



## User Guide

SC-000865-UG

# AS6040-DK V1.0

**Development Kit for Ultrasonic Gas Meter Frontend**

Preliminary Version for B-Samples

v2-00 • 2020-Jun-26

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# 1 Introduction

The AS6040-DK V1.0 is a platform for a quick and easy start-up and evaluation of the AS6040 ultrasonic flow converter (UFC). It supports the functionality needed for standard water and heat meters. The development kit offers user-friendly configuration and extensive testing of the AS6040, but also the complete assembler environment for programming the device. For a proper use of the evaluation system, we strongly recommend to refer to the latest AS6040 datasheets.

## 1.1 Kit Content & Ordering Information

**Figure 1: Kit Content**

AS6040-DK (Based on AS6040 in QFN48 package)



Cable connecting board and PICOPROG



PICOPROG V3.0 (Programmer and interface)



USB cable (Connects PICOPROG V3.0 to PC)



Please download the latest software for the kit from <https://downloads.sciosense.com/as6040>

Ordering Code	Part Number	Description
AS6040-DK V1.0	221010003	AS6040 Demo Kit including PICOPROG and cables
AS6040-DK	221010002	AS6040 Reference board

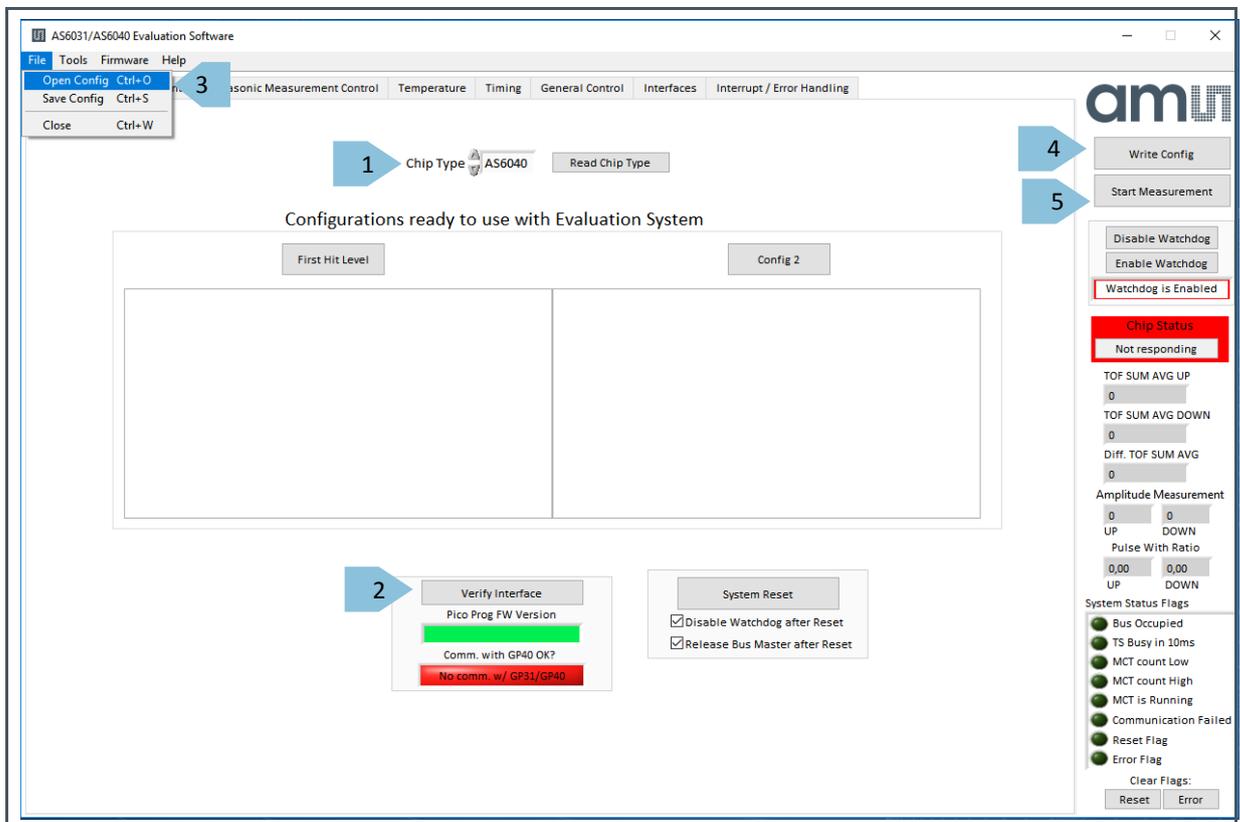
## 2 Quick Start Guide

This section describes how to quickly set up the AS6040-DK V1.0, establish basic operation and make measurements.

- It is crucial to install the software before connecting the evaluation kit to your computer:  
<https://downloads.sciosense.com/as6040/>
- Unzip the package to the desired directory, open “setup.exe” and follow the instructions on the screen
- Connect the PICOPROG V3.0 to the computer using the USB cable. And connect the board to the PICOPROG using the DB15 connector cable.
- Connect your spool piece to US\_UP and US\_DOWN. US\_UP fires upstream, means versus flow. US\_DOWN fires downstream, with the flow.
- Quick Start for Initial Measurements

From the “Start” menu, go to “All Programs” and then to the “SciSense” directory. Double click the “AS6031\_AS6040\_Frontpanel” icon (or newer versions, if available) to begin execution of the evaluation software. The following screen should appear:

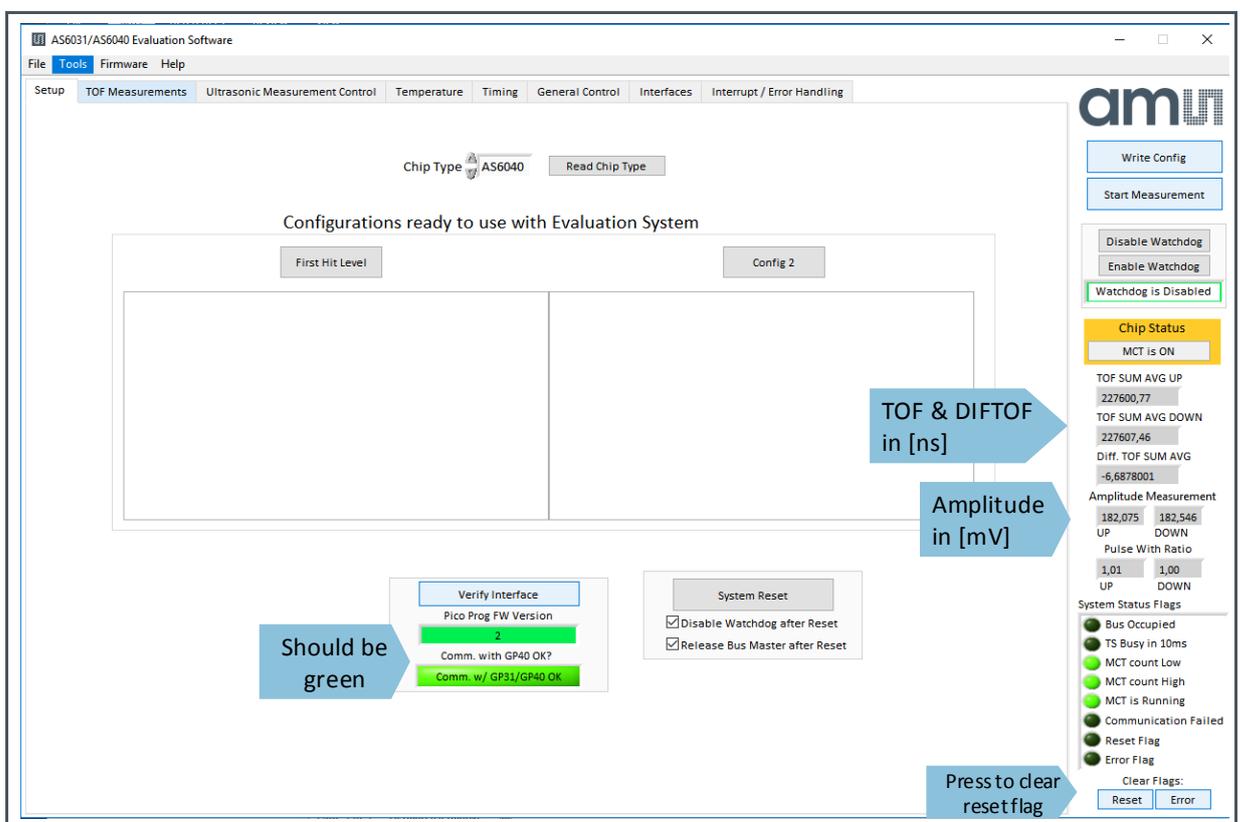
**Figure 2 :**  
**Opening Page**



- Check for the right device, AS6031 or AS6040. Click the “Verify Interface” button to confirm communication between PICOPROG V3.0 and AS6040 is working. Both fields, “Pico Prog FW version” and “Comm. W. GP31/GP40 OK”, should become green.
- Next, open our configuration AS6031\_water\_meter\_Demo\_FHL.cfg and download it into the chip, pressing “Write Config”.
- Press “Start Measurement” to begin measuring.

At this point, after successful completion of the above steps, a basic operation of the EVA kit should be possible.

**Figure 3:**  
**Setup Window**

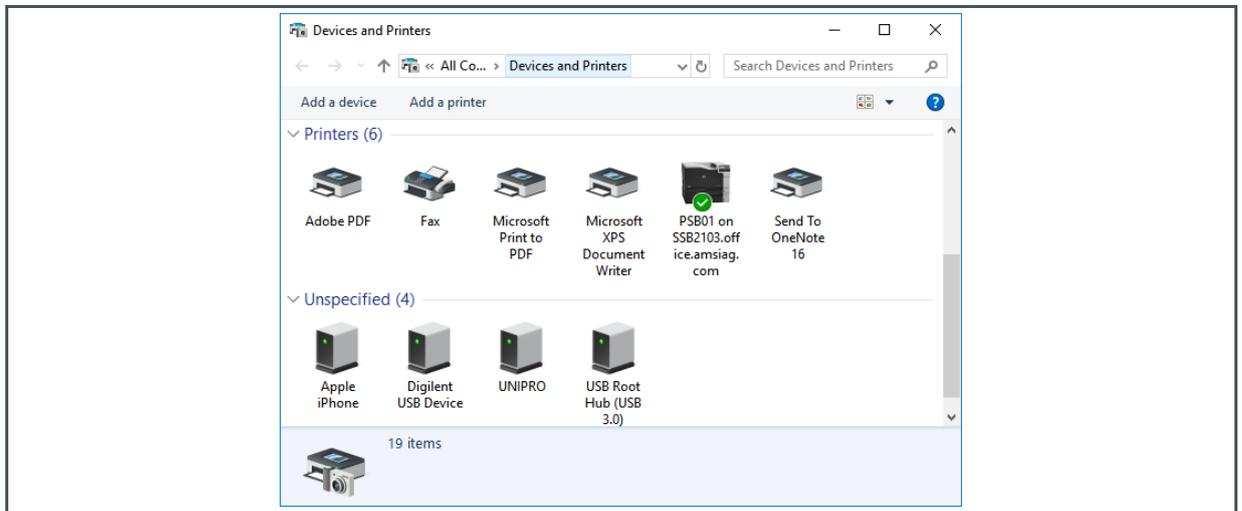


Clear the reset and error flags by pressing the buttons at the lower right. MCT Count Low and High should blink while the measurement is running.

## 2.1 Manual driver Installation

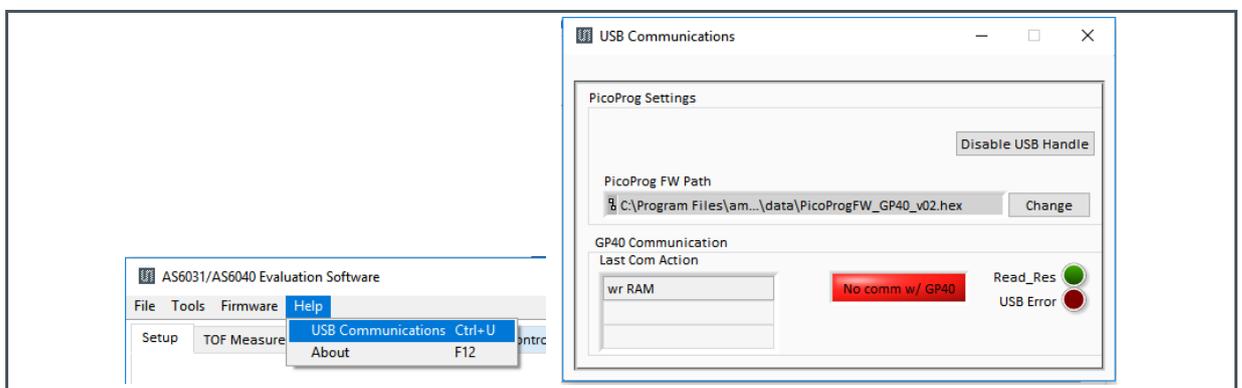
If PICOPROG is not displayed correctly then go to the drivers folder , e.g. C:\Program Files\ScioSense\AS6031\_AS6040\drivers and install the driver for your operating system manually.

