

## **TDC-GP30**

### **Reference Board**

**GP30-DEV-KIT** 

ams Demo Kit Manual [v1-01] 2017-Oct-23 Page 1 Document Feedback

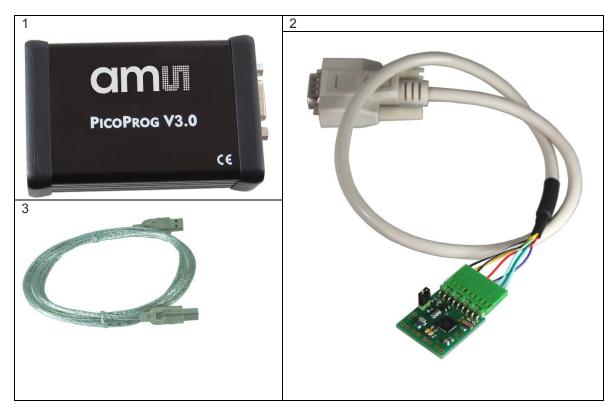
#### **Content Guide**

1	Introduction	3
2	Quick Start Guide	4
2.1	Install the Software	4
2.2	Install the Hardware:	4
2.3	Quick Start for Initial Measurements	4
3	Hardware Description	6
3.1	Introduction	6
3.2	Communication Interface	6
4	Software Description	7
4.1	Measurement	7
4.1.1	First step with measurement control elements	7
4.1.2	Time of Flight Measurement Results	8
4.1.3	2-Wire Temperature Measurement Results	9
4.2	Ultrasonic Measurement Control 1	0
4.3	Temperature Measurement Control 1	1
4.4	General Control1	2
4.5	Interfaces 1	3
4.6	Interrupt & Error Handling 1	4
4.7	acam 1	4
4.8	Firmware Parameters and Firmware Error Counters1	4
5	Software Menu 1	6
5.1	File1	6
5.2	Tools	6
5.3	Firmware 1	9
5.4	Help2	2
6	Schematics, Layers and BOM2	24
7	Ordering & Contact Information	27
8	Copyrights & Disclaimer2	8
9	Revision Information	9

#### 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.





Pos.	Item	Comment
1	PICOPROG V3.0	Programmer and interface
2	GP30-DEMO MODULE	Based on TDC-GP30 in QFN32 package
3	USB cable	Connects PICOPROG V3.0 to PC

Please download the latest software for the kit from

http://www.acam.de/download-center/ultrasonicflowconverter/

#### 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.

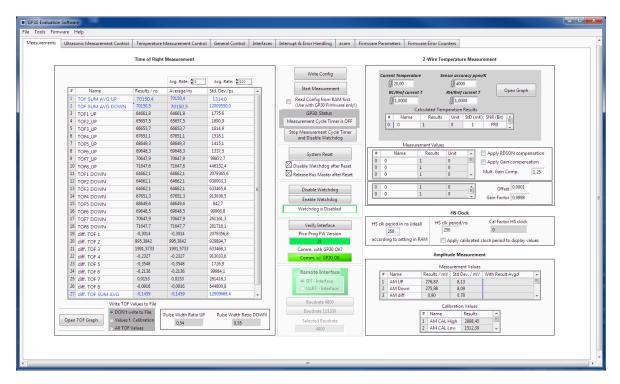
#### 2.2 Install the Hardware:

- 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 "acam" directory. Double click the "GP30\_v1\_5\_3" icon (or newer versions, if available) to begin execution of the evaluation software. The following screen should appear:

#### Figure 2: Measurement Page

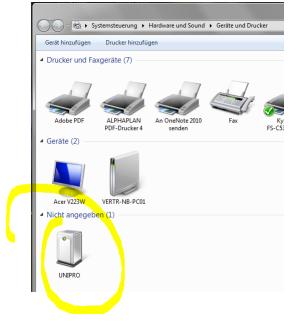




- Click the "Verify Interface" button to confirm communication between PICOPROG V3.0 and TDC-GP30 is working. Both fields, "Pico Prog FW version " and "Comm. With GP30 OK?" should become green.
- 2. Next, open our configuration GP30Y\_config\_default\_A1.A2.11.03 and download it into the chip, pressing "Write Config".
- 3. Connect your spool piece to pins US\_UP and US\_DOWN.
- 4. 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)\acam-messelectronic\GP30\drivers\Win7\_8 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:

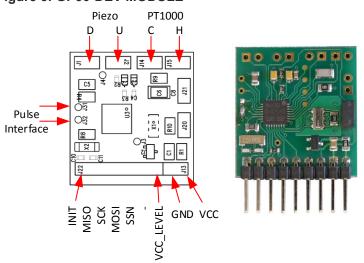


Tools Firmware	Help		PicoProg Settings	ī
asurements I III+r	USB Communications		Picoprog Settings	
asurements Ultr	About	F12	Disable USB Handle	
			PicoProg FW Path	
			뭥 C:\Users\GP3\GP30Y Software\PicoProgFW_GP30_v20.hex Change	
			GP30 Communication	
			Last_Com_Action Read_Res	
			stop_meas Comm w/ GP30 OK USB Error	
				1

