

# Ultrasonic-Flow-Converter Data Sheet

# **GP30-DEV-KIT**

Development System for TDC-GP30 Ultrasonic Flow Converter

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# **GP30-DEV-KIT**

### 1 Introduction

### 1.1 General

The GP30-DEV-KIT is designed as a platform for a quick and easy start-up and evaluation of the TDC-GP30 Ultrasonic Flow Converter. 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. Please request them from acam.



### **1.2 System Components**

The GP30-DEV-KIT includes the following components:

- GP30-DEMO--PCB: Small demo board with TDC-GP30, assembled with DSUB15 cable
- PICOPROG V3.0: USB-to-SPI/UART communication interface
- USB cable: For connecting the PICOPROG communication Interface to the local PC
- CD-ROM: Contains software, drivers, examples and technical documentation

The GP30-DEMO-PCB is connected to the PC via the PICOPROG SPI-to-USB converter.

Figure 1





### 2 Hardware Description

### 2.1 Introduction

The GP30-DEMO-PCB, shown in figure Fig 2.1, represents the complete front-end for a water or heat meter. The transducers and temperature sensors can be connected directly to this board. It comes with a 32,768 kHz quartz (X2) and a 4 MHz ceramic oscillator (X1).



### 2.2 Communication Interface

The PICOPROG device is acam's standard USB-to-SPI converter box that interfaces all acam evaluation systems. With version 3.0, the PICOPROG also supports the USB-to-UART conversion of GP30. The PICOPROG is registered by operating system initially as "picoprog v3.0 unprogrammed". As soon as the GP30 evaluation software is started, a special firmware is written into the PICOPROG to make the SPI or UART communication with the GP30. For SPI communication only, PICOPROG version 2.0 is sufficient.

Figure 2.2 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 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 2.2



13 8	000	INTN MISO / TXD SCK / RXD	
1	Ó	MOSI	CD20
6	0	SSN	GP30
	0	-	DEMO
14	0	VCC_LEVEL	
3	0	GND VCC	
	Ľ		

# GP30-DEV-KIT

### **3** Software Installation

The GP30 evaluation software described here is an early version for use with the TDC-GP30. It is continuously under evaluation and subject to on-going improvement. Please hold contact with acam to be informed about latest revisions.

The description herein is based on software version 1.2.7

To install the software, go to folder GP30y\_Software\acam GP30 Installer v1\_2\_7\ Volume and run setup.exe. Follow the instructions. After starting the software the PICOPROG is listed under devices and printers as "UNIPROG".

If not, go to the drivers folder , e.g. GP30\_Confidential\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. The driver is located in C:\Program Files (x86)\acammesselectronic\GP30\data.



Therefore 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

File Tools Firm	ware	Help	
Measurements	Ultra	Help Contents	F1
lease in the second		USB Communications	Ctrl+U
		About	F12

PicoProg Settings		
	Disa	able USB Handle
PicoProg FW Path		
B 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



