Application Note

AN000660

AS7341 Demo for Fast Measurement Using Unicom Board

Quick Start Guide for Fast Measurement with AS7341 Spectral Sensor

v1-00 • 2019-Dec-09

Content Guide

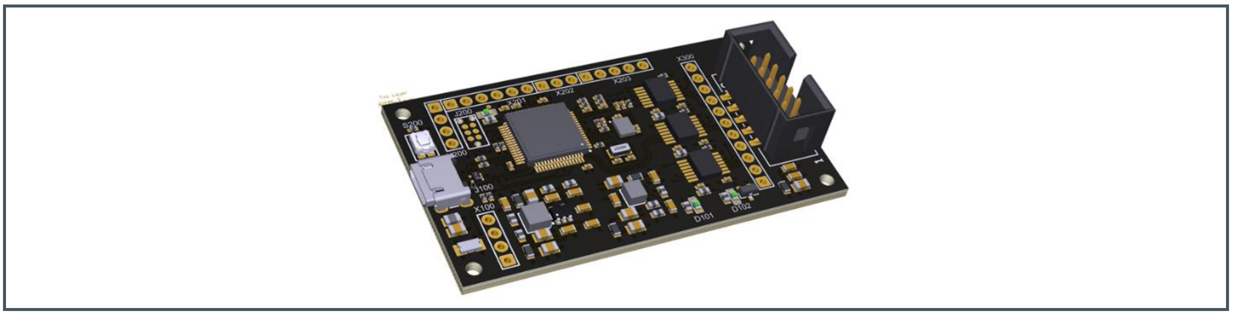
1 Introduction

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 in parallel to its EVKs via FTDI for fast measurement of AS7341 by using a special digital board solution. This digital board is named as Unicom board and is a demo solution where a higher speed of the measurement is an important factor.

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 Unicom Board

Figure 1:
Unicom Board

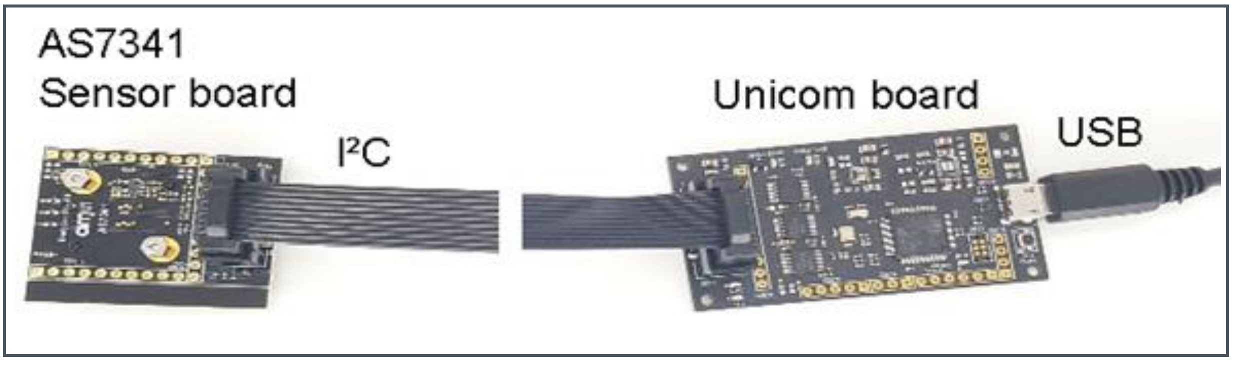


Unicom board derived from microcontroller STM32F413 provides generic interface like USB to I^2C, SPI, and UART etc. The I^2C (inter-integrated circuit) bus interface handles communications between the microcontroller and the serial I^2C bus. It supports Standard-mode (Sm), Fast-mode (Fm) and Fast-mode Plus (Fm+). Unicom board supports the connection with AS7341 via I^2C 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).

2.1 Connecting Unicom Board and AS7341 Sensor

Unicom board should be loaded with the latest firmware before connecting the AS7341 sensor. Once the firmware is loaded to Unicom board, connect the AS7341 EVK Sensor board to the Unicom board as shown in Figure 2.