**Figure 4:**  
Device Manager



In case of an upgrade of the software to a newer version please make sure that the software uses the latest driver. For manual installation open the USB communications window and check the firmware version of the PICOPROG. It should be version PicoProgFW\_GP40\_v02.hex or higher:

**Figure 5:**  
PICOPROG Manual Installation

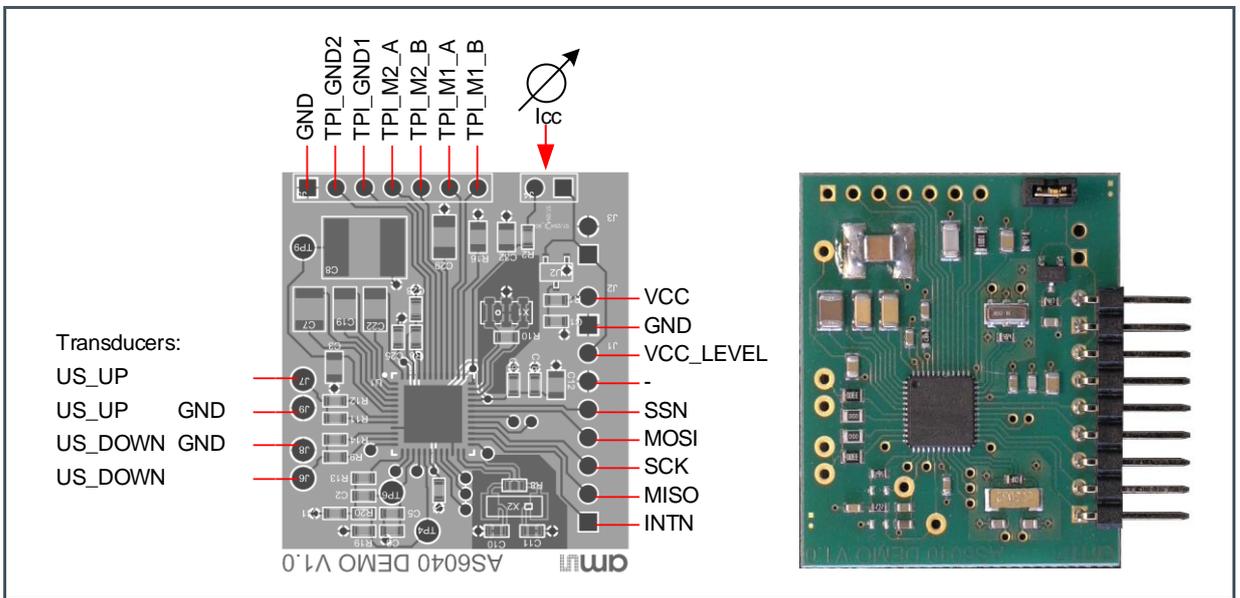


### 3 Hardware Description

#### 3.1 Introduction

The AS6040-DK board, shown in Figure 6, is a front-end for a water or heat meters. The transducers and temperature sensors are directly connected to this board. It comes with a 32.768 kHz quartz (X2) and a 4 MHz ceramic oscillator (X1).

**Figure 6:**  
AS6040-DK



#### 3.2 Communication Interface

The PICOPROG device is a USB-to-SPI converter box that interfaces all UFC evaluation systems. The PICOPROG is registered by the operating system initially as “PICOPROG v2.0 unprogrammed”. As soon as the AS6040-DK evaluation software starts, a special firmware is written into the PICOPROG to handle the SPI communication with the AS6040-DK V1.0. The PICOPROG is now listed as “UNIPRO” in the device manager. For SPI communication only, PICOPROG version 2.0 is sufficient.

The flat connector connecting the PICOPROG and the AS6040-DK. includes the power lines and the SPI communication lines. VCC\_LEVEL is the voltage feedback for the PICOPROG level shifters.

## 4 Software Description

### 4.1 A First Measurement

When started, the software comes up with the main window, showing the “Setup” tab. See [Figure 3: Setup Window](#).

A good first step is to load a working configuration and make measurements in frontend mode (without using the internal 32-Bit  $\mu$ P). **SciSense** provides a sample configuration files, which you can select from the setup tab. You find them also in the data folder. They typically work well with DN20 spool pieces.

**Load Configuration File:** File menu → Open Config → choose appropriate configuration file

1. Press “System Reset” button. Now the PICOPROG FW version field should get green and the appropriate version should be displayed (20 or higher). Further, “Comm GP40 OK?” should get green to show that communication with AS6040-DK V1.0 works.
2. If watchdog is not disabled by “System Reset”. Button → press “Disable Watchdog” button.
3. Press “Write Config” button to download the configuration settings into AS6040.
4. Press “Start measurement” button. Now the chip starts to measure and the software displays the major results on the right side.

You can now modify the configuration to fit it to his needs. Having done this, you can store your own configuration files.

#### 4.1.1 Time of Flight Measurement Results

The TOF Measurements page gives a complete overview of the individual TOF measurement results. AS6040 stores the first 8 hits of every TOF direction separately and also the average of all measured hits. These 9 results are displayed for both directions, as we call them up and down. The evaluation software additionally calculates the difference between up and down stream, DIFF-TOF. In total, all 27 results are displayed in the “Results” column.

In the “Average” column the sample size for the averaging is 100 by default. The same number of samples is used for the standard deviation.

The same is done with the amplitude values of the receiving signals and the pulse width ratio between first hit and start hit. The values for both directions are displayed.

Figure 7:  
TOF Measurements

The screenshot shows the AS6031/AS6040 Evaluation Software interface. The main window is titled "AS6031/AS6040 Evaluation Software" and contains several tabs: Setup, TOF Measurements, Ultrasonic Measurement Control, Temperature, Timing, General Control, Interfaces, and Interrupt / Error Handling. The "TOF Measurements" tab is active, displaying a "TOF Results Table" with columns for #, Name, Results / ns, Average/ns, and Std. Dev./ps. The table lists various TOF measurements, including TOF SUM AVG UP, TOF SUM AVG DOWN, TOF UP Value 0-9, TOF DOWN Value 0-9, and diff. TOF 0-9. The "Amplitude Measurement" section is also visible, showing Measurement Values and Calibration Values tables. The "HS Clock" section includes controls for HS clk period in ns (Ideal) set to 250, HS Clock Divider (NOT Set), and Cal Factor HS clock (250). A green status bar indicates "Internal HS clock is 4MHz". The right sidebar contains "amun" branding, "Write Config", "Start Measurement", "Disable Watchdog", "Enable Watchdog", "Watchdog is Disabled", "Chip Status" (MCT is ON), and "System Status Flags" (Bus Occupied, TS Busy in 10ms, MCT count Low, MCT count High, MCT is Running, Communication Failed, Reset Flag, Error Flag).



### Information

The high speed calibration is by default off. This is more convenient when comparing measurement data. But when collecting data for calibration it is strongly recommended to have this active

The measurement data can be exported into text files, either the main values for calibration only, or the full data.

Figure 8:  
Data Export for Calibration

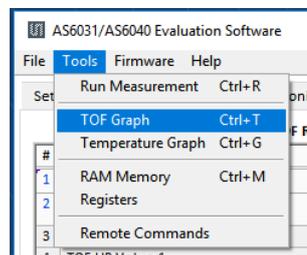
	A	B	C	D	E	F	G	H	I	J	K	L
1	08.08.2016 16:18	s Elapsed	diffTOFSu	sumTOFSu	diffTOF1	sumTOF1	PW UP	PW DOW	AM UP	AM DOW	Status Register	
2	16:18:50	0	0,000000	0,000000	0,000000	0,000000	1,992,187	1,992,187	7,168,211	6,991,830		FFFFFFFF
3	16:19:03	13,69	0,000000	0,000000	0,000000	0,000000	1,992,187	1,992,187	7,152,268	7,215,327		FFFFFFFF
4	16:19:04	14,03	0,000000	0,000000	0,000000	0,000000	1,992,187	1,992,187	7,152,268	7,215,327		FFFFFFFF
5	16:19:04	14,49	0,000000	0,000000	0,000000	0,000000	1,992,187	1,992,187	8,988,957	9,103,998		FFFFFFFF
6	16:19:05	15,02	0,000000	0,000000	0,000000	0,000000	1,992,187	1,992,187	9,177,363	9,125,247		FFFFFFFF

**Figure 9:**  
Data Export Complete

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI		
1	15:17:11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	15:17:11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	15:18:22	12.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	15:18:22	12.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	15:18:23	12.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	15:18:23	13.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	15:18:24	13.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

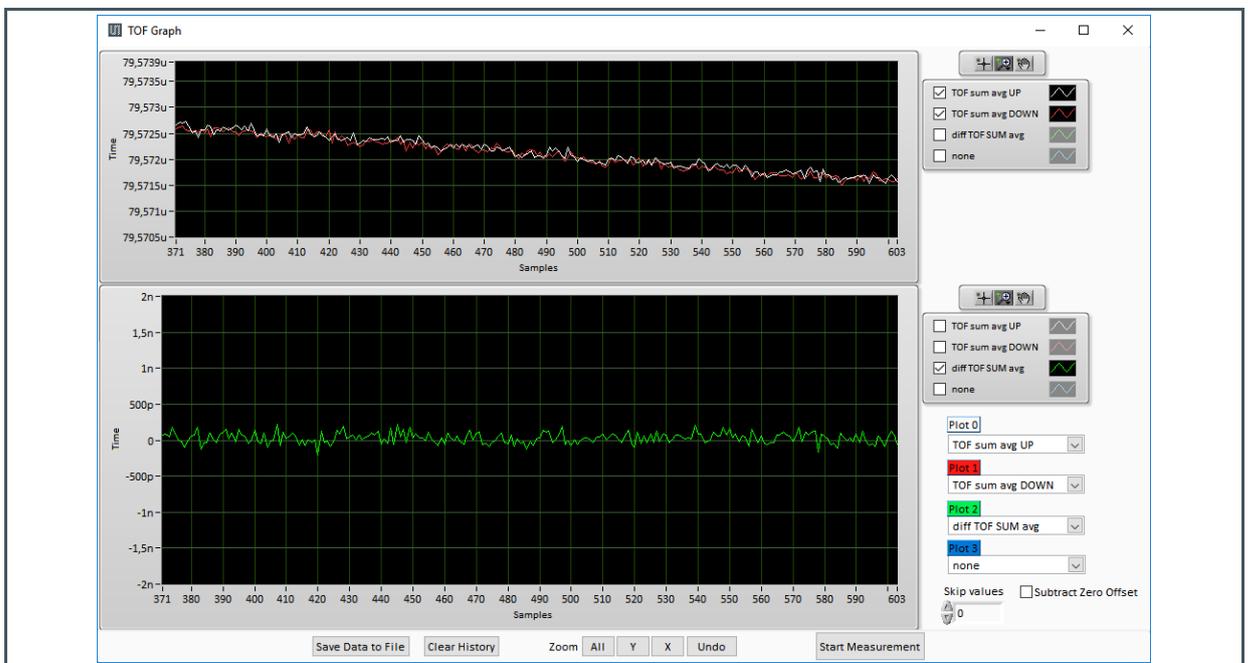
It is possible to display the results graphically, too. Open menu item “Tools/TOF Graph” to open this separate window.

**Figure 10:**  
Opening a TOF Graph



It is possible to activate up to four plots. Each plot has various selections, e.g. TOF1UP, TOF2UP etc..

**Figure 11 :**  
TOF Graph



## 4.2 Ultrasonic Measurement Control

On this page the user makes all settings for an appropriate ultrasonic measurement. They group as follows:

- Time of Flight Sequence Control
- Time of Flight Hit Control
- Amplitude Measurement Control
- Transducer Interface Options

**Figure 12 :**  
**Ultrasonic Measurement Control Tab**

The screenshot displays the 'Ultrasonic Measurement Control' tab in the AS6031/AS6040 Evaluation Software. The interface is divided into several sections:

- Fire Burst Generator:** Includes 'Fire Pulse Clock Divider' (set to 4), 'HS clock Divider' (set to 21), and 'Fire Burst Frequency' (set to 1000 kHz).
- First Hit Level:** Features 'Find FHL' and 'Amplitude sample&hold' options, with 'First Hit Level Up' and 'Down' set to 45 mV.
- Noise Mask Window:** Set to 40, with a 'Noise mask: mid between fire and receive' callout.
- Start Hit Mode:** 'Start Hit defined by TOF\_MH\_START' is set to 0, with a callout: 'Start hit defined by first-hit level or window'.
- PGA (Programmable Gain Amplifier):** Includes 'PGA Gain' (set to 2) and 'PGA Vref Mode' (set to 0), with a callout: 'PGA gain'.
- Receive Settings:** 'Selected Start Hit after First Hit Detection' is set to 7, and 'No. of TOF Hits for sum' is set to 10, with a callout: 'Receive settings'.
- Amplitude Measurement:** Includes 'Amplitude Measurement Mode' (set to 'AM before end of TOF'), 'Peak Detection End' (set to 7), and 'Peak Detection Timeout' (set to 16 μs).
- System Status Flags:** Shows various indicators like 'Bus Occupied', 'TS Busy in 10ms', and 'MCT count Low/High'.

