本资料所涉及产品主要应用于
■温湿度 ■水表 ■热表 ■气表
■液位计 ■压力变送器

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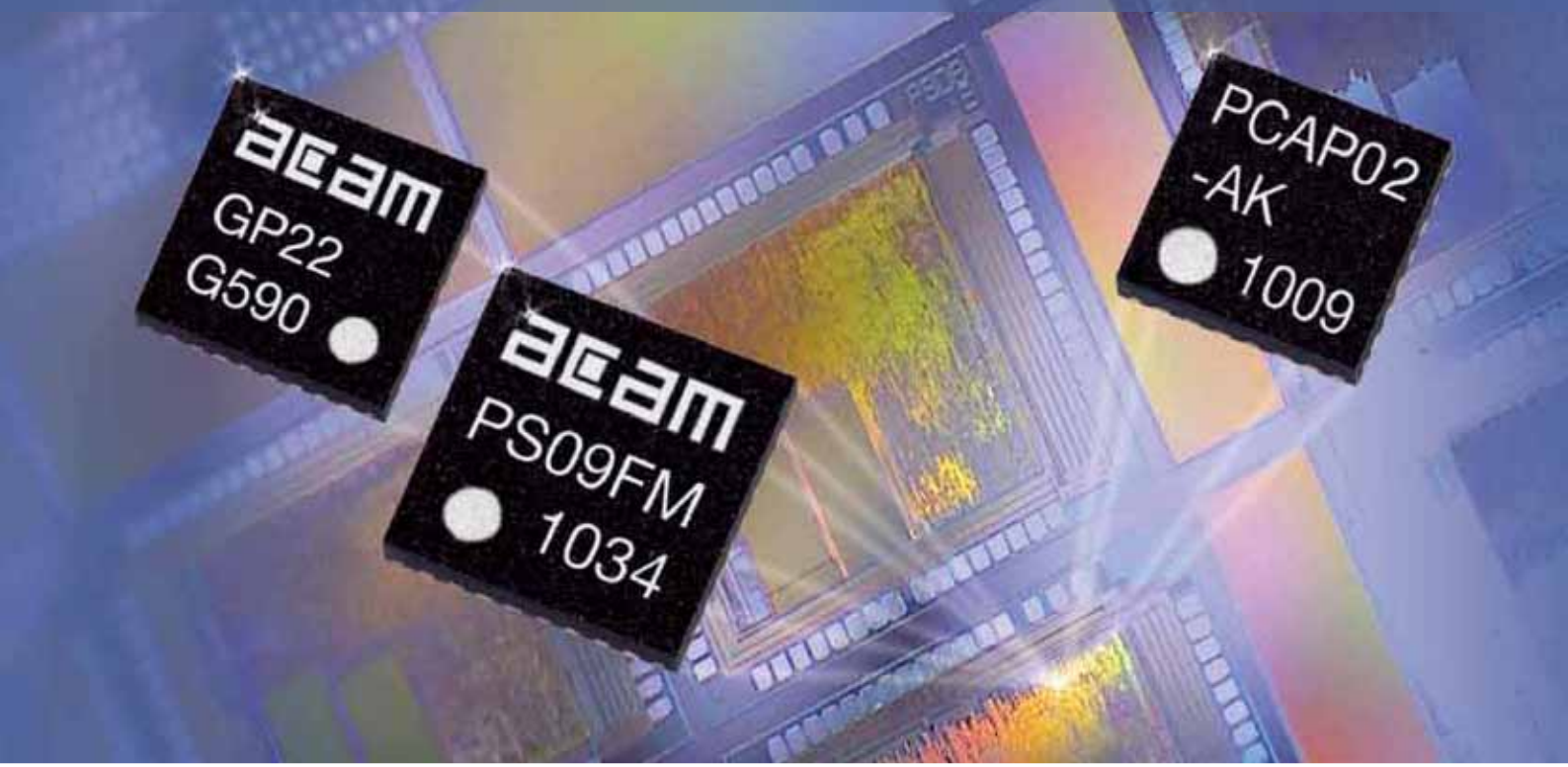
Microchip solutions for your measurement application



TDC **UFC** **PICOCAP®** **PICOSTRAIN®**

Product Overview

Chip Products

acam - messelectronic

acam - the company

Since its founding in 1996, acam has continued to invent integrated circuits and system solutions based on picosecond time-interval measurement. The aim is to provide innovative solutions with added value to customers by means of novel technical concepts. The key to acam's products is ultra-precise time interval measurement in terms of Time-to-Digital Converters (TDC).

In this field, acam developed its core technology over many years, integrating digital measuring circuits in standard CMOS technology that meet an extremely high degree of precision, measurement rate, power savings and compactness. The universal applicability of time measurement opens a wide market for such circuits.

Time-to-Digital Converters

acam's focus is on measuring tasks that require a resolution down to a few picoseconds. While a standard counter needs several hundred gigahertz, acam's products work with low and medium range reference clocks and are easy to use for the customer. acam offers the full range from low-cost ICs for industrial mass production through high-end ICs to full system solutions. The use of pure digital circuit design makes it easy to adapt the TDC to different measurement tasks. Accordingly, acam's strong core competence is the development of customized TDC's which are tailored to the specific measurement requirements of the customer. acam's TDCs are used in industrial, biomedical and scientific products.

Ultrasonic Flow Converters

Ultrasonic flow meters for heat, water and gas are getting more popular. From the beginning acam TDC products successfully solved the time-of-flight measurement task in those applications. With the UFC family acam provides advanced solutions that extend the pure time measurement functionality. In the UFC devices all major elements of the ultrasonic front end electronics are integrated. In the end, this family will grow to converters that offer calculated flow information as final result.

PICOCAP

Capacitive sensors cover a wide field of applications, from MEMS acceleration sensors to humidity sensors to touch key sensors. The range of applications for these converters is very diverse. With PICOCAP acam offers a family of capacitance-to-digital converters that can be seen an all-in-one solution. PICOCAP devices offer the highest flexibility in the market with respect to capacitance range, resolution, speed and power consumption. The patented compensation method guarantees a high level of measurement quality and stability. The integrated processor and memory allow on-chip signal conditioning as it is needed in compact sensor solutions.

PICOSTRAIN

Time measurement also covers precision resistance measurement as required in all weight and force measurement applications based on metal strain gages. The award-winning PICOSTRAIN technology impressively demonstrates the advantages of the time-based measurement principle for strain gages compared to classic analog solutions. Outstanding features of resolution, temperature stability and especially low current consumption empower the customer to develop new products that were not possible before.

PICOTURN

Rotational speed sensing. Please see separate documentation.

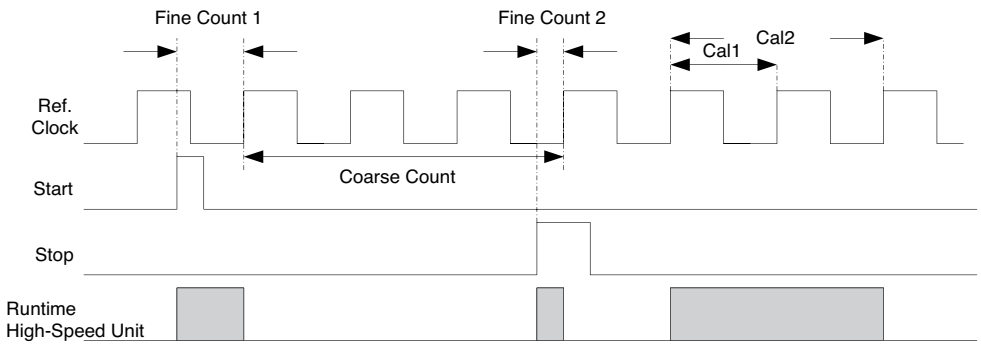
Product Overview

1.1 Time-to-Digital Converters (TDC)

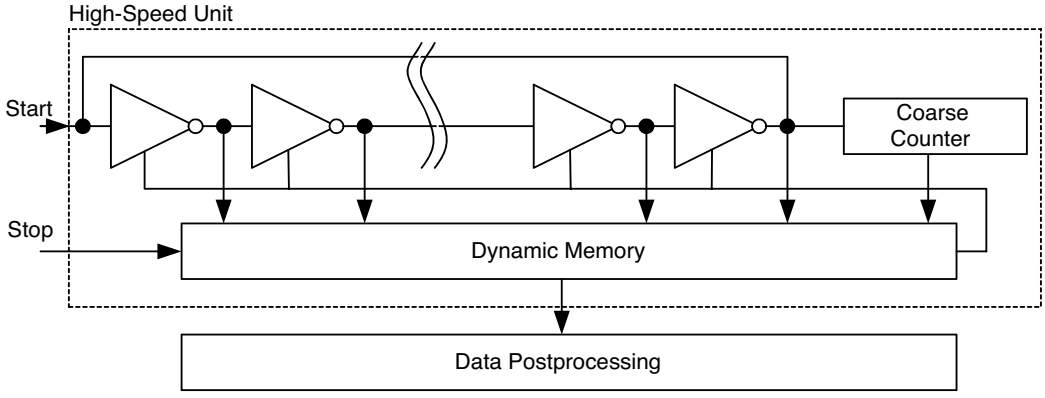
More and more applications are based on measuring time intervals with very high precision. The required resolution in time-of-flight measurements is often less than 1 ns, in many applications even only a few picoseconds. Applications are found in the industrial, automotive, medical, and scientific markets. Those customers demand economically attractive solutions that combine precision, compactness, competitive pricing, and commercial availability.