Figure 2:
AS7341 Connection to PC via Unicom Board



3 AS7341 Fast Measurement GUI Software

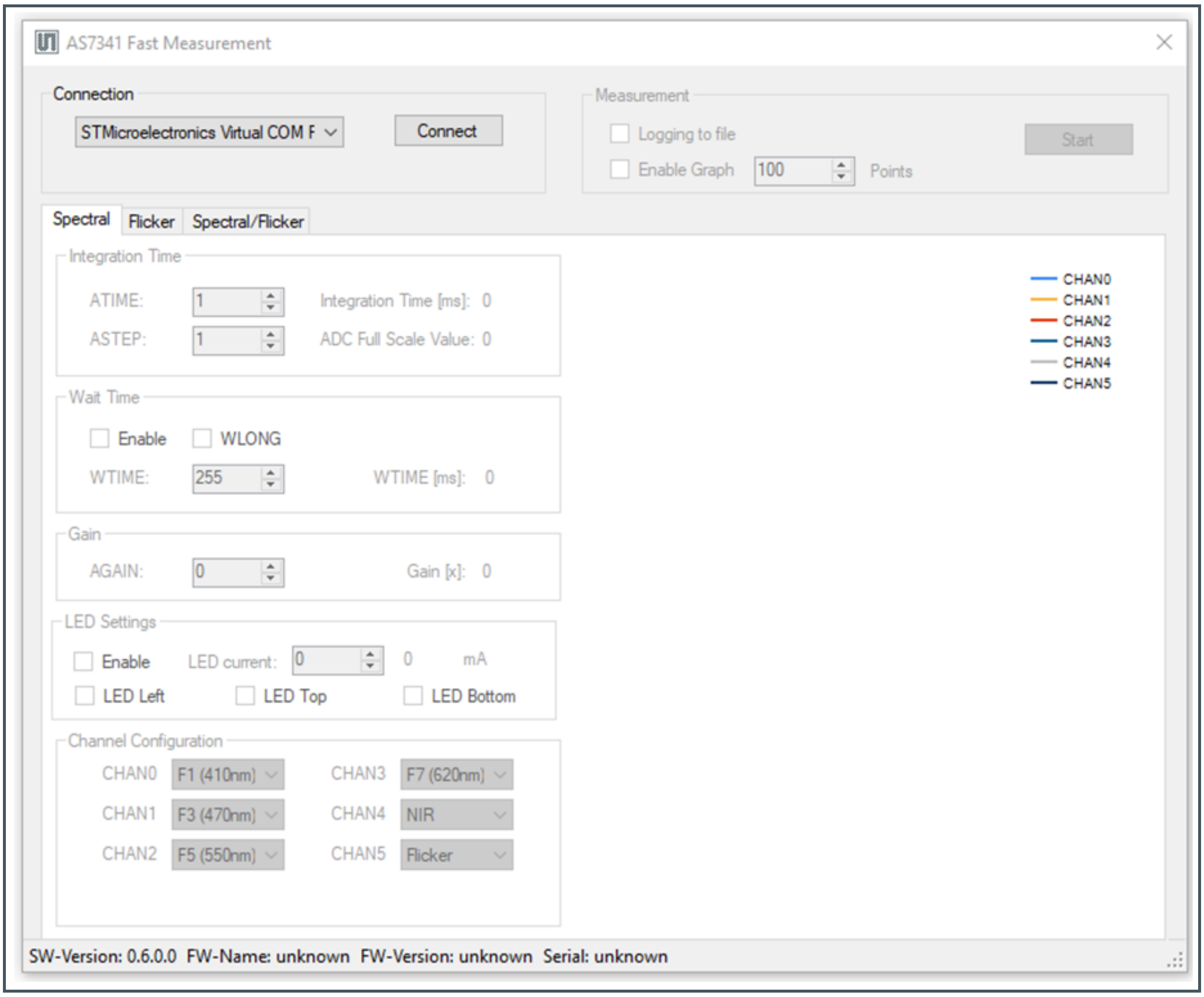
The GUI AS7341 for Fast measurement is for Windows 10 based systems where .net Framework 4.5.2 or later versions are preinstalled.

