Product Overview

November 2010
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 saving 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 measuring tasks. Accordingly, acam’s strong core competence is the development of customized TDCs which are tailored to the specific measurement requirements of the customer: acam’s TDCs are used in industrial, biomedical and scientific products.

PICOSTRAIN

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

PICOCAP

Capacitive sensors cover a wide field of applications, from MEMS acceleration sensors over humidity sensors to touch key sensors. Accordingly, the technical requirement to a converter are wide spread. With PICOCAP acam offers a family of capacitance-to-digital converters that can be seen as all-in-one solution. PICOCAP devices show 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.

PICOTURN

With the PICOTURN product family, acam has established a popular and well-known series of rotational speed sensors for turbochargers. With these products, acam has proven that precision time measurement covers an unexpected range of applications. acam develops products to a high level of technical maturity that are cost-effective at the same time.
# Product Overview

## 1. TDCs – Time-to-Digital Converters

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## 3. PICOCAP – Capacitance-to-Digital Converters

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## 4. PICOTURN – The Successful Solution To Detect Turbo Speed

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## 5. Contact

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<td>5</td>
<td>Contact</td>
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1.1 Time-to-Digital Converters (TDCs)

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 measuring methods, the main advantages of digital TDCs are high measure rates, excellent pulse-pair resolution, and low power dissipation.

The basic 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 resolution extremely stable.
acam offers a spectrum of off-the-shelf standard and high performance TDCs that can solve a wide range of measurement tasks. The digital measuring unit allows the use of most modern CMOS technologies and offers high variability in design. Latest acam TDCs include also analog elements, making electronic circuits more and more compact, combined with increased reliability and security. 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**

<table>
<thead>
<tr>
<th>Integrated Circuits</th>
<th>Product</th>
<th>Part No.</th>
<th>Package</th>
<th>Standard Pack Quantity</th>
<th>Package Carrier</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>TDC-GP1</td>
<td>278</td>
<td>TQFP44</td>
<td>160</td>
<td>Tray</td>
<td>2-channel TDC with 125/250 ps resolution, 250 ms maximum range, 1 MHz maximum data rate</td>
<td></td>
</tr>
<tr>
<td>TDC-GP2</td>
<td>1058</td>
<td>QFN32</td>
<td>240</td>
<td>Tray</td>
<td>2-channel TDC with 65 ps resolution, 4 ms maximum range, temperature measuring unit, fire-pulse generator, 1 MHz maximum data rate</td>
<td></td>
</tr>
<tr>
<td>TDC-GP21</td>
<td>1720</td>
<td>QFN32</td>
<td>2000</td>
<td>T&amp;R</td>
<td>2-channel TDC with 22/45/90 ps resolution, 4 ms maximum range, analog switches, chopper stabilized comparator, temperature measuring unit, fire-pulse generator. Especially dedicated to ultrasonic flow and heat meters</td>
<td></td>
</tr>
<tr>
<td>TDC-GPX</td>
<td>975</td>
<td>TQFP100</td>
<td>50</td>
<td>Tray</td>
<td>2-channels with 10/27/41 ps resolution, 8 channels with 81 ps resolution, endless range, 200 MHz peak / 40 MHz continuous data rate</td>
<td></td>
</tr>
<tr>
<td>TDC-GPX -FG</td>
<td>1089</td>
<td>TBGA120</td>
<td></td>
<td>Tray</td>
<td></td>
<td></td>
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</table>

**Evaluation Systems**

<table>
<thead>
<tr>
<th>Evaluation Systems</th>
<th>Product</th>
<th>Part No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>GP2-EVA-KIT</td>
<td>1780</td>
<td></td>
<td>Evaluation system based on TDC-GP2, including PICOPROG, evaluation software, cables</td>
</tr>
<tr>
<td>GP21-EVA-KIT</td>
<td>1781</td>
<td></td>
<td>Evaluation system based on TDC-GP21, including PICOPROG, evaluation software, cables</td>
</tr>
<tr>
<td>ATMD-GPX PCI-System</td>
<td>1532</td>
<td></td>
<td>Evaluation system based on TDC-GPX, including a AM-GPX module, PCI-interface, cables and software</td>
</tr>
</tbody>
</table>
The TDC-GP1 is a universal 2-channel multihit Time-to-Digital Converter that has been proved into a wide range of applications for several years. 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 cost-effective solution for a wide range of applications and due to its extremely low power consumption, the device is perfectly suited for battery-driven systems as well.