The meanings of the various settings are displayed in clear text. For more details about the register settings please refer to the AS6040 manual.

## 4.3 Temperature Measurement Control

All settings for an appropriate temperature measurement are done in this tab, which are grouped as follows:

- Sequence Control
- Measurement Control
- Temperature Measurement Cycle Time

On the right side, the individual measurements of the temperature measurement task are displayed numerically.

**Figure 13 :**  
**Temperature Tab**

The screenshot displays the 'Temperature' tab in the AS6031/AS6040 Evaluation Software. The interface is divided into several sections:

- Sequence Control:**
  - Port Measurement Order: Reversed Order (dropdown), 1 (input)
  - Temperature Measurement Subtask Handling (Pause Time): Only One Measurement per Cycle (dropdown), 0 (input)
  - Pause between Temperature Measurements: N/A ms
- Measurement Control:**
  - Measurement Mode: Off (dropdown), 0 (input)
  - \* Current Software Release supports only 2-wire Temperature Mode
  - Inactive Ports during Measurement: Pulled to GND (dropdown), 0 (input)
  - Number of Fake Measurements: 2 Fake Measurements (dropdown), 0 (input)
  - Discharge Select: 512  $\mu$ s (dropdown), 0 (input)
- Temperature Measurement Table:**

Name	Results / ns	RAM Address
Gain Compensation		0x80
Reference Port REF-AB		0x81
Temperature Port M1-A		0x82
Temperature Port M2-A		0x83
RDSO Compensation		0x84
Internal Temperature Reference		0x85
Internal Temperature Compensation		0x86
Internal Temperature Measurement		0x87
Pressure Port M1-B		0x88
Pressure Port M1-B		0x89
Pressure Port M2-B		0x8C
Pressure Port M2-B		0x8D
Gain Compensation		0x8E
Reference Port REF-A		0x8F
Temperature Port M1-A		0x90
Temperature Port M2-A		0x91
RDSO Compensation		0x92
Internal Temperature Reference		0x93
Internal Temperature Compensation		0x94
Internal Temperature Measurement		0x95
Pressure Port M1-B		0x96
Pressure Port M1-B		0x97
Pressure Port M2-B		0x9A
Pressure Port M2-B		0x9B
- System Status and Controls:**
  - Buttons: Write Config, Start Measurement, Disable Watchdog, Enable Watchdog, Watchdog is Disabled.
  - Chip Status: MCT is ON (highlighted in yellow).
  - TOF SUM AVG UP: 79579,449
  - TOF SUM AVG DOWN: 79579,419
  - Diff. TOF SUM AVG: 0,029754639
  - Amplitude Measurement: 240,907 UP, 241,574 DOWN, Pulse With Ratio 0,62 UP, 0,62 DOWN.
  - System Status Flags: Bus Occupied, TS Busy in 10ms, MCT count Low, MCT count High, MCT is Running, Communication Failed, Reset Flag, Error Flag.
  - Clear Flags: Reset, Error.

The meanings of the various settings are displayed in clear text. For more details about the register settings please refer to the AS6040 manual.

In addition, a separate window for a graphical display can be opened. In this window also the amplitudes and pulse width ratios can be displayed.

Figure 14:  
Opening a Temperature Graph

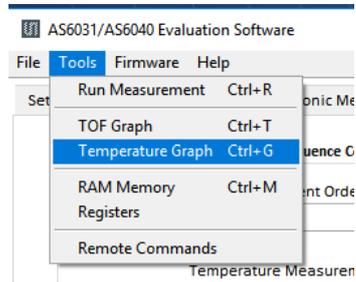
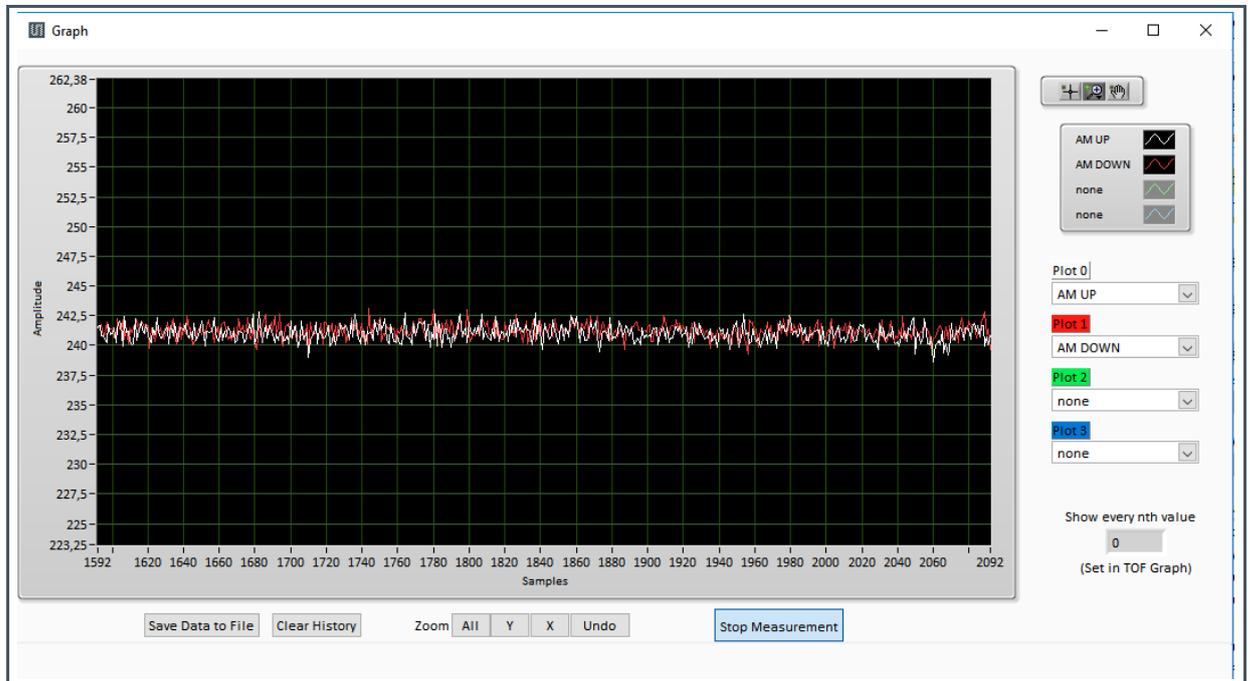


Figure 15:  
Temperature Graph

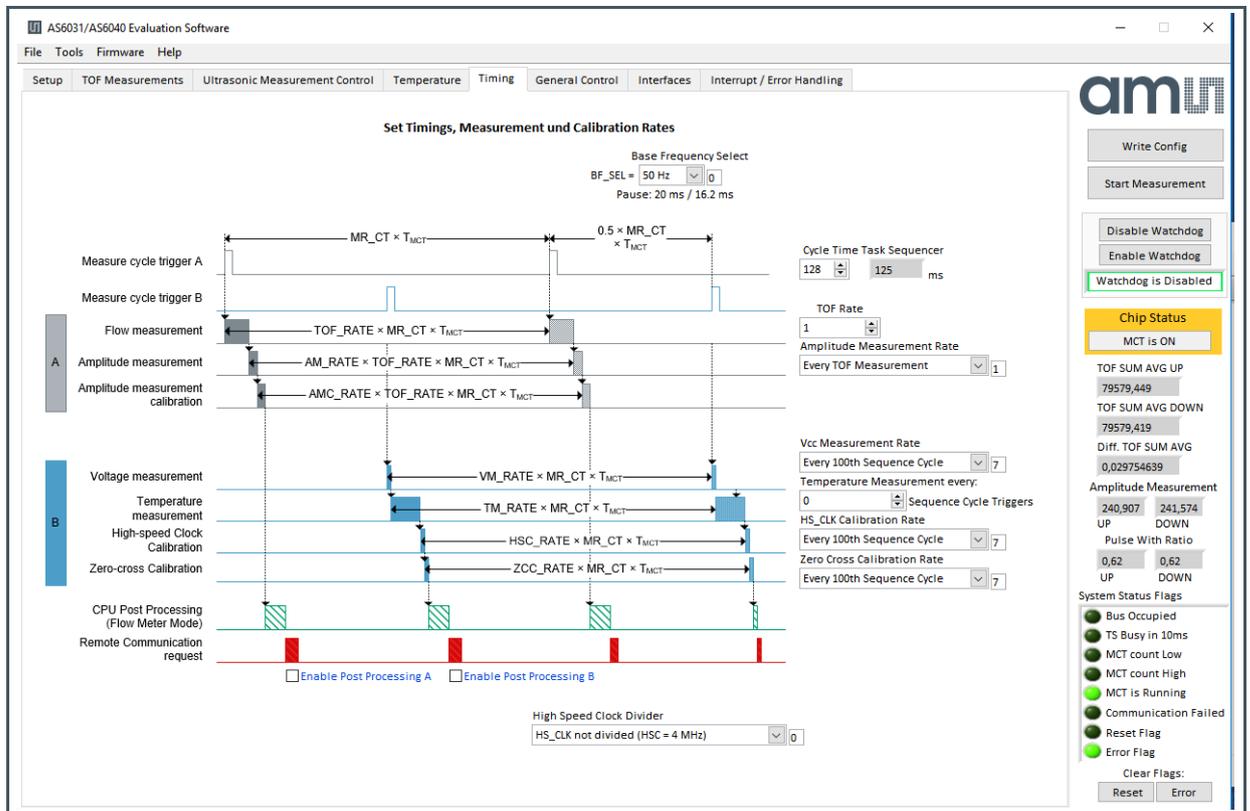


## 4.4 Timing Control

On this page the settings for the major timings of the task sequencer are set.

- Cycle time of the task sequencer
- TOF rate
- Amplitude measurement rate
- Vcc measurement rate
- Temperature measurement rate
- High-speed clock calibration rate
- Zero-cross calibration rate

**Figure 16:**  
Timing Control



## 4.5 General Control

The “General Control” page covers configuration settings for

- Task sequencing
- High speed clock control
- Charge pump control (relevant for AS6040 only)
- Voltage measurement
- CPU handling
- Timer settings
- Bootloader initialization values for FHL and TOF rate

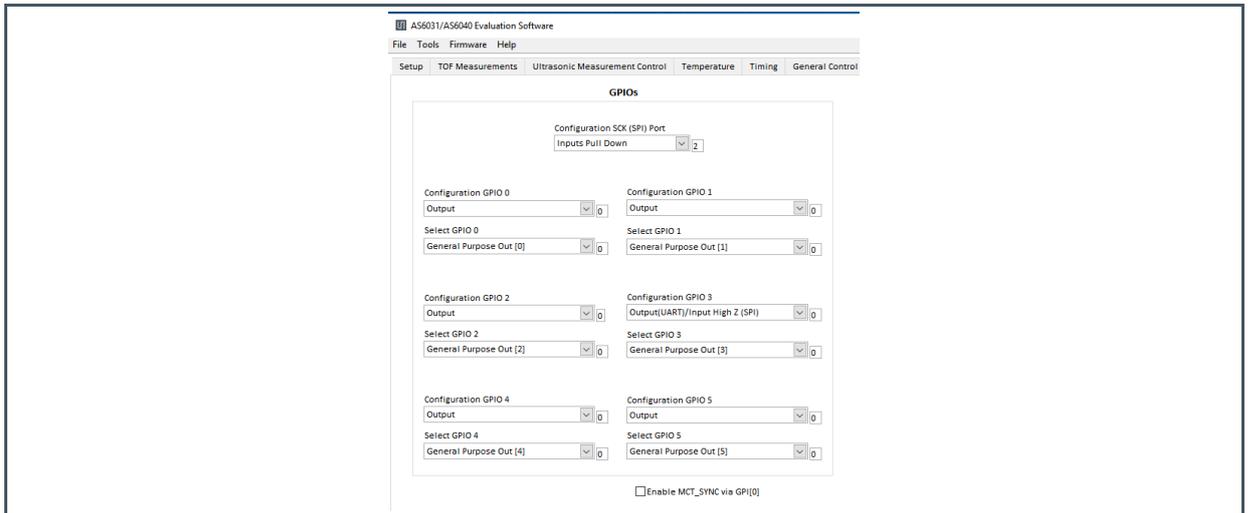
**Figure 17 :**  
**General Control Tab**

The meanings of the various settings are displayed in clear text. For more details about the register settings please refer to the AS6040 manual

## 4.6 Interfaces

The “Interfaces” tab covers configuration settings for the GPIOs.