The Time-to-Digital Converters (abbreviated to TDC) from acam offer the ideal platform for these systems. The all-digital integrated circuits are based on buffer delay times and can be manufactured using standard CMOS process technologies. Compensation methods for temperature and voltage variation guarantee high stability and repeatability. In comparison to analog measurement methods, the main advantages of digital TDCs are high measurement rates, excellent pulse-pair resolution, and low power dissipation.

The basic timing principle is to use an array of buffer delays. Intelligent circuit structures, redundant circuitry, and special methods of on-chip layout permit reconstruction of the exact number of gates that a signal passes through. The maximum possible resolution strongly depends on the minimum possible gate propagation delay on the chip. The measuring device is actuated by a START signal and stopped by a STOP signal. Based on the position of the ring oscillator and the coarse counter, the time interval between START and STOP is calculated. The temperature and voltage dependencies of the buffer delays can be corrected in two ways, both using an external reference clock in the range of 1 to 40 MHz. The first is calibration, which means that the TDC automatically measures two periods of the reference clock and internally calculates the calibrated time measurement result. The second is resolution-adjust mode where the voltage of the measurement core is regulated to maintain the stability of the resolution.



Time = Tref x (Cc + (Fc1 - Fc2)/(Cal2 - Cal1))



acam offers a spectrum of off-the-shelf standard and high performance TDCs that can solve a wide range of measurement tasks. The digital measurement unit allows the use of most modern CMOS technologies and offers high flexibility in design.

With acam's many years of experience in the design of TDCs and TDC based system-on-chip solutions, we are able to solve almost every application.

Time-to-Digital Converters Overview

Integrated Circuits					
Product	**Part No.**	**Package**	**Standard Pack Quantity**	**Package Carrier**	**Description**
TDC-GP1*	278	TQFP44	160	Tray	2-channel TDC with 125/250 ps resolution, 250 ms maximum range, 1 MHz maximum data rate
TDC-GP2**	1058 1480	QFN32	240 2000	Tray T&R	2-channel TDC 65 ps resolution, 4 ms range, temperature measuring, fire pulse generator
TDC-GP22	1950 1949	QFN32	5000 490	T&R Tray	2-channel TDC with 90 ps resolution, 45/22 ps on 1 channel, 4 ms range
TDC-GPX TDC-GPX -FG	975 1089	TQFP100 TBGA120	90 250	Tray Tray	2-channels with 10/27/41 ps resolution, 8-channels with 81 ps resolution, endless range, 200 MHz peak / 40 MHz continuous data rate
Evaluation Systems					
Product	**Part No.**	**Description**			
ATMD-GPX PCI-System	1532	Evaluation system based on TDC-GPX, including a AM-GPX module, PCI-interface, cables and software			

* Not for new designs ** TDC-GP22 preferred for new designs

ATMD System

1.2 TDC-GP1

General Description

The TDC-GP1 is a universal 2-channel multi-hit Time-to-Digital Converter. It is the first TDC from acam and it is still in production, but not recommended for new designs. The TDC-GP1 can be operated in calibrated mode or resolution-adjust mode, both offering results that are stable with temperature and voltage variations. Four additional ports offer the capability to measure capacitances, resistances, inductances. The TDC-GP1 represents a proven solution for a wide range of applications.

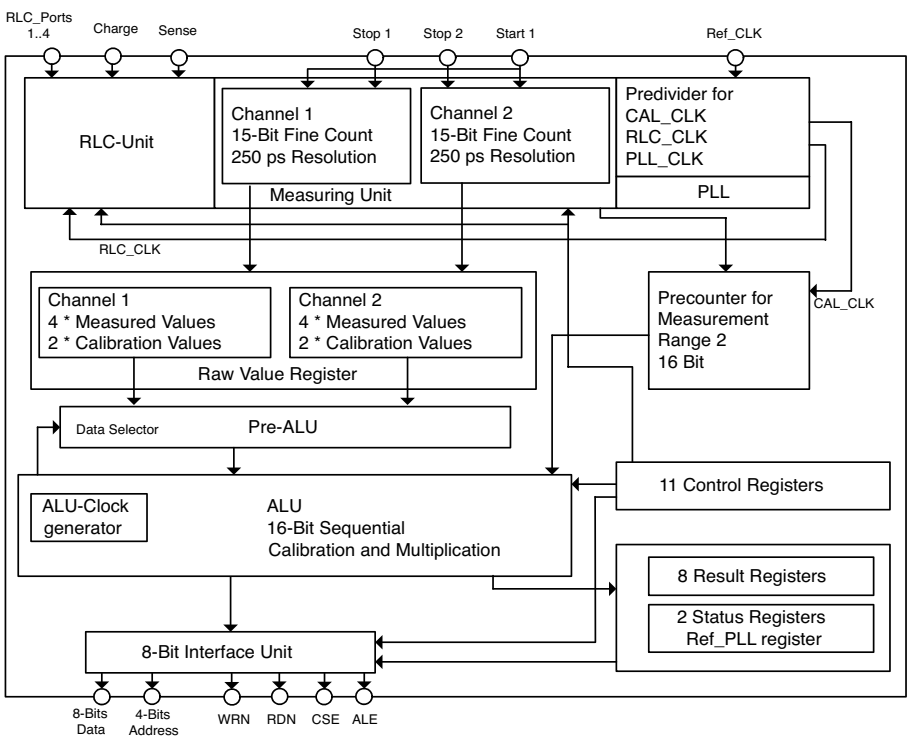
Applications: Laser distance measurement, Positioning systems and ToF spectroscopy.

Features

- Resolution-adjust mode: quartz-accurate adjustment of resolution
- 4 ports for the measurement of resistance, inductance, or capacitance
- Programmable edge sensitivity
- Stop enable pins
- Reference clock input from 500 kHz to 35 MHz (100 MHz with internal predivider)
- Operating voltage : 2.7 V to 5.5 V
- Industrial temperature range: - 40°C to + 85°C
- TQFP44 package

Mode	Channels	Resolution	Range	No. Of Hits
Measure range 1	2 1	250 ps 125 ps 15 ns pulse-pair	3 ns to 7.7 µs 3 ns to 3.8 µs	2 x 4, 1 x 8 1 x 4
Measure range 2	1	250 ps/125 ps 60 ns pulse-pair	60 ns to 200 ms	1 x 4 1 x 3
Resolution adjust mode	2 1	250 ps 125 ps 15 ns pulse-pair	-3.8 µs to 3.8 µs 15 ns to 1.9 µs	1 x 4 1 x 3

Block Diagram



1.3 TDC-GP2

General Description

The TDC-GP2 is the second generation of acam general-purpose TDCs. Higher resolution and smaller package size make it ideal for cost-sensitive industrial applications. With special function blocks like a fire pulse generator, stop enable, temperature measurement, and clock control, it was designed for flowmeter and heat meter applications. For new designs we recommend TDC-GP22.

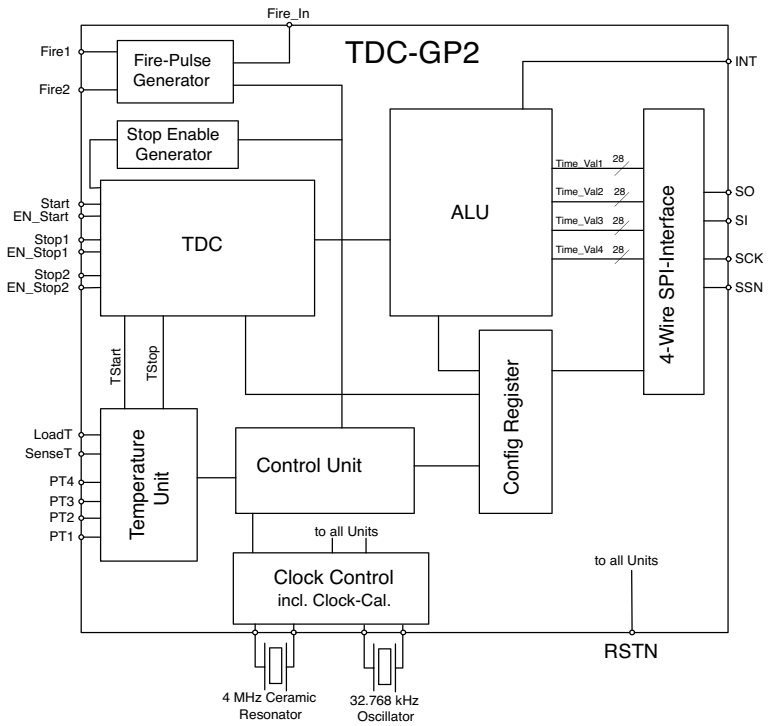
Applications: Ultrasonic heat meters, Ultrasonic flow meters, Laser range finders, Laser scanners, Magnetostrictive positioning, ATE

