

User Guide

UG000292

TDC-GP30

Reference Board

GP30-DEV-KIT

v1-00 • 2019-Feb-26



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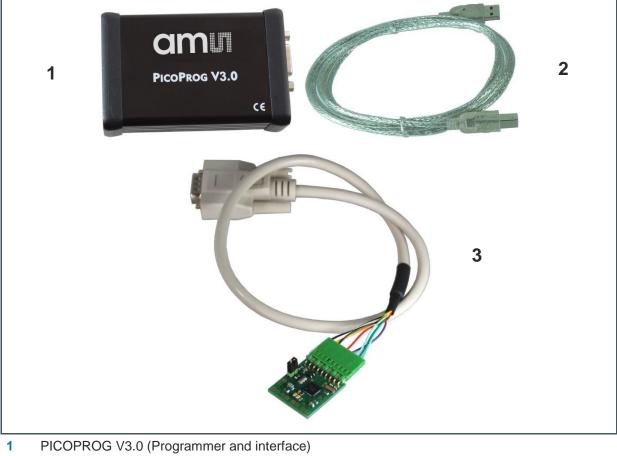
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1 Introduction

The GP30-DEV-KIT is a platform for a quick and easy start-up and evaluation of the TDC-GP30 ultrasonic flow converter (UFC). It supports the QFN32 package, which offers the functionality need for standard water and heat meters. The development kit offers user-friendly configuration and extensive testing of the TDC-GP30, 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 TDC-GP30 datasheets.

1.1 Kit Content

Figure 1: Kit Content



- 2 USB cable (Connects PICOPROG V3.0 to PC)
- **3** GP30-DEMO MODULE (Based on TDC-GP30 in QFN32 package)

Please download the latest software for the kit from https://download.ams.com/SPECIALTY-SENSORS/TDC-GP30

1.2 Ordering Information

Ordering Code	Part Number	Description
GP30-DEV-KIT	220260003	TDC-GP30 Demo Kit for QFN32 version including PICOPROG and cables
GP30-DEMO-KIT-F01	220260006	TDC-GP30 Demo Kit with firmware for QFN32 version including PICOPROG and cables
GP30-DEMO MODULE	220260002	GP30 demo board for QFN32 version
GP30-DEMO-US-F01	220260005	GP30 demo board with firmware for QFN32 version

2 Quick Start Guide

This section describes how to quickly set up the GP30-DEV-KIT, establish basic operation and make measurements.

2.1 Install the Software

It is crucial to install the software before connecting the evaluation kit to your computer. A default driver loading of your OS may interfere with correct installation.

- Download the latest zipped software installation package to the desired directory.
- Unzip the package to the desired directory.
- Open "setup.exe" from the unzipped directory.
- Follow the instructions on the screen.

2.2 Install the Hardware

- Make sure software is installed correctly before proceeding with this step!
- Connect your computer with the PICOPROG V3.0 using USB cable.
- Connect PICOPROG V3.0 and the evaluation kit motherboard using the DB15 interfaces
- The green LED on the evaluation kit should be on.
- Connect your spool piece to US_UP and US_DOWN

2.3 Quick Start for Initial Measurements

From the "Start" menu, go to "All Programs" and then to the "ams" directory. Double click the "GP30_v1_7_0" icon (or newer versions, if available) to begin execution of the evaluation software. The following screen should appear:



Figure 2: Measurement Page

surements	Ultrasonic Measurement Control	Temperature	Measurement Control	General Control Interfaces	irmware Parameters Firmware Error Counters	
		Time of Fligh	t Measurement			2-Wire Temperature Measurement
			Avg. Rate:	Avg. Rate:	Write Config	Current Temperature Sensor accuracy ppm/K
	# Name	Results / ns	Average/ns	Std. Dev./ps	Start Measurement	RC/Rref current T RH/Rref current T Open Graph
	1 TOF SUM AVG UP	59849,4	59849.5	91,8	Read Config from RAM first	RC/Ref canent Riving canent I
	2 TOF SUM AVG DOWN	60845,9	60845,9	81,2	(Use with GP30 Firmware only!)	1,0000
	3 TOF1 UP	61843,2	61843.0	89,4	GP30 Status	Calculated Temperature Results
	4 TOF2 UP	62839,3	62839,2	91,0	Measurement Cycle Timer is OFF	# Name Results Unit StD (mK) SNR (Bit)
	5 TOF3 UP	61344,4	61344,4	59,5	-	0 0 1 0 1 FR0 🗸
	6 TOF4 UP	59849,6	59849,4	98,6	Stop Measurement Cycle Timer and Disable Watchdog	
	7 TOF5 UP	60846,0	60845,8	96,1	and Disable Watchuog	Measurement Values
	8 TOF6_UP	61843,0	61843,0	93,7	Curture Durat	# Name Results Unit A Apply RDSON compensation
	9 TOF7_UP	62839,2	62839,2	80,5	System Reset	
	10 TOF8_UP	61344,5	61344,3	63,9	Disable Watchdog after Reset	
	11 TOF1 DOWN	-0,2480	0,0872	141,7	Release Bus Master after Reset	0 0 1 0 Mult. Gain Comp. 1,25
	12 TOF2 DOWN	-0,1106	0,0652	112,0		
	13 TOF3 DOWN	0,2594	0,0673	118,6	Disable Watchdog	0 0 1 0 ^ Offset 0,0001
	14 TOF4 DOWN	0,0839	0,0385	117,7	Enable Watchdog	0 0 1 0 Gain Factor 0,9998
	15 TOF5 DOWN	-0,0191	0,0657	80,2		
	16 TOF6 DOWN	0,0000	0,0000	0,0	Watchdog is Enabled	HS Clock
	17 TOF7 DOWN	0,0000	0,0000	0,0000		HS clk period in ps (ideal) HS clk period/ns Cal Factor HS clock
	18 TOF8 DOWN	0,0000	0,0000	0,0000	Verify Interface	HS CIK period in hs (ideal)
	19 diff. TOF 1	0,0000	0,0000	0,0000	Pico Prog FW Version	230
	20 diff. TOF 2	0,0000	0,0000	0,0000	21	according to setting in RAM Apply calibrated clock period to display values
	21 diff. TOF 3	0,0000	0,0000	0,0000	Comm. with GP30 OK?	
	22 diff. TOF 4	0,0000	0,0000	0,0000	Comm. w/ GP30 OK	Amplitude Measurement
	23 diff. TOF 5	0,0000	0,0000	0,0000		Measurement Values
	24 diff. TOF 6	0,0000	0,0000	0,0000	Remote Interface	# Name Results / mV Std Dev. / mV With Result Avgd
	25 diff. TOF 7	0,0000	0,0000	0,0000	SPI - Interface	0 0 1 1 FR0
	26 diff. TOF 8	0,0000	0,0000	0,0000	OUART - Interface	0 0 1 1 FR1
	27 diff. TOF SUM AVG	0,0000	0,0000	0,0000 🗸		0 0 1 1 FR2 v
	Write TOF	Values to File			Baudrate 4800	Calibration Values
	ODON'T	write to File	Pulse Width Ratio UP	Pulse Width Ratio DOWN	Baudrate 115200	# Name Results ^
	Open TOF Graph OValues f	Calibration	0.00	0.00	Selected Baudrate	