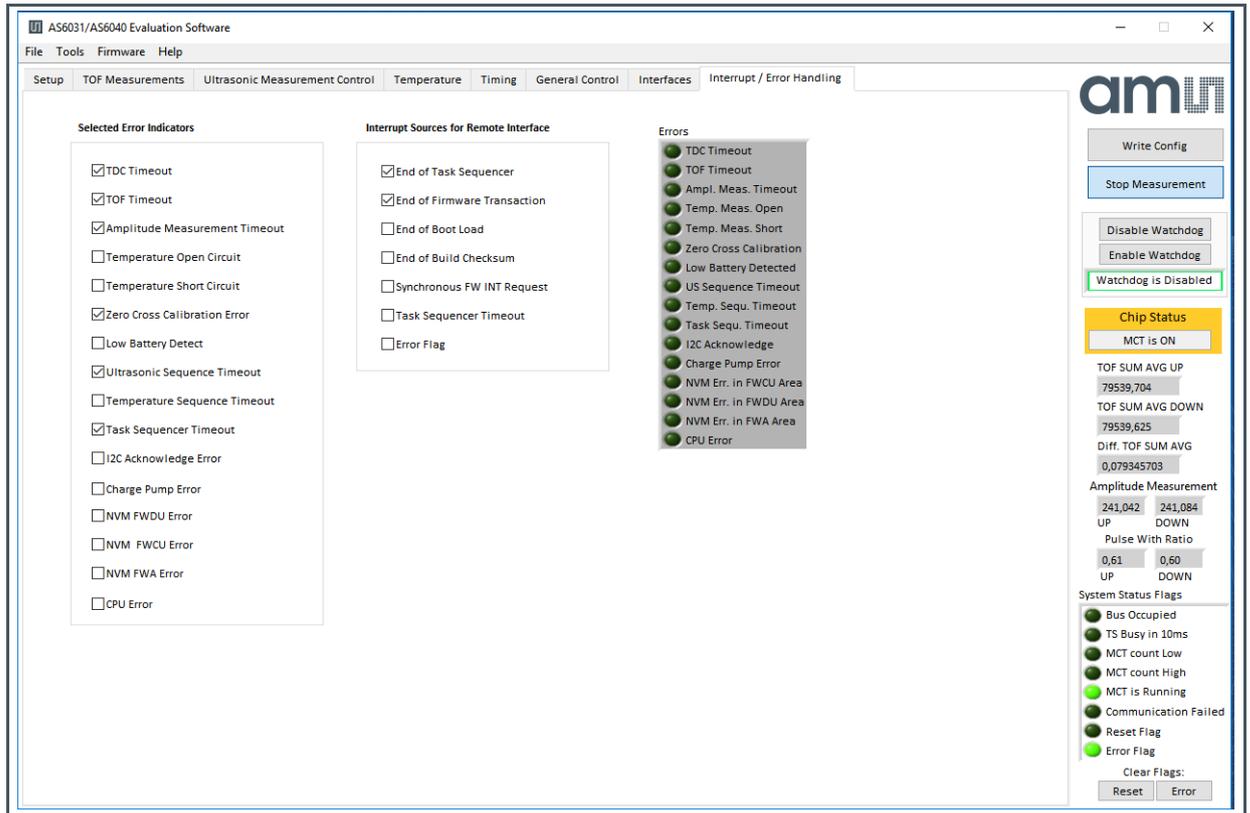
**Figure 18 :**  
**Interfaces Tab**



## 4.7 Interrupt & Error Handling

On this tab error indicators and interrupt sources for remote interface can be selected.

**Figure 19 :**  
**Interrupt and Error Handling**



The meanings of the various settings are displayed in clear text. For more details about the register settings please refer to the AS6040 manual.

## 5 Software Menu

Beside main window, the software menu allows the opening of other windows. There are some menu items which are redundant to available buttons of main window.

### 5.1 File

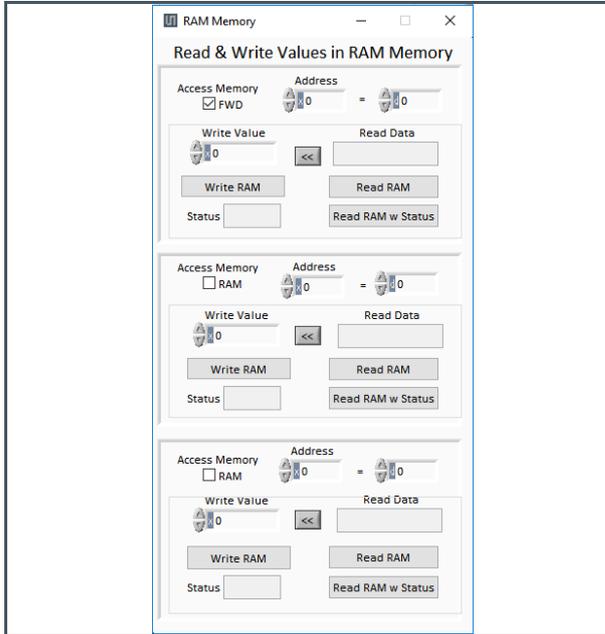
- **Open Config**  
This dialog box allows the path selection of a configuration file, covering the register settings, necessary for a proper configuration of the AS6040. After opening this file, the control settings are updated in the GUI.
- **Save Config**  
This menu item allows the saving of the current GUI control settings into a configuration file
- **Close**  
Close all open windows of the AS6040F1 Evaluation software.

### 5.2 Tools

- **Run Measurement**  
Same function as “Start/Stop Measurement” button in “Measurement” tab of main window.
- **TOF Graph**  
Same function as “Open TOF Graph” button in “Measurement” tab of main window.
- **Temperature Graph**  
Same function as “Open Graph” button for temperature measurement in “Measurement” tab of main window.

- RAM Memory

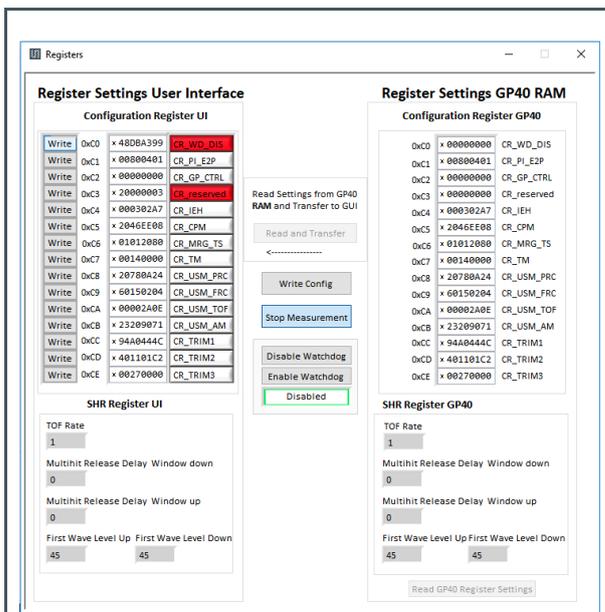
Figure 20:  
RAM Memory Access



- Opens a window which allows single write and read access to random access area or to firmware data.
- Please refer to the AS6040 datasheet for the meaning of the individual addresses.

- Registers

Figure 21:  
Registers

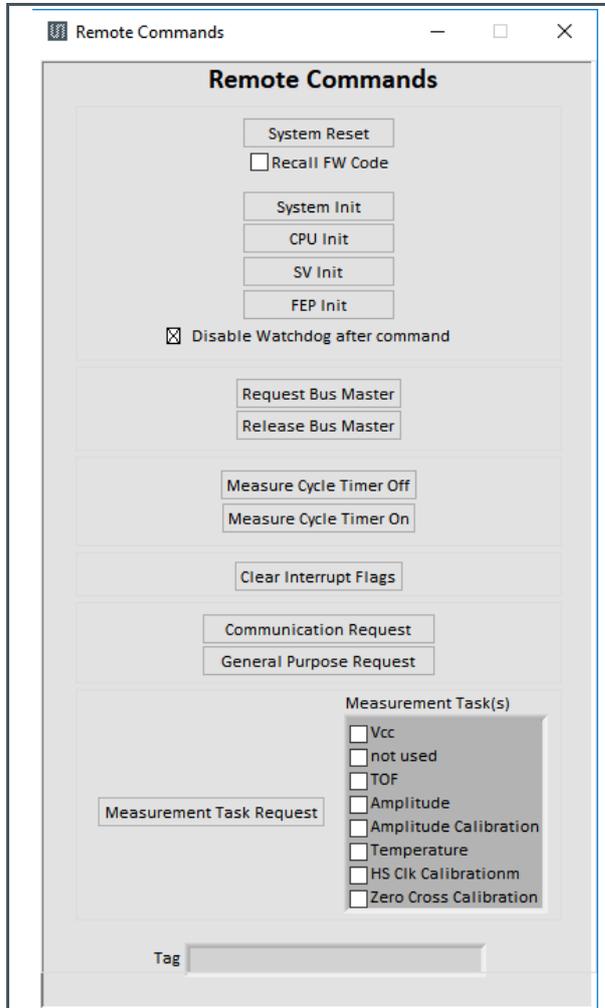


- Opens a window, which shows the registers important for a proper configuration setting of the AS6040. In the left column, the register contents correspond to the settings done in tabs of GUI main window. If the button “Read AS6040 Register Settings” is pressed, the configuration settings located in AS6040 registers are displayed in the right column, by pressing “Read and Transfer” button, the register settings in the tabs of main window and in the left column of this window are updated with the register settings from right column. Description of Position 2
- Red field indicate differences between user interface and AS6040 RAM.

- Remote Commands

This window summarizes some additional commands, which can be executed via remote interface.

**Figure 22:**  
**Remote Commands**



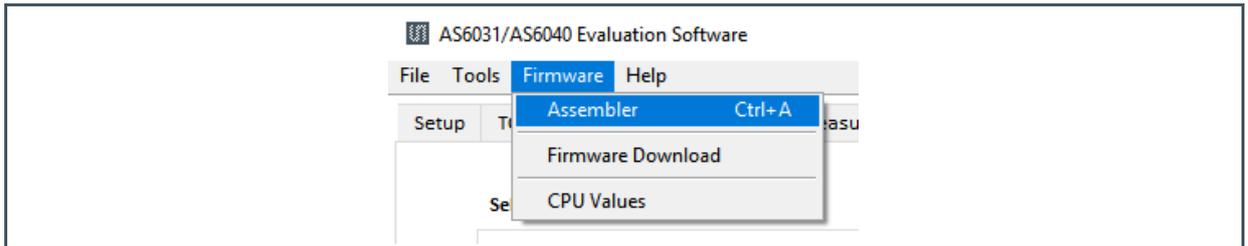
- **System Reset:** Executes a complete system reset of AS6040. Same function as “System Reset” button in “Measurement” tab of main window
- **System Init:** Same function as “System Reset” without clearing the configuration (CR\_...) and the system handling (SHR\_...) register.
- **CPU Init:** Clears the CPU block in AS6040
- **SV Init:** Clears the supervisor block in AS6040
- **FEP Init:** Clears the frontend processing block in AS6040
- **Request/Release Bus Master:** Allows the request of the bus master in AS6040, e.g. if the random access bus is blocked by a deadlock, caused by an improper firmware download.
- **Measure Cycle Timer Off/On:** Stop & start of the measure cycle timer
- **Clear Interrupt Flags:** Clears all bits in SRR\_IRQ\_FLAG register
- **Communication Request:** Allows an asynchronous demand by remote controller to get an interrupt by AS6040, signaling the time for remote communication.
- **General Purpose Request:** Allows an asynchronous request by remote controller to initiate a general purpose handling in in firmware of integrated AS6040CPU.