Features

- Max. 1 MHz continuous data rate
- 4 wire SPI interface
- Voltage I/O 1.8 V to 5.5 V, Core 1.8 V to 3.6 V
- Temperature range - 40°C to +125°C
- QFN 32 package

Mode	Channels	Resolution	Range	No. Of Hits
Measure range 1	2 1	65 ps (50 ps rms) 15 ns pulse-pair	0 ns to 1.8 µs	2 x 4
Measure range 2	1	65 ps (50 ps rms) 500 ns pulse-pair	500 ns to 4 ms	1 x 3
	Specials: Precise stop enable by windowing, Clock calibration unit, fire pulse generator			
Temperature	4	16 bits (0.004°C with PT)	Pt500, Pt1000	

Block Diagram



1.4 TDC-GPX

General Description

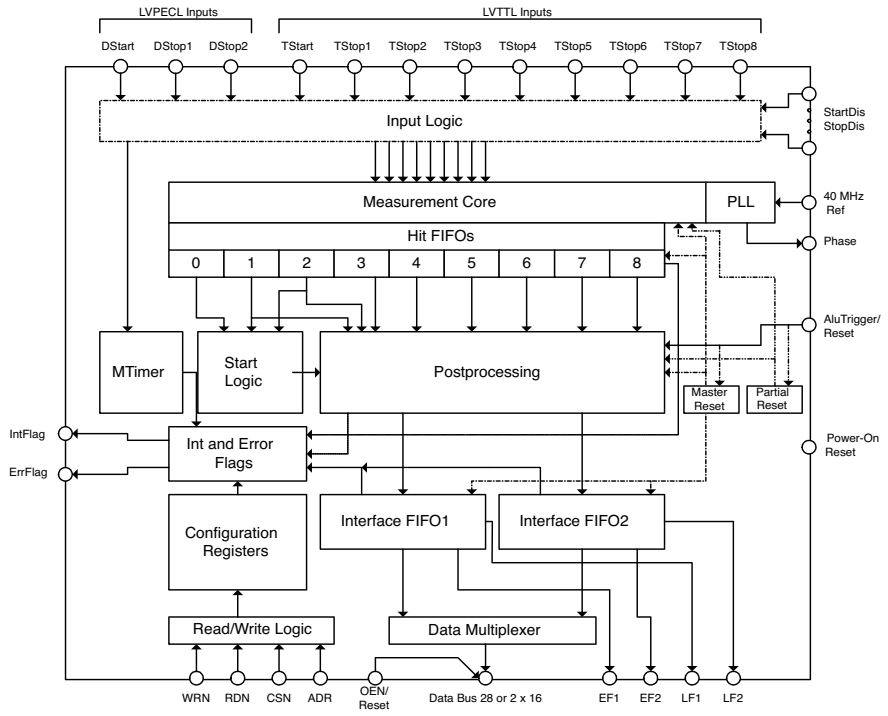
The TDC-GPX is the most powerful member in our TDC family. With its multifunctional architecture, especially designed for applications where high single-shot resolution, best pulse-pair resolution, and high measurement rates are required, the TDC-GPX realizes a huge step forward in time measurement based on TDCs.

With 4 different operation modes, 8-channels with 32-fold multi-hit capability and a resolution down to 10 ps make the TDC-GPX perfectly suited for industrial and scientific applications where the highest performance and precision are demanded.

Features

- Resolution down to 10 ps rms
- 40 MHz data rate per chip, 200 MHz peak rate
- 5.5 ns pulse pair resolution
- LVTTL/LVECL inputs
- Optional quiet mode for noise reduction in R,G, and M-Mode
- Rising and/or falling edge sensitivity
- Start-retrigger option
- 28-bit asynch. parallel data bus (opt. 2 x 16-bit) with Chipselect, Readstrobe, Writestrobe
- 4-bit address range
- I/O voltage 3.0 V to 3.6 V
- Core voltage 2.4 V to 3.6 V
- Temperature range Tj -40°C to +125°C
- TQFP100, TFBGA120 packages

Block Diagram

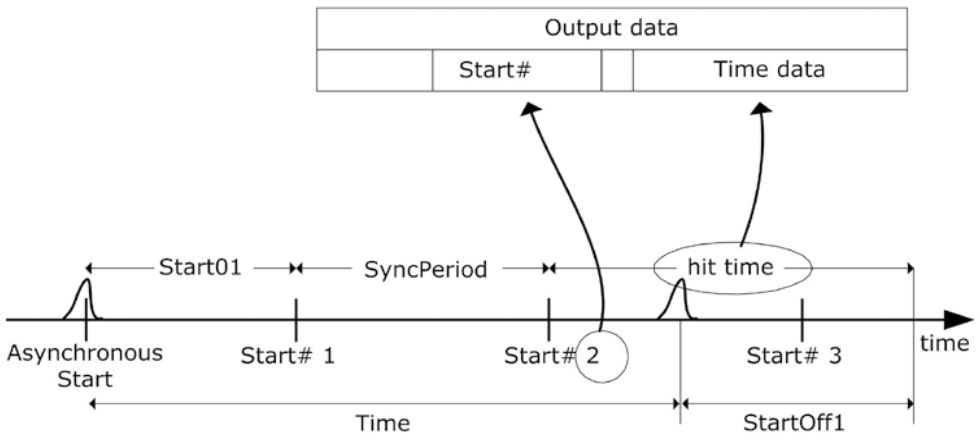


Applications

- Laser scanners
- Time-of-flight spectroscopy
- Time-of-flight measurement
- Biomedical technology
- Automated test equipment (ATE)

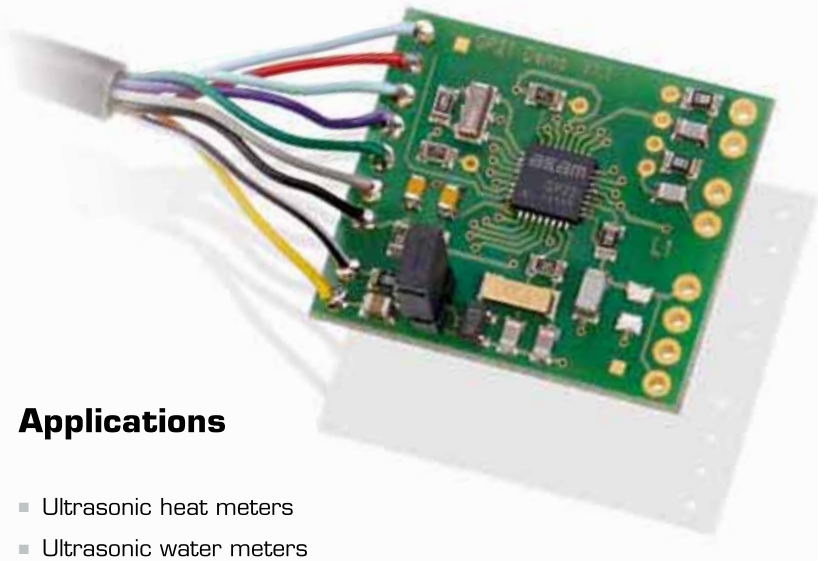
Mode	Channels	Resolution	Max. Rate	Range	No. of Hits
I-Mode	8	81 ps	Stop: 10 MHz/ch. (200 MHz peak) Start: 7 MHz	0 ns to 9.4 µs or unlimited	≥ 32
G-Mode	2	41 ps	Stop: 20 MHz/ch. (200 MHz peak) Start: 5 MHz	0 ns to 64 µs	≥ 32
R-Mode	2	27 ps	Stop: 40 MHz/ch. (200 MHz peak) Start: 9 MHz	0 ns to 40 µs	≥ 32
M-Mode	2	10 ps rms	Stop: 500 kHz/ch. Start: 500 kHz	(0) to 10 µs	1

Extended Measurement Range in I-Mode



2.1 UFC – Ultrasonic Flow Converters

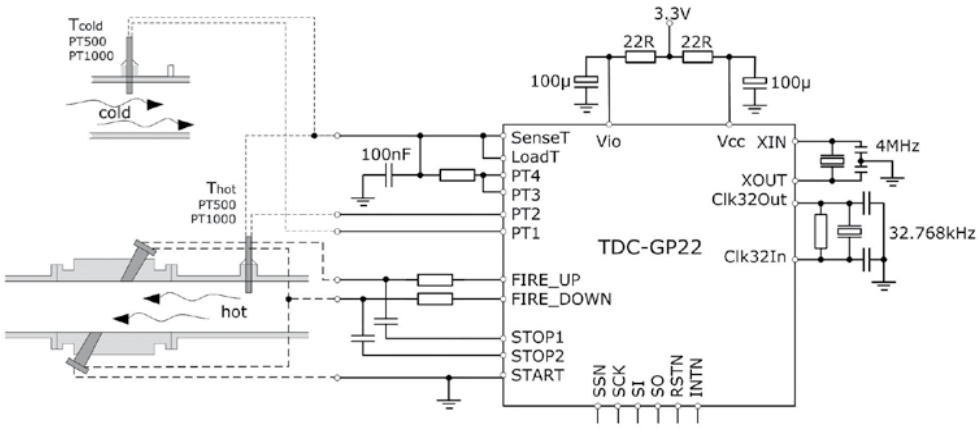
Ultrasonic flow meters for heat, water and gas are getting popular. From the beginning acam TDC products successfully solved the time-of-flight measurement task in those applications. With the UFC family acam provides solutions that extend the pure time measurement functionality. The flow measurement part of the electronics can be designed in a very compact manner as the main elements of the analog frontend like comparator and temperature measurement are already integrated into the UFC. With products like TDC-GP22 a major task in ultrasonic flow metering is easily solved. The time-of-flight measurement precision is better than 100 ps rms, which is needed for small and compact instruments. The current consumption can be as low 2 µA at 1 Hz update rate, or only 12 µA at 10 Hz update rate. Battery life easily reaches 10 years. The offset stabilized comparator guarantees a high stability of the result over a wide temperature range. Finally, with special features like first-hit detection and amplitude monitoring it is very easy for the user to handle the various operating conditions in ultrasonic flow meters.