### 4 Software Tabs in Main Window

### 4.1 Measurement

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

Figure 5 Main window

surements Ultrasonic Measu	urement Control	Temperature Measur	rement Control	General Cor	ntrol Interfaces	Interrupt & Er	rror Han	dling aca	m				
10	Time of Flight	Measurement							2-Wir	e Tempe	erature N	leasurement	
≠ Name	Results / ns	Average / ns 🗍 1	Std. Dev. / ps	100	Weite C		(	Current Ten	nperature	Senso	or accurac	cy ppm/K	
TOF SUM AVG UP	64020,2	64020,2	275,0		write C	ontig		() 20,0	00		3 4000		
2 TOF SUM AVG DOWN	64020,2	64020,2	269,2					RC/Rref o	urrent T	Rł	I/Rref cur	rrent T	Open Graph
3 TOF1 UP	60530,3	60530,3	305,4		Stop Meas	surement		() 1,0	000		() 1,0000	0	
TOF2_UP	61527,1	61527,1	281,3		Read Config	from RAM first		Cal	culated Te	mperatu	ire Result	<	
TOF3_UP	62524,7	62524,7	280,5				#	Name	Recult	c IIni	+ S+D (r	mK) SNR (Bit)	1
TOF4_UP	63521,9	63521,9	274,7		-		1 1 7	Taala	16 200	5 UIII	7 510 (1		
TOF5_UP	64518,8	64518,8	285,4		System	Reset	1 7 7		16,309		1,5	7 15,0	
TOF6_UP	65516,4	65516,4	281,1		Disable W	/atchdog	2		10,545	L C	4,0	0,01	
TOF7_UP	66512,6	66512,6	276,0		-		[]	Meas	urement V	alues			
0 TOF8_UP	67509,8	67509,8	277,9		Watchdog i	s Disabled	#	Name	F	Results	Unit	Apply RDS	ON compensation
1 TOF1 DOWN	60530,2	60530,2	281,0		Disable Watchdog		1	t Ref	-25	,662	μs	Apply Gair	compensation
2 TOF2 DOWN	61527,1	61527,1	277,4				2	t cold	-25	,285	μs	W Apply Gai	compensation
3 TOF3 DOWN	62524,7	62524,7	266,2		chubic vi	atendog	3	t Hot	-25	,289	μs	Mult. Gain C	omp. 1,25
4 TOF4 DOWN	63521,9	63521,9	279,6						0.0	000	-		0.0001
15 TOF5 DOWN	64518,8	64518,8	278,2		Verify In	terface	4	RCOId/Rret	0,5	054		Uffse	20,0001
16 TOF6 DOWN	65516,5	65516,5	276,9		Dias Dass D	A/ Manalana	2	Khot/Kref	0,5	/854		Gain Facto	or 0,9998
TOF7 DOWN	66512,9	66512,9	272,8	5	Pico Prog P	vv version				ŀ	IS Clock	2	
18 TOF8 DOWN	67509,7	67509,7	281,7	Ū.	20				HS clk	period/r	ns Cal F	actor HS clock	
l9 diff. TOF 1	0,1297	0,1297	114,5		Comm. with	GP30 OK?			24	9.71	0.99	98827	
0 diff. TOF 2	0,0000	0,0000	97,0		Comm. w/	GP30 OK		10	Apply ca	librated o	lock peri	od to display va	lues
diff. TOF 3	0,0191	0,0191	95,6		and the second		L		TEV -	Amplitud	la Mascu	romont	
22 diff. TOF 4	0,0229	0,0229	103,8	Č.			r		0	Inpittue	ie measu	nement	
23 diff. TOF 5	-0,0267	-0,0267	84,7		Romoto I	ntorfaca		_		Measu	irement V	/alues	
24 diff. TOF 6	-0,0725	-0,0725	109,4		a spi t-	orface		#	Name		Results /	mV Std Dev. /	mV
25 diff. TOF 7	-0,3052	-0,3052	107,2		UAPT -	Interface		1	AM UP		411,57	0,74	
26 diff. TOF 8	0,0839	0,0839	107,6		C/UART-	ancerroce.		2	AM Dow	/n	410,35	0,65	
27 diff. TOF SUM AVG	-0,0186	-0,0186	49,6		Baudrat	e 4800		3	AM diff		1,22	0,69	
					Raudeste	115200			-	Calib	ration Va	lues	
	P	ulse Width Ratio UP	Pulse Width Rat	tio DOWN	Daudidle	113200			# 1	Vame	R	lesults	
Open TOF Graph		0,59	0,59		Selected E	Baudrate			1 /	AM CAL I	High 2	2471,45	
					48	00			2 /	AM CAL I	Low 1	1240,86	

#### 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). acam provides some sample configuration files the software which are working well. Please use those for a first measurement

- Load configuration file: File menu → Open Config → choose appropriate config 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). Also "Comm GP30 OK?" should get green to show that communication with GP30 works.
- Next step: If watchdog is not disabled by "System Reset" button → press "Disable Watchdog" button.
- **Next step:** Press "Write Config" button. Now the configuration settings are downloaded to GP30 and written to register area of GP30.
- **Next step:** Press "Start measurement" button. Now the chip starts to measure and the results are displayed in the tables of different measurements.

Now, this configuration can be modified to fit the user's needs. In the end 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. For both directions these 9 results are displayed. The evaluation software additionally calculates the difference between up and downstream, 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) and 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.

A graph to display TOF measurement results can be opened in a separate window by "TOF Graph" button

Up to 4 plots can be activated. Every plot have various possible values which can be shown (e.g. TOF1UP, TOF2UP ...). The averaged values are displayed.



Figure 6 TOF Graph



#### 4.1.3 **2-Wire Temperature Measurement Results**

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



#### Figure 7

### 4.2 Ultrasonic Measurement Control

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

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

#### Figure 8

		1			
usurements Ultrasonic Measurement Control	Temperature Measurement Control	General Control Interfa	ices Interrupt & Error H	andling acam	
Time of Flight: Sequence Control					
TOF Rate	Ultrasonic Pause Handling			Direction Mode	
1		Pause b	etween TOF Up and TOF D	Toggle Direction with	every Measurement 💌 2
Zero Cross Calibration Rate	Pause 1,0 * T(BF_SEL) in ms	▼ 4	20,00 ms	Time Of Flight Edge M	lode
Every 20th Sequence Cycle Trigger 🗾 5		12-00		Positive Edge of TOF H	Hit 💽 0
Fire Pulse Clock Divider Register Setting HS Clock Divisor 3 4	Number of Fire Pulses	Noise Mas 40	k Window Ξ 39,6 μs	Timeout TOF	
Time Of Flight: Hit Control					
No. of TOF Hits 8 Hits 8 TOF Hits Stored i No. of ignored Hits 0 Hits 9 0	n Front End data Buffer ind first 8 TOF values 💌 1	Start Hit Mode Start Hit by First Hit Dete Selected Start Hit after Fir 5. Hit Start Hit Delay Window	ttion 0 tt Hit Detection	First Hit Level Up 40 🗇 35,2 mV First Hit Level Down 40 🐨 35,2 mV	First Hit Polarity Positive
		0	ns	Enable Pulse Width Detectio	n
Amplitude Measurement Control					
Amplitude Measurement Nate		Amplitude Measurement	Peak Detection End		
Every 5th Amplitude Measurement	3	After 8 Hits	8		
Transducer Interface Options					
Transducer Interface Select		Enable Gas Meter	Mode		
Fire Buffer 1 & Receive Path 1 Selected	nlv)	Enable Both Fire E     Enable Both Recei     Enable Precharge	uffer ve Path Transistors Transistors in both US Buff	Enable Pull-Down Tran	sistors in both US Buffer s in both US buffer





