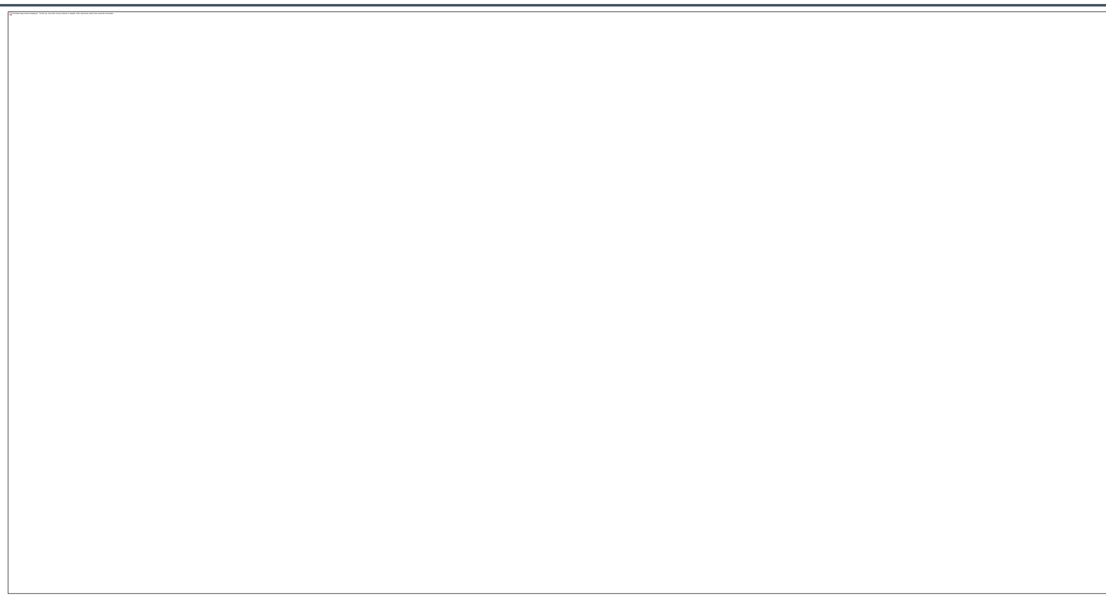


Figure 15:
Results of Flicker Detection – Diagram with Flicker, Frequency and Digital Output



Other results can be not so obvious. Figure 16 shows two FFT Results of disturbed flicker detections with correct and wrong result.

Figure 16:
FFT Results of Two Disturbed Flicker Detections with Correct and Wrong Result



The measurement were done with one identical hardware, under same conditions but with using different sampling rates of 1 kHz and 2 kHz. The high rates were used to achieve a high dynamic range. If the flicker frequency is unknown, then a high sampling rate is recommend to be able to sample high and low frequencies. However, a high sampling rate may lead to low digits. This may cause the 1-0-1 transitions to become less clean (noisy or deleted) and the FFT may result in mirrored flicker frequencies.

In Figure 16 and left side is the result of the FFT (blue line) for 1000 Hz sampling rate with up to 16 digits for high signal. The detected frequency is 203 Hz and correct. The red line is flicker and shows already clear unclean transitions, but with <2 lux the sensor is already in the limit range. Nevertheless, the result is still correct - see a strong peak for 203 Hz '600' amplitude with various smaller highs and lows below ‘250'.

In Figure 16 and right side is for the same measurement the result with double the sampling rate = 2033 Hz. The counts are halved due to the shorter sampling rate. This leads to a stronger noise and unclean transitions. The reflections of the flicker frequency as a result of the FFT increase. There are two peaks, at 203 Hz and 406 Hz with maximum amplitude (406 Hz is Max) on the blue line. Further reflections follow at generally n * 203 Hz (n=2,3,4 ...). The evaluation = Flicker frequency is frequency with maximum amplitude leads here to a wrong result.

In such cases, there are not enough information's in the FFT results to make a correct decision based on such an situation, i.e. to build it into the software as a rule. This would be possible if:

1. The frequency searched for is approximately known in the application (as in the measuring range)
2. There is always enough light available that a high sampling rate does not lead to insufficient digits and insufficient 1-0-1 transitions, which become frequency mirroring's in the FFT.