Applications

- Ultrasonic heat meters
- Ultrasonic water meters
- Industrial flow indicators
- Ultrasonic gas meters
- Ultrasonic density meters

Block Diagram



Ultrasonic Flow Converters Overview

Integrated Circuits					
Product	**Part No.**	**Package**	**Pack Quantity**	**Package Carrier**	**Description**
TDC-GP21	1720 1839	QFN32	5000 490	T&R Tray	25 ps TDC with analog frontend for ultrasonic flow metering, including fire puls generator, offset stabilized comparator and analog switches
TDC-GP22	1950 1949	QFN32	5000 490	T&R Tray	25 ps TDC with analog frontend for ultrasonic water meter, additional first-hit detection and pulse width measurement

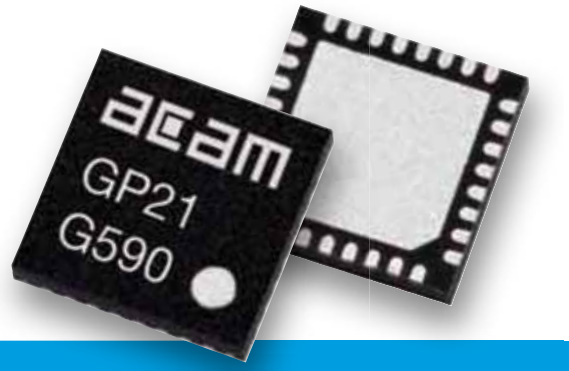
Evaluation Systems		
Product	**Part No.**	**Description**
GP22-EVA-KIT	1951	Evaluation system for TDC-GP22 and TDC-GP21, including a universal test board, the PICOPROG interface, cables and software.
GP22-DEMO-KIT	1979	Evaluation system for TDC-GP22 in ultrasonic flow meter applications, including a compact and optimized front end board, the PICOPROG interface, cables and software.

Evaluation Kit

2.2 TDC-GP21/TDC-GP22

General Description

TDC-GP21 and follower TDC-GP22 offer pin-to-pin and functional compatibility to TDC-GP2, adding new features and several improvements. Analog elements like a chopper stabilized comparator and analog switches simplify the external circuits of ultrasonic flowmeters significantly. In parallel, measurement quality is improved and operating current is reduced.
The fire pulse generator is extended, a new low-power 32 kHz oscillator driver is implemented and the temperature measuring unit is further improved. All in all, the TDC-GP21/GP22 is perfectly suited to design ultra-compact and low-cost ultrasonic flow meters and heat meters.



Features

Measure Mode 2

- 1 channel with typ. 90 ps resolution
- Double resolution mode with 45 ps, quad resolution mode with 22 ps resolution
- Measurement range 500 ns to 4 ms
- 2 x CLKHS pulse-pair resolution with 3-fold multihit capability
- Each of the 3 events can be assigned an adjustable measuring window with 10 ns resolution

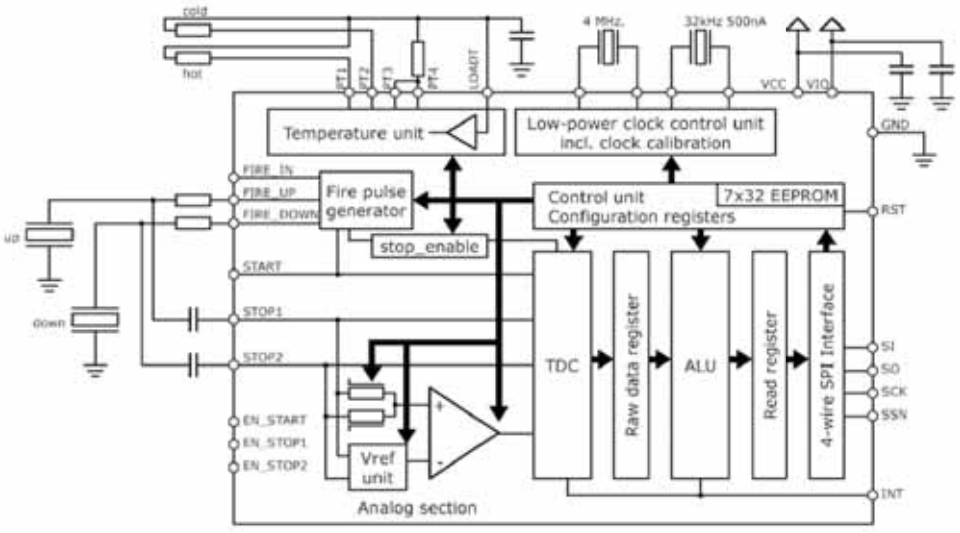
Analog Input Circuit

- Chopper-stabilized comparator with low offset drift
- 2 analog switches for up/down input selection
- External circuit is reduced to 2 resistors and 2 capacitors

TDC-GP22 Specials

- First-Hit detection
- Pulse width measurement
- Bubble and empty tube detection

Block Diagram



Special Functions

- Fire pulse generator, up to 127 pulses
- Trigger to rising and/or falling edge
- Precise stop enable by windowing
- Low-power 32 kHz oscillator (500 nA)
- Clock calibration unit

Temperature Measurement Unit

- 2 or 4 sensors, 2-wire connection
- PT500/PT1000 or higher
- Schmitt trigger integrated
- Very high resolution: 16 bit eff. (0.004°C resolution for platinum sensors)
- Ultra low current (0.08 µA when measuring every 30 seconds)

Measure Mode 1

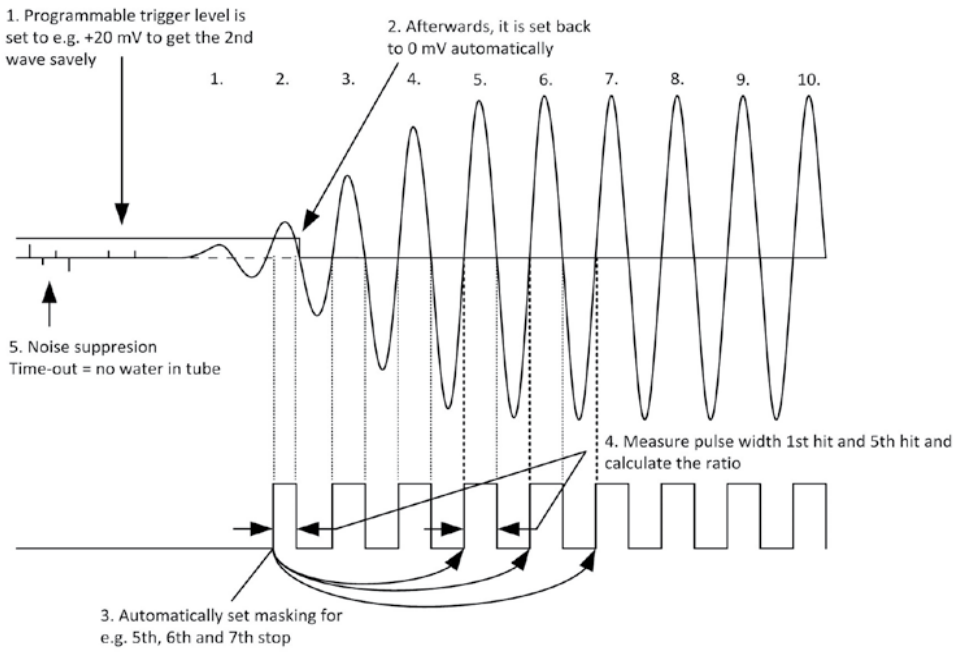
- 2 channels with typ. 90 ps resolution
- 1-channel double resolution with typ. 45 ps
- Range 3.5 ns (0 ns) to 2.5 µs
- 22 ns pulse-pair resolution, 4-fold multihit

General

- 4-wire SPI interface
- 1 MHz continuous data rate max. in mode 1
- I/O voltage 2.5 V to 3.6 V
- Core voltage 2.5 V to 3.6 V
- Temperature range - 40°C to +125°C
- Available in QFN32 package

Mode	Channels	Resolution	Range	No. of Hits
Measure Mode 1	2	45 / 90 ps	0 ns to 2.4 µs	2 x 4
Measure Mode 2	1	22 / 45 / 90 ps	500 ns to 4 ms	1 x 3
Temperature	4	16 bits	PT500, PT1000 or higher	