### 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 9

main.vi					- • •
File Tools Firmware Help					
Measurements Ultrasonic Measurement Control	Temperature Measurement Control	General Control Interfac	es Interrupt & Error Handling	acam	•
Measurement R Temperature A Port Measurem	epetion Rate Measurement every: 4 🚖 Sequ	ience Cycle Triggers	Temperature Measurement S Only One Measurement Pause between Temper	Subtask Handling (Pause Time) tt per Cycle 💽 0 rature Measurements	
1. Default Oro Measurement Con	ter -> 2. Reversed 💌 2		N/A	ms	
Wire Mode * 2-Wire Measurement N External Resis * Current Softw	Port	Control Number of Ports 3 Ports 1 Inactive Ports during Mee Set to High 1 erature Mode	Surement	umber of Fake Measurements 2 Fake	E
Temperature Mea Discharge Sel 512 μs	surement Cycle Time ect v 0		11		

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### 4.4 General Control

The "General Control" tab covers configuration settings for

- Task sequencer
- High speed clock control
- Voltage measurement
- CPU handling
- Timer Settings

#### Figure 10

TOOIS TIITI	ware ricip								7
easurements	Ultrasonic Measureme	nt Control	Temperature Measurement	Control	General Control	Interfaces	Interrupt & Error Handling	acam	
ask Sequencin	g								
Set Cycle Tim	ne of Task Sequencer	Select Base	Frequency for Pause Times			Enable Tas	k Sequencer Restart		Bandgap Pulse Mode
Cycle Time	Task Sequencer	Ba	se Frequency Select			Task Sequenc	er Start Mode		Synchronized with task sequencer
256	250 ms	BF_	SEL = 50 Hz 💌 0	Task	Sequencing Starts	Only if Rem	ote Interface is Idle	• 0	
High Speed Clo	ck Control								
Set	tling Time			н	igh Speed Clock S	elect			HS_CLK Calibration Rate
135 µs	2				4MHz 💌	0			Every 20th Sequence Cycle 💽 5
Voltage Measur	rement								
Vcc Measure	ment Rate			Low Batte	erv Detection Thre	shold			Vcc Measured
Disabled	•	0		40	3,13	/olt			0,00 Read Measured Vcc
CPU Handling									
Enable Pos	t Processing	🔲 32-bit C	PU Enable						
Post Processi	ng Mode					Enable (	Seneral Purpose Timer Regu	est	Checksum Execution after Bootloader
Post Processi	ng after every Measurer	nent Cycle	• 0			Endblev	seneral raipose niner nequ	c.r.	
Timer									
					General Purpose T	imer			
Update	Mode for Time Stamp V	alue			1 hour 💌	D			Checksum Timer
Updated A	utomatically every secor	nd 💌 1							Checksum Timer Disabled 💌 0
					📃 General Purp	ose Handling	with HS Clock		
	-								



#### 4.5 Interfaces

The "Interfaces" tab covers configuration settings for

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

#### Figure 11

surements Ultrasonic Measurement Control	Temperature Measurement Control	General Control	Interfaces	interrupt & Error Handling	acam
Pulse Interface		GPIO	5		UART Interface Control *
Pulse Interface Control	Conf	auration SCK (SDD)			CRC Control
Enable Pulse Interface     General Undets Mode	Inpu	t High Z		JIL JIL	UART CRC Polynomial
Undate by PI UPD only	GPIO 0			GPIO 1	LIART CRC Reversed Order
Output Mode	Configuration GPIO 0		Configuration	GPIO 1	MART CRC in Unreversed Order
Forward and Backward Pulses on 1 Line	Output	• 0	Output	• 0	
Pulse Width	Select GPIO 0		Select GPIO 1		UART Initial CRC Value
10 🜩 9.766 ms	Pulse Interface->Pulse	• 1	Pulse Interfac	->Direction 1	Initial CRC Value 0x0000
Pulse Interface Test	CRIO 2			CRIO 2	UART CRC Mode
	GPIO 2				Configured Settings
Update Pulse Interface	Configuration GPIO 2		Configuration		
No. of Pulses	Output	• 0	Output(UART)	/input High Z (SPI) 💌 🛛	UART Wake Up Command Enable
0,00000	Select GPIO 2		Select GPIO 3		Wake Up Command Enabled 💌 1
	General Purpose Out [2]	• 0	General Purpo	se Out [3] 🔹 0	Baudrate
Minimum Distance 2 Pulses	GPIO 4 (QFN 40 o	nly)	GPIC	5 (QFN 40 only)	
10,742 ms	Configuration GPIO 4		Configuration	GPIO 5	UART High Baud Rate
Time Between Internal Updates	Output	• 0	Output	• 0	19200 Baud
3 🚖 2,93 ms	Select GPIO 4		Select GPIO 5		High Baud Rate Timeout
No. of Internal Upd. between General Upd.	General Purnose Out 141		General Purp	ise Out [5]	120 ms 7
	ocherari arpose out [4]		Concrarration	0	UART High Baud Mode
	GPIO 6 (QFN 40 o	nly)			High Baud rate controlled by remote controller 💌 🛛
External EEPROM Interface Control	Configuration GPIO 6				Clear Mode for UART IRO
EEPROM Interface Mode	Output	• 0			UART INT cleared by remote controller
EEPROM Disabled 🔹 0	Select GPIO 6				
EEPROM Pull Up Enable	General Purpose Out [6]	<b>T</b> 0			UART Data Message
Interface Pull Ups Enabled	1				Address Length
EEPROM Slave Address					0 🐳 0 🐳
80					* Current Software Release supports only SPI Interface