Unfortunately, (1) and (2) are not always possible. For such cases, gain must be increased (if possible) or sample time must be decreased before new measurements will be started with a new FFT run. This could have the effect of preventing 'not clean transitions' and noise and make the result more unique. Or, the parameter optimization could lead to abort because under the given conditions, a measurement flicker is not possible. However, this changing of setup requires at least one additional measurement and thus costs time. On the other side, a reducing of sample time will limit the dynamic to recognize the flicker frequency. It is always better to know the ranges for measurements and to consider them during parameter setup.

4.2 Limitations of Flicker Detection

- When the amplitude of the FIFO samples is more than the FD_TIME, digital saturation is signaled. To overcome this condition, FD_GAIN should be lowered or any other optical adaptation is recommend to reduce the optical signal (aperture, filter, etc.).
- Maximum detectable frequency is the half the sampling frequency rate (see chapter 4.1).
- Faster scanning can give results with higher accuracy. On the other hand, due to lower counts, faster scanning leads to a lower signal-to-noise ratio or less accurate signal separation. The result can be no flicker detection or wrong flicker detection
- The range of practical and detectable flickering frequency is from 10 Hz to 8150 Hz. The range of detectable frequency is always depending on the given light situation and/or application, optical coupling light into sensor and the selected integration time and gain.
- The most practicable integration time[3] (FD_TIME) is 21 to 2047 i.e. FDint time 0.078 ms (12,8 kHz) to 5.688 ms (175.8 Hz).

4.3 Example for Detection Flicker and Duty Cycle from Log File

An example shows the complete procedure of a flicker measurement. First, parameters must be selected to determine a flicker signal optimized for an application as a function of gain and integration time (see also chapter 0). The following figures show alternative setups and results in the enabled graph. The next two figures (Figure 17 and Figure 18) show parameter setups where the FFT algorithm could not detect useful and clearly flicker frequencies. The software produces a rushing digital and graphic result.

[3] Integration times, outside this range, can result FIFO overflow.

Figure 17:
Rushing Results based on too low Gain

Figure 18:
Rushing Results based on too low Integration Time

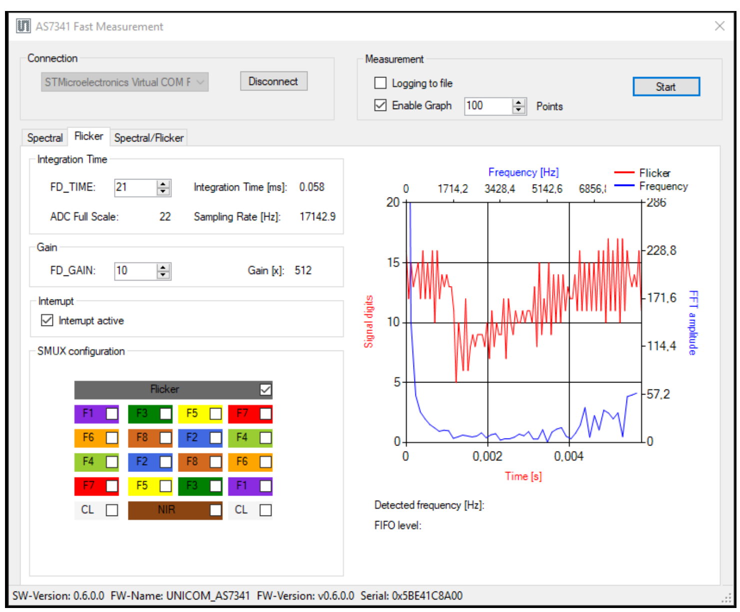
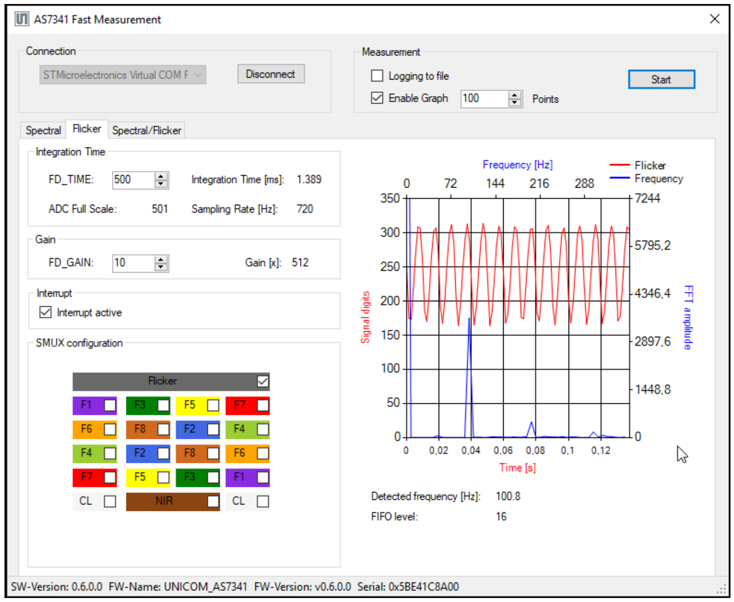