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 3. 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 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.

Figure 3:
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*.

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.

Figure 4:
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 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 sec.

*A*ctivating 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.

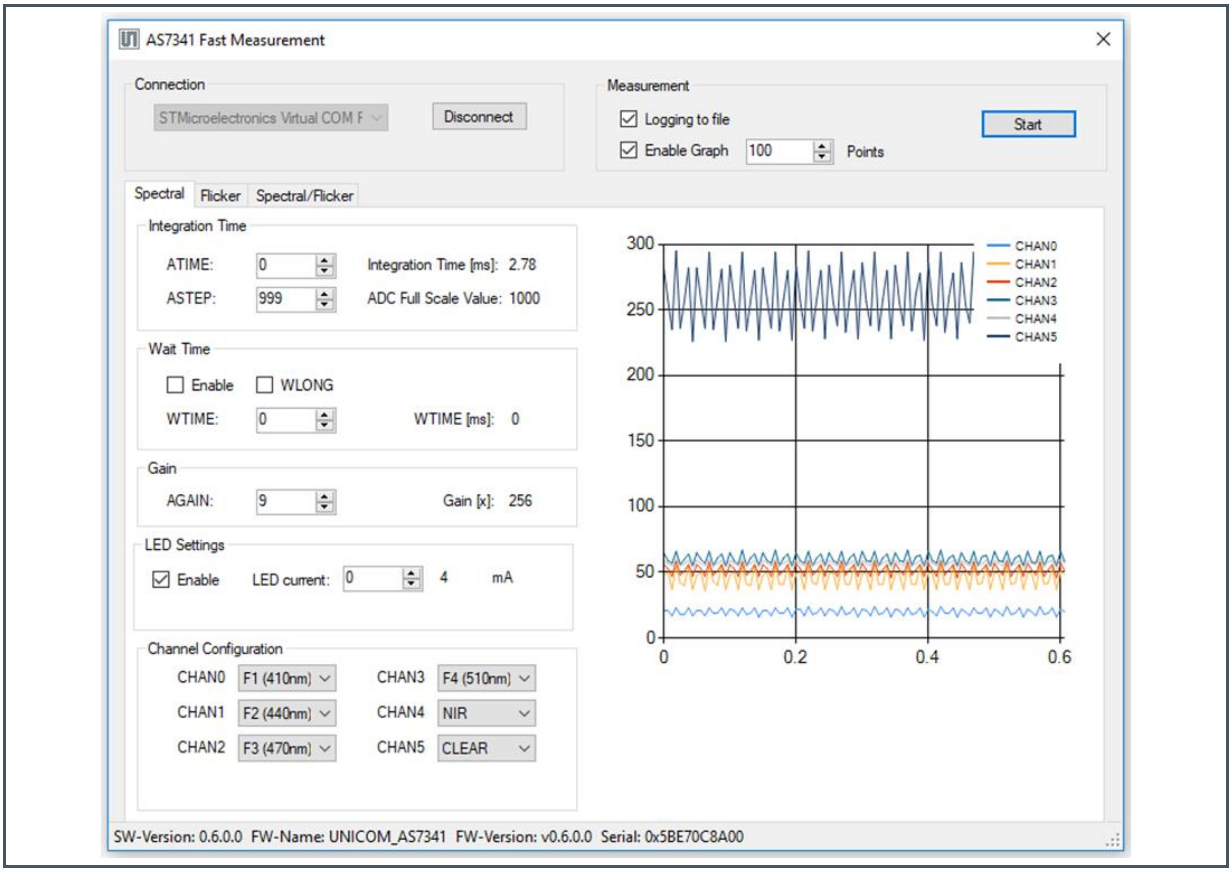
3.1 Spectral Tab

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.

An optimized parameter setup is important to get useful results and/or to be in the working range of the single components. Inform yourself about all working conditions and prevent setups outside the given maximal conditions before you start any tests.