#### 3 Hardware Description

#### 3.1 Introduction

The GP30-EVA MODULE board, shown in figure 3, 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-DEV MODULE

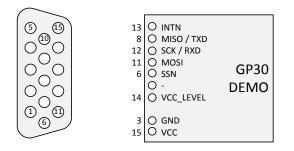
#### 3.2 Communication Interface

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 4 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



#### 4 Software Description

#### 4.1 Measurement

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

#### Figure 7 Main window

Itrasonic Measurement Control		Measurement Contro	ol General Control		Interrupt & Error Handling acam Fi	imware Parameters Firmware Error Counters
	Time of Flight	t Measurement				2-Wire Temperature Measurement
					Write Config	Current Temperature Sensor accuracy ppm/K
		Avg. Rate: 📲	Avg. Rate: \$100		Start Measurement	() 20,00 () 4000
# Name	Results / ns	Average/ns	Std. Dev./ps			RC/Rref current T RH/Rref current T Open Graph
1 TOF SUM AVG UP	70150,4	70150,4	1314,0		Read Config from RAM first	1,0000
2 TOF SUM AVG DOWN	70150,5	70150,5	12009550,0		(Use with GP30 Firmware only!)	Calculated Temperature Results
3 TOF1 UP	64661,8	64661,8	1775,6		GP30 Status	# Name Results Unit StD (mK) SNR (Bit)
4 TOF2_UP	65657,5	65657,5	1690,9		Measurement Cycle Timer is OFF	0 0 1 0 1 FR0
5 TOF3_UP	66653,7	66653,7	1614,9		Stop Measurement Cycle Timer	· · · · · · · · · · · · · · · · · · ·
6 TOF4_UP	67651,1	67651,1	1518,1		and Disable Watchdog	
7 TOF5_UP	68649,3	68649,3	1415,1			Measurement Values
8 TOF6_UP	69648,3	69648,3	1337,5		System Reset	# Name Results Unit Apply RDSON compensation
9 TOF7_UP	70647,9	70647,9	99872,7	-	Maria	0 0 1 0 E Apply Gain compensation
10 TOF8_UP	71647,6	71647,6	446132,4	-	Disable Watchdog after Reset	0 0 1 0 Mult. Gain Comp. 1,25
11 TOF1 DOWN	64662,1	64662,1	2079365,6	-	Release Bus Master after Reset	0 0 1 0 + Mult. Gain Comp. 1,25
12 TOF2 DOWN	64662,1	64662,1	930003,3	- 1		0 0 1 0 Offset 0,0001
13 TOF3 DOWN	64662,1	64662,1	633465,6	=	Disable Watchdog	
14 TOF4 DOWN	67651,3	67651,3	913036,5	- 11	Enable Watchdog	Gain Factor 0,9998
15 TOF5 DOWN	68649,6	68649,6	842,7	- 11	Watchdog is Disabled	<u>u</u>
16 TOF6 DOWN	69648,5	69648,5	99906,8		Trateina og is ofsatorea	HS Clock
17 TOF7 DOWN	70647,9	70647,9	261161,3 281718 1		Verify Interface	HS clk period in ns (ideal) HS clk period/ns Cal Factor HS clock
18 TOFS DOWN	71647,7	71647,7	2079356.8			250 250 0
19 diff. TOF 1	995,3842	995.3842	929894,7	- 11	Pico Prog FW Version	according to setting in RAM Apply calibrated clock period to display values
20 diff. TOF 2 21 diff. TOF 3	1995,5842 1991,5733	1991,5733	633468.1		21	Apply calibrated clock period to display values
	-0.2327	-0.2327	913033.6		Comm. with GP30 OK?	Amplitude Measurement
22 diff. TOF 4 23 diff. TOF 5	-0,2327	-0,2327	913033,6	-	Comm. w/ GP30 OK	
24 diff. TOF 5	-0,3548	-0,3548	99984.1	- 11		Measurement Values
24 diff. TOF 6 25 diff. TOF 7	-0,2136	-0,2136	281418.1	-	Remote Interface	# Name Results / mV Std Dev. / mV With Result Avgd
25 diff. TOF 8	-0.0916	-0.0916	544800.8	_	SPI - Interface	1 AM UP 276,87 8,13
27 diff. TOF SUM AVG	-0.1459	-0.1459	12009668.4	-	O UART - Interface	2 AM Down 275,98 8,09
	1.1	0,1109	200000,4		Baudrate 4800	3 AM diff 0,90 0,78 +
	Values to File					Calibration Values
		Pulse Width Ratio UP	Pulse Width Ratio	DOWN	Baudrate 115200	# Name Results
	f. Calibration	0,54	0,55		Selected Baudrate	1 AM CAL High 2898,45
C All TOP	Values				4800	2 AM CAL Low 1512,39 +