First Hit Detection



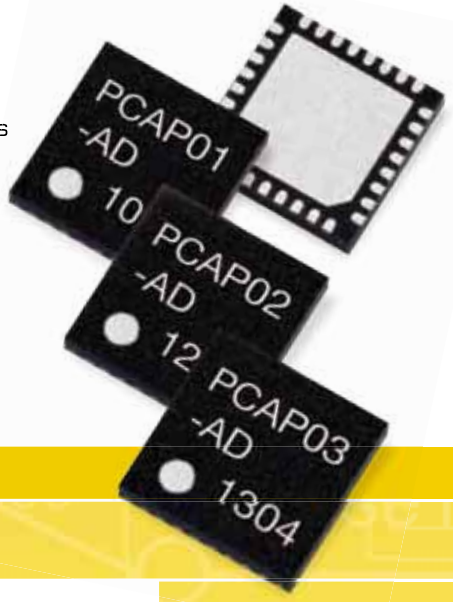
3.1 PICOCAP – Capacitance-to-Digital Conver

The patented PICOCAP measuring principle is a versatile approach to capacitance measurement. There is practically no limit for the capacitor value since the device covers a capacitance input range from a few fF up to several hundred of nF. It allows for easy configuration for various requirements and can be used with a broad range of sensors. The PICOCAP chips are suited for applications with low current consumption (a few µA) as well as applications that require the highest precision (up to 22 bits) or applications requiring high update rates (up to 500,000 measurements per seconds).
The fully-programmable internal 48-bit DSP gives the capability to perform high level processing of the data collected, e.g. to do an on-chip sensor linearization.

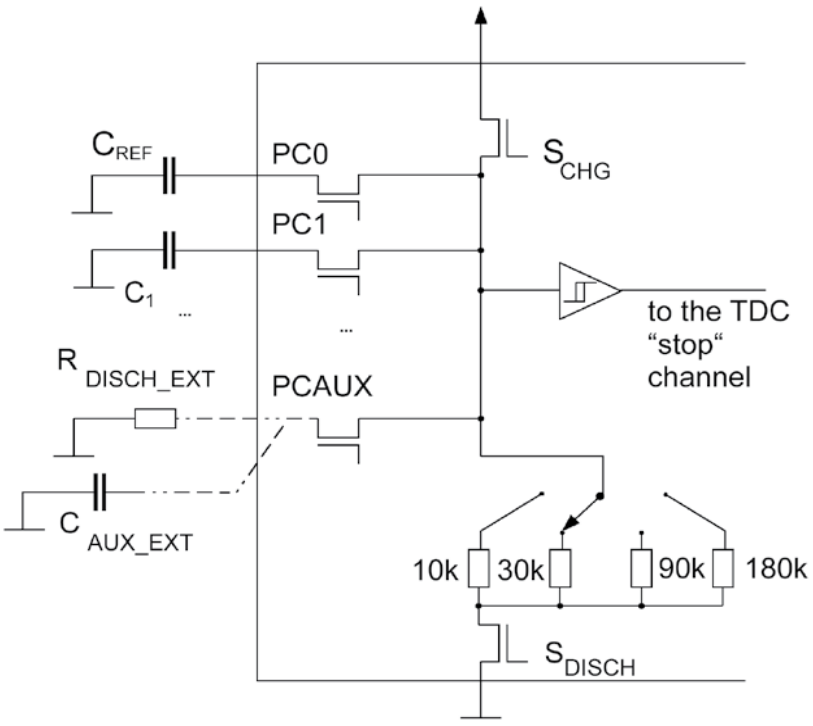
Measurement principle: PICOCAP transforms the capacitance measurement into a precision time interval measurement. For this purpose, the sense capacitors and a reference capacitor are connected to a resistor, forming a low-pass filter (see picture below). The capacitors are charged to the supply voltage and then discharged through the resistor alternating between the reference capacitor and the unknown capacitor. The discharge times are measured with a high precision time-to-digital converter (TDC). The ratio of the capacities is given by the ratio of discharge times. Patented algorithms provide an excellent suppression of parasitic capacities and ensure very good temperature stability.

Applications

- Humidity sensors
- Dew-point sensors
- Pressure sensors
- Inertial and motion sensors
- MEMS
- Fill level sensors
- Proximity switches
- Free-fall sensors
- Touch sensors
- Combo sensors



Measuring Principle



PICOCAP Products Overview

Integrated Circuits					
Product	**Part No.**	**Package**	**Pack Quantity**	**Package Carrier**	**Description**
PCapØ1A	1613	Dice	100 221	Tray	Capacitance-to-Digital Converter for up to 8 capacitors 5 GPIO
PCapØ1AD	1793	QFN32	490 6000	Tray T&R	Capacitance-to-Digital Converter for up to 8 capacitors 5 GPIO
PCapØ1AK	1795	QFN24	92 5000	Tray T&R	Capacitance-to-Digital Converter for up to 8 capacitors 3 GPIO
PCapØ2A	2001	Dice	100	Tray	Capacitance-to-Digital Converter for up to 8 capacitors 5 GPIO
PCapØ2AE	2039	QFN32	490 6000	Tray T&R	Capacitance-to-Digital Converter for up to 8 capacitors 5 GPIO
PCapØ3A*	2063	Dice		Tray	Capacitance-to-Digital Converter for up to 6 capacitors 5 GPIO
PCapØ3AE*	2066	QFN32	490 6000	Tray T&R	Capacitance-to-Digital Converter for up to 6 capacitors 5 GPIO
Evaluation Systems					
Product	**Part No.**	**Description**			
PCapØ1-EVA-KIT	1912	Evaluation system for PCapØ1 including PICOPROG and evaluation software			
PCapØ2-EVA-KIT	2055	Evaluation system for PCapØ2 including PICOPROG and evaluation software			
PCapØ3-EVA-KIT**	2075	Evaluation system for PCapØ3 including PICOPROG and evaluation software			

* Series available in Q1/2014
** Available in Q4/2013

Overview

	Meas. range (pF-nF)	Max. channels[1]	DSP	Lowest noise[2]	Parameter EEPROM	Improved MEMS excitation[3]	Integrated reference cap	LF osc.[4]	HF osc.[5]
	✓	8	✓	✓	⊘	⊘	⊘	✓	⊘
	✓	8	✓	⊘	✓	✓	✓	✓	✓
	✓	6	✓	✓	✓	✓	✓	✓	✓

[1] In single grounded mode, includes reference cap.
[2] RMS noise < 10 aF
[3] Possibility to charge MEMS sensor in several stages to avoid ringing effect
[4] LF = low frequency oscillator, typically 50 kHz
[5] HF = high frequency oscillator, typically 4 MHz

3.2 PCapØ1

General Description

PCapØ1 – the first generation of the PICOCAP series – is not only a capacitance-to-digital converter but a complete frontend solution due to the integrated digital signal processor (DSP) and the various interface options. It offers a high degree of flexibility and can be configured to fit the various requirements of capacitive sensing. The sensor data can be linearized and filtered on-chip and the results are communicated via digital interfaces (SPI or IIC) or dedicated IOs for PWM/PDM signal output.

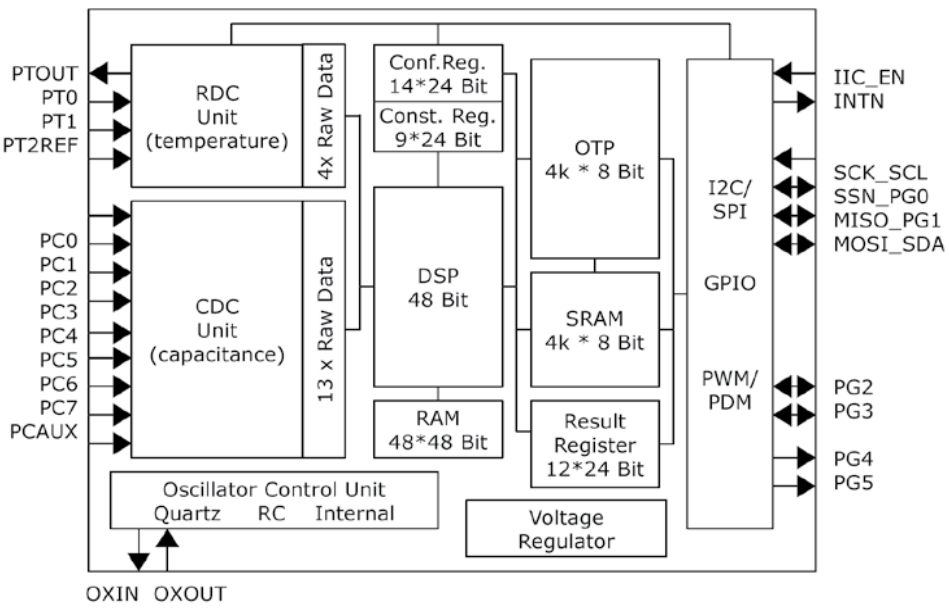
Features

- Digital measuring principle in CMOS technology
- Up to 8 capacitances in grounded mode
- Up to 4 capacitances in floating mode (potential free and with zero bias voltage)
- Several compensation modes available
- High resolution:
  - 4 aF or 21 bits at 2 Hz and 10 pF base capacitance
  - 25 aF or 22 bits resolution at 2 Hz, 100 pF base capacitance
- High measurement rate: up to 500 kHz
- Extremely low current consumption: As low as 4.0 µA at 3 Hz with 12.2 bits resolution
- High temperature stability (low gain and offset drift)
- Internal temperature measurement (25 mK resolution) or dedicated ports for precision temperature measurement with Pt1000 sensors (5 mK resolution)
- RISC processor core using Harvard architecture
- 4 k x 8 bit volatile program memory (SRAM) for high-speed operations (40 to 100 MHz)
- 4 k x 8 bit non-volatile (OTP) program memory for normal speed operations (up to 40 MHz)
- Self-boot capability
- SPI, I²C compatible interfaces
- Single power supply (2.1 V to 3.6 V)
- QFN24, QFN32 package or dice

Applications

- Mid to high-end pressure sensors
- MEMS
- Fill level sensors

Block Diagram



General Description

The PCapØ2 offers – like its predecessor PCapØ1 – a high degree of flexibility but with additional features. The advantages of the patented PICOCAP concept are still prevalent, for example the wide input range or the manifold configuration possibilities for high resolution or low current or a high measurement rate. On top of that, a number of new features have been added, e.g. the internal reference capacitance to save external components or the newly added EEPROM for storing user calibration data. Further, improvements for the operation with humidity and MEMS sensors have been made.