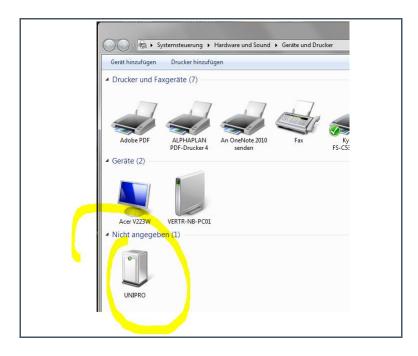
- Click the "Verify Interface" button to confirm communication between PICOPROG V3.0 and TDC-GP30 is working. Both fields, "Pico Prog FW version" and "Comm. With GP30 OK?", should become green.
- Next, open our configuration GP30Y_config_default_A1.A2.11.03 and download it into the chip, pressing "Write Config".
- Connect your spool piece to pins US_UP and US_DOWN.
- 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. The following sections provide a detailed description of the hardware and software for advanced operation.





Figure 3: PICOPROG Registry



If PICOPROG is not displayed correctly then go to the drivers folder, e.g. C:\Program Files (x86)\ams\GP30\data\ and install the driver for your operating system manually. 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 PICOPROG_GP30_v21.hex or higher:

Figure 4:

PICOPROG Manual Installation

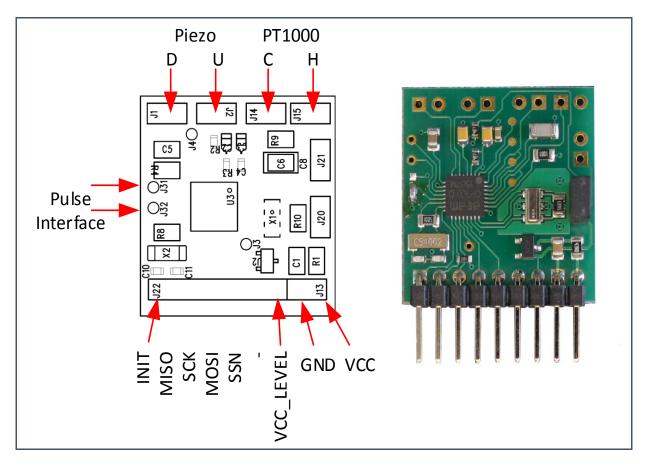
	GP30 Evaluation Software File Tools Firmware Help Measurements Ultr USB Communications Ctrl+U About F12
	Time of Flight
🔳 USE	3 Communications —
	PicoProg Settings
	Disable USB Handle
	PicoProg FW Path
	C:\Program Files (x86)\am\data\PicoProgFW_GP30_v21.hex Change
	GP30 Communication
	Last_Com_Action FW check rd RAM 0xE9 Comm w/ GP30 OK USB Error USB Error

3 Hardware Description

3.1 Introduction

The GP30-DEMO MODULE board, shown in Figure 5, 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). All ports of TDC-GP30 are available. Additional patch fields allow an easy extension with additional circuits. Those can be amplifiers or analog switches for operation in gas meter mode.

Figure 5: GP30-DEMO MODULE



3.2 Communication Interface

The PICOPROG device is a USB-to-SPI converter box that interfaces all UFC evaluation systems. With version 3.0, the PICOPROG also supports the USB-to-UART conversion of TDC-GP30. The PICOPROG is registered by the operating system initially as "PICOPROG v3.0 unprogrammed". As



soon as the GP30 evaluation software starts, a special firmware is written into the PICOPROG to handle the SPI or UART communication with the TDC-GP30. The PICOPROG is now listed as "UNIPRO" in the device manager. For SPI communication only, PICOPROG version 2.0 is sufficient.

Figure 6 shows the connection between the PICOPROG and the GP30 board. The flat connector includes the power lines and the SPI or UART communication lines. On the demo board the communication interface is initially selected to SPI (by solder bridge LJ2).

VCC_LEVEL is the voltage feedback for the PICOPROG level shifters.

Figure 6: SUBD15-Connector

13 \bigcirc INTN 8 \bigcirc MISO / TXD 12 \bigcirc SCK / RXD 11 \bigcirc MOSI 6 \bigcirc SSN \bigcirc - DEMO 14 \bigcirc VCC_LEVEL 3 \bigcirc GND 15 \bigcirc VCC	
15 O VCC	

4 Software Description

4.1 Measurement

When started, the software comes up with the main window, showing the "Measurements" tab.