## 5.3 Firmware

- Assembler

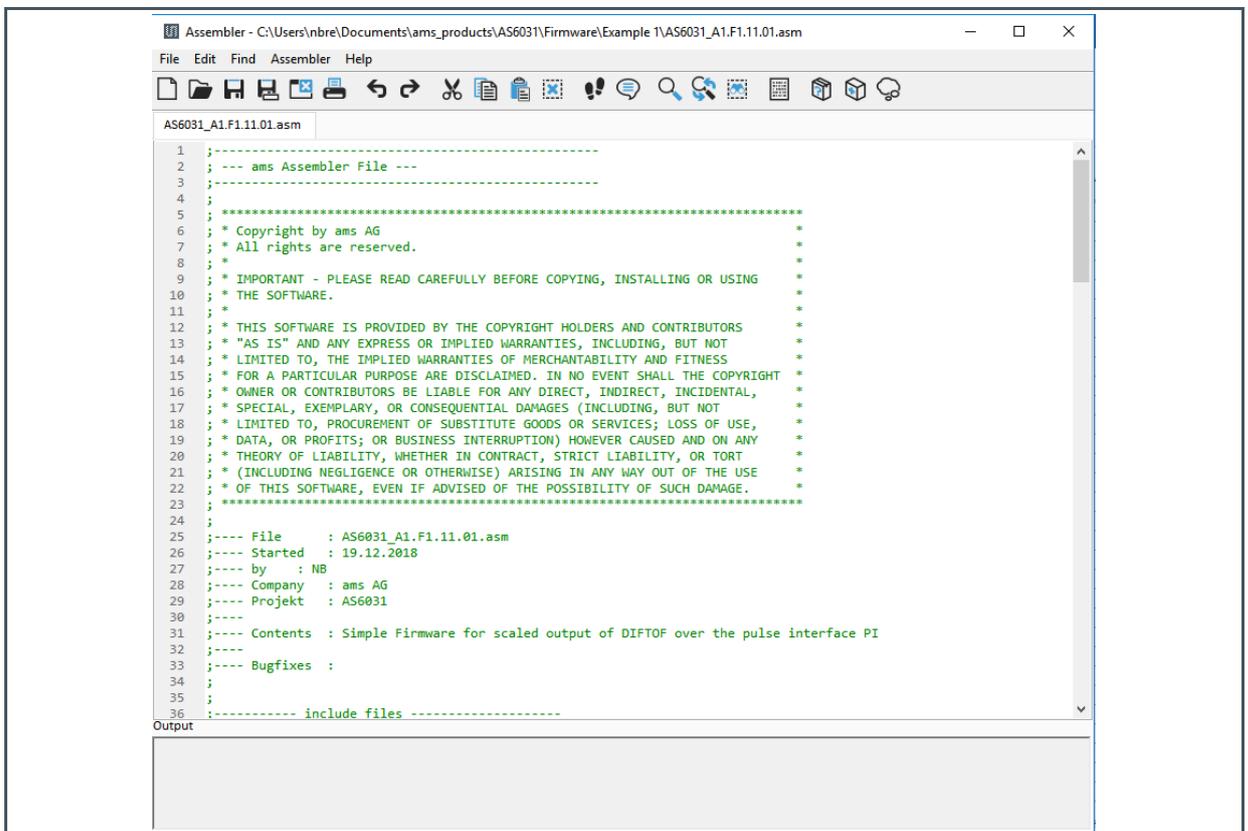
The AS6040-DK V1.0 assembler is integrated into the AS6040-DK evaluation software. It is opened in the Firmware menu of the main program:

**Figure 23:**  
Opening the Assembler



The following window comes up:

**Figure 24 :**  
Assembler Window



This is a comfortable editor with syntax highlighting, search and replace, copy and paste functions.

Under menu item “Assembler” the user finds the compile and download options. The download option effects, that “Firmware Download” window is opened (see also below).

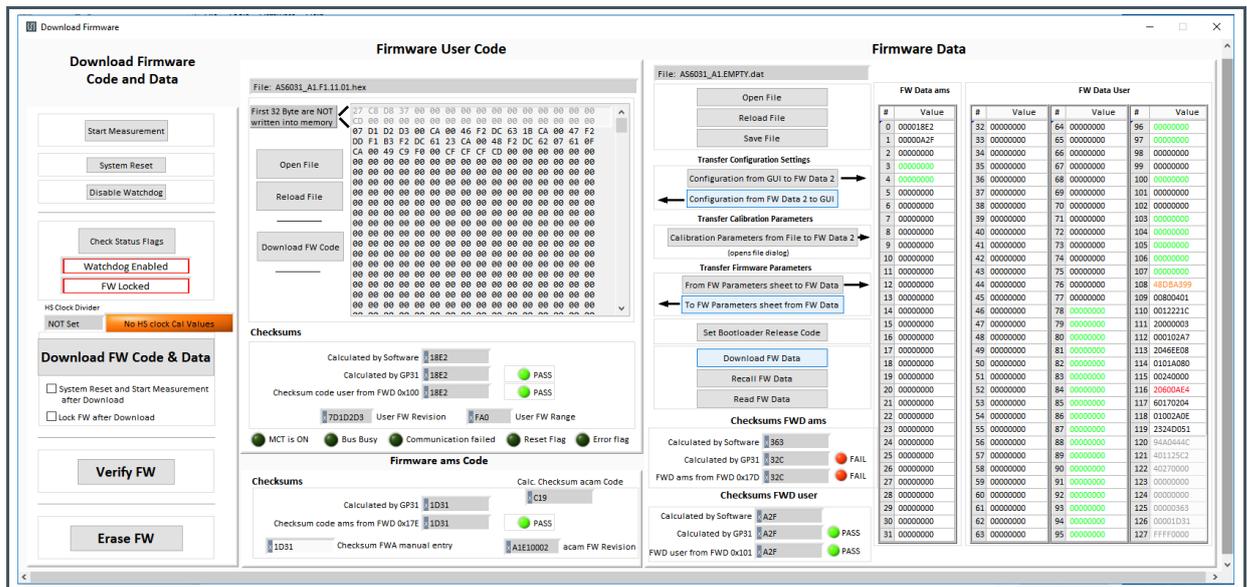
Whether the call of these functions was successful or not is indicated by the messages at the bottom of the assembler window.

- Firmware Download

This window allows the download of the user code and firmware data, including the configuration, to the non-volatile memory. In case the bootloader release code is set, the configuration from the FW Data 2 section is copied into the configuration registers.

“Firmware User Code” is either one of **ScioSense** firmware examples, either the customers code or in case of chips with **ScioSense** firmware (AS6040F1) the open source part. The FW Data 1 and 2 include firmware relevant coefficients and the configuration. The figure below shows an example for an AS6040 applicatin. As free part of the user code firmware AS6031\_A1.F1.11.01.hex is loaded. For the configuration and other data file AS6031\_A1.EMPTY.dat is loaded.

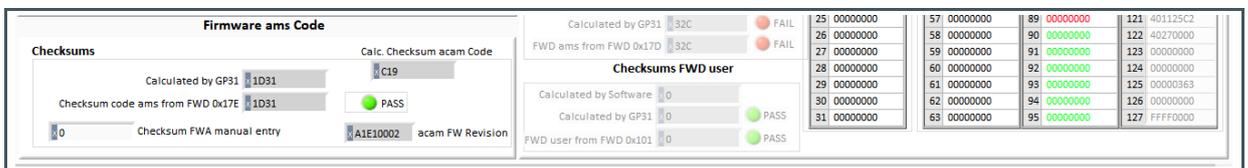
Figure 25 :  
Firmware Download



- With “Check Status Flag”, the watchdog and the lock state of the AS6040 can be checked. Please make sure that the watchdog is disabled before starting a download or other transactions in this window
- In the “Firmware User Code” section, a firmware user code file (\*.hex), which is typically generated by the assembler tool and intended for the user part of 4kx8 Program NVRAM, can be loaded by pressing “Open File”.

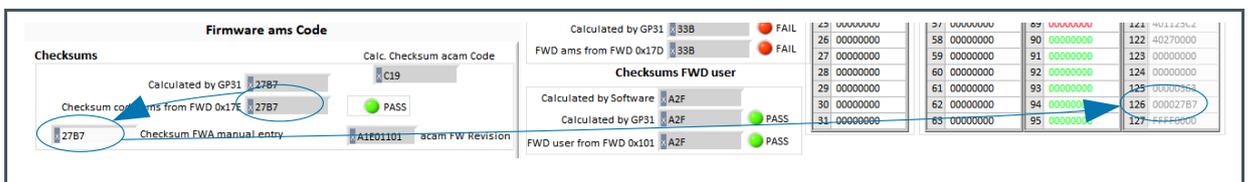
- In the “Firmware Data” section, a firmware data file (\*.dat), which is intended for the 128x32 Data NVRAM, can be loaded by pressing “Open File”. This section also contains some additional transfer options from GUI to FW Data 2 fields and from AS6040 back to FW Data 2 fields. The configuration can be exchanged between the GUI of the evaluation file and the data file. Calibration can also be exchanged between GUI and data file.
- By pressing “Download FW Code & Data” both files are stored in the corresponding NVRAMs. This action takes a few seconds. After the download, both files are located in the volatile as well in the non-volatile part of the appropriate NVRAMs. The download can be combined with a lock option of the firmware.
- When pressing “Download FW Code & Data” any running firmware program is stopped. If a new proper auto running firmware program is downloaded, this firmware can be started again by performing a system reset. A select box allows to reset and restart measurement automatically after download.
- The last four addresses of the FW Data 2 section contain the checksums which are stored to AS6040 when downloading firmware to AS6040. These fields are directly updated, when firmware files are loaded or content of firmware data fields are changed.
- Pressing the “Verify FW” button after downloading compares the content of the NVRAMs with the given files by their checksums. The software calculates the checksum of the given files and reads the calculated checksums of AS6040 as well as the stored checksums at the end of FWD2 section. Note: The firmware data file word 127 is by default empty, not knowing the checksum of the on-chip **ScioSense** firmware.

**Figure 26 :**  
**Firmware ScioSense Code**



So copy manually the calculated checksum for the **ScioSense** code into the field “Checksum FWY manual entry”. Word 127 in the data will be updated and after downloading again the verification will pass for all.

**Figure 27 :**  
**Verification by Calculated Checksum**



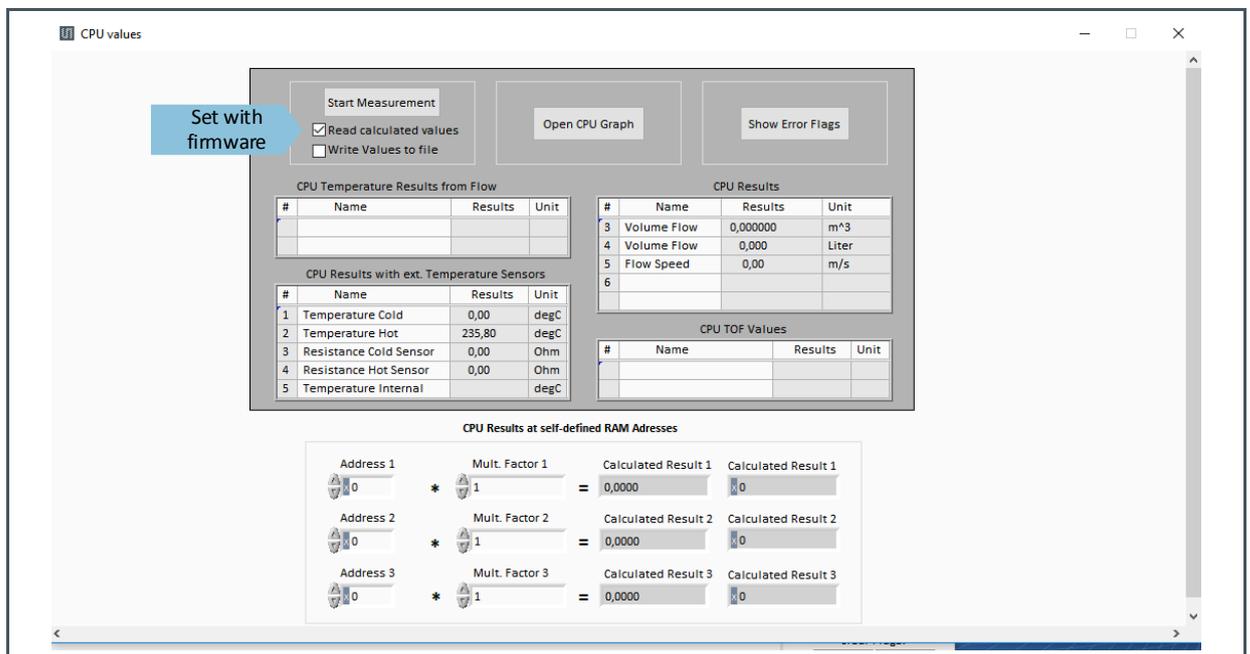
- In the “Firmware ams Code” section, the checksums for the **ScioSense** firmware code are also checked and displayed after a “Verify FW”. The **ScioSense** firmware code cannot be modified by user. Therefore a checksum calculated by software field is missing in this section.

- A lock state of AS6040 or a hang-up, caused by a faulty firmware user code can be dissolved by pressing “Erase FW” button. After that, a new firmware (user code & data) need to be downloaded again.
- CPU Values

**This tab is only for customer who uses the ScioSense firmware for flow calculation.** It reads out some important CPU values like water temperature, flow, velocity, etc. To enable the readout the “Read calculated values” checkbox has to be set.