New Features with PCapØ2

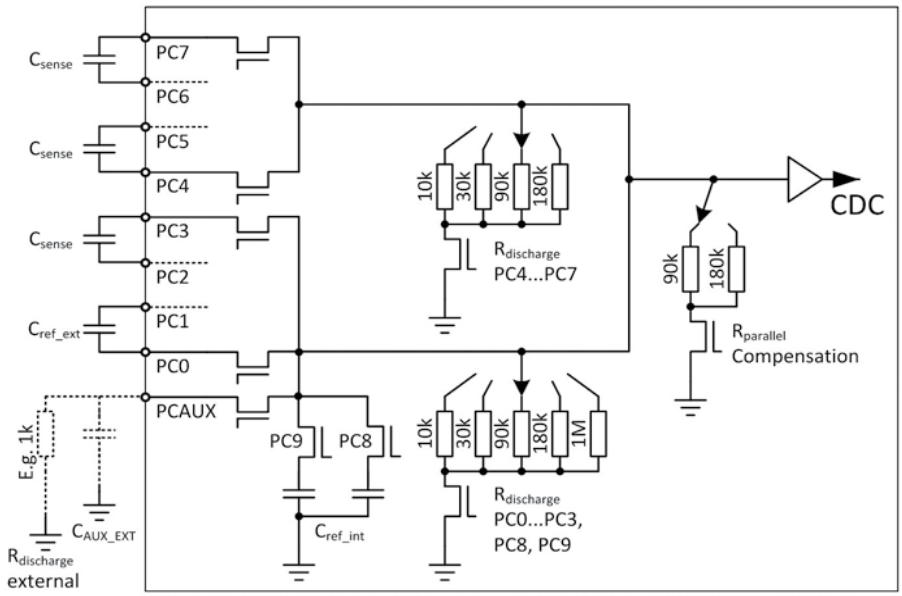
- High resolution
  - 23 aF or 18.7 bits at 5 Hz and 10 pF base capacitance
  - 650 aF or 17.1 bits at 5 Hz and 100 pF base capacitance
- Extremely low current consumption: As low as 2.5 µA at 3 Hz with 13.1 bits resolution
- Serial peripheral interface (SPI compatible), now with multi-slave capability
- Inter-Integrated Circuit Interface (I2C compatible), now with auto-increment
- Integrated reference capacitor (1pF to 31pF)
- Enlarged set of discharge resistor up to 1 MOhm (for humidity sensors)
- Two internal discharging resistor sets to operate two different sensors (Combo sensors)
- Pre-charge option for slow charging to reduce mechanical stress (for MEMS sensors)
- Integrated low-power clock and high-speed oscillator
- Self-test capability for differential sensors (for e.g. MEMS)
- Integrated 128 bytes EEPROM for calibration data
- PDM and PWM output up to 16 bits
- QFN32 package or dice

Applications

- Humidity sensors
- Dew-point sensors
- MEMS
- Fill level sensors
- Combo sensors

New Feature

Two group of ports to accommodate combo sensors



3.4 PCapØ3

General Description

PCapØ3 is the latest release of the PICOCAP series and will set new performance standards in capacitance measurements. This performance refers particularly to the low-noise PCapØ3 can offer combined with a significantly increased overall stability of the measurement results. All the new features introduced with PCapØ2 are also available with PCapØ3. The main difference between PCapØ2 and PCapØ3 is the reduced number of channels (from 8 to 6) due to the optimized layout to reach superior noise performance. These features make PCapØ3 perfectly suitable for high-end applications, e.g. high-end pressure sensors or combo-sensors with sensors of different capacitance ranges.

Engineering samples: Available
Full production: Q1/2014

New Features with PCapØ3

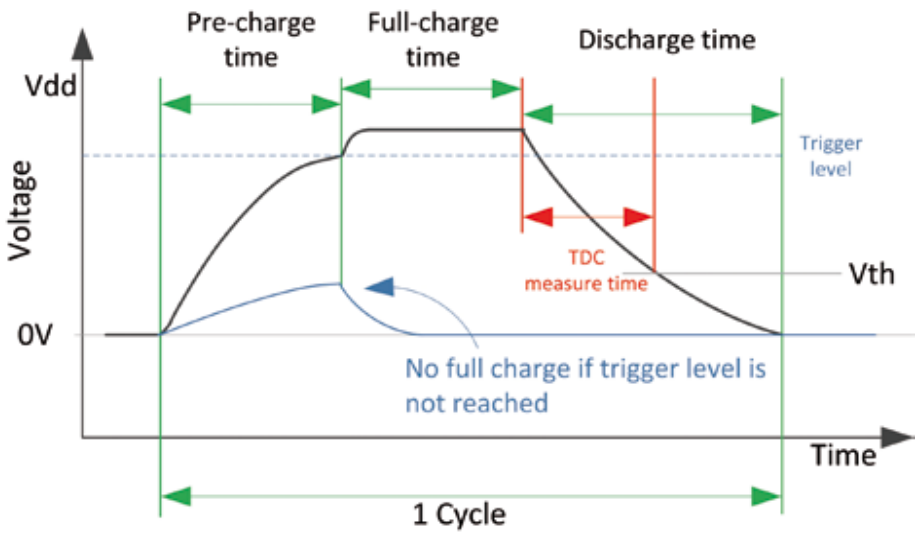
- Up to 6 capacitances in grounded mode
- Up to 3 capacitances in floating mode (potential free and with zero bias voltage)
- High resolution
  - 8 aF or 20.2 bits at 3 Hz and 10 pF base capacitance
  - 390 aF or 14.6 bits at 9 kHz and 10 pF base capacitance
- Very good long-term stability
- Active guarding for proximity switches

Applications

- High-end pressure sensors
- Inertial and motion sensors
- MEMS
- Fill level sensors
- Proximity switches
- Free-fall sensors
- Touch sensors
- Combo sensors

New feature

Programmable charging time (useful for e.g. MEMS sensors)



3.5 PCap EVA-KITS

General Description

There is no faster way to get started with PICOCAP than with the dedicated evaluation kits. The evaluation kits allows quick and easy evaluation of the PICOCAP chips by offering a plug-and-play module with corresponding software for Microsoft Windows® operating systems. A kit consists of a base module, a plug-in module with the PCap-chip on it, a programmer called PICOPROG to connect the board to the PC and the evaluation software to run the evaluation-kit.

This evaluation kit can also be used as full development platform when using the Assembler software to program application specific firmware for the DSP.

Evaluation Systems		
Product	**Part No.**	**Description**
PCapØ1-EVA-KIT	1912	Evaluation system for PCapØ1 including PICOPROG and evaluation software
PCapØ1 plug-in module	1916	Plug-in module with PCapØ1
PCapØ2-EVA-KIT	2055	Evaluation system for PCapØ2 including PICOPROG and evaluation software
PCapØ2-plug-in module	2056	Plug-in module with PCapØ2
PCapØ3-EVA-KIT*	2075	Evaluation system for PCapØ3 including PICOPROG and evaluation software
PCapØ3-plug-in module*	2076	Plug-in module with PCapØ3 including PICOPROG and evaluation software