#### 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  $\mu$ P). 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

- **Next step:** 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.
- Next step: If watchdog is not disabled by "System Reset" button → press "Disable Watchdog" button.
- Next step: Press "Write Config" button to download the configuration settings into TDCX-GP30.
- **Next step:** 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

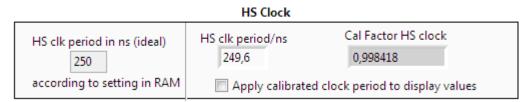
GP30 stores the first 8 hits of every TOF direction separately and also the sum of all measured hits. These 9 results are displayed for both directions, as we call them up and down. The evaluation software additionally calculates the difference between up and down stream, DIFF-TOF. In total, all 27 results 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.

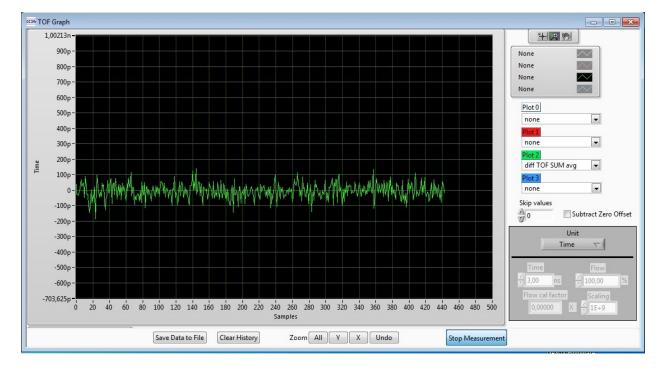
**Note**: The high speed calibration is by default off. This is more convenient when comparing measurement data. But when collecting data for calibration it is strongly recommended to have this active.

#### Figure 8 HS Clock calibration



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

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



#### Figure 9 TOF Graph

ams Demo Kit Manual [v1-01] 2017-Oct-23 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

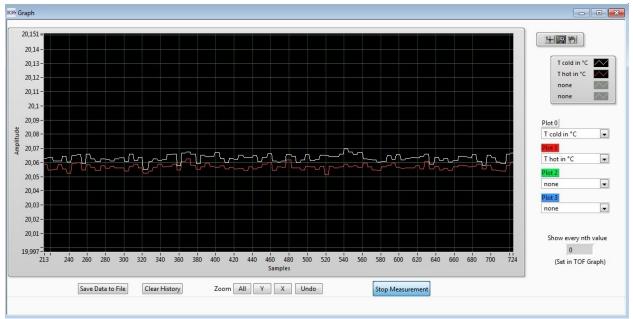
#### Figure 11 Dat export complete

	A	в	С	D	E	F	G	н	1	J	K	L	M	N	0	P	0	B	s	т	U	V	V	×	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AL
1	******	s Elapse	TOFSum	TOFSur	TOF1up	TOF2 up	TOF3 up	TOF4 up	TOF5 up	TOF6 up	TOF7 up	TOF8 up	TOF1dov	TOF2 do	TOF3 do	TOF4 do	TOF5 do	TOF6 do	TOF7 do	TOF8 do	diff. TOF	diff. TOF	diff. TOF	dilf. TOF4	diff. TOF	PW UP	PW DOW	AMUP	AMDOW	Status B	egister				
2	16:19.10	0	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	0,00000	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	8,89	9,10		FFFFFFFF
3	16:19:22	12,05	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	0,00000	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	9,26	8,81		FFFFFFFF
4	16:19:22	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	0,00000	0,00000	0,00000	0,00000	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	9,26	8,81		FFFFFFFF
5	16:19:23	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	0,00000	0,00000	0,00000	0,00000	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	8,81	8,46		FFFFFFFF
6	16:19:23	13,30	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00000	0,00000	0,00000	0,00000	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	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	0,00000	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

#### 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.





#### 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

GP30 Evaluation Software							<b>D</b> X				
File Tools Firmware Help											
Measurements Ultrasonic Measurement Control Temperature Measurements	surement Control General Control	Interfaces Interrupt & Error Handling	acam Firmware Parar	eters Firmware Error Co	ounters						
		Time of Flight:	Sequence Control								
			Ultrasonic Pause Handling			Direction Mode					
	umber of Fire Pulses	Pause 1,0 * T(BF_SEL) in ms		TOF Up and TOF Down 00 ms	Toggle Direction	<b>v</b> 2					
Fire Pulse Clock Divider Zero			Time Of Flight Edge Mode								
Register Setting HS Clock Divisor 3 A E 4	uence Cycle Trigger 💽 6	Noise Mask Window 40 (* 39,6	μs	eout TOF	Positive Edge of	f TOF Hit	• 0				
		Time Of Flight: Hit Contro	bl								
TOF Hits St	tored in Front End data Buffer	Start Hit Mode									
No. of TOF Hits           12 Hits         12	and first 8 TOF values	Start Hit by First Hit Detection	• 0 85	First Hit Level Up	mV	First Hit Polarity Positive 0					
		Selected Start Hit after First Hit De	etection								
No. of ignored Hits Star 0 Hits 0	ert Hit Delay Window	9. Hit	<ul> <li>■ 8</li> <li>85</li> </ul>	First Hit Level Down 74,8	mV	Enable Pulse Width Detection	n				
		Amplitude Me	asurement Control								
	Amplitude Measurement Rate	Amplitude Measur	rement Calibration Rate	Amplitude Measu	urement Peak Detecti	ion End					
E	very TOF Measurement	Every 20th Amplitude I	Measurement 💌 5	After 8 Hits		• 8					
		Transducer Is	nterface Options								
Transducer Interface Sel	Transducer Interface Select     Image: Constitution of the second s										
•		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.