Figure 19:
Correct Setup for Gain and TINT with still Image and Results without Noise



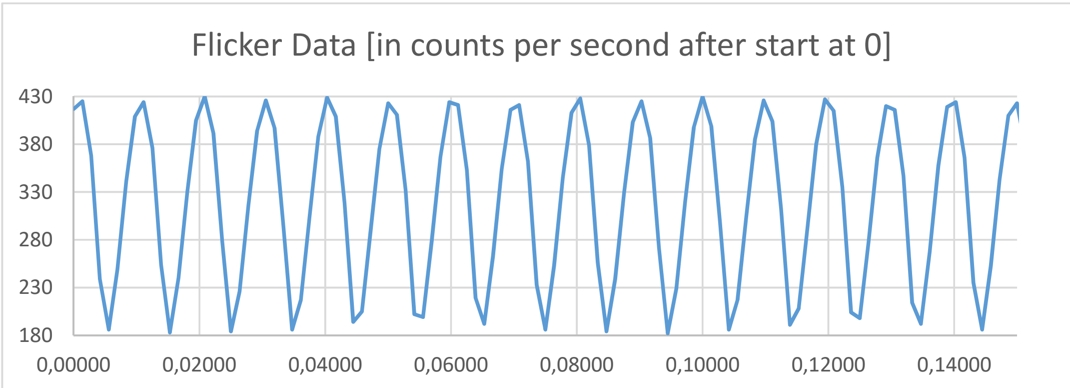
If a logfile is enabled in the GUI then flicker results can be used in own software to detect flicker frequency and duty cycle of the measured light. Figure 20 shows a part of a logfile. Use the columns timestamp in seconds and flicker data in counts to identify the light parameters.

Figure 20:
Part of Logfile with Timestamp and Flicker Data's

error code	FIFO level	timestamp [s]	flicker data [counts]
0	16	0,00000	417
0	16	0,00139	425
0	16	0,00278	368
0	16	0,00417	239
0	16	0,00556	186
0	16	0,00694	249
0	16	0,00833	341
0	16	0,00972	409
0	16	0,01111	424
0	16	0,01250	376
0	16	0,01389	254
0	16	0,01528	183
0	16	0,01667	240
0	16	0,01806	330
0	16	0,01944	405
0	16	0,02083	430
0	16	0,02222	391
0	16	0,02361	279
0	16	0,02500	184
0	16	0,02639	226

Figure 21 shows the graphical results as diagram in the range 0 sec up to 0.1 sec after sensor start.

Figure 21:
Diagram of measured Flicker Data's from Figure 20



In the next steps, these data's are used to calculate flicker frequency and duty cycle by a simple algorithm. Often FFT based algorithms are common, which are provided in mathematical libraries. For example, the following steps are in an MS Excel spreadsheet.