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 5:
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:

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

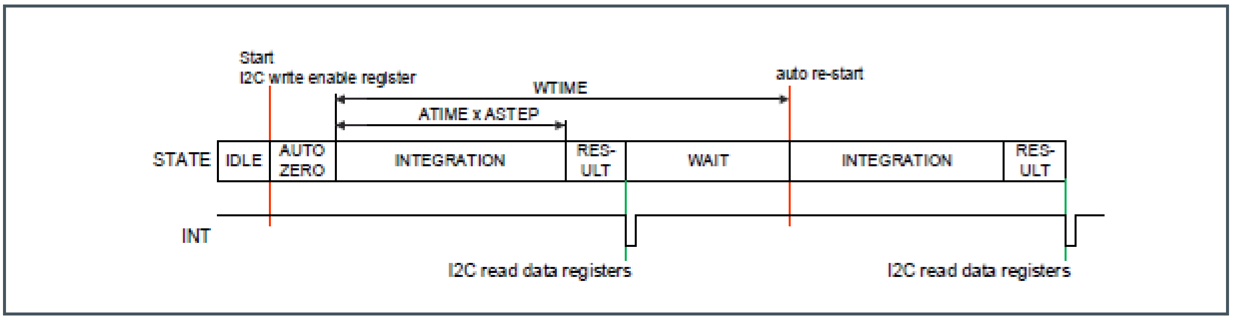
Sensed raw values exceeds the ADC full-scale value results in saturation.

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 6:
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].

3.2 Flicker Tab

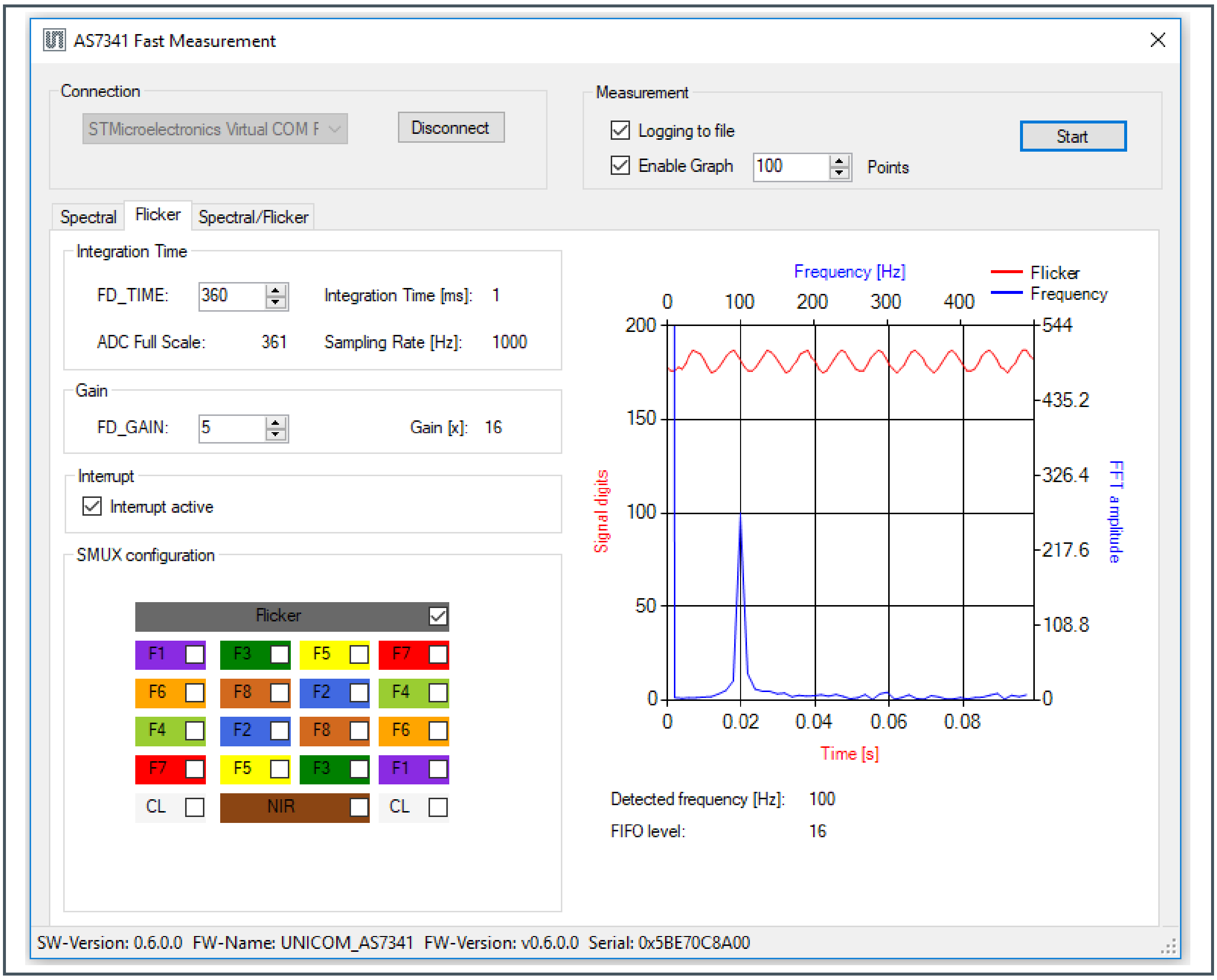
The AS7341 device is integrated ambient light flicker detection. The fully processing is similar to the Spectral tab.