### 4.6 Interrupt & Error Handling

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

#### Figure 12

acan main.vi							
File Tools Firm	iware Help						
Measurements	Ultrasonic Measurement Control	Temperature Measurement Control	General Control Inter	faces Interrupt & Er	rror Handling	acam	^
	Selected E Ø TDC Timeout Ø ToF Timeout Ø Amplitude Mi Ø Temperature Ø Zero Cross Ca Ø Low Battery D Ø Ultrasonic Sec Ø Temperature Ø Task Sequenc EEPROM Ackr © Checksum FV © Checksum FV	rror Indicators easurement Timeout Open Circuit : Short Circuit libration Error etect uuence Timeout sequence Timeout er Timeout owledge Error /D1 Error /D2 Error /D2 Error /A Error		In	terrupt Source	es for Remote Interface sk Sequencer mware Transaction ot Load ild Checksum ous FW INT Request ous FW INT Request sp Finished	
	- Charles - Char						



### 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

#### 5.1.1 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.

#### 5.1.2 Save Config

This menu item allows the saving of the current GUI control settings into a configuration file

#### 5.1.3 **Close**

Close all open windows of the GP30 Evaluation software.

### 5.2 Tools

#### 5.2.1 Run Measurement

Same function as "Start/Stop Measurement" button in "Measurement" tab of main window.

#### 5.2.2 TOF Graph

Same function as "Open TOF Graph" button in "Measurement" tab of main window.

#### 5.2.3 **Temperature Graph**

Same function as "Open Graph" button for temperature measurement in "Measurement" tab of main window.

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#### 5.2.4 RAM Memory

#### Figure 13



#### 5.2.5 Registers

Figure 14

gister	Settings	User Interface	•	Register	Settings	GP30 RAM
3	Configuratio	n Register UI		Config	uration Regi	ster 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	0xC3	× 00003000	CR_UART
0xC4	× 00230808	CR_IEH		0xC4	× 001F03FF	CR_IEH
0xC5	× 00230808	CR_CPM	Read and Transfer	0xC5	× 00680AE8	CR_CPM
0xC6	× 00230808	CR_MRG_TS	<	0xC6	× 00012100	CR_MRG_TS
0xC7	× 00230808	CR_IM		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	× 00230808	CR_TRIM1		0xCC	× 04A0C07C	CR_TRIM1
0xCD	× 00230808	CR_TRIM2		0xCD	× C03765CF	CR_TRIM2
0xCE	× 00230808	CR_TRIM3		0xCE	× 00230808	CR_TRIM3
	SHR Regis	ter UI		S	HR Register	GP30
	TOF Rate			1	FOF Rate	
	1				1	
	Start Hit Dela	y Window		9	Start Hit Delay	Window
	0			1	0	
	First Wave Le	vel Un			inst Wave Leve	Lille
	40	ici op		1	40	rop
	First Wave Le	vel Down			First Ways Love	Down
	40			i i	40	Down
				Read	GP30 Register	Settings

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.

-

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.



#### 5.2.6 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 15

Remote Commands	
Remote communus	
System Reset	
System Init	
CPU Init	
SV 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.

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### 5.3 Firmware

#### 5.3.1 Assembler

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

#### Figure 16

acan	m	ain.	vi							
Fil	le	Т	ools	Firmware Calibration			elp	_		
	Measureme			Assembler			rl+A	+A trol Te		
				Debugging			rl+D			
	# 1 TOF			Firmwar	re Download			ic Mea	surem	
				CPU Val	ues	Ctr	l+V			
				INdiffie		_	Result	s / ns	Avera	
				SUM AVG UP			64558	,4	64558	
	2 TOF SUM AVC				NWO		64558	,4	64558	

The following window comes up:

#### Figure 17

acan a	cam Assemble	r		
File	Edit Find	Assembler Help		
GP	30Y FW v2.1.2	Compile F5		
190 191	; ; Opera	Download F6 Assembler Info	ME_INT (3	32-bit Integer) and RAM_FLOW_VOLUME_FRACTION (32-bit Fraction) ^ TOR -> Flow in Cubic per cycle -> Accumulated to the Flow Volume (
192	; Call	Settings Ct	trl+F5	
193	;			
194	.CM CAT	F FLOW VOLUME.		
195	, SM_SAV	E_FLOW_VOLDME:		
197	mul	t y, x		; Flow (fd 16) * Volume multiplication factor (fd 44)
198				; Result with 4 int + 60 fd
199				
200	; 1	Accu: 4 Int	+28 fd and X	X Accu : 32 fd
201	; (	ftp v 14	ormat -> X Acci	1 : 32 Fa
202	shi	ftR x. 14		: Shifting out 28 fds from X moving 31:28 in the lowest 4
204	and	x, 0x0	000000F	; Retaining only 4 fd from the result in X
205	mov	re z, y		; Moving Y content to Z for manipulation
206	shi	ftL z, 4		; Removing the 4 integer bits
207	or	x, z		; X Accu : 32 bit Fractional bits
208				
209	; Cumul	ative Flow volu	ume in cubic me	eter per measurement cycle in RAM_FLOW_VOLUME_INT & RAM_FLOW_VOLU
210	alr	c.		
211	ran	adr RAM FI	LOW VOLUME FRAC	CTION
213	abs	x		; Taking absolute value of fractional part
214	get	flag y		; Checking if original 64 bit was a negative number
215				; If yes, then subtract abs(fractional part) and on carry
216				: If no. then add fractional part and on carry increment

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.

#### 5.3.2 **Debugging**

Not supported in this software revision.

#### 5.3.3 Firmware Download

This window allows the download of the firmware which is typically handeld by 2 files, one for the "Firmware User Code" and one for the "Firmware Data".

Figure 18

		Firmware User (	Code			Firmware D	ata		
Download Firmware	File: GP30Y_A1.F1.12.02	hex		File: GP30Y_A1.F1.12.02.dat	1	FW Data 1		FW Data 2	
Code and Data		00 T2 TB 62 4B 61 42 65 4	CA 20 T2 T2 T2 T2 T2 C6 TC		_	# Value	E Value	Z Value	# Valu
	Open File	A5 CB SF FF FF FC OC CB J	AC F2 DC 61 2B 64 73 CA	Open File		0 000 40000	22 00000000	54 00000000	06 00000000
		F7 3F F2 DC 61 13 CA 00 3	SE F2 DC 61 23 CA 00 35		_	1 00000000	32 0000000	65 0000000	97 0000000
	Paland File	CD F2 DC 0B CD 00 00 00 0	00 F2 DC F1 13 CF A5 62	Reload File		2 00000000	34 0000000	66 00000000	98 0000000
Check Status Flags	Neluad File	F2 80 77 F2 84 78 98 73 0	CB 74 F2 A5 7D 76 9B 73		_	2 0000000	25 00000000	67 00000000	00 00000000
		CB 74 F2 A6 7D CA FA EE 1	F2 5E 77 CB 54 CA FF 9B	Save File		4 0000000	35 0000000	68 0000000	100 0000000
Watchdog Disabled		75 3B 9A CA 00 CB 54 CA 1	FF 9B F3 00 77 CB 54 CA		_	F 00000000	37 0000000	50 00000000	101 00000000
	Download FW Code	FF 9B 82 7C CA F9 FF CF 1	F2 A6 73 F2 A5 33 87 7C	Transfer Configuration Set	1	5 0000000	37 0000000	70 0000000	101 00000000
FW Unlocked	bonnioud i n couc	00 3D 09 00 F2 5E 7F 00 0	00 04 31 F2 C5 62 43 F2	Transfer Configuration se	ungs	7 00000000	30 0000000	70 00000000	102 00000000
		5F D3 F2 C5 62 43 F2 5E 0	C3 F2 CA 73 CB 80 00 00	From GUI to FWD2 1st Hit	Level to FWD2	8 0000000	40 0000000	71 0000000	103 0000000
		1F 00 CE 70 9B 7C F2 C6	73 CB 80 00 00 1F FF 09			0 0000000	40 0000000	72 00000000	104 00000000
		E3 63 47 75 00 01 06 24 0	75 CB 00 CB 54 CE 50 F2	C	_	10 0000000	41 00000000	73 00000000	105 0000000
		F3 5B 73 F3 5C 77 F2 9E 1	78 CA F2 DC 8A 7C F2 9E	Set Bootloader Release C	ode	11 00000000	42 0000000	75 0000000	103 0000000
		77 CE 51 70 01 2% 42 F9 0	CB 54 CE B0 CB 80 00 0F		_	12 0000000	43 0000000	75 0000000	107 00000000
aumland FM Code & Data	FF FF CE B9 CE 79 CB 85 01 F0 00 00 CB A1 89 7C						44 0000000	78 0000000	108 AF0A745
Jownload PW Code & Data		00 00 00 00 00 00 00 00 00		Download FW Data		14 0000000	45 0000000	77 0000000	110 00000044
						16 0000000	40 0000000	70 0000000	110 0000044
Last Diversity of	Checksums			Recall FVV Data		15 0000000	47 0000000	79 0000000	112 01150255
Lock PW after Download				Read EW Data		10 0000000	48 0000000	80 0000000	112 011P03PP
	Calc	ulated by Software A727		incontri buta		17 0000000	49 0000000	82 0000000	113 00280AE8
		C.I	Darr.	Charksums EWD1		10 0000000	50 0000000	82 0000000	114 00010080
		Calculated by GP30 gA727	PASS	checksums PHD1		19 0000000	51 0000000	85 0000000	115 001999400
		Read from FWD2 A727	PASS	Calculated by Software		20 0000000	52 0000000	84 0000000	110 00002824
				Calculated by Software and	-	21 0000000	53 0000000	85 0000000	117 U3E48C83
Verify FW	A1FI	1202 User FW Revision	40 User FW Range	Calculated by GP30 A	PASS	22 0000000	54 0000000	86 0000000	118 0000C10
			Read from FWD2	PASS	23 0000000	55 0000000	87 0000000	119 00006481	
		Firmware Acam C	ode			24 0000000	50 0000000	88 0000000	120 04A0C0/0
	Checksums			Checksums FWD 2		25 0000000	57 0000000	89 0000000	121 403/65CF
	circusuilis					28 0000000	50 0000000	90 00000000	122 00230808
		Calculated by GP30		Calculated by Software 11D9		27 0000000	59 0000000	A000000A	123 ABCD/65
Frase FW			Darre .	Calculated by GP30 1109	PASS	28 0000000	60 0000000	92 00000888	124 000000A
LIGSCIT		Read from FWD2 3BCFC	PASS	conconnect by OP30 MIDS	PASS	29 0000000	61 0000000	93 00000055	125 00001109
	BBCEC CH	ecksum FWA manual entry	A1A11201 acam EW Periries	Read from FWD2 11D9	PASS	30 0000000	62 0000000	94 0000000	120 0000A/2/
	Spere en	constant in the standard entry	ATATIZOT acam PVV Revision			31 00000000	03 00000000	32 00000000	12/ 0003BCFC