- Use Max/Min function to detect the counts for high/low signal – see "cell C2' in Figure 22
- Counts for each time stamp are transferred to high (=max) if greater than Mean (average between high and low) or low (=min) if smaller than Mean – see 'column E' in Figure 22
- Use a digital filter to eliminate unwanted spikes – see red broken line ellipse in Figure 23 – in the example, n steps from 'cell D5' are used as minimum-high sequence to eliminate high levels spikes
- Marking of the filtered 1-0 transitions to detect period and frequency – see 'columns E up to I' in Figure 22
- Counting of highs and lows per detected period can be used to calculate the duty cycles per period – see 'columns L up to N' in Figure 22
- Using Maximum or Averaging results similar duty cycles which are shown in 'cell K6:N6' in Figure 22

Figure 22:
MS Excel Spread Sheet to Calculate Flicker and Duty Cycle

	C	D	E	F	G	H	I	J	K	L
1	min	182	0					Duty Cycle		
2	max	431	1		Number 1	1129	57%	1,31		Frequency
3	mean	306,5			Number 0	864	43%	1,00		101,1
4	digiF	3								
5	timestamp [s]	flicker data [counts]	0 or 1	Signal Raw	Digit Filter 1	Digit Filter 2	0-1	TimeDiff	TimePeriod	Frequency
6	0,00000	417	431	1	1	1	0	FALSE	0	FALSE
7	0,00139	425	431	1	2	1	0	FALSE	0	FALSE
8	0,00278	368	431	1	3	1	0	FALSE	0	FALSE
9	0,00417	239	182	0	0	0	0	FALSE	0	FALSE
10	0,00556	186	182	0	0	0	0	FALSE	0	FALSE
11	0,00694	249	182	0	0	0	0	FALSE	0	FALSE
12	0,00833	341	431	1	1	1	1	0,008333333	0,008333333	120,0
13	0,00972	409	431	1	2	1	0	FALSE	0	FALSE
14	0,01111	424	431	1	3	1	0	FALSE	0	FALSE
15	0,01250	376	431	1	4	1	0	FALSE	0	FALSE
16	0,01389	254	182	0	0	0	0	FALSE	0	FALSE
17	0,01528	183	182	0	0	0	0	FALSE	0	FALSE
18	0,01667	240	182	0	0	0	0	FALSE	0	FALSE
19	0,01806	330	431	1	1	1	1	0,018055556	0,009722222	102,9
20	0,01944	405	431	1	2	1	0	FALSE	0	FALSE
21	0,02083	430	431	1	3	1	0	FALSE	0	FALSE
22	0,02222	391	431	1	4	1	0	FALSE	0	FALSE
23	0,02361	279	182	0	0	0	0	FALSE	0	FALSE
24	0,02500	184	182	0	0	0	0	FALSE	0	FALSE
25	0,02639	226	182	0	0	0	0	FALSE	0	FALSE
26	0,02778	316	431	1	1	1	1	0,027777778	0,009722222	102,9
27	0,02917	394	431	1	2	1	0	FALSE	0	FALSE
28	0,03056	426	431	1	3	1	0	FALSE	0	FALSE
29	0,03194	397	431	1	4	1	0	FALSE	0	FALSE
30	0,03333	294	182	0	0	0	0	FALSE	0	FALSE
31	0,03472	186	182	0	0	0	0	FALSE	0	FALSE
32	0,03611	217	182	0	0	0	0	FALSE	0	FALSE
33	0,03750	305	182	0	0	0	0	FALSE	0	FALSE
34	0,03889	388	431	1	1	1	1	0,038888889	0,011111111	90,0
35	0,04028	429	431	1	2	1	0	FALSE	0	FALSE
36	0,04167	409	431	1	3	1	0	FALSE	0	FALSE
37	0,04306	319	431	1	4	1	0	FALSE	0	FALSE
38	0,04444	194	182	0	0	0	0	FALSE	0	FALSE
39	0,04583	205	182	0	0	0	0	FALSE	0	FALSE
40	0,04722	290	182	0	0	0	0	FALSE	0	FALSE
41	0,04861	375	431	1	1	1	1	0,048611111	0,009722222	102,9