The lower sections allows to read from any RAM addresses.

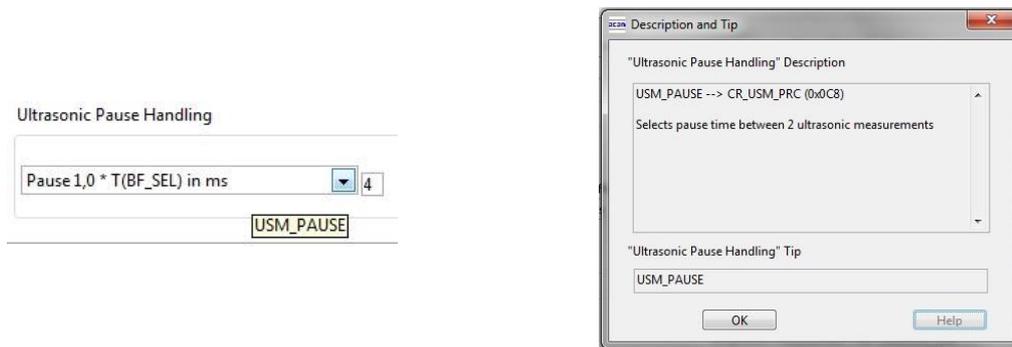
**Figure 28 :**  
**Flow Calculation Tab**



## 5.4 Help

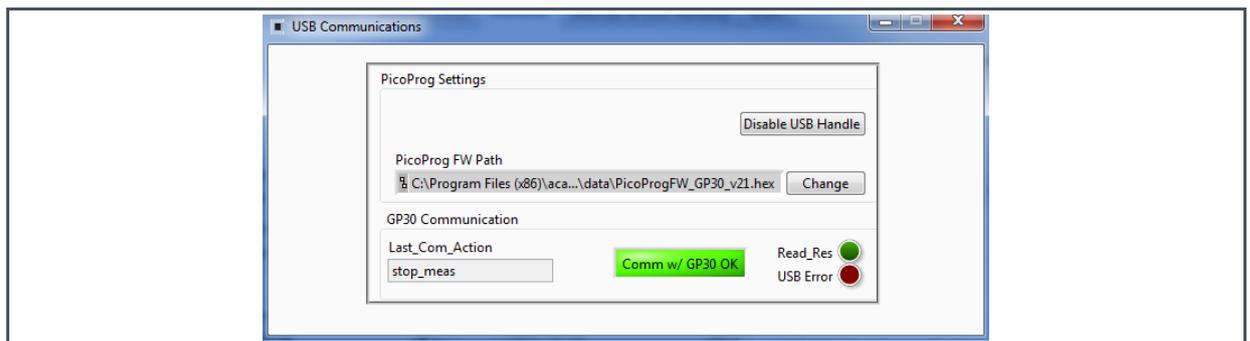
When moving the cursor over the values in tabs of main window, the parameter name (used in the AS6040 manual) is displayed. By right-click and selection of “Description and Tip”, a window is opened showing additional description of the value.

**Figure 29:**  
Description and Tip Window



- Help Contents  
Not supported in this software revision.
- USB Communication

**Figure 30:**  
USB Communication



As described in chapter “Software Installation”.

- About  
Displays software version number together with general information about software and **SciSense**.

## 6 Measurements in Practice

This section describes how to set up a gas flow measurement and shows some sample results of a real gas meter spool piece. Configuration example AS6040\_gas\_200kHz\_DLY.cfg is used as basis. The example is built around 200kHz transducers from Jiakang in a distance of about 5 cm.

The example configuration likely needs to be adjusted to the customers setup. The most important parameters are:

- Fire pulse frequency
- Number of fire pulses
- Number of TOF hits
- Method for the start hit definition
- PGA gain of receiving amplitude
- Amplitude measurement
- Charge Pump Voltage
- Measurement Rate

In general, we recommend to have a look at the receive signal by means of an oscilloscope. This clearly helps to find the right settings.

### 6.1 Measure Receiving Amplitude with Oscilloscope

If the signal is measured after the internal PGA stage there is no influence of the probe capacitance to the measured time values. You can measure the receiving amplitude at test point TP4, which connects to pin pin 17, COMP\_IN.. In Figure 31 this points is marked. Another probe should be connected to US\_UP for the trigger signal. When looking at minimum noise then this probe of course needs to be removed.

**Figure 31:**  
**Measure Points**

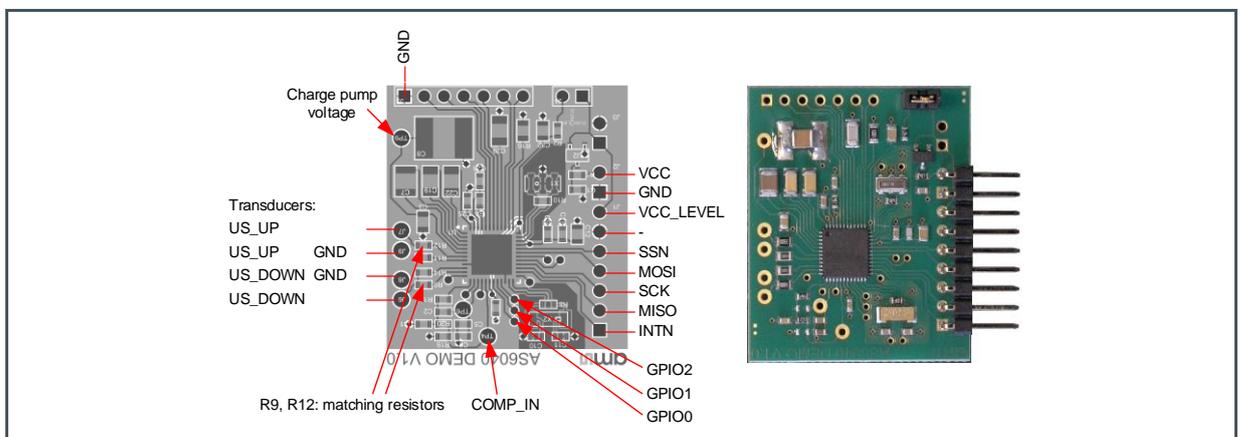
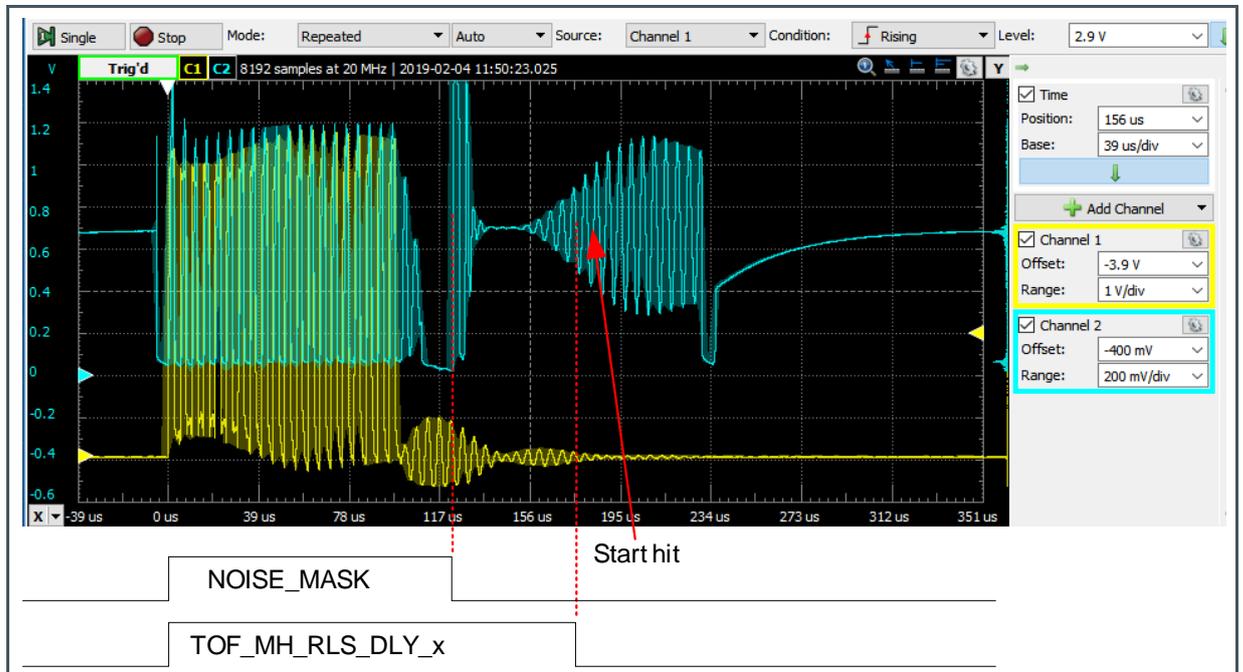


Figure 32:  
Typical Send and Receive Signals

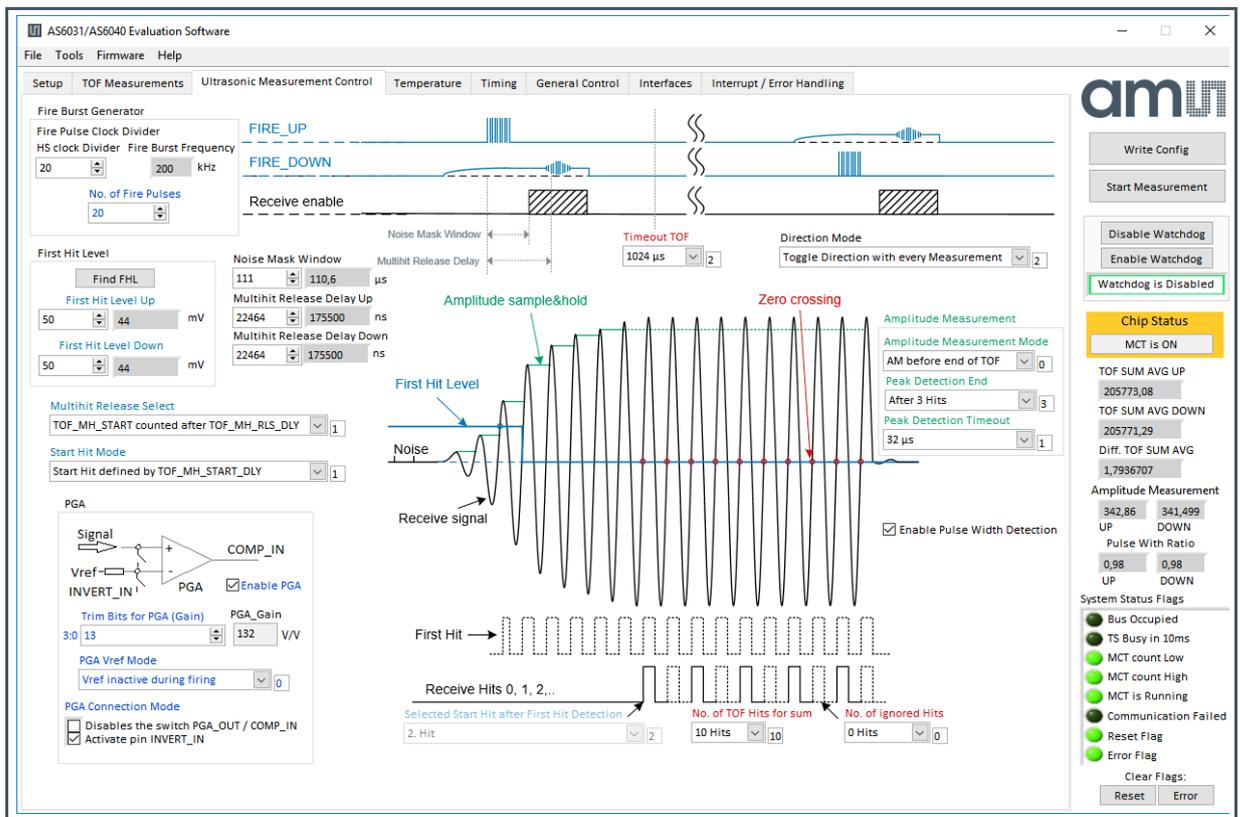


The on-board matching resistors R9 and R12 with 330 Ohm are a good fit for the tested transducers. For other transducers it might be necessary to adopt the values.

## 6.2 Major Parameter Settings

1. Fire pulse frequency: The high speed clock divider is set to 20 to match the 200 kHz transducer frequency
2. Method for the start hit definition: With gas the amplitude varies likely too much for a reasonable first hit level detection. Therefore we decide to go with the delay window, which directly opens the window for ToF measurements in the center of the receive burst. Ideally, the window opens half a period in advance to the next zero crossing.
3. Number of fire pulses: As we plan to measure 10 stops, starting with the 2<sup>nd</sup> hit after the window opening, and assuming several waves before the opening, we choose 20 fire pulses. The target is that the fire burst as minimum as long as the receive burst.
4. Number of TOF hits: 10
5. PGA gain of receiving amplitude: In our application we set the gain to 132 V/V to get >300mV receive amplitude.
6. Amplitude measurement: We stop the measurement after already 3 hits, because the amplitude should have reached the high level already.