#### 4.3 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

GP30 Evaluation Software				- • ×
File Tools Firmware Help				
Measurements Ultrasonic Measurement Control Temperature	e Measurement Control General Control Interfaces Interrup	ot & Error Handling acam Firmware Parameters	Firmware Error Counters	
		Sequence Control		
	Measurement Repetition Ra	te		
	Temperature Measurement every: 0	Sequence Cycle Triggers	Measurement Subtask Handling (Pause Time) 5 * T(BF_SEL) in ms	
	Port Measurement Order 1. Default Order -> 2. Reversed	Pause I	between Temperature Measurements 30,00 ms	
		Measurement Control		
	Wire Mode *			
		Port Control		
		Number of Ports 3 Ports 1	Number of Fake Measurements	=
	Measurement Mode	s Ports	2 Fake Measurements	
	Internal Resistor	Inactive Ports during Measurement Pulled to GND		
* Curren	nt Software Release supports only 2-wire Temperature Mode			
		Temperature Measurement Cycle Time		
	Į	Discharge Select		
				-
•		m		► a

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

GP30 Evaluation Software		
File Tools Firmware Help		
Measurements Ultrasonic Measurement Control Temperature Measurement Control General Control Interfaces	Interrupt & Error Handling acam Firmware Parameters Firmware E	rror Counters
	Task Sequencing	
Set Cycle Time of Task Sequencer Select Base Frequency for Pause Times	V Enable Task Sequencer Restart	Bandgap Pulse Mode
Cycle Time Task Sequencer Base Frequency Select	Task Sequencer Start Mode	Synchronized with task sequencer
128 m 125 ms BF_SEL = 50 Hz 💌 0 T	Task Sequencing Starts: Independent of Remote Interface State 💌 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	
VEnable Post Processing VCPU Request Enable V 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
Updated Automatically every second	1 hour 💌 D	Checksum Every hour
	General Purpose Handling with HS Clock	
4	111	•
٠		• at

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

#### 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

Firmware Help						
nents Ultrasonic Measurement Control Temperature Measurem	nent Control General Control Ir	nterfaces Interr	upt & Error Handling acam	Firmware Parameters	Firmware Error Counters	
Pulse Interface		G	PIOs		UART Interface Control *	
Pulse Interface Control					CRC Control	
Enable Pulse Interface		Configuration SCK	(SPI) or RxD (UART) Port		UART CRC Polynomial	
General Update Mode						
Update by PI_UPD only	GPIO 0		GPIO 1		UART CRC Reversed Order	
Output Mode	Configuration GPIO 0		Configuration GPIO 1		UART CRC in Unreversed Order	0
Forward and Backward Pulses on 1 Line	Output	• 0	Output	- 0	UART Initial CRC Value	
Pulse Width	Select GPIO 0		Select GPIO 1		Initial CRC Value 0x1111	1
32 🚔 31,25 ms	Pulse Interface->Pulse	1	Pulse Interface->Direction	• 1	UART CRC Mode	
Pulse Interface Test					Default Settings	0
ruse interiace lest	GPIO 2		GPIO 3			
Update Pulse Interface	Configuration GPIO 2		Configuration GPIO 3		UART Wake Up Command Enable Wake Up Command Enabled	
No. of Pulses	Input Pull Up	• 1	Input Pull Up	■ 1	Wake Up Command Enabled	L
0,00000	Select GPIO 2		Select GPIO 3		Baud rate	
Minimum Distance 2 Pulses	General Purpose Out [2]	• 0	General Purpose Out [3]	- 0	UART High Baud Rate	
Minimum Distance 2 Pulses 32,227 ms	GPIO 4 (QFN 40 d	only)	GPIO 5 (QFN 40	only)	19200 Baud	0
	Configuration GPIO 4	,,	Configuration GPIO 5		High Baud Rate Timeout	-
Time Between Internal Updates	Input Pull Up	• 1	Input Pull Up	• 1	120 ms	
3 2,93 ms	Select GPIO 4		Select GPIO 5		UART High Baud Mode High Baud rate controlled by remote controller	
No. of Internal Upd. between General Upd.	General Purpose Out [4]		General Purpose Out [5]	• 0	rign baud rate controlled by remote controller	0
0	Teners share any [4]				Clear Mode for UART IRQ	
	GPIO 6 (QFN 40 d	only)			UART INT cleared by remote controller	0
External EEPROM Interface	Configuration GPIO 6				UART Data Message	
PROM Interface Mode	Input Pull Up	<b>1</b>			Address Length	
PROM Disabled	Select GPIO 6				0 -	
	General Purpose Out [6]	• 0				
PROM Pull Up Enable terface Pull Ups Disabled					* Current Software Release supports only SPI Interface	e
PROM 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.