Figure 23:
Measured Flicker Counts with SET High and Low

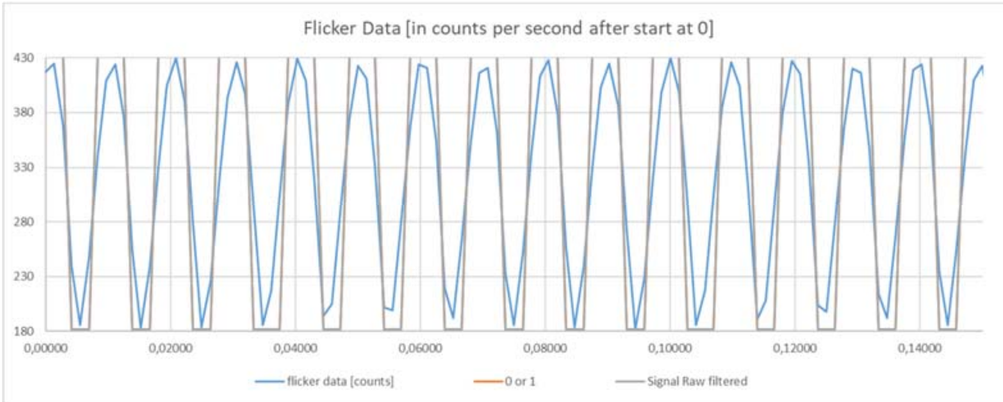


Figure 24:
Measured Flicker Counts with Marked Periods

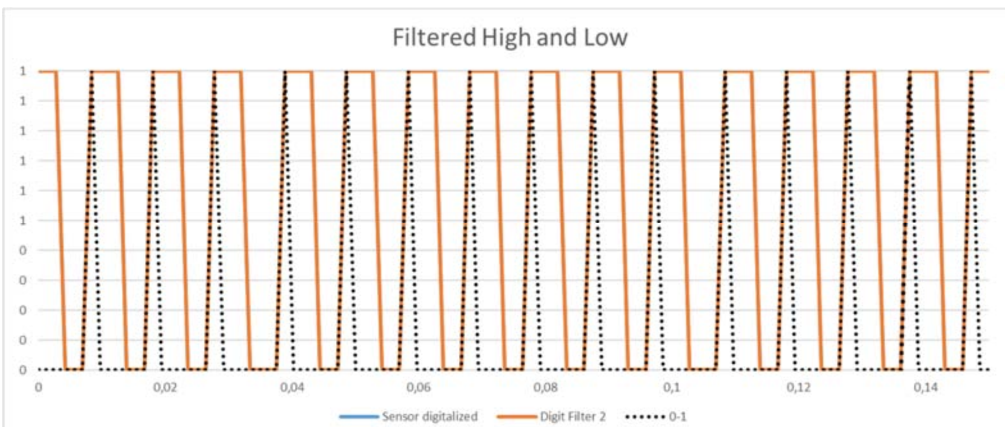


Figure 25:
Results for the Flicker Example 102 Hz with a duty cycle of 1:1.3

			Duty Cycle		
Number 1	**1129**	57%	**1,31**		**Frequency**
Number 0	**864**	43%	**1,00**		**101,1**

The shown algorithm to calculate flicker frequency and duty cycle is not optimized and don't consider limited conditions and parameters as described. It is only an example to give an impression how to use sensor and its data's for such an application. It should be clear that every application needs its optimized parameters, which an application specific algorithm must first find out and test internally.

The next figures show the Excel sheets and results of a logfile where identical parameters for gain and integration time but different sizes for the digital filter were used. Therefore, the results also different (positive with detected frequency and negative without calculable frequency) because filter, integration time and number of digitalized steps are connected. The frequency could be calculated based on the set integration time after the digital filter was reduced (see Figure 26 and Figure 27).