Figure 7: Main Window

ments	Ultrasonic Measurement Control	Temperature	Measurement Contro	General Control Interfaces	Interrupt & Error Handling acam Fi	irmware Parameters Firmware Error Counters
_		Time of Flight	Measurement		_	2-Wire Temperature Measurement
			Avg. Rate: \$1	Avg. Rate: \$100	Write Config	Current Temperature Sensor accuracy ppm/K
	# Name	Results / ns	Average/ns	Std. Dev./ps	Start Measurement	
	1 TOF SUM AVG UP	59849.4	59849,5	91.8	Read Config from RAM first	KOKIEJ CUITERE I
	2 TOF SUM AVG DOWN	60845.9	60845.9	81,2	(Use with GP30 Firmware only!)	÷) 1,0000
	3 TOF1_UP	61843,2	61843,0	89,4	GP30 Status	Calculated Temperature Results
	4 TOF2_UP	62839,3	62839,2	91,0	Measurement Cycle Timer is OFF	# Name Results Unit StD (mK) SNR (Bit)
	5 TOF3_UP	61344,4	61344,4	59.5		0 0 1 0 1 FR0
	6 TOF4 UP	59849.6	59849.4	98.6	Stop Measurement Cycle Timer and Disable Watchdog	
	7 TOF5 UP	60846,0	60845,8	96,1	and Disable watchdog	Measurement Values
	8 TOF6 UP	61843.0	61843.0	93.7		
	9 TOF7 UP	62839.2	62839.2	80.5	System Reset	
	10 TOF8 UP	61344.5	61344.3	63.9	Disable Watchdog after Reset	0 0 1 0 Apply Gain compensation
	11 TOF1 DOWN	-0,2480	0,0872	141,7	Release Bus Master after Reset	0 0 1 0 Mult. Gain Comp. 1
	12 TOF2 DOWN	-0,1106	0,0652	112,0		
	13 TOF3 DOWN	0,2594	0,0673	118,6	Disable Watchdog	0 0 1 0 ^ Offset 0,0001
	14 TOF4 DOWN	0,0839	0,0385	117,7		0 0 1 0 Gain Factor 0,9998
	15 TOF5 DOWN	-0,0191	0,0657	80,2	Enable Watchdog	
	16 TOF6 DOWN	0,0000	0,0000	0,0	Watchdog is Enabled	HS Clock
	17 TOF7 DOWN	0,0000	0,0000	0,0000		
	18 TOF8 DOWN	0,0000	0,0000	0,0000	Verify Interface	HS cik period in hs (ideal)
	19 diff. TOF 1	0,0000	0,0000	0,0000	Pico Prog FW Version	230
	20 diff. TOF 2	0,0000	0,0000	0,0000	21	according to setting in RAM Apply calibrated clock period to display value
	21 diff. TOF 3	0,0000	0,0000	0,0000	Comm. with GP30 OK?	
	22 diff. TOF 4	0,0000	0,0000	0,0000	Comm. w/ GP30 OK	Amplitude Measurement
	23 diff. TOF 5	0,0000	0,0000	0,0000		Measurement Values
	24 diff. TOF 6	0,0000	0,0000	0,0000	Remote Interface	# Name Results / mV Std Dev. / mV With Result Avgd
	25 diff. TOF 7	0,0000	0,0000	0,0000	SPI - Interface	
	26 diff. TOF 8	0,0000	0,0000	0,0000	OUART - Interface	0 0 1 1 FR1
	27 diff. TOF SUM AVG	0,0000	0,0000	0,0000 🗸		0 0 1 1 FR2
	Write TOF	/alues to File			Baudrate 4800	
	ODON'T	uter en Ette			Baudrate 115200	Calibration Values
	Open TOF Graph OValues f		Pulse Width Ratio UP	Pulse Width Ratio DOWN	Selected Baudrate	# Name Results ^

4.1.1 First Step with Measurement Control Elements

A good first step is to load a working configuration and make measurements in frontend mode (without using the internal 32-Bit µP). **ams** provides a sample configuration file named GP30Y_config_default_A1.A2.11.03 which typically works well with DN20 spool pieces.

Load Configuration File: File menu \rightarrow Open Config \rightarrow 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 GP30 OK?" should get green to show that communication with TDC-GP30 works.
- 2. If watchdog is not disabled by "System Reset". Button \rightarrow press "Disable Watchdog" button.
- 3. Press "Write Config" button to download the configuration settings into TDCX-GP30.
- **4.** Press "Start measurement" button. Now the chip starts to measure and the software displays the results in the table "Time of Flight Measurements".

The user can now modify the configuration to fit it to his needs. Having done this, the user can store his own configuration files.

4.1.2 Time of Flight Measurement Results

GP30 stores the first 8 hits of every TOF direction separately and also the sum 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 user can set the sample size for the averaging (<1000). The software calculates the rolling average of the results accordingly. In "Std. Dev." column the standard deviation, calculated over a variable sample size, is displayed. The number of samples can be chosen (e.g. 100).

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.

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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

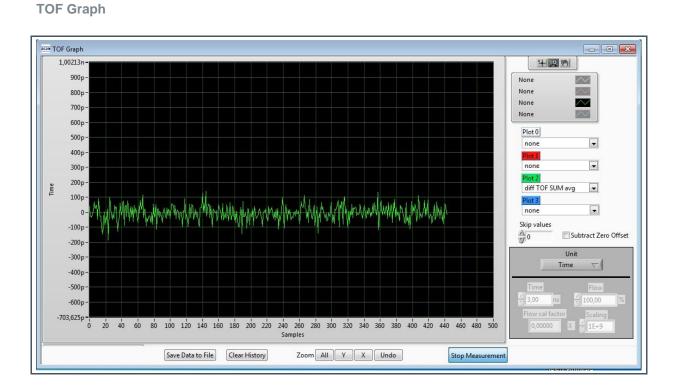
Figure 8: HS Clock Calibration

	HS Clock					
HS clk period in ns (ideal)	HS clk period/ns	Cal Factor HS clock				
250	249,6	0,998418				
according to setting in RAM	Apply calibrated clock period to display values					

A graph to display TOF measurement results opens in a separate window by pressing "TOF Graph" button

Figure 9:

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



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

Figure 10: Data Export for Calibration

	А	В	С	D	E	F	G	Н	I	J	К	L
1	08.08.2016 16:18	s Elapsed	diffTOFSu	sumTOFS	diffTOF1	sumTOF1	PW UP	PW DOW	AM UP	AM DOW	Status Re	gister
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		FFFFFFF
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		FFFFFFF
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		FFFFFFF
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		FFFFFFF
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		FFFFFFF

Figure 11: Data Export Complete

								1.11			L K			51	0		0	0	6	T			1	v	v	2	AA	AB	AC	40	AE	AF	40	A14	A1
		- Elerer	TOPS	TOES	TOEL	TOE2	TOE2	TOFA	TOFF	TOPE	TOEZ	TOER	TOPLAN	TOE2 Ju	TOE2 Ju	TOFA	P 1000	TOER Ju	0	TOES J.	AN TOP		JK TOE	AN TOP	46 TOE	AN TOP			diff. TOF P				AMDOL	An O	74
-	10, 10, 10	s Liepse	a ror sur	0.00	0.00	0.00	0.00			0.00			0.00																0.000000 1			8.89			FFFFFFFF
6	16:13:10	10.05	0,00		0,00	0,00	0,00																						0.000000 1.			9.26			FFFFFFFF
3	10:13:22	12,05	0,00	0,00	0,00	0,00	0,00			0,00			0,00	0,00															0.000000 1.						FFFFFFFF
4	10:13:22	12,30	0,00	0,00	0,00	0,00	0,00			0,00	0,00	0,00	0,00	0,00																	1,99	9,26	0,01		FEFFFFFF
5	16:19:23		0,00	0,00	0,00	0,00	0,00			0,00	0,00	0,00	0,00	0,00															0,00000 1,		1,99	8,81	8,46		
6	16:19:23	13,30	0,00	0,00	0,00	0,00	0,00			0,00	0,00		0,00	0,00						0,00000											1,99	8,18	8,41		FFFFFFFF
7	16:19:24	13,79	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00000	0,00000	0,00000	0,000000	0,00000	0,00000	0,00000	0,00000	0,00000	0,00000	0,00000	0,00000	0,00000	0,00000	0,00000 1,	,99	1,99	6,81	6,91		FFFFFFFF

0

4.1.3 2-Wire Temperature Measurement Results

A graph to display temperature measurement results opens in a separate window by "Temperature Graph" button, similar to TOF graph.