#### **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.

#### 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

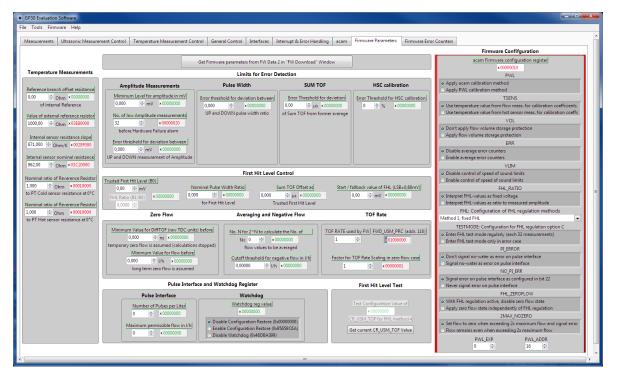
The meanings of the various settings are displayed in clear text. For more details about the register settings please refer to the GP30 manual.

#### 4.7 acam

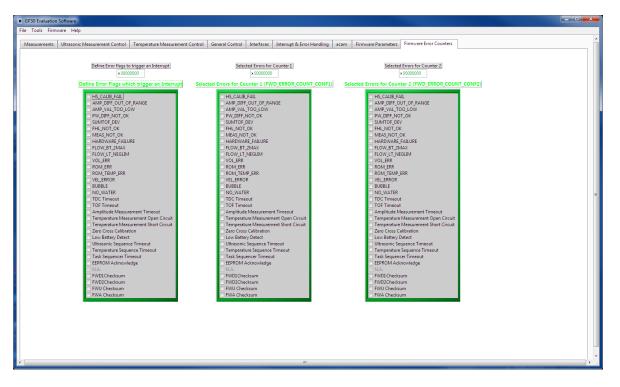
On this tab specific parameters are displayed, but for ams internal use and analysis only.