* Available in Q4/2013

Evaluation Kit

4.1 PICOSTRAIN – Resistance-to-Digital Con

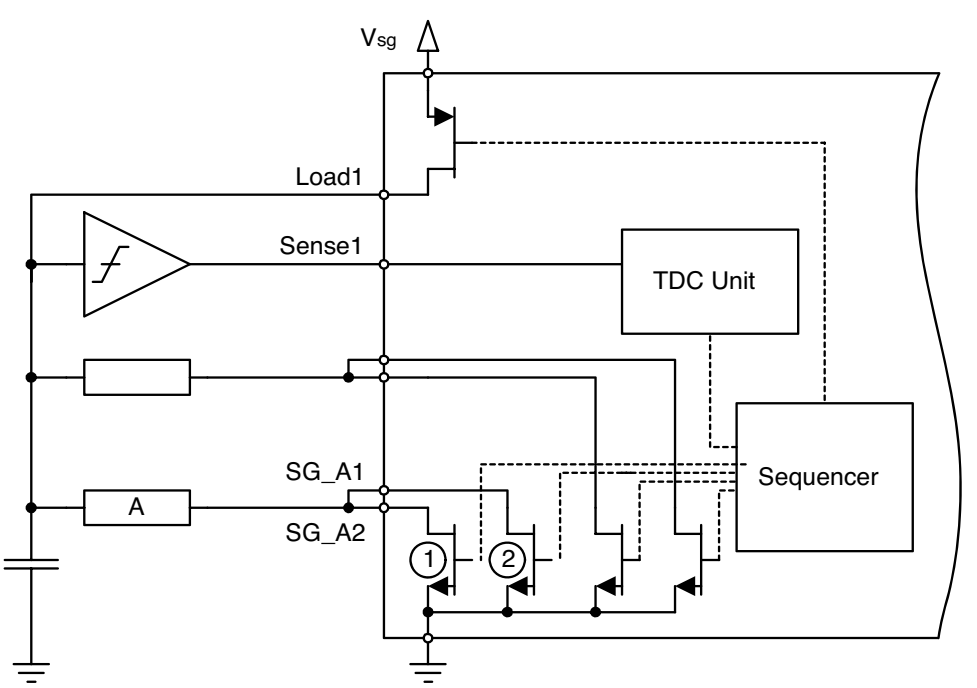
PICOSTRAIN stands for an innovative digital concept to measure resistance. Resistive sensors, for example metal strain gages, change their resistance value with mechanical deformation. The resistance variation is a measure of weight, force or pressure. PICOSTRAIN transfers this variation into a time interval variation, compared to the A/D converter where the variation in resistance is transformed into a variation in voltage.

With PICOSTRAIN, resistors of a half or full bridge are connected to a capacitor, forming a low-pass filter. The capacitor is charged to the supply voltage and then discharged through each of the resistors. The discharge time down to an arbitrary trigger level is measured with ultra-high precision using a TDC (Time-to-Digital Converter).

The ultra-low current consumption, not only of the chip but of the sensor, opens up a wide range of new design options for the customer. Smaller batteries, solar cell, and wireless are the key words that highlight the sensor applications which benefit from PICOSTRAIN.

With this patented innovative measuring principle, PICOSTRAIN devices do not require a full bridge. With the improved performance using PICOSTRAIN, half bridges are sufficient in most applications and our circuits can even measure several half bridges independently. Integrated span and offset correction capabilities can significantly simplify the temperature correction process of the sensor, e.g. in weighing technology load cells' strain gages do not need to be matched or balanced any longer.

Measuring Principle



Applications

The current consumption of the whole system is dramatically reduced compared to typical ADC systems due to the pulsed current into the strain gage. There is also no need for a separate supply for the strain gage and a reference voltage is not required. Additional patented circuits and algorithms compensate for error sources like temperature, the switch-on resistance of the output drivers (Rdson), and the propagation delay of the comparator. The result is very precise measurement, virtually free from gain error and very stable with temperature. The precision achieved with PICOSTRAIN devices is higher than most 24-bit A/D converters and surpasses them at high measurement rates. In combination with the low power consumption, PICOSTRAIN is ideal for all applications that require high measurement rate, high accuracy, as well as portable and battery-driven solutions that require low current consumption.

- Strain gage sensors
- Force sensors
- Pressure sensors
- Torque wrenches
- Digital load cells
- Bathroom scales (solar and battery)
- Kitchen scales (solar and battery)
- Legal for trade scales (OIML, NTEP)

PICOSTRAIN Products Overview

Integrated Circuits

Product	Part No.	Package	Standard Pack Quantity	Package Carrier	Description
PSØ21* PSØ21FN*	1002 1001	TQFP48 QFN48		Tray	Digital amplifier for strain gages. Up to 50 kHz measuring rate.
PSØ81 PSØ81FN	1615 1612	Dice QFN56	140 4000	Waffle pack T&R	System-on-Chip solution for weight scales with MCU, LCD driver, ROM and 2k EEPROM, 21 I/O's
PSØ9 PSØ9FN	1783 1840	Dice QFN40	- 4000	Waffle pack T&R	System-on-Chip solution for weight scales with MCU, ROM and OTP, capacitive switch inputs

Systems

Product	Part No.	Description
PSØ81-EVA-KIT	1525	Evaluation kit for PSØ81 System-on-Chip for weight scales - including baseboard with 3 plug-in modules, programmer, 10 kg load cell, assembler and evaluation software
PSØ9-EVA-KIT	1785	Evaluation kit for PSØ9 System-on-Chip for weight scales - including baseboard with 1 plug-in module, programmer, 10 kg load cell, assembler and evaluation software
PSØ9-DLC-KIT	1927	Evaluation kit for digital load cell, based on PSØ9 - including 10 kg digital load cell, baseboard, programmer, 10 kg load cell, assembler and evaluation software

Modules

Product	Part No.	Description
PSØ81-EVA-STD	1545	PSØ81 Standard plug-in module 2-layer
PSØ81-EVA-HR	1544	PSØ81 High resolution plug-in module 4-layer
PSØ81-EVA-WH	1546	PSØ81 Wheatstone plug-in module 4-layer
PSØ9-EVA-HR	1786	PSØ9 High resolution plug-in module 4-layer
PSØ9-EVA-LC	1921	PSØ9 High low cost plug-in module 2-layer

* Not recommended for new designs

4.2 PSØ81

General Description

PSØ81 is a System-on-Chip for ultra low-power and high resolution applications. It was designed specifically for weigh scales but fits into any kind of force or torque measurement application based on metal strain gages. Taking full advantage of the PICOSTRAIN measurement principle it combines the performance of a 28-bit signal converter with a 24-bit microprocessor. Additional elements like the integrated LCD driver and the 2k EEPROM program memory round out the device. A sophisticated power management in combination with the PICOSTRAIN measurement principle can reduce the total system current down to 15 µA – including the sensor current. Because of the low current the PSØ81 is perfectly suited for battery driven or solar cell driven applications. With maximum 1 million internal divisions (200,000 stable display divisions) the PSØ81 delivers top performance. With PSØ81 it is possible to build legal for trade scales that run with 2 AA batteries for more than 1500 operating hours. Special features like software adjustment of the offset and gain compensation allows the PSØ81 to open the door to new and innovative product solutions.

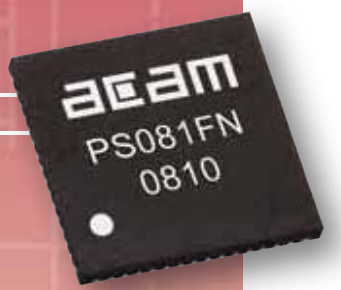
Features

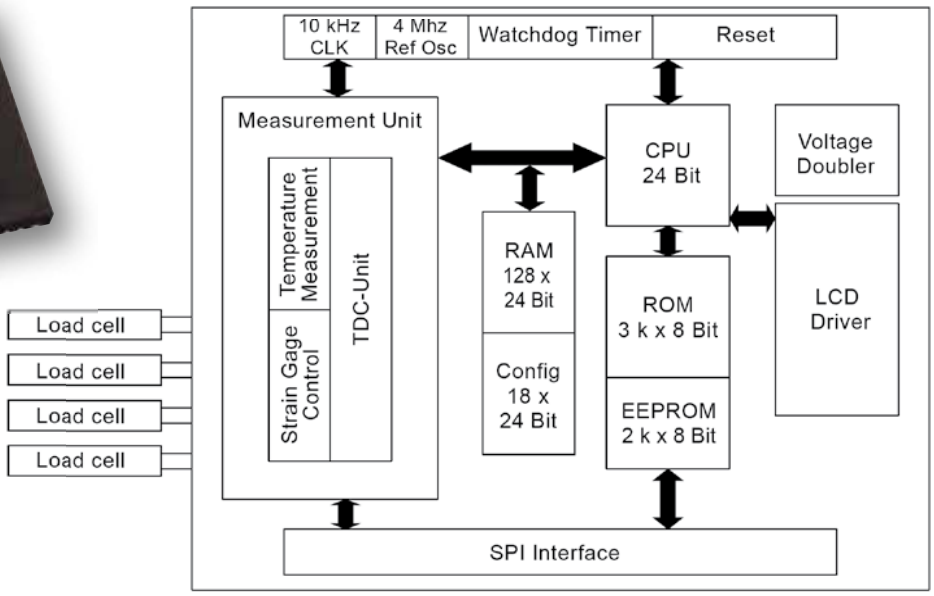
- PICOSTRAIN front end with up to 1 million effective scale divisions (@2mV/V) = 200,000 peak-peak divisions
- 24-bit microprocessor, 2 k 8-bit EEPROM, 3 k x 8-bit ROM
- Embedded very low current 10 kHz oscillator
- Driver for external 4 MHz ceramic oscillator
- Standby current <1 µA, operational current down to 15 µA
- Up to 21 programmable I/O ports
- 4 x 14, 3 x 15, 2 x 16 LCD driver, charge pump integrated
- Option to drive an external LCD driver
- Embedded band gap voltage reference for low battery detection
- Serial SPI interface
- Supply voltage 2.1 V to 3.6 V at 120 dB PSRR
- Dice (115 µm pitch) or QFN56 (7 x 7 mm²)

Applications

- Legal for trade scales (OIML, NTEP)
- Torque wrenches
- Bathroom scales (solar and battery)
- Kitchen scales (solar and battery)

Block Diagram





General Description

The PSØ9 extends the PICOSTRAIN family as a very compact, space-saving solution. Typical of PICOSTRAIN, PSØ9 combines the highest resolution and accuracy at very low power consumption for the entire system. The integrated patented software calibration allows a fully automated correction of temperature errors in load cells. This raises production quality to a level at which the (digital-) load cell easily meets the requirements for specifications like OIML or NTEP. The PSØ9 is both a complete single-chip solution including everything, and a frontend chip with a lot of built-in-intelligence. Special features like the capacitive inputs for buttons or sliders that need only 1 µA operating current round out the functionality.