Figure 12:

Temperature Measurement Results Graph



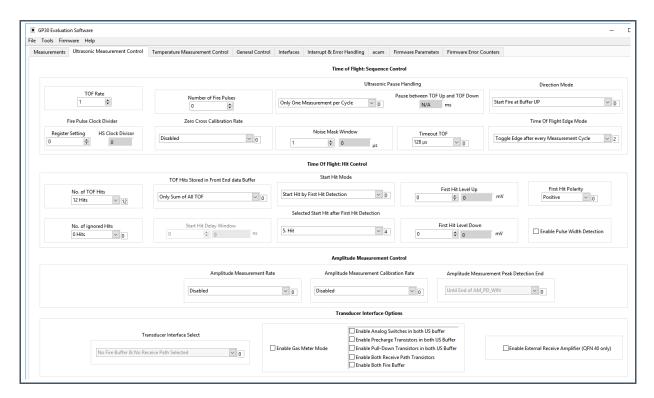
4.2 Ultrasonic Measurement Control

In this tab 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 13: Ultrasonic Measurement Control Tab



The meanings of the various settings are displayed in clear text. For more details about the register settings please refer to the GP30 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



Figure 14: Temperature Measurement Control Tab

GP30 Evaluation Software					-
File Tools Firmware Help					
Measurements Ultrasonic Measurement Control Temperature Measure	ement Control General Control Interfaces	Interrupt & Error Handling acam Firr	mware Parameters Firm	nware Error Counters	
		Sequence Control			
	Measurement Repet				
		- Lord	Temperature Mea	surement Subtask Handling (Pause Time)	
	Temperature Measurement every: 0	Sequence Cycle Triggers	Pause 1,5 * T	(BF_SEL) in ms 💽 5	
	Port Measuremen	nt Order	Pause bet	ween Temperature Measurements	
	1. Default Order -> 2. Reversed	d 💌 2		30,00 ms	
		Measurement Control			
	Wire Mode *	Port Control			
2-Wire N	Measurement 🔹 🛛	Number of Ports		Number of Fake Measurements	
	Measurement Mode	3 Ports	• 1	2 Fake Measurements	
Internal	Resistor 💌 1	Inactive Ports during Meas Pulled to GND	urement		
* Current Softwar	e Release supports only 2-wire Temperature Mode				
		Temperature Measurement Cy	cle Time		
		Discharge Select	• 1		
			1		
					-
		m			E .

The meanings of the various settings are displayed in clear text. For more details about the register settings please refer to the GP30 manual.

4.4 General Control

The "General Control" tab covers configuration settings for

- Task sequencing
- High speed clock control
- Voltage measurement
- CPU handling
- Timer settings



Figure 15: General Control Tab

GP30 Evaluation Software		
File Tools Firmware Help		
Measurements Ultrasonic Measurement Control Temperature Measurement Control General Control Interface	es Interrupt & Error Handling acam Firmware Parameters Firmware Erro	or Counters
	Task Sequencing	
Set Cycle Time of Task Sequencer Select Base Frequency for Pause Times	Enable Task Sequencer Restart	Bandgap Pulse Mode
Cycle Time Task Sequencer Base Frequency Select	Task Sequencer Start Mode	
128 👾 125 ms BF_SEL = 50 Hz 💌 0	Task Sequencing Starts: Independent of Remote Interface State	Synchronized with task sequencer 💌 1
	High Speed Clock Control	
Settling Time	High Speed Clock Select	HS_CLK Calibration Rate
135 µs 💌 2	4MHz 💌 0	Every 20th Sequence Cycle 🔹 5
	Voltage Measurement	
Vcc Measurement Rate	Low Battery Detection Threshold	Vcc Measured
Every 50th Sequence Cycle 6	14 - 2,48 Volt	0,00 Read Measured Vcc
	CPU Handling	
Enable Post Processing CPU Request Enable Post Processing Enable		
Post Processing Mode	Enable General Purpose Timer Request	Checksum Execution after Bootloader
Post Precessing only after TOF, AM, AMC, TM or HCC Measurement		
	Timer	
Update Mode for Time Stamp Value	General Purpose Timer	Checksum Timer
	1 hour 💌 🕡	
Updated Automatically every second	General Purpose Handling with HS Clock	Checksum Every hour
	m	

The meanings of the various settings are displayed in clear text. For more details about the register settings please refer to the GP30 manual

4.4.1 Firmware

In case the TDC-GP30 has firmware, setting flag "Enable post processing" turns on the CPU (flow meter mode). Having this not set, the GP30 runs as front-end in time conversion mode.

4.5 Interfaces

The "Interfaces" tab covers configuration settings for

- Pulse interface including test option
- EEPROM interface
- GPIO control
- UART remote interface.



Figure 16: Interfaces Tab

Pulse Interface	G	PIOs	UART Interface Control *
Pulse Interface Control			CRC Control
☑ Enable Pulse Interface	Configuration SCK (Input Pull Down	SPI) or RxD (UART) Port	UART CRC Polynomial
General Update Mode	GPIO 0	GPIO 1	1021
Update by PI_UPD only 0 Dutput Mode	Configuration GPIO 0	Configuration GPIO 1	UART CRC Reversed Order
Forward and Backward Pulses on 1 Line	Output 💌 🛛	Output 0	UART Initial CRC Value
Pulse Width	Select GPIO 0	Select GPIO 1	Initial CRC Value 0x1111
32 🜲 31,25 ms	Pulse Interface->Pulse	Pulse Interface->Direction	UART CRC Mode Default Settings
Pulse Interface Test	GPIO 2	GPIO 3	
Update Pulse Interface	Configuration GPIO 2	Configuration GPIO 3	UART Wake Up Command Enable
No. of Pulses	Input Pull Up 💌 1	Input Pull Up	Wake Up Command Enabled
0,00000	Select GPIO 2 General Purpose Out [2]	Select GPIO 3 General Purpose Out [3]	Baud rate
Minimum Distance 2 Pulses		General Purpose Out [3]	UART High Baud Rate 19200 Baud
32,227 ms	GPIO 4 (QFN 40 only)	GPIO 5 (QFN 40 only)	High Baud Rate Timeout
Time Between Internal Updates	Configuration GPIO 4	Configuration GPIO 5	120 ms T
3 🚖 2,93 ms	Input Pull Up	Input Pull Up 1	UART High Baud Mode
No. of Internal Upd. between General Upd.	Select GPIO 4	Select GPIO 5	High Baud rate controlled by remote controller 💌 🛛
0	General Purpose Out [4]	General Purpose Out [5]	Clear Mode for UART IRQ
	GPIO 6 (QFN 40 only)		UART INT cleared by remote controller
External EEPROM Interface	Configuration GPIO 6		UART Data Message
OM Interface Mode	Input Pull Up		Address Length
ROM Disabled	Select GPIO 6 General Purpose Out [6]		
OM Pull Up Enable			* Current Software Release supports only SPI Interface
face Pull Ups Disabled 💽 0			
OM Slave Address			
*			

The meanings of the various settings are displayed in clear text. For more details about the register settings please refer to the GP30 manual.