#### 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





#### 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 19

RAM Memory			
	Read & Write Va	ues in RAM Memory	
		ddress	
	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 20
Registers
                                                                                              Register Settings User Interface
                                                               Register Settings GP30 RAM
          Configuration Register UI
                                                                  Configuration Register GP30
      0xC0 × 00230808 CR WD DIS
                                                                    0xC0 × 00000000 CR WD DIS
      0xC1 × 00230808 CR_PI_E2P
                                                                    0xC1 × 0034010A CR_PI_E2P
      0xC2 × 00230808 CR_GP_CTRL
                                                                    0xC2 × 00000044 CR_GP_CTRL
      0xC3 × 00230808 CR_UART
                                       Read Settings from GP30
RAM and Transfer to GUI
                                                                   0xC3 × 00003000 CR_UART
           × 00230808 CR_IEH
                                                                   0xC4 × 001F03FF CR_IEH
      0xC4
      0xC5 × 00230808 CR_CPM
                                                                   0xC5 × 00680AE8 CR_CPM
                                        Read and Transfer
      0xC6 × 00230808 CR_MRG_TS
                                                                    0xC6 × 00012100 CR_MRG_TS
      0xC7 × 00230808 CR TM
                                                                    0xC7 × 003B0004 CR_TM
      0xC8 × 00230808 CR_USM_PRC
                                                                    0xC8 × 00002824 CR_USM_PRC
      0xC9 × 00230808 CR_USM_FRC
                                                                    0xC9 × 03E68C83 CR_USM_FRC
      0xCA × 00230808 CR_USM_TOF
                                                                    0xCA × 00002808 CR_USM_TOF
      0xCB × 00230808 CR_USM_AM
                                                                    0xCB × 0000B481 CR_USM_AM
                                                                    0xCC × 04A0C07C CR_TRIM1
      0xCC x 00230808 CR_TRIM1
      0xCD × 00230808 CR_TRIM2
                                                                    0xCD × C03765CF CR_TRIM2
      0xCE × 00230808 CR_TRIM3
                                                                   0xCE × 00230808 CR_TRIM3
            SHR Register UI
                                                                       SHR Register GP30
            TOF Rate
                                                                       TOF Rate
            1
                                                                       1
            Start Hit Delay Window
                                                                        Start Hit Delay Window
            0
                                                                       0
            First Wave Level Up
                                                                       First Wave Level Up
            40
                                                                        40
            First Wave Level Down
                                                                        First Wave Level Down
            40
                                                                       40
                                                                    Read GP30 Register Settings
```

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.

Remote Commands

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

- 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.



#### Figure 21

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		

- 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

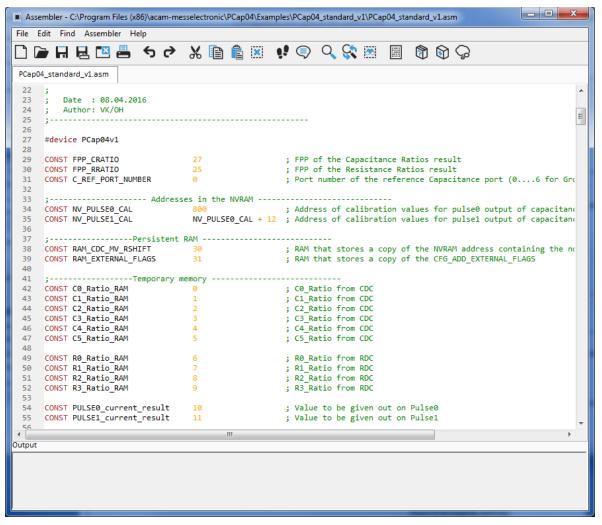
The TDC-GP30 assembler is integrated into the GP30 evaluation software. It is opened in the Firmware menu of the main program:

Figure 22

acar	main.vi								
F	ile	Тс	ols	Firmware Calibration			elp	_	
	Measureme		Assemb	ler	Ct	rl+A	trol	Temp	
ŀ				Debugging		Ctr	rl+D		
				Firmwa	re Download			ic Mea esults	Table
	# 1 TOF		CPU Va	CPU Values C		rl+V			
			INdiffie		_	Result	s / ns	Avera	
			SUM AVG U	JP		64558	,4	64558	
		2	TOF	SUM AVG [	NWOC	6455		,4	64558

The following window comes up:

#### Figure 23



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).

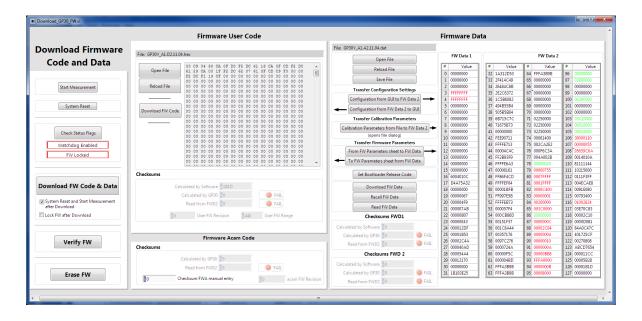
Whether the call of these functions was successful or not is indicated by the messages at the bottom of the assembler window.

• Firmware Download

Figure 24

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.



- 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.

Firmware Acam Code	Calculated by GP30 11CC	PASS	25 00001B53 26 00002C4A	57 00357176 58 0097C276	89 00000004 90 00000010	121 401725CF 122 00270808	
Checksums		Read from FWD2 11CC	PASS	27 000040AD	59 0000724A	91 0000000A	123 ABCD7654
		Checksums FWD 2		28 000054A4	60 00000F5C	92 00000BB8	124 000011CC
Calculated by GP30 6A3BA			r	29 00012170	61 000004BD	93 FFFA0000	125 00005B28