PSØ9 allows to build scales with up to 150,000 stable peak-peak divisions at 2 mV/V. On the other hand, sophisticated power management can reduce the total system current, e.g. 40 µA with 3 Hz and 14 bits at 2 mV/V.

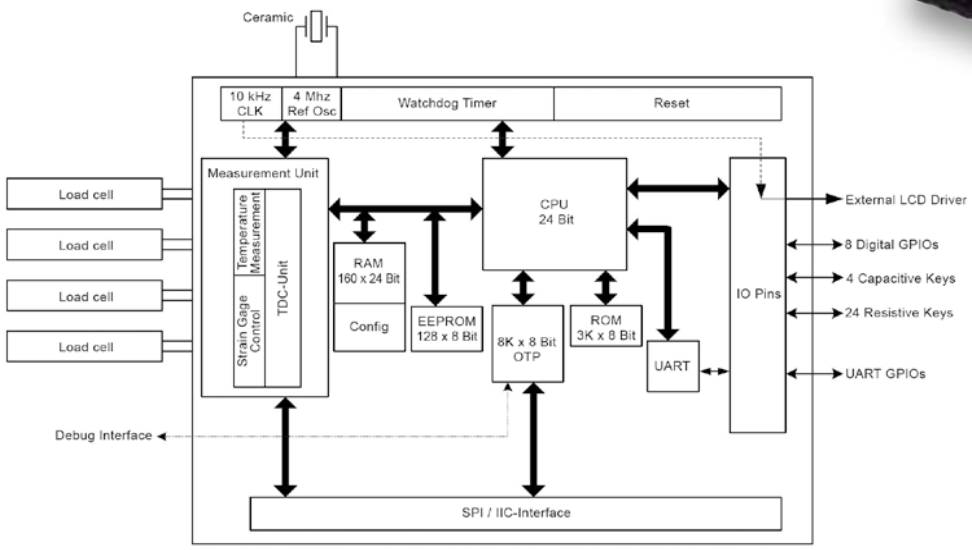
Features

- RMS noise down to 9 nV at SINC5, 5 Hz
- Up to 150,000 peak-peak divisions at 2 mV/V
- Scalable update rate from < 1 Hz to 1000 Hz
- 24-bit internal microprocessor with 160 x 24-bit RAM
- 8 k x 8-bit OTP, 128 byte user EEPROM
- SPI, I²C, UART interfaces
- Interface to drive external LCD driver circuits
- 7 GPIOs pins, up to 24 inputs possible
- 4 capacitive inputs
- Analog switches integrated to drive Wheatstone bridges
- Embedded 18 bits temperature measurement
- Very low gain and offset drift
- Power supply voltage: 2.1 V to 3.6 V
- Dice (1.98 x 1.7 mm²) or QFN40 (6 x 6 mm²)

Applications

- Digital load cells
- Bathroom scales (solar and battery)
- Kitchen scales (solar and battery)
- Piezo-resistive sensors
- Thick-film resistors

Functional Block Diagram



4.4 PSØ21

General Description

The PSØ21 is a digital front-end device for measuring strain gages. Using PICOSTRAIN measurement principle the PSØ21 provides a high degree of flexibility. The current consumption of the total system, including the sensor, can be reduced down to less than 100 µA. The precision that can be achieved is better than most 24-bit A/D-converters and even surpasses them at high measurement rates. The PSØ21 is capable of measuring 2 Wheatstone bridges, 2 full or 4 half-bridges. Driving one half bridge is also possible without any loss in precision. An additional port for temperature measurement, patented compensation methods and a serial SPI interface makes the PSØ21 an innovative front end for various strain gage applications.

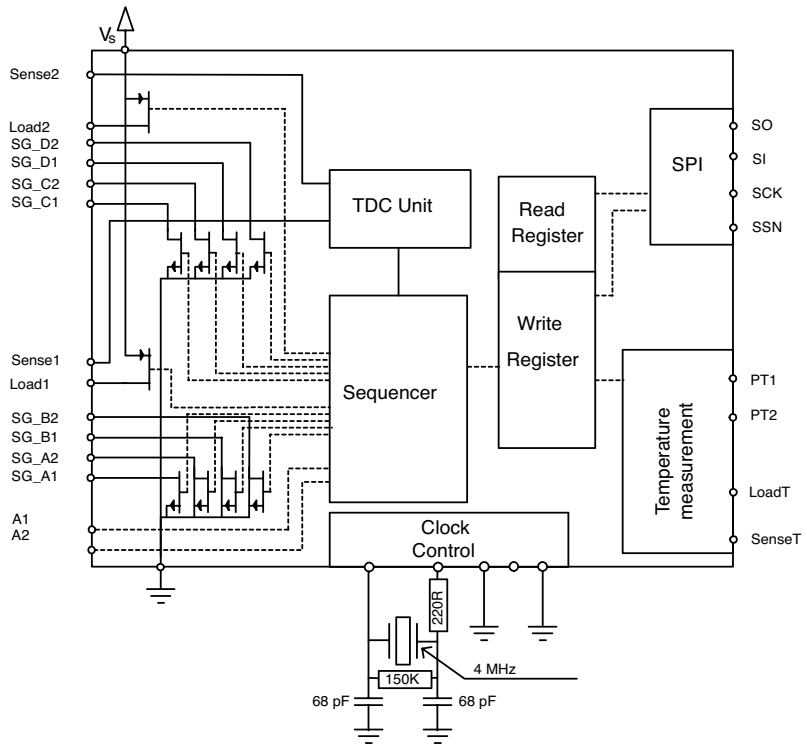
Features

- Up to 4 half bridges, 2 full bridges, or 2 Wheatstone bridges
- Programmable resolution up to 19 bits rms
- Measuring rate up to 50 kHz
- Extremly low current consumption (down to 15 µA incl. the strain gage)
- Wide offset range, +/- 250 mV/V
- Separate temperature measurement port
- Resistance strain gages: 350 Ohm to 10 kOhm
- High temperature stability and low gain error (1ppm / K)
- SPI interface with separate supply voltage
- Core voltage 1.8 V to 3.6 V, I/O voltage 1.8 V to 5.5 V
- Temperature range –40°C to +120°C
- TQFP48 / QFN48 package, 7 x 7 mm^2 body

Applications

- Telemetric applications
- Force sensors/load cells
- Pressure sensors (also 4 – 20 mA)

Block Diagram



4.5 Evaluation Kits

General Description

Plug it, test it, and be convinced. That's the aim of the PSØ81/PSØ9 and DLC evaluation kits. Therefore, these are not just PCBs but complete weighing systems with load cell weighing platform and easy to use measurement software. The PSØ81/PSØ9-EVA-Kits consists of a motherboard with one (PSØ9) or three (PSØ81) plug-in modules. On the motherboard, the user finds the LCD, a solar panel, and the power supply circuit.

Digital load cells (DLC) are becoming more and more attractive. With PICOSTRAIN's ability to do compensation with software production of DLCs can be simplified and automated. The DLC evaluation kit delivers a complete solution to the developer, based on PICOSTRAIN method. The PSØ9-DLC kit has a small PCB integrated directly into the load cell.

The electronics is connected to the user's PC with the PICOPROG programmer. The software package includes evaluation software with a convenient graphical user interface and the assembler/debugger.

System Overview

PSØ81-EVA-KIT

- Main board with LCD display, power select, solar panel, battery holder, wall power supply, 10 pushbuttons
- PSØ81-EVA-HR for up to 100,000 stable scale divisions
- PSØ81-EVA-STD for up to 40,000 stable scale divisions
- PSØ8-EVA-WB Wheatstone module
- 10 kg load cell (350 Ohm), mounted on platform

PSØ9-EVA-KIT

- Main board with LCD display, power select, battery holder, wall power supply, 8 pushbuttons and 4 capacitive buttons
- PSØ9-EVA-HR high-resolution module
- 10 kg load cell (350 Ohm), mounted on platform

PSØ9-DLC- KIT

- 10 kg digital load cell, mounted on platform, with 350 Ohm sensors, wired as 2 half bridges with 1 span compensation resistor
- SPI / I2C / UART interfaces

All systems come with PICOPROG interface and cables

Evaluation Kit

5. Contact

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