**Figure 33:**  
**Ultrasonic Measurement Control**



- Charge Pump Voltage: The voltage is set to the low value of 7.4V for power saving reasons.

Figure 34:  
Charge Pump Setting

**Charge Pump Control**

<b>Charge Pump Mode</b> Enabled twice at start of US <span style="float: right;">2</span>	<b>Ref. Charge Pump Voltage</b> 2	<b>Fire Voltage (estimated)</b> 7.4	<b>Main Charge Pump Trim Bits</b> 10:8 1	<b>Charge Pump Wait Time</b> 0.52 ms <span style="float: right;">0</span>
<b>Charge Pump Enable Mode</b> C5:31 As given by Frontend Control <span style="float: right;">0</span>				

- Measurement Rate: This one is defined by the measurement task and the limit in current consumption.  
With 125ms cycle time = 8 Hz the current consumption at 200  $\mu$ s TOF is about 20  $\mu$ A.

## 6.3 Results

Figure 35:  
Numerical Results

AS6031/AS6040 Evaluation Software

File Tools Firmware Help

Setup TOF Measurements Ultrasonic Measurement Control Temperature Timing General Control Interfaces Interrupt / Error Handling

#	Name	Results / ns	Average/ns	Std. Dev./ps
1	TOF SUM AVG UP	205753,0	205753,0	502,3
2	TOF SUM AVG DOWN	205753,3	205753,3	513,9
3	TOF UP Value 0	183386,5	183386,5	1666,4
4	TOF UP Value 1	188352,9	188352,9	1569,4
5	TOF UP Value 2	193319,3	193319,3	1367,3
6	TOF UP Value 3	198292,3	198292,3	1189,9
7	TOF UP Value 4	203266,3	203266,3	1240,9
8	TOF UP Value 5	208235,9	208235,9	1438,3
9	TOF UP Value 6	213209,2	213209,2	1456,3
10	TOF UP Value 7	218182,1	218182,1	1299,5
11	TOF UP Value 8	223155,3	223155,3	1179,9
12	TOF UP Value 9	228129,9	228129,9	1378,9
13	TOF DOWN Value 0	183387,0	183387,0	1968,7
14	TOF DOWN Value 1	188349,3	188349,3	1685,3
15	TOF DOWN Value 2	193319,4	193319,4	1389,9
16	TOF DOWN Value 3	198293,1	198293,1	1292,5
17	TOF DOWN Value 4	203263,8	203263,8	1322,1
18	TOF DOWN Value 5	208238,7	208238,7	1208,7
19	TOF DOWN Value 6	213210,5	213210,5	1364,2
20	TOF DOWN Value 7	218181,8	218181,8	1507,1
21	TOF DOWN Value 8	223157,8	223157,8	1508,1
22	TOF DOWN Value 9	228131,4	228131,4	1438,5
23	diff. TOF 0	-0,4883	-0,4883	2702,6
24	diff. TOF 1	3,6469	3,6469	2394,4
25	diff. TOF 2	-0,0725	-0,0725	2025,3
26	diff. TOF 3	-0,7935	-0,7935	1830,4
27	diff. TOF 4	2,5558	2,5558	1733,3
28	diff. TOF 5	-2,7924	-2,7924	1642,8
29	diff. TOF 6	-1,2398	-1,2398	1821,9
30	diff. TOF 7	0,3128	0,3128	1915,3
31	diff. TOF 8	-2,5024	-2,5024	1989,1
32	diff. TOF 9	-1,5259	-1,5259	2100,1
33	diff. TOF SUM AVG	-0,2899	-0,2899	702,7

#	Name	Results / mV	Std Dev. / mV	With Result Avg
1	AM UP	344,31	1,01	
2	AM Down	342,91	0,88	
3	AM diff	1,40	1,22	

#	Name	Results
1	AM CAL High	4475,28
2	AM CAL Low	2973,12

**HS Clock**

Internal HS clock is 4MHz

HS clk period in ns (ideal)     Read HS CLK Divider    HS Clock Divider     HS clk period/ns     Cal Factor HS clock

Apply calibrated clock period to display values

Write TOF Values to File      Show TOF Values in Color

Write Config

Stop Measurement

Disable Watchdog

Enable Watchdog

Watchdog is Disabled

**Chip Status**

MCT is ON

TOF SUM AVG UP  
205752,97

TOF SUM AVG DOWN  
205753,26

Diff. TOF SUM AVG  
-0,28991699

Amplitude Measurement  
344,604    343,223

UP    DOWN

Pulse With Ratio  
0,98    0,98

UP    DOWN

System Status Flags

- Bus Occupied
- TS Busy in 10ms
- MCT count Low
- MCT count High
- MCT is Running
- Communication Failed
- Reset Flag
- Error Flag

Clear Flags:

Demo Kit Manual • PUBLIC  
SC-000865-UG • v2-00 • 2020-Jun-26

40 | 29

# 7 Schematics, Layers and BOM

Figure 36:  
Board Schematics

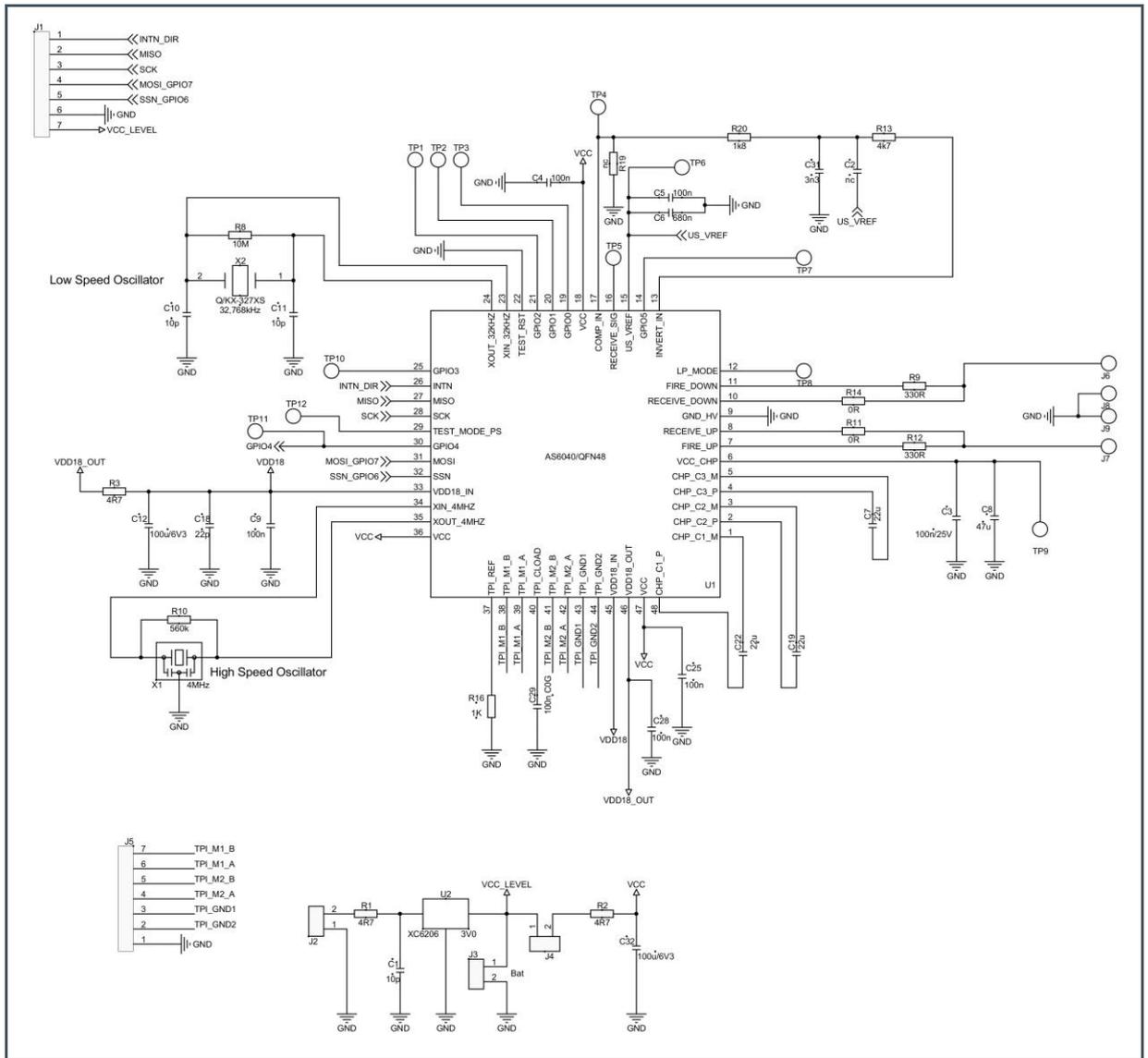


Figure 37:  
Board Layout

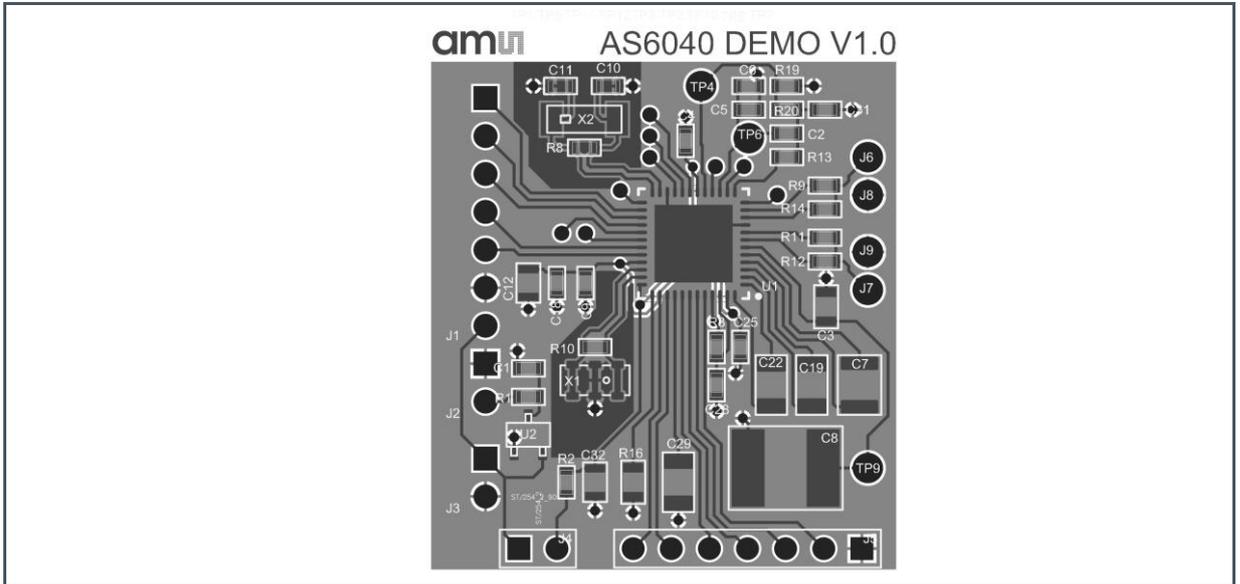
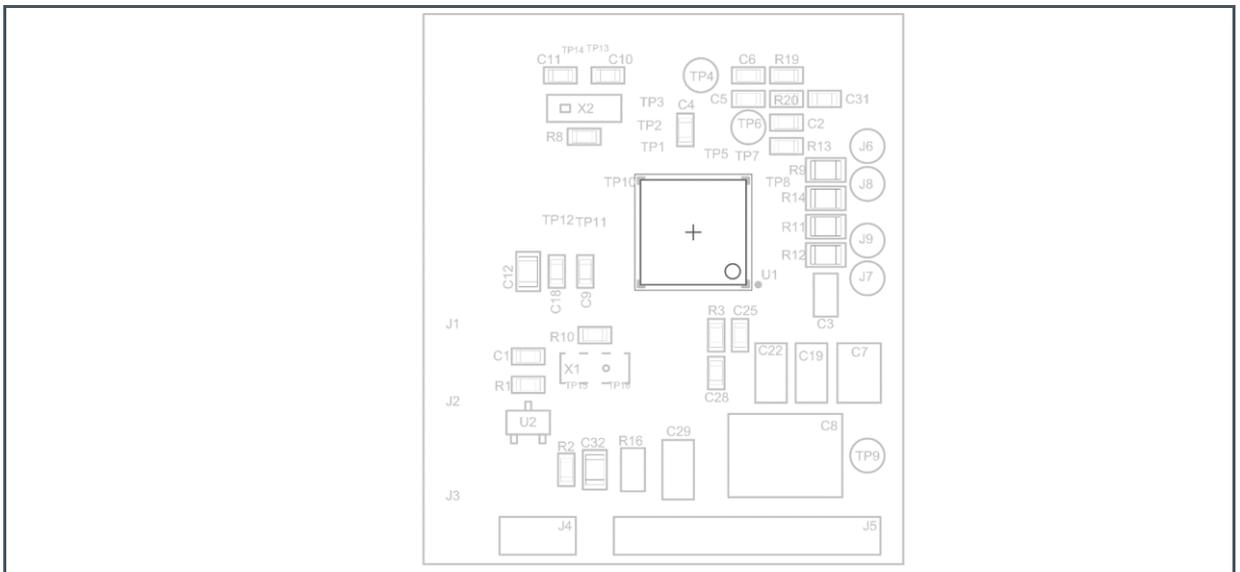