Read from FWD2 0	FAIL	Calculated by Software 5B28		30 00000000	62 FFFA3B9B	94 000000B	126 00001B1D
		Calculated by GP30 SB28	PASS	31 1B193E25	63 FFFA3B9B	95 00008000	127 00000000
0 Checksum FWA manual entry	A1A21103 acam FW Revision	Read from FWD2 5B28	PASS				

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.



- In the "Firmware Acam 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 filed 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 25

<complex-block></complex-block>	™ CPU values File Edit Operate Too	ls Window Help								
Open CPU Graph         Temperature Results from How         Open CPU Graph         Temperature Cold        Open CPU Graph         Open CPU Graph         Temperature Internal       Open CPU Graph         Open CPU Graph       Total         Temperature Internal       Open CPU Graph         Open CPU Graph       Total         Open CPU Graph       Total         Open CPU Graph       Total         Open CPU Graph       Total         Open CPU Graph       Total	Set for	using on-chip	firmwa	re						
#       Name       Results       Unit         1       Temperature       30,28       *C         2       Sound Velocity       1510,36       µs         DPU Results with ext. Temperature Sensors       #       Name       Results       Unit         1       Temperature Cold       0,00       *C         2       Temperature Cold       0,00       *C         3       Resistance Cold Sensor       0,00       O         4       Resistance Cold Sensor       0,00       O         5       Temperature Internal       0,00       *C         7       Name       Results       Unit         1       TOF sum       141777,25       ns         2       TOF diff       -0,0648       ns         2       TOF diff       -0,0648       ns		Read of	alculated value	-5				ts		
1       Temperature       30,28       °C         2       Sound Velocity       1510,36       µs         CPU Results with ext. Temperature Sensors         #       Name       Results       Unit         1       Temperature Cold       0,00       *C         2       Temperature Cold       0,00       *C         3       Resistance Cold Sensor       0,00       Ohm         5       Temperature Internal       0,00       *C         #       Name       Results       Unit         1       ToF sum       141777,25       ns         2       ToF sum       141777,25       ns         2       ToF sum       141777,25       ns         2       ToF diff       -0,0648       ns	1		and the second second	Unit	#	Name	Resu	lts L	Init	
2       Sound Velocity       1510,36       µs         CPU Results with ext. Temperature Sensors         #       Name       Results       Unit         1       Temperature Cold       0,00       *C         2       Temperature Cold       0,00       *C         3       Resistance Cold Sensor       0,00       Ohm         4       Resistance Hot Sensor       0,00       *C         5       Temperature Internal       0,00       *C         #       Name       Results       Unit         1       TOF sum       141777,25       ns         2       TOF diff       -0,0648       ns		1			-		1			
CPU Results with ext. Temperature Sensors         #       Name       Results       Unit         1       Temperature Cold       0,00       *C         2       Temperature Hot       0,00       *C         3       Resistance Hot Sensor       0,00       *C         *       Name       Results       Unit         1       Temperature Rot       0,00       *C         3       Resistance Hot Sensor       0,00       O         *       Tof Sum       141777.25       ns         2       TOF defined RAM Adresses         CPU Results at self-defined RAM Adresses         Address 1         *       0       =       0         Address 2       Mult. Factor 1       Calculated Result 1         *       0       =       0         Address 3       Mult. Factor 3       Calculated Result 3					-					
#       Name       Results       Unit         1       Temperature Cold       0,00       *C         3       Resistance Cold Sensor       0,00       *C         3       Resistance Cold Sensor       0,00       *C         1       TOF sum       141777,25       ns         2       Tof sum       141777,25       ns         2       TOF diter       -0,0648       ns         2       TOF diff       -0,0648       ns         CPU Results at self-defined RAM Adresses         CPU Results at self-defined RAM Adresses         Address 1       Mult. Factor 1       Calculated Result 1         0       Address 2       Mult. Factor 2       Calculated Result 2         0       Address 3       Mult. Factor 3       Calculated Result 3										
1       Temperature Cold       0,00       C         2       Temperature Hot       0,00       C         3       Resistance Cold Sensor       0,00       Ohm         4       Resistance Hot Sensor       0,00       Ohm         5       Temperature Internal       0,00       *C         CPU Results at self-defined RAM Adresses         CPU Results at self-defined RAM Adresses         Address 1         4       Mult. Factor 1       Calculated Result 1         0       -       -       Calculated Result 2         0       -       -       -         0       -       -       -         0       -       -       -         0       -       -       -         0       -       -       -         0       -       -       -         0       -       -       -       -         0       -       -       -       -         0       -       -       -       -         0       -       -       -       -         0       -       =       0       -	_			1	4	Volume Flow	0,000	L	iter	