- 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.

[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.

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 7). 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 7:
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*

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.

3.2.1 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.
- Maximum detectable frequency is the half the sampling frequency rate.
- The range of detectable flickering frequency is from 10 Hz to 8150 Hz and the range of detectable frequency depends on the selected integration time.
- The possible integration time (FD_TIME) is 21 to 2047 i.e. FDint time 0.061 ms to 5.689 ms.

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 8:
Spectral/Flicker Tab Measurement Cycle

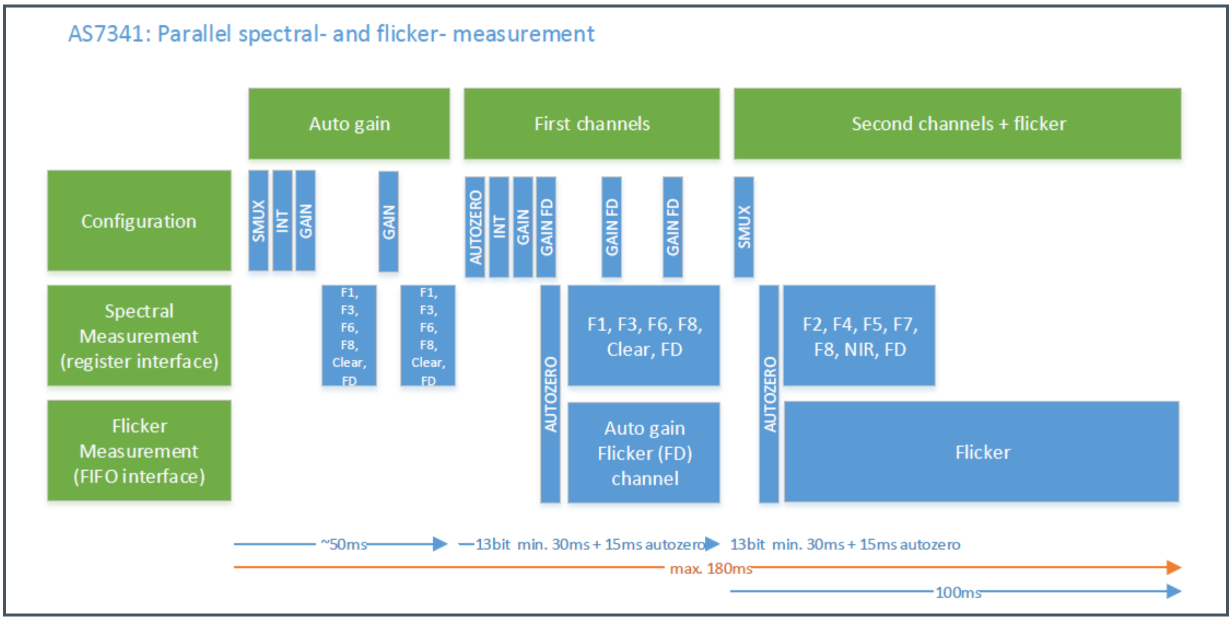
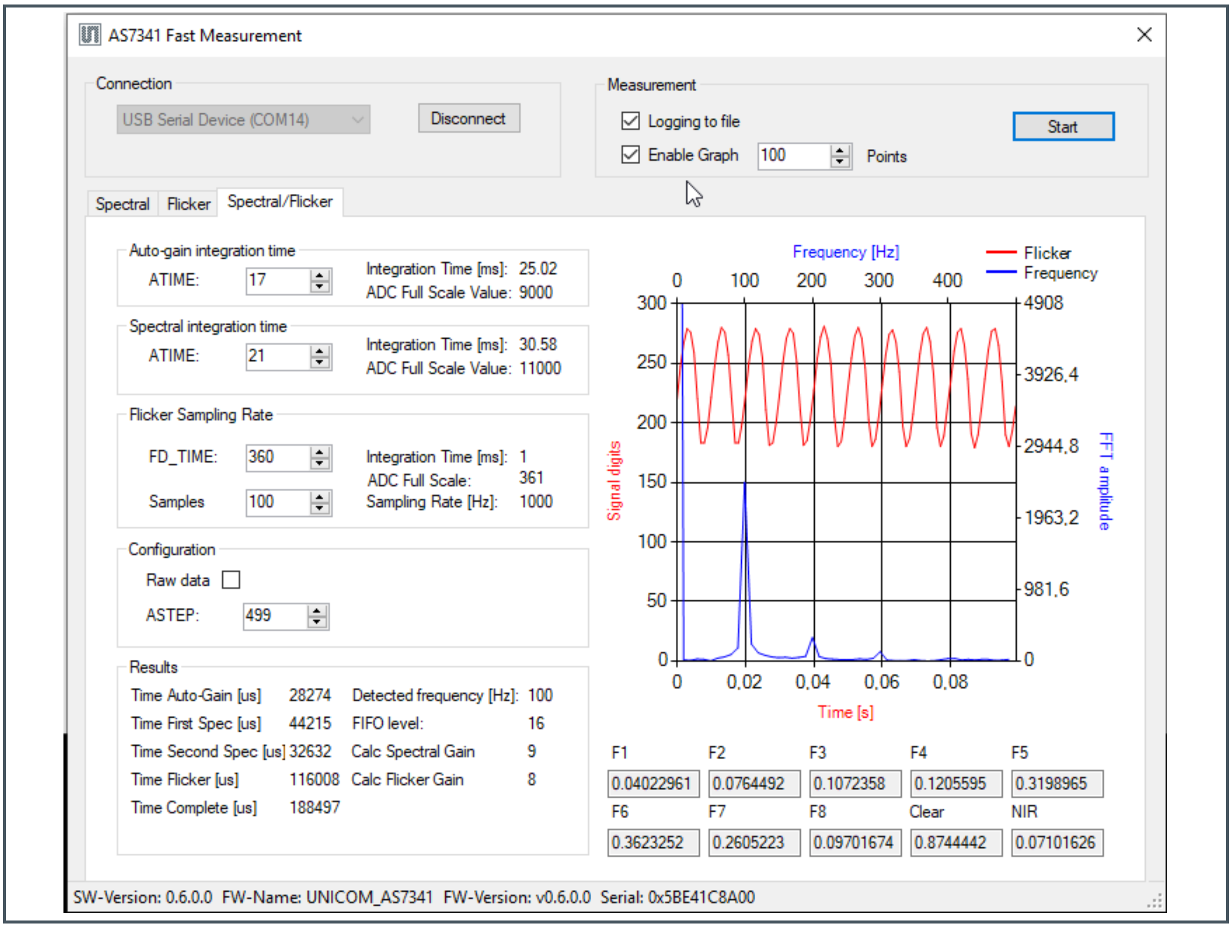


Figure 8 shows the single steps of the simultaneously flicker and spectral detection within a maximum of time of 180 ms (= cycle time) under following conditions:

- 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.
- 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 9:
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 Revision Information

Changes from previous version to current revision v1-00	Page
Initial version	

- 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.

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