4.5.1 Pulse Interface

The pulse interface needs an appropriate firmware in the chip. The settings in the evaluation software only generate an artificial pulse to test the general functionality. The output is not related to any measurement.

4.5.2 UART

The UART is not supported in this software version.

4.6 Interrupt & Error Handling

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



Figure 17: 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 GP30 manual.

4.7 ams

On this tab, named acam, specific parameters are displayed, but for **ams** internal use and analysis only.

4.8 Firmware Parameters and Firmware Error Counters

Those two tabs display and allow editing of parameters related to the **ams** flow firmware. They are of use only for TDC-GP30-F01. For details please refer to the datasheet TDC-GP30 Vol.4 Firmware Overview.



Figure 18: Firmware Parameters Tab

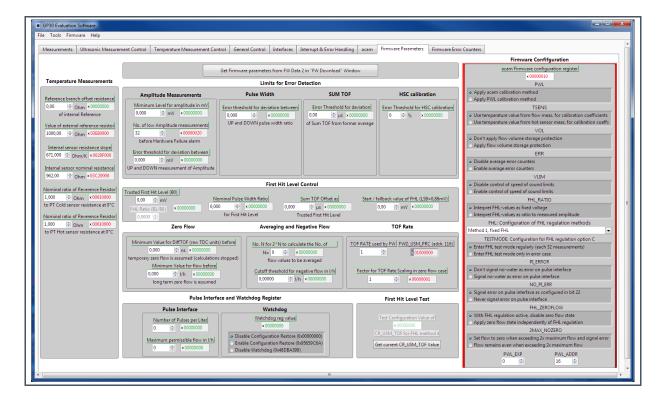
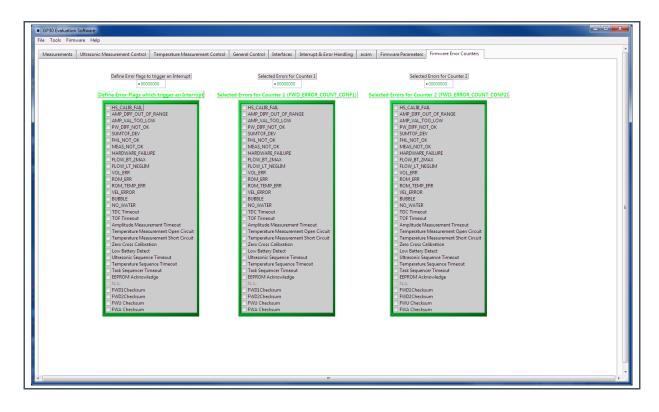


Figure 19: Firmware Error Counters



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 GP30. 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 GP30 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

acan RAM Memory			
		ues in RAM Memory	
	Ad	ldress EC	
	Write Value	Read Data	
	1556	00 00 09 40	
	Write RAM	Read RAM	

- Opens a window which allows single write and read accesses to random access area for addresses 0x000 – 0x0FF.
- The random access area from 0x100 0x17F, containing the firmware data, can be accessed separately by "Firmware Download" window

Registers

Figure 21: Registers

egister	Settings	User Interface		Register	Settings	GP30 RAM
	Configuratio	n Register UI		Config	uration Regi	ster GP30
0xCD		CR_WD_DIS CR_PI_E2P CR_GP_CTRL CR_UART CR_IEH CR_CPM CR_MRG_TS CR_TM CR_USM_PRC CR_USM_FRC CR_USM_FRC CR_USM_AM CR_TRIM1 CR_TRIM2 CR_TRIM2 CR_TRIM3	Read Settings from GP30 RAM and Transfer to GUI Read and Transfer	0xC4 0xC5 0xC6 0xC7 0xC8 0xC9 0xCA 0xCB 0xCC	x 00000000 x 0034010A x 000000044 x 00003000 x 001F03FF x 006580458 x 00012100 x 00380004 x 00380004 x 00368084 x 00002808 x 00002808 x 00002808 x 0000265F x 00230605	
	SHR Regis TOF Rate 1 Start Hit Delay 0 First Wave Lee 40 First Wave Lee 40	y Window vel Up		T S F	HR Register TOF Rate 1 istart Hit Delay V 0 irist Wave Leve 40 irist Wave Leve 40	Window Il Up

• Opens a window, which shows the registers important for a proper configuration setting of the GP30. In the left column, the register contents correspond to the settings done in tabs of GUI main window. If the button "Read GP30 Register Settings" is pressed, the configuration settings located in GP30 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



Remote Commands

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

Figure 22: Remote Commands

Remote Commands	
System Reset Recall FW Code System Init CPU Init SV Init FEP Init	
Request Bus Master Release Bus Master	
Measure Cycle Timer Off Measure Cycle Timer On	
Clear Interrupt Flags	
Communication Request General Purpose Request	
Tag Measure Cycle Timer Off	

- System Reset: Executes a complete system reset of GP30. 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 GP30
- SV Init: Clears the supervisor block in GP30
- FEP Init: Clears the frontend processing block in GP30
- Request/Release Bus Master: Allows the request of the bus master in GP30, 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 GP30, signalizing 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 GP30 CPU.

5.3 Firmware

Assembler

The TDC-GP30 assembler is integrated into the GP30 evaluation software. It is opened in the Firmware menu of the main program:



Figure 23: Firmware Menu

ſ	acan N	nain	vi						
	File	Т	ools	Firmware	Calibration	Н	elp		
	Measureme		Assemb	Assembler		I+A	trol	Temp	
			Debugging		Ctrl+D			remp	
			Firmwa	re Download			ic Mea esults	Table	
		_		CPU Va	lues	Ctr	l+V		
		#		warme		_	Result	s / ns	Avera
		1	TOF	SUM AVG UP			64558	,4	64558
		2	TOF	SUM AVG E	NWOO		64558	,4	64558

The following window comes up:



Figure 24:

Assembler Window

Assembler - C:\Program Files (x86)\ams\GP30\data\ams firmware\ProgramRessources\GP30Y_A1.D2.11.04.asm - X								
File Edit Find Assembler Help								
🗋 庙 🕂 🛃 🖼 ち ♂ 🐰 🗎 🔓 🛒 👎) 🔍 💸 💹 🗐 🕅 🕅 🖓							
GP30Y_A1.D2.11.04.asm								
52 ;====================================	·····							
	file containing memory address and constants definitions							
	tion of ROM routine start addresses - commons							
	s of ROM routine start addresses - commons - included in the							
58								
59								
60 CONST FW_ROMVERSION_REV 0xA1 ; 61 CONST FW VERSION NUM 0xD20000 ;								
62 CONST FW_VERSION_MAJ 0x001000 ;								
63 CONST FW_VERSION_MIN 0x000100 ;								
64 CONST FW_VERSION_BLD 0x000004 ; 65 CONST FW VERSION FW VERSION NUM + FW VERSI	CON MAJ + FW VERSION MIN + FW VERSION BLD ;							
	ton_has + tw_version_him + tw_version_beb ,							
67 ; The following org command is needed at the start of the	e code							
68 org 0 69 :								
70 ;======================= Check of CPU Request:								
71 ;								
72 ; This routine checks the status flags for activity reque 73 ; Inputs : Status flags in SRR_FEP_STF and SHR (
74 ; Output : all processing done and status flags								
75 ; (total)unused : (all used)								
76 ; Temporary RAM : -								
77 ; Permanent RAM : RAM_R_FW_STATUS 78 ; Routines used : ROM FWI, ROM EH, MK PP, MK GPH, ROM CPU	Ј СНК							
79 ;	-							
80 81 ;################ LEAVE THE FOLLOWING 9 LINES ON TOP OF THE	CODE LITTUOLIT ANY CHANGE BERRERRERRERRERRERRERRERRERRERRERRER							
81 ;####################################	CODE WITHOUT ANY CHANGE ####################################							
83 nop ;								
	essary initialisation, function and security check as well							
	any other activity, in particular before any ROM call; el:							
<	>							
Output								

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.

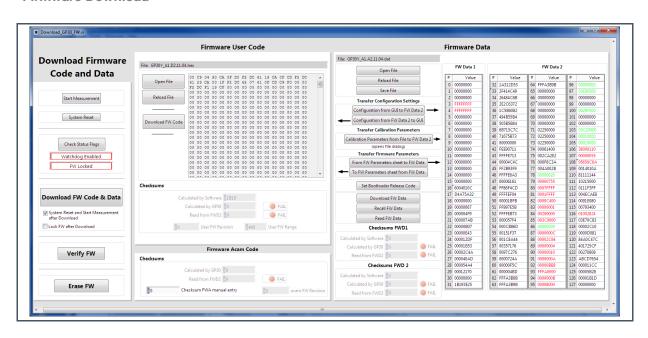
• Firmware Download

This window allows the download of the user code and firmware data, including the configuration, to the non-volatile memory. In case the bootlaoder 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 **ams** firmware examples, either the customers code or in case of chips with **ams** firmware (TDC-GP30-F01) the open source part. The FW Data 1 and 2 include firmware relevant coefficients and the configuration. The figure below shows an example for anTDC-GP30-F01 application. As free part of the user code firmware GP30Y_A1.D2.11.04.hex is loaded. For the configuration and flow calculation data file GP30Y_A1.A2.11.04.dat is loaded.

Figure 25: Firmware Download



- With "Check Status Flag", the watchdog and the lock state of the GP30 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 GP30 back to FW Data 2 fields. The configuration can 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 GP30 when downloading firmware to GP30. 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 GP30 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 **ams** firmware.

Figure 26: Firmware ams Code

Firmware Acam Code	Calculated by GP30 11CC PASS	25 00001B53	57 00357176	89 00000004	121 401725CF
	Read from FWD2 11CC PASS	26 00002C4A	58 0097C276	90 00000010	122 00270808
Checksums	Checksums FWD 2	27 000040AD 28 000054A4	59 0000724A 60 00000F5C	91 0000000A 92 00000BB8	123 ABCD7654 124 000011CC
Calculated by GP30 6A3BA	Calculated by Software 5828	29 00012170	61 000004BD	93 FFFA0000	125 00005B28
Read from FWD2 0		30 00000000	62 FFFA3B9B	94 0000000B	126 00001B1D
0 Checksum FWA manual entry A1A21103 acam FW Revision	Calculated by GP30 5828 OPASS Read from FWD2 5828 OPASS	31 1B193E25	63 FFFA3B9B	95 00008000	127 00000000

So copy manually the calculated checksum for the **ams** 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

Firmware Acam Code	Calculated by GP30	PASS	25 00001855 26 00002C4A	57 00537170 58 0097C276	90 0000004	121 401723CF
Checksums	Read from FWD2 11CC	PASS	27 000040AD	59 0000724A	91 0000000A	123 ABCD7654
Calendated by GP30	Checksums FWD 2		28 000054A4	60 00000F5C	92 00000BB8	124 000011CC
Read from EWD2 6A3BA	Calculated by Software 5828	[29 00012170 30 00000000	61 000004BD 62 FFFA3B9B	93 FFFA0000 94 0000000B	125 00005B28 126 00001B1D
	Calculated by GP30 5B28	PASS	31 1B193E25	63 EFEA3R9R	95 00008 30	127 0006A3BA
6A3BA Clecksum FWA manual entry A1A21103 acam FW Revision	Read from FWD2 5B28	O PASS				

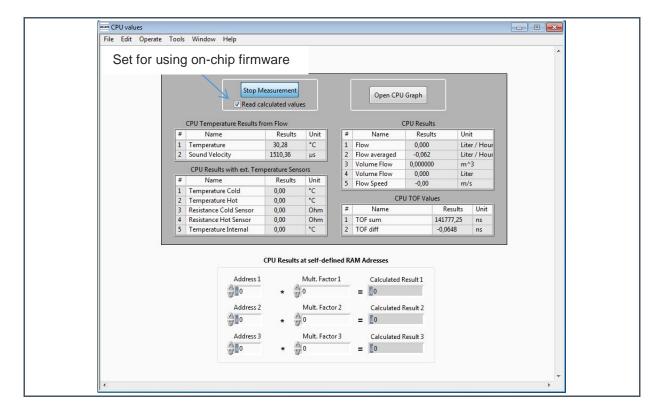
- In the "Firmware ams Code" section, the checksums for the **ams** firmware code are also checked and displayed after a "Verify FW". The **ams** firmware code cannot be modified by user. Therefore a checksum calculated by software field is missing in this section.
- A lock state of GP30 or a hang-up, 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 ams 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 GP30 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

Ultrasonic Pause Handling
Pause 1,0 * T(BF_SEL) in ms
USM_PAUSE
Description and Tip
"Ultrasonic Pause Handling" Description USM_PAUSE> CR_USM_PRC (0x0C8) Selects pause time between 2 ultrasonic measurements
"Ultrasonic Pause Handling" Tip
USM_PAUSE

Help Contents

Not supported in this software revision.