2       Temperature Hot       0,00       *C         3       Resistance Cold Sensor       0,00       Ohm         4       Resistance Hot Sensor       0,00       Ohm         5       Temperature Internal       0,00       *C         CPU ToF Values         # Name       Results       Unit         1       TOF sum       141777,25       ns         2       TOF diff       -0,0648       ns    CPU Results at self-defined RAM Adresses          CPU Results at self-defined RAM Adresses    Address 1          Address 2       Mult. Factor 1       Calculated Result 1         0       =       0       =         Address 2       Mult. Factor 2       Calculated Result 2         0       =       0       =         Address 3       Mult. Factor 3       Calculated Result 3					5	Flow Speed	-0,00	n	n/s	
Image: splate cold sensor       0,00       Ohm         4       Resistance Cold Sensor       0,00       Ohm         5       Temperature Internal       0,00       *C         For perature Internal         0,00       *C         CPU Results at self-defined RAM Adresses         Address 1       Mult. Factor 1       Calculated Result 1         0       *       0       =       0         Address 2       Mult. Factor 2       Calculated Result 2       Calculated Result 2         0       -       0       =       0         Address 3       Mult. Factor 3       Calculated Result 3						CD		uer	L	
4       Resistance Hot Sensor       0,00       00m         5       Temperature Internal       0,00       *C         I TOF sum       141777,25         I TOF diff         OUD Generature Internal         OUD CPU Results at self-defined RAM Adresses         CPU Results at self-defined RAM Adresses         Address 1       *       0       =       0         Address 2       Mult. Factor 1       Calculated Result 1         Address 2       Mult. Factor 2       Calculated Result 2         0       =       0         Address 3       Mult. Factor 3       Calculated Result 3					#				Unit	
5       Temperature Internal       0,00       *C       2       TOF diff       -0,0648       ns         CPU Results at self-defined RAM Adresses         Address 1         Address 1       Mult. Factor 1       Calculated Result 1         Address 2       Mult. Factor 2       Calculated Result 2         0       Address 3       Mult. Factor 3       Calculated Result 3					-					
CPU Results at self-defined RAM Adresses Address 1 * 0 = 0 Address 2 * 0 = 0 Address 2 * 0 = 0 Address 3 Mult. Factor 3 Calculated Result 3				[1] [1] [2] [2] [2] [2] [2] [2] [2] [2] [2] [2	12.000					
Address 1Mult. Factor 1Calculated Result 1 $4$ ddress 2 $4$ ddress 2Mult. Factor 2Calculated Result 2 $4$ ddress 3Mult. Factor 3Calculated Result 3		Temperature internal	0,00		-	Tor un		0,0040	113	
Address 2       Mult. Factor 2       Calculated Result 2         Image: Construction of the sector 3       Mult. Factor 3       Calculated Result 3		2		Mult. Factor 1		Calculated	Result 1			
Address 3 Mult. Factor 3 Calculated Result 3		9-	÷.				Result 2			
		0		0		= 0				
						Calculated	Result 3			
		0	* 8	0		= 0				

#### 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.

Pause 1,0 * T(BF_SEL) in ms	<b>4</b>
	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	
ОК	Help

Help Contents

Not supported in this software revision

USB Communication

ams Demo Kit Manual [v1-01] 2017-Oct-23

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

As described in chapter "Software Installation".

About

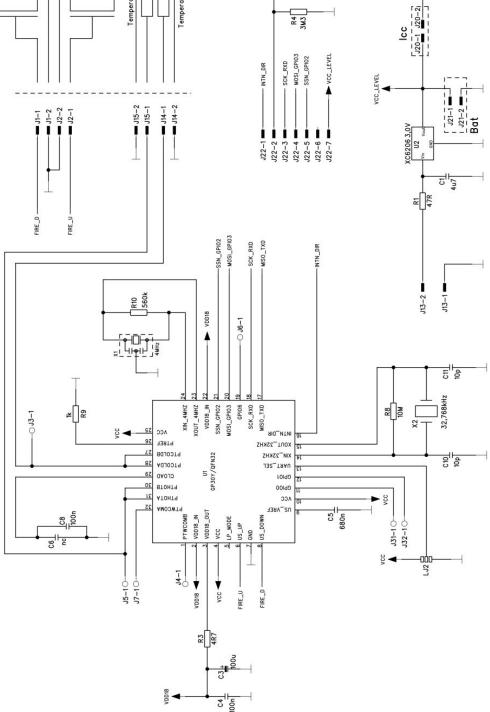
Displays software version number together with general information about software and ams.

A 40

C2 +

R2 4R7

# 6 Schematics, Layers and BOM Figure 26: GP30-DEMO MODULE Schematics

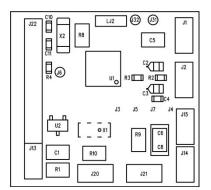


#### Figure 27: GP30-DEMO MODULE Layout (200% size)

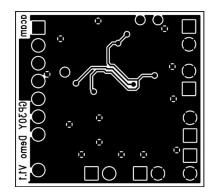
Top layer

# 

#### Assembly



#### **Bottom layer**



Item	Qty	Reference	Part Name	PART DESC	ТҮРЕ
1	1	U1	GP30	QFN32	TDC GP30
2		U2	3.0 V	XC6206	Voltage Regulator
3	1	X1	4 MHz	CSTR_G	Ceramic Resonator
4	1	X2	32.768 kHz	KX-327XS	Quartz Crystal
5	1	C1	4u7	C805	Chip Capacitor
6	2	C2, C3	100u	F95_P	Solid Tantalum
7	1	C4	100n	CC603	Chip Capacitor
8	1	C5	680n	C805	Chip Capacitor
9	1	C6	nc	C805	Chip Capacitor
10	1	C8	100n	C1206	Chip Capacitor
11	2	C10, C11	10p	CC603	Chip Capacitor
12	1	R1	47R	R805	Chip Resistor
13	2	R2, R3	4R7	R603	Chip Resistor
14	1	R4	3M3	R603	Chip Resistor
15	1	R8	10M	R805	Chip Resistor
16	1	R9	1k	R805	Chip Resistor
17	1	R10	560k	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

#### Figure 28: Bill of Materials for GP30-DEMO MODULE

#### 7 Ordering & Contact 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-DEV-F01 MODULE	220260005	GP30 demo board with firmware for QFN32 version

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#### 9 Revision Information

#### Changes from previous version to current revision 1-01 (2017-Oct-23)

Page

Updated screenshots software

**Note:** Page numbers for the previous version may differ from page numbers in the current revision. Correction of typographical errors is not explicitly mentioned.