Figure 26:
No Calculated Flicker because Digital Filter is defined too large for the integration time

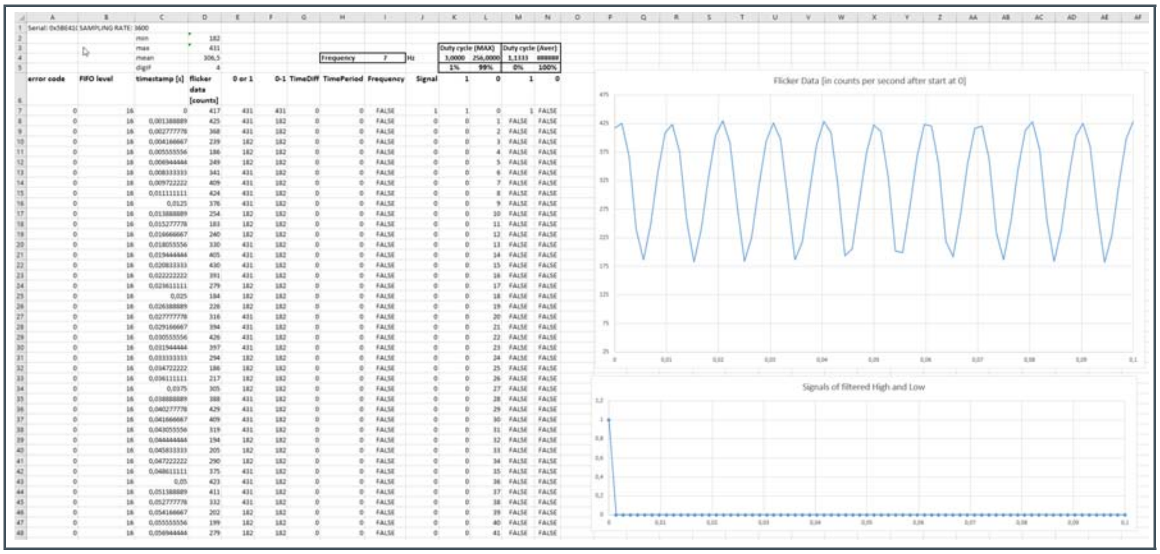
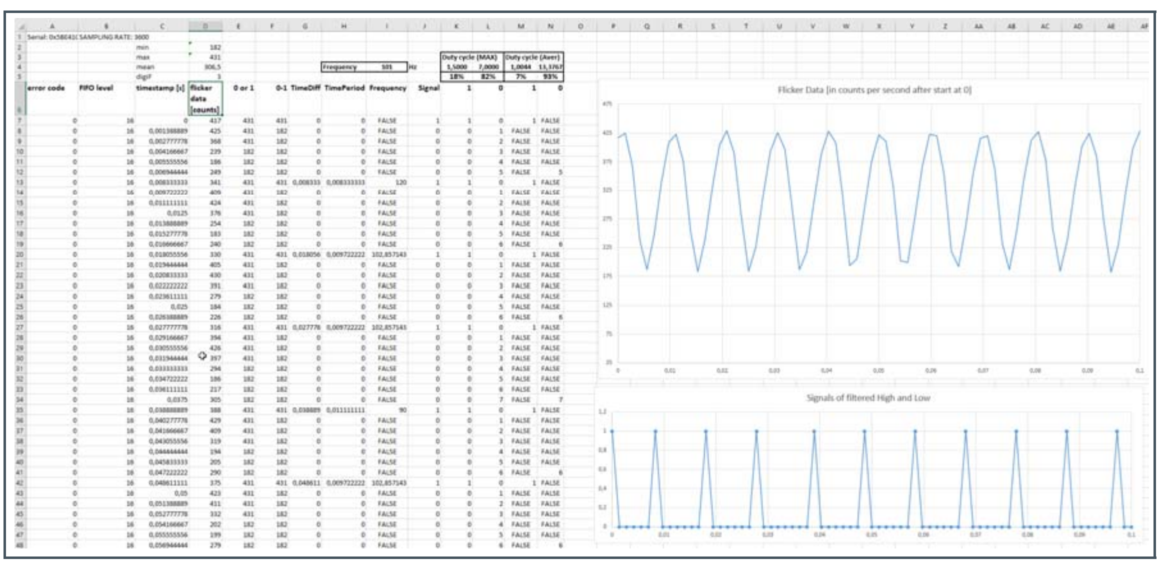


Figure 27:
Flicker after Reducing Digital Filter



5 Revision Information

Changes from previous version to current revision v2-00	Page
Introduction	3
Hardware details Unicom Board	4 - 5
Example for Flicker Detection plus Calculation Frequency and Duty Cycle	11 - 16

- 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.

6 Legal Information

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