USB Communication

Figure 30: USB Communications

USB Commu	unications
	PicoProg Settings
	Disable USB Handle PicoProg FW Path
	C:\Program Files (x86)\aca\data\PicoProgFW_GP30_v21.hex Change GP30 Communication
	Last_Com_Action Stop_meas Comm w/ GP30 OK Read_Res USB Error USB Error

As described in chapter "Software Installation".

About

Displays software version number together with general information about software and **ams**.

6 Schematics, Layers and BOM

Figure 31:

GP30-DEMO MODULE Schematics

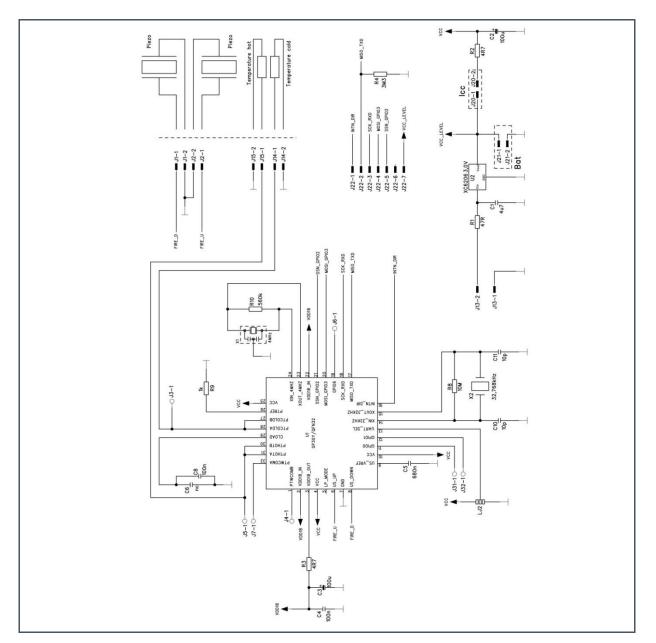


Figure 32: GP30-DEMO MODULE Layout (200% size)

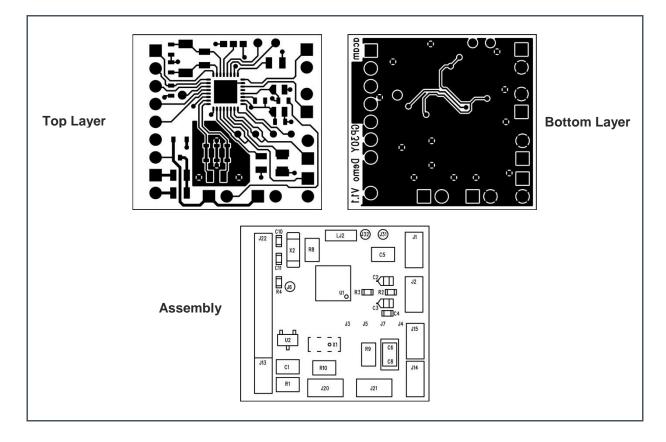


Figure 33: Bill of Materials for GP30 Demo Module

ltem	Qty	Reference	Value	Part Desc	Туре
1	1	U1	TDC-GP30	QFN32	TDC-GP30 UFC ams
2		U2	3.0 V	XC6206	Voltage regulator
3	1	X1	4 MHz	CSTR_G	Ceramic resonator Murata
4	1	X2	32.768 kHz	KX-327XS	Quartz crystal Geyer
5	1	C1	4.7 µF	C805	Chip capacitor
6	2	C2,C3	100 µF	F95_P	Solid tantalum
7	1	C4	100 nF	CC603	Chip capacitor
8	1	C5	680 nF	C805	Chip capacitor
9	1	C6	Nc	C805	Chip capacitor
10	1	C8	100 nF	C1206	Chip capacitor
11	2	C10, C11	10 pF	CC603	Chip capacitor
12	1	R1	47 Ω	R805	Chip resistor
13	2	R2, R3	4.7 Ω	R603	Chip resistor
14	1	R4	3.3 MΩ	R603	Chip resistor

ltem	Qty	Reference	Value	Part Desc	Туре
15	1	R8	10 MΩ	R805	Chip resistor
16	1	R9	1 k Ω	R805	Chip resistor
17	1	R10	560 k Ω	R805	Chip resistor
18	1	J13	2.pol	ST/254_2	Connector for power supply (combined with J22)
19	1	J22	7.pol	ST/254_7_1R	Connector for SPI interface (combined with J13)
20	1	J20	2.pol	ST/254_2	Jumper for current measurement of Vcc
21	1	LJ2	3 pol.		Solder bridge to select between SPI & UART

7 Reference Modules and Transducers

7.1 Modules

ams 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, as the final housing will have a major impact on the calibration.

7.1.1 Water Meter Modules Made of Brass

DN15 and DN20 modules come with tubes made of brass and the sensor frontend are based on TDC-GP22.

Figure 34: Water Meter Module, Brass

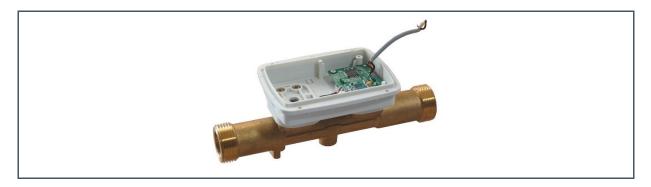


Figure 35: Ordering Information

Ordering Code	Description	Part Number	Markup Information ⁽¹⁾
t.b.d.	Water meter module with brass pipeline No calibration	IA-UWM-1-GP22-DN20	IA-UWM-1-GP22-DN20- YYYYMMDD-SSSSSS
t.b.d.	Water meter module with brass pipeline With calibration	IA-UWM-2-GP22-DN20	IA-UWM-2-GP22-DN20- YYYYMMDD-SSSSSS

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



Figure 36: Measurement Characteristics

Nominal Diameter [mm]	15	20	25	32	40
Starting Flow [m ³ /h]	0.002	0.003	0.003	0.005	0.005
Minimum Flow Rate Q1 [m3/h]	0.010	0.016	0.025	0.040	0.064
Transitional Flow Rate Q ₂ [m ³ /h]	0.016	0.025	0.040	0.064	0.100
Permanent Flow Rate Q ₃ [m ³ /h]	2.500	4.000	6.300	10.000	16.000
Overload Flow Rate Q ₄ [m ³ /h]	3.125	5.000	7.875	12.500	20.000
Flow Range Ratio R (Q ₃ /Q ₁)	R250 ⁽¹⁾ , R400				
Accuracy Class	Class 2				
Temperature Class	T30 ⁽¹⁾ , T50				
Sample Rate	0.5 Hz to 4 Hz, fixed or self-adopting ⁽¹⁾				
Maximum Admissible Pressure		1.0 MPa			
Pressure Loss Range		< 63 kPa < 40 kPa		à	
Flow Data Storage		Accur	nulated volume	e 90 days	

(1) Default

7.1.2 Water Meter Modules Made of Plastic

DN15 and DN20 modules come with tubes made of plastic and the sensor frontend are based on TDC-GP30.