- 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.
- 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" a possible auto 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.
- The last 4 addresses of FW Data 2 section contains the fields for the checksums which are stored to GP30 when downloading firmware to GP30. These fields are directly updated, when firmware files are loaded or contents of firmware data fields are changed.
- If pressing the "Verify FW" button after downloading, the content of the NVRAMs can be compared 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. Then the checksums of every section are compared to each other. In case of a successful programming all indicators have to be green.
- In the "Firmware Acam Code" section, the checksums for the firmware acam code are also checked and displayed after a "Verify FW". The firmware acam 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.

#### 5.3.4 CPU Values

This tab is only for customer who uses the acam 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.



#### Figure 19

Address 2 Address 3 Mult. Factor 2 Calculated Results 7 Coll Calput of the factor 3 Calculated Result 3 Coll Calput of the factor 3 Calculated Result 3 Coll Calput of the factor 3 Calculated Result 3 Coll Calput of the factor 3 Calculated Result 3 Coll Calput of the factor 3 Coll Calput of the factor 3 Calculated Result 4 <pcalput 4<="" factor="" of="" p="" the=""> <pcalput 4<="" factor="" of="" p="" the=""> <pcalput of="" t<="" th=""><th>CPU values</th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th></pcalput></pcalput></pcalput>	CPU values										
<complex-block></complex-block>	File Edit Operate T	ools	Window Help								
Stop Measurement         Open CPU Graph         CPU Temperature Results from Flow         Temperature       30,28       °C         2 Sound Velocity       1510,36       µs         Temperature Cold       0,00       °C         3 Resistance Cold Sensor       0,00       °C         3 Resistance Hot Sensor       0,00       °C         4 Resistance Hot Sensor       0,00       °C         5 Temperature Internal       0,00       °C         1 Temperature Internal       0,00       °C         2 GPU Results with ext. Temperature Sensor       CPU Results       Unit         1 Temperature Cold       0,000       °C       °C         3 Resistance Cold Sensor       0,000       Ohm       °C       °C         1 TOF sum       141777,25       ns       °C         2 TOF diff       -0,0648       ns       °C         2 TOF diff       -0,0648       ns       °C         2 Open CPU alues       Calculated Result 1       °C       °C         2 TOF diff       -0,0648       ns       °C       °C         2 TOF diff       °C       °C       °C       °C       °C         4 @0<	Set fo	οrι	using on-chip	o firmw	are						
#       Name       Results       Unit         1       Temperature       30,28       *C         2       Sound Velocity       1510,36       µs         Delta velocity       1510,36       µs         Temperature Cold       0,00       *C         3       Resistance Cold Sensor       0,00       *C         3       Resistance Cold Sensor       0,00       Ohm         4       Resistance Hot Sensor       0,00       Ohm         5       Temperature Internal       0,00       *C         2       Temperature Internal       0,00       *C         Mame       Results       Unit       Top Sum       CPU ToF Values         *       Name       Results       Unit       ToF sum       14177,25       ns         2       TOF diff       -0,0648       ns       2       TOF diff       -0,0648       ns         4       Address 1       *       *       0       =       0       - <td></td> <td></td> <td>Stop N Read c</td> <td>Aeasurement alculated value</td> <td>:5</td> <td></td> <td>Open CPL</td> <td>J Graph CPU Resul</td> <td>ts</td> <td></td> <td></td>			Stop N Read c	Aeasurement alculated value	:5		Open CPL	J Graph CPU Resul	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         3       Resistance Cold Sensor       0,00       OU       Unit         4       Resistance Hot Sensor       0,00       OU       OU       ToF sum         5       Temperature Internal       0,00       *C       #       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       *       #       0       =       Calculated Result 1         #       #       0       =       ©       Calculated Result 2         #       #       #       0       =       ©       Calculated Result 3		#	Name	Results	Unit	#	Name	Resu	ts L	Jnit	
2       Sound Velocity       1510,36       µs         CPU Results with ext. Temperature Sensors       2       Flow averaged       -0,062       Liter / Hour         1       Temperature Cold       0,00       * C         2       Temperature Cold       0,00       * C         3       Flow Speed       -0,00       Liter / Hour         4       Volume Flow       0,000       Liter         5       Temperature Cold       0,00       * C         6       Resistance Cold Sensor       0,00       Ohm         5       Temperature Internal       0,00       * C         7       ToF sum       141777,25       ns         2       TOF diff       -0,0648       ns         CPU Results at self-defined RAM Adresses		1	Temperature	30,28	°C	1	Flow	0,000	L	iter / Hour	