Figure 38:  
Board components



**Figure 39:**  
**BOM**

Item	QTY	Reference	Value	Part Description	Type
1	1			PCB	
2	3	C1, C10, C11	10 pF	0603	Chip capacitor
3	1	C18	22 pF	0603	Chip capacitor
4	1	C31	4.7 nF	0603	Chip capacitor
5	5	C4, C5, C9, C25, C28	100 nF	0603	Chip capacitor
6	1	C6	680 nF	0603	Chip capacitor
7	1	C3	100 nF/25V	0805	Chip capacitor
8	2	C12, C32	100 µF/6V3	0805	Chip capacitor
9	1	C29	100 nF C0G	1206	GRM31C5C1E104JA01L Murata
10	2	C19, C22	22 µF/10V	1206	1206ZD226KAT2A AVX
11	1	C7	22 µF/16V	1210	1210YD226KAT2A AVX
12	1	C8	22 mF/25V	CKG57	12103D226KAT2A AVX
13	3	R1, R2, R3	4.7 Ω	0603	Chip resistor
14	1	R20	2.7 kΩ	0603	Chip resistor
15	1	R13	5.6 kΩ	0603	Chip resistor
16	1	R10	560 kΩ	0603	Chip resistor
17	1	R8	10 MΩ	0603	Chip resistor
18	2	R11, R14	0 Ω	0805	Chip resistor
19	2	R9, R12	330 Ω	0805	Chip resistor
20	1	R16	1 kΩ	0805	Chip resistor
21	1	U1	AS6040	QFN48	AS6040 UFC ScioSense
22	1	U2	3,0V	XC6206	XC6206P302MR-G Torex
23	1	X1	4MHz (8MHz)	CERAMIC RESONATOR	CSTCR4M00G53-R0 (CSTNE8M00G55A000R0)
24	1	X2	32.768kHz	Quartz Crystal	KX-327XS Geyer
25	1	J1		7x1x180° 2,54	2.54 male connector
26	1	J2		2x1x180° 2,54	2.54 male connector
27	1	J4		2x1x90° 2,54	2.54 male connector

## 8 Reference Modules and Transducers

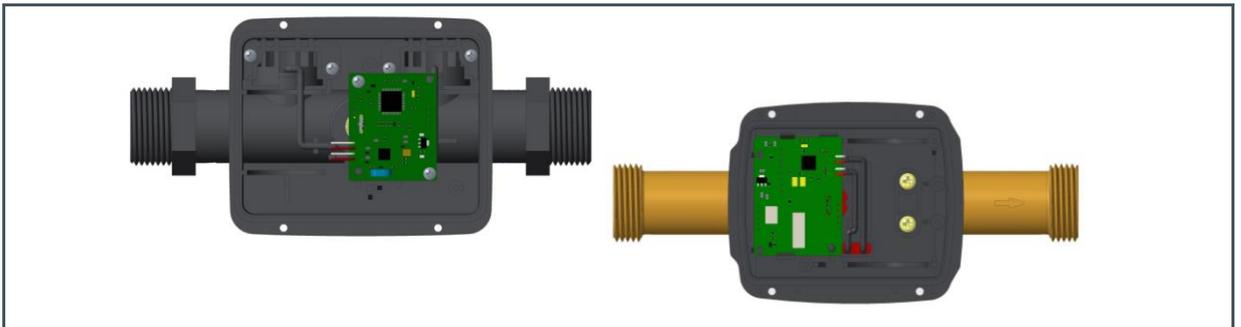
### 8.1 Modules

**SciSense** has a close cooperation with Qingdao iESLab to support customers with complete ultrasonic flow modules for water and gas. For water, iESLab offers pipes made of brass and made of plastic and modules can be ordered un-calibrated or calibrated. The gas meter modules are made of plastic and come un-calibrated, because the final housing will have a major impact on the calibration.

#### 8.1.1 Water Meter Modules

iESLab offers modules for DN15, DN20 and DN25, made of brass or composite.

**Figure 40:**  
**Water Meter Module, Brass**



**Figure 41:**  
**Ordering Information**

Ordering Code	Description	Part Number	Markup Information <sup>(1)</sup>
	With brass pipeline <b>(with calibration parameter)</b>	IA-UWM-1-GP30-DNxx	IA-UWM-1-GP30-DNxx- YYMMDD-SSSS
	With brass pipeline <b>(without calibration parameter)<sup>®</sup></b>	IA-UWM-2-GP30-DNxx	IA-UWM-2-GP30-DNxx- YYMMDD-SSSS
	With Composite Material <b>(with calibration parameter)</b>	IA-UWM-3-GP30-DNxx	IA-UWM-3-GP30-DNxx- YYMMDD-SSSS
	With Composite Material <b>(without calibration parameter)</b>	IA-UWM-4-GP30-DNxx	IA-UWM-4-GP30-DNxx- YYMMDD-SSSS

(1) YYYY = year, MM = month, DD = day, SSSSSS = product serial number that day

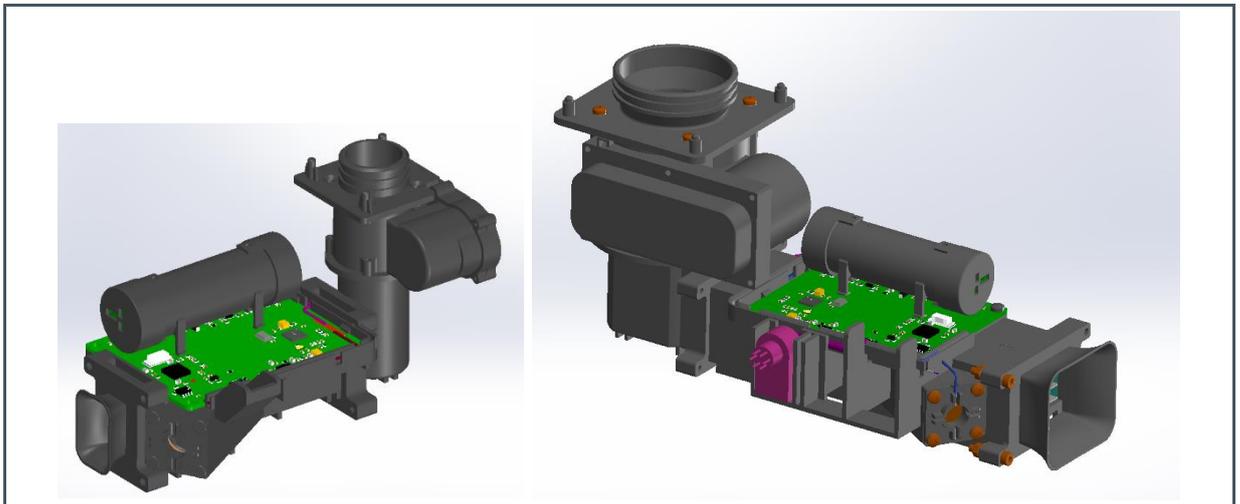
**Figure 42:**  
**Measurement Characteristics**

Nominal Diameter (DN)	15	20	25
Starting Flow (m <sup>3</sup> /h)	0.002	0.003	0.005
Minimum Flow Rate Q <sub>1</sub> (m <sup>3</sup> /h)	0.010	0.016	0.025
Transitional Flow Rate Q <sub>2</sub> (m <sup>3</sup> /h)	0.016	0.025	0.040
Permanent Flow Rate Q <sub>3</sub> (m <sup>3</sup> /h)	2.5	4.0	6.3
Overload Flow Rate Q <sub>4</sub> (m <sup>3</sup> /h)	3.125	5.0	7.875
Flow Range Ratio (Q <sub>3</sub> /Q <sub>1</sub> )	400、250 (default)		
Accuracy Class	Class 2		
Temperature Classes	T50 <sup>®</sup> / T30(default)		
Sample Rate	8Hz~32Hz, 8Hz (default)		
Maximum Admissible Pressure	1.6MPa / 1.0MPa		
Pressure Loss Range	<63KPa / <40KPa		
Flow data storage	Accumulation flow(90 days)		

### 8.1.2 Gas Meter Modules

Those residential and industrial modules come with tubes made of plastic and the electronics are based on AS6031.

**Figure 43:**  
**Gas Meter Module brass**



**Figure 44:**  
**Ordering Information**

Ordering Code	Description	Part Number	Markup Information <sup>(1)</sup>
	Gas meter module residential	IA-UGM-1	IA-UGM-1-YYYYMMDD-SSSSSS
	Gas meter module industrial and commercial	IA-UGM-2	IA-UGM-2-YYYYMMDD-SSSSSS

(1) YYYY = year, MM = month, DD = day, SSSSSS = product serial number that day

**Figure 45:**  
**Measurement Characteristics**

Application	Residential	Commercial & Industrial
Flow Range	G1.6 to G4	G6 to G25
Flow Range Ratio	R250	R350
Accuracy Class	Class 1.5	Class 1.5
Temperature Range	-25°C to 55°C	
Pressure Range	60 to 150 kPa	
Sampling Frequency	0.5 to 16 Hz @ working mode	
Outputs	Temperature, pressure (optional), flow under working condition and standard condition	
Auto-calibration for Gas	Yes	
Compensation	Temperature and pressure	
Power Consumption	< 50µA @ 8 Hz sampling rate	

Contact information:

Qingdao iESLab Electronic Co., Ltd.  
17th Floor, Building A2-3, Hanyu Jingu, High-tech Zone, Jinan City, Shandong, China  
<http://www.qd-ies.com>

MR. Yang Shuo  
Mobile: +86 131-7665-5636  
Email: yangshuo@ieslab.cn  
ysieslab@qq.com  
WeChat: deltonys

## 8.2 Transducers

For transducers we can recommend products from Zhejiang Jiakang Electronics Co., Ltd.:



Part number	Frequency	Part number
PSC1.0M020160H2AD1-B0	f: 1.0 ± 0.1 MHz R1MHz 150 to 350 Ω Cp 1200 pF ± 20% Top -40 to 85 °C S >800mV (@ 2Vpp, 110mm)	
PSC1.0M014083H2AD2-B0	f: 1.0 ± 0.1 MHz R1MHz 500 to 1500 Ω Cp 600 pF ± 20% Top -40 to 85 °C S >450mV (@ 2Vpp, 110mm)	
PSC1.0M022300H2AD4-B0	f: 1.0 ± 0.1 MHz R1MHz 150 to 500 Ω Cp 1300 pF ± 20% Top -40 to 85 °C S >700mV (@ 2Vpp, 110mm)	
PSC2.0M014083H2AD2-B0	f: 2.0 ± 0.1 MHz R1MHz 100 to 400 Ω Cp 1200 pF ± 20% Top -40 to 85 °C S >450mV (@ 2Vpp, 110mm)	
PSC2.0M018223H2AD2-B0	f: 2.0 ± 0.1 MHz R1MHz 150 to 500 Ω Cp 1100 pF ± 20% Top -40 to 85 °C S >200mV (@ 3Vpp, 140mm)	
PSC4.0M018223H2AD2-B0	f: 4.0 ± 0.2 MHz R1MHz 30 to 150 Ω Cp 2050 pF ± 20% Top -40 to 85 °C S >200mV (@ 3Vpp, 140mm)	

Tstrg = -40 to 85°C for all parts

## 9.

Contact data:

Zhejiang Jiakang Electronics Co., Ltd.  
 No.1188 Jiahang Road, Jiaxing City, Zhejiang Province, China  
<http://www.jkelec.com/>  
 dym@jkelec.com T. 13967380228  
 ayq@jkelec.com T. 13857347855

Overseas markets:  
[sally.ma@jkelec.com](mailto:sally.ma@jkelec.com) M+15906738799

## 9 Revision Information

Changes from previous version to current revision v1-00	Page
First release	all
Update on 3 <sup>rd</sup> party modules	Sec. 8

- 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.

## 10 Legal Information

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