Figure 37: Water Meter Module, Plastic





Figure 38:

Ordering Information

Ordering Code	Description	Part Number	Markup Information ⁽¹⁾
t.b.d.	Water meter module with plastic pipeline No calibration	IA-UWM-3-GP30-DN20	IA-UWM-3-GP30-DN20- YYYYMMDD-SSSSSS
t.b.d.	Water meter module with plastic pipeline With calibration	IA-UWM-4-GP30-DN20	IA-UWM-4-GP30-DN20- YYYYMMDD-SSSSSS

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

Figure 39:

Measurement Characteristics

Nominal Diameter [mm]	15	20	25	32	40	
Starting Flow [m ³ /h]	0.002	0.003	0.003	0.005	0.005	
Minimum Flow Rate Q ₁ [m ³ /h]	0.010	0.016	0.025	0.040	0.064	
Transitional Flow Rate Q ₂ [m ³ /h]	0.016	0.025	0.040	0.064	0.100	
Permanent Flow Rate Q ₃ [m ³ /h]	2.500	4.000	6.300	10.000	16.000	
Overload Flow Rate Q ₄ [m ³ /h]	3.125	5.000	7.875	12.500	20.000	
Flow Range Ratio R (Q ₃ /Q ₁)		<u></u>	R250 ⁽¹⁾ , R400		<u></u>	
Accuracy Class		Class 2				
Temperature Class	T30 ⁽¹⁾ , T50					
Sample Rate	8 Hz to 32 Hz (8 Hz default)					
Maximum Admissible Pressure	up to 1.6 MPa (1.0 MPa @ default)					
Pressure Loss Range		< 40 kPa				
Flow Data Storage	Accumulated volume 90 days					

(1) Default

7.1.3 Gas Meter Modules

The residential and industrial modules come with tubes made of plastic and the sensor frontend are based on TDC-GP22.





Figure 40: Gas Meter Module, Brass

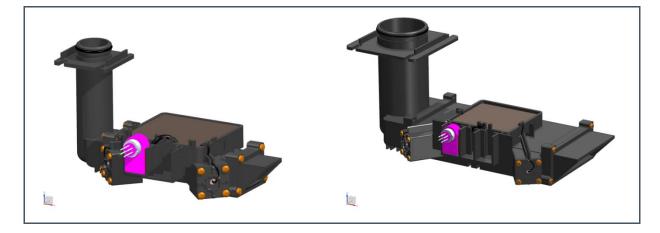


Figure 41: Ordering Information

Ordering Code	Description	Part Number	Markup Information ⁽¹⁾
t.b.d.	Gas meter module residential	IA-UGM-1	IA-UGM-1-YYYYMMDD- SSSSSS
t.b.d.	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 42: 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	-15°C	to 45°C		
Pressure Range	60 to 1	60 to 150 kPa		
Sampling Frequency	0.5 to 4 Hz @	0.5 to 4 Hz @ working mode		
Outputs		under working condition and standard dition		
Auto-calibration for Gas	Yes			
Compensation	Temperature	and pressure		
Power Consumption	< 50µA @ 4 Hz sampling rate			



Contact information:

Qingdao iESLab Electronic Co., Ltd. High-tech Zone, Han Yu Valley Building A2-3 17 layers, Ningxia Road 288, Qingdao Software Park Building 3, Room 601, Qingdao, 266070, China

http://en.qdies.com

Mr. WANG Chuan Mobile: +86 177-5310-5044 Email: wangchuan@ieslab.cn Address: No. 1677, Kehang Rd., Licheng Dist., Jinan City, Shandong, PR. China WeChat: wangchuan9418

7.2 Transducers

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

Figure 43:

Zhejiang Jiakang Ultrasonic Transducers

Part Number	Frequency	Drawing
Gas Meters		
PSC500K018060H2AD2-B1	f: 500 ± 10 kHz Cp 470 pF ± 10% Top -35 to 70 °C	
PSC200K018102H3AD0-B1	f: 200 ± 10 kHz Cp 2000 pF ± 20% Top -35 to 70 °C	
PSC200K018102H3AD1-B1	f: $200 \pm 10 \text{ kHz}$ Cp $430 \text{ pF} \pm 20\%$ Top $-35 \text{ to } 70 ^{\circ}\text{C}$ Angle $12^{\circ} \text{ (average)}$ Q $2.9 \pm 0.3 \text{ g}$	

Part Number	Frequency	Drawing
PSC200K016191H2AD1-B1	f: $200 \pm 10 \text{ kHz}$ Cp $600 \text{ pF} \pm 20\%$ Top $-35 \text{ to } 70 ^{\circ}\text{C}$ Angle $> 6^{\circ}$ (half angle)	
Water Meters	1	
PSC1.0M020100H2AD0- B0/PSC1.0M020107H2AD0-B0	f: 1.0 ± 0.1 MHz R1MHz 100 to 350 Ω Cp 1300 pF ± 20% Top -40 to 85 °C S >800mV (@ 2Vpp, 110mm)	
PSC1.0M019168H2AD2-B0	f: $1.0 \pm 0.1 \text{ MHz}$ R1MHz $150 \text{ to } 400 \Omega$ Cp $1000 \text{ pF} \pm 20\%$ Top $-40 \text{ to } 85 ^{\circ}\text{C}$ S >700mV (@ 2Vpp, 110mm)	019,2±0.05 260±10 16,8±0.05 01 132±0.02 01 01 01 01 01 01 01 01 01 01
PSC1.0M020160H2AD1-B0		
PSC1.0M014083H2AD2-B0	f: $1.0 \pm 0.1 \text{ MHz}$ R1MHz $500 \text{ to } 1500 \Omega$ Cp $600 \text{ pF} \pm 20\%$ Top $-40 \text{ to } 85 ^{\circ}\text{C}$ S $>450 \text{mV}$ (@ 2Vpp, 110mm)	●14.8±0.1 ●14.8±0.1
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)	214 8±01 1 4 8±01 1 4 8±01 1 4 8±01 1 5 8

Part Number	Frequency	Drawing
PSC2.0M018223H2AD2-B0	f: $2.0 \pm 0.1 \text{ MHz}$ R1MHz $150 \text{ to } 500 \Omega$ Cp $1100 \text{ pF} \pm 20\%$ Top $-40 \text{ to } 85 ^{\circ}\text{C}$ S >200mV (@ 3Vpp, 140mm)	
PSC4.0M018223H2AD2-B0		

(1) Tstrg = -40 to 85° C for all parts

Contact information:

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

Revision Information 8

31ff

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.

9 Legal Information

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