CPU Results with ext. Temperature Sensor         # Name         1       Temperature Cold         2       Temperature Cold         3       Resistance Cold Sensor         0,000       *C         CPU TOF Values         # Name       Results         1       Temperature Cold         0,000       *C         CPU TOF Values         # Name       Results         Unit       1         1       Temperature Internal         0,000       *C         CPU Results at self-defined RAM Adresses         Address 1       * 0         Address 2       Mult. Factor 1         Address 3       Mult. Factor 3         Calculated Result 2         0       * 0         0       = 0         Address 3       Mult. Factor 3         Calculated Result 3         0       * 0         0       = 0		2	Sound Velocity	1510,36	μs	2	Flow averaged	-0,062	L	iter / Hour	
CPU Results with Ext. Temperature Sensors         I       Name       Results       Unit         I       Temperature Cold       0,00       "C         3       Resistance Hot Sensor       0,00       OH         4       Volume Flow       0,00       Liter         5       Temperature Hot       0,00       "C         3       Resistance Hot Sensor       0,00       OH         5       Temperature Internal       0,00       "C         2       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       *       0       =       0         Address 2       Mult. Factor 1       Calculated Result 1       Calculated Result 2         0       *       0       =       0       0         Address 3       Mult. Factor 3       Calculated Result 3       Calculated Result 3		1	CDU Davalha jak ant Taa			3	Volume Flow	0,00000	0 r	n^3	
I       Temperature Cold       0.000       "C         2       Temperature Cold       0.000       "C         3       Resistance Cold Sensor       0.000       Ohm         4       Resistance Hot Sensor       0.000       Ohm         5       Temperature Internal       0.00       "C         CPU TOF Values         #       Name       Results       Unit         1       TOF Sum       141777,25       ns         2       TOF Idff       -0,0648       ns    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 2       -         #       0       =       0       -         Address 3       Mult. Factor 3       Calculated Result 3       -         #       0       =       0       -		<b>#</b>	CPU Results with ext. Ten	Denuite Denuite	ors	4	Volume Flow	0,000	L	iter	
Image: Intermperature Lot of a constraint of the second		# Name		Results	Unit	5	Flow Speed	-0,00	-0,00 m/s		
Image: solution of the second sensor0,00C3Resistance Cold Sensor0,00Ohm4Resistance Cold Sensor0,00Ohm5Temperature Internal0,00*C <b>CPU Results at self-defined RAM Adresses</b> CPU Results at self-defined RAM AdressesAddress 1Mult. Factor 1Calculated Result 1 $0$ * $0$ = $0$ Address 2Mult. Factor 2Calculated Result 2 $0$ * $0$ = $0$ * $0$ * $0$ * $0$ * $0$ * $0$ $0$ * $0$ $0$ * $0$ * <tr< td=""><td></td><td>1</td><td>Temperature Cold</td><td>0,00</td><td>°C</td><td colspan="5">CPU TOE Values</td><td></td></tr<>		1	Temperature Cold	0,00	°C	CPU TOE Values					
4Resistance Hot Sensor0,00Ohm5Temperature Internal0,00*C1TOF sum141777,25ns2TOF diff-0,0648nsCPU Results at self-defined RAM AdressesAddress 1 $4$ ddress 2Mult. Factor 1Calculated Result 1 $4$ ddress 2Mult. Factor 2Calculated Result 2 $4$ ddress 3Mult. Factor 3Calculated Result 3 $4$ ddress 3Mult. Factor 3Calculated Result 3 $4$ ddress 3Mult. Factor 3Calculated Result 3		3	Resistance Cold Sensor	0,00	Ohm	#	Name		Results	Unit	
S       Temperature Internal       0,00       *C       2       TOF diff       -0,0648       ns         CPU Results at self-defined RAM Adresses         Address1       *       0       =       0         Address2       Mult. Factor 1       Calculated Result 1         Address 2       *       0       =       0         Address 3       Mult. Factor 3       Calculated Result 2         0       =       0       =       0         Address 3       Mult. Factor 3       Calculated Result 3         0       =       0       =       0		4	Resistance Hot Sensor	0.00	Ohm	1	TOF sum		141777.25	ns	
CPU Results at self-defined RAM Adresses         Address 1       *       Mult. Factor 1       Calculated Result 1         Address 2       Mult. Factor 2       Calculated Result 2         Address 3       Mult. Factor 3       Calculated Result 2         Address 3       Mult. Factor 3       Calculated Result 3         Address 3       Mult. Factor 3       Calculated Result 3		5	Temperature Internal	0.00	°C	2	TOF diff		-0.0648	ns	
Address 1Mult. Factor 1Calculated Result 1 $Address 2$ $\star$ $\blacksquare$ 0=0Address 2 $\star$ $\blacksquare$ 0=0Address 3 $\star$ $\blacksquare$ 0=0 $Address 3$ $\star$ $\blacksquare$ 0=0				CPU Results	at self-define	d R	AM Adresses				
$\begin{array}{c} \text{Address}^{2} \\ \text{Address}^{2} \\ \text{Address}^{3} \\$			Address 1		Mult Factor 1		Calculated	Porul+1			
Address 2 Address 2 Address 3 Address 3 Address 3 Address 3 Address 3 Address 3 Address 4 Address 4			Allo	A	0	-		Result 1			
Address 2Mult. Factor 2Calculated Result 2 $address 3$ $\star$ $mult. Factor 3$ $address 3$ $address 3$ $\star$ $mult. Factor 3$ $address 3$ $address 3$ $\star$ $mult. Factor 3$ $address 3$			3 × 0	* 🐨	0		= 00				
$\begin{array}{c}  \\  \\  \\  \\ \hline \\ \end{matrix} \\ \hline \\ \end{matrix} \\ \hline \\ \end{matrix} \\ \hline \\ \\ \\ \\$			Address 2		Mult. Factor 2		Calculated	Result 2			
$\frac{\text{Address 3}}{\sqrt[3]{0}} \star \frac{\text{Mult. Factor 3}}{\sqrt[3]{0}} = \boxed[0]{0}$			A 0	*	0	Т	= 0				
Address 3 Mult. Factor 3 Calculated Kesult 3 $0$ $\star$ $0$ $=$ $0$			A 11-1-2	÷.	M. I. C						
			Address 5	A	Wult, Factor :	-	Calculated	Kesult 3			
			<b>W</b> 0	* 🐨	0		= 0				

### 5.4 Calibration

Not supported in this software revision

### 5.5 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		- 4
	USM PAUS	E

1_PAUSE> CR_USM_PRC (0x0C8)	
cts pause time between 2 ultrasonic measurements	
sonic Pause Handling" Tip	
sonic Pause Handling" Tip 1 PAUSE	

#### 5.5.1 Help Contents

Not supported in this software revision

#### 5.5.2 **USB Communication**

As described in chapter "Software Installation".

#### 5.5.3 About

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

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# 6 Development Board Hardware Details

### 6.1 Schematics / Layout

Figure 20 Schematics



### **GP30-DEV-KIT**

Figure 21 Top layer





Figure 23 Assembly





### 6.2 Bill of Materials

Table 6.1 GP30-DEMO-US-PCB BOM

Qty	Reference	Value	Part	Description
1	U1	GP30	QFN32	TDC GP30
	U2	3,0 V	XC6206	Voltage Regulator
1	X1	4 MHz	CSTR_G	Ceramic Resonator
1	X2	32,768 kHz	KX-327XS	Quartz Crystal
1	C1	4u7	C805	Chip Capacitor
2	C2, C3	100u	F95_P	Solid Tantalum
1	C4	100n	CC603	Chip Capacitor
1	C5	680n	C805	Chip Capacitor
1	C6	nc	C805	Chip Capacitor
1	C8	100n	C1206	Chip Capacitor
2	C10, C11	10p	CC603	Chip Capacitor
1	R1	47R	R805	Chip Resistor
2	R2, R3	4R7	R603	Chip Resistor
1	R4	3M3	R603	Chip Resistor
1	R8	10M	R805	Chip Resistor
1	R9	1k	R805	Chip Resistor
1	R10	560k	R805	Chip Resistor
1	J13	2 pol.	ST/254_2	Connector for power supply (combined with J22)
1	J22	7 pol.	ST/254_7_1 R	Connector for SPI interface (combined with J13)
1	J20	2 pol.	ST/254_2	Jumper for current measurement of Vcc
1	LJ2	3 pol.		Solder bridge to select between SPI & UART

### 7 Miscellaneous

### 7.1 Literature Guide

#### Datasheets

Title	Document-No.
TDC-GP30 Datasheets	DB_GP30_Vol1.en
	DB_GP30_Vol2.en
Development kits	DB_GP30-DEV_en

#### **Application Notes**

Title	Document-No.

The latest versions of the available documents can be downloaded from the acam website at:

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

### 7.2 Last Changes

18.03.2015 First release







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