### Features
- **2 channels with 250 ps resolution**
- **1 channel with 125 ps resolution**
- **Pulse-pair resolution typ. 15 ns**
- **4-fold multihit capabilities per channel**
- **Queuing for up to 8-fold multihit**
- **Measurement ranges**
  a. 3 ns to 7.6 μs (measurement range 1)
  b. 60 ns to 200 ms (measurement range 2 with predivider)
  c. −3.8 μs to 3.8 μs (resolution adjust mode)
- **Resolution-adjust mode:** quartz-accurate adjustment of resolution

### Mode

<table>
<thead>
<tr>
<th>Mode</th>
<th>Channels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurement range 1</td>
<td>2</td>
</tr>
<tr>
<td>Measurement range 2</td>
<td>1</td>
</tr>
<tr>
<td>Resolution-adjust mode</td>
<td>2</td>
</tr>
</tbody>
</table>

### Block Diagram

The block diagram illustrates the internal structure of the TDC-GP1, including the RLC-Unit, Measuring Unit, Channel 1 and Channel 2 blocks, along with other components like PLL, Predivider, Precounter, 8-Bit Interface Unit, ALU-Clock, and ALU module.
Applications

- 4 ports for the measurement of resistance, inductance, or capacitance
- Programmable edge sensitivity
- Stop enable pins
- Up to 4 calibrated or 8 uncalibrated measurements
- 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

<table>
<thead>
<tr>
<th>Resolution</th>
<th>Range</th>
<th>No. of Hits</th>
</tr>
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<tbody>
<tr>
<td>250 ps</td>
<td>3 ns to 7.6 μs</td>
<td>2 x 4, 1 x 8</td>
</tr>
<tr>
<td>125 ps</td>
<td>3 ns to 3.8 μs</td>
<td>1 x 4</td>
</tr>
<tr>
<td>250 ps</td>
<td>60 ns to 200 ms</td>
<td>1 x 4</td>
</tr>
<tr>
<td>125 ps</td>
<td>60 ns to 200 ms</td>
<td>1 x 3</td>
</tr>
<tr>
<td>250 ps</td>
<td>-3.8 μs to 3.8 μs</td>
<td>1 x 4</td>
</tr>
<tr>
<td>125 ps</td>
<td>15 ns to 1.9 μs</td>
<td>1 x 3</td>
</tr>
</tbody>
</table>

Package Outline

TQFP 44 Package
# 1.3 TDC-GP2

## General Description

The TDC-GP2 is the next 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 is perfectly suited for flow-meter and heat-meter applications.

## Features

### Measurement range 1
- 2 channels with typ. 65 ps resolution (50 ps rms)
- Measurement range 0 to 1.8 μs
- 15 ns pulse-pair resolution with 4-fold multihit capability
- 4 events can be measured arbitrarily against each other
- Windowing for precise stop enable

### Measurement range 2
- 1 channel with typ. 65 ps resolution (50 ps rms)
- Measurement range 500 ns to 4 ms
- 2 x CLKHS pulse-pair resolution with 3-fold multihit capability
- Trigger to rising or falling edge
- Each of the 3 events can be assigned to an adjustable measuring window with 10 ns resolution

### Temperature measurement unit
- 2 or 4 sensors
- Pt500/Pt1000 or higher
- Very high resolution: 16 bit rms (0.004°C resolution for platinum sensors)
- Ultra-low current (0.08 μA when measuring every 30 seconds)

## Block Diagram
General

- 1 MHz continuous data rate max.
- 4 wire SPI interface
- Fire pulse generator
- Clock calibration unit
- Precise stop enable by windowing
- Trigger to rising and/or falling edge
- I/O voltage 1.8 V to 5.5 V
- Core voltage 1.8 V to 3.6 V
- Temperature range -40°C to +125°C
- QFN 32 package

Applications

- Ultrasonic heat meters
- Ultrasonic flow meters
- Laser range finders
- Laser scanners
- Magnetostrictive positioning

<table>
<thead>
<tr>
<th>Mode</th>
<th>Channels</th>
<th>Resolution</th>
<th>Range</th>
<th>No. of Hits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurement range 1</td>
<td>2</td>
<td>65 ps (50 ps rms)</td>
<td>0 ns to 1.8 μs</td>
<td>2 x 4</td>
</tr>
<tr>
<td>Measurement range 2</td>
<td>1</td>
<td>65 ps (50 ps rms)</td>
<td>500 ns to 4 ms</td>
<td>1 x 3</td>
</tr>
<tr>
<td>Temperature</td>
<td>4</td>
<td>16 bit (0.004°C with Pt-sensors)</td>
<td>Pt500, Pt1000</td>
<td></td>
</tr>
</tbody>
</table>

Package Outline

QFN32 Package

Top View

Bottom View

Original Size
TDC-GP21 is next generation’s upgrade for TDC-GP2. It offers pin-to-pin and functional compatibility, several feature improvements and an extended functionality. Analog elements like a chopper stabilized comparator and analog switches simplify external circuits of ultrasonic flowmeters in a significant manner. In parallel, measurement quality is improved and operating current is reduced. The firepulse 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 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

**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

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### Analog Section

- Fire pulse generator
- Control unit with configuration registers
- Configuration registers
- TDC
- Analog section
- Vref unit
- 7x32 EEPROM
- 4-line SPI interface

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### Temperature Unit

- Low-power clock control unit incl. clock calibration
- 4 MHz, 32KHz, 300KHz

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### Start/Stop

- Start
- N_Start
- Stop1
- Stop2
- EN_START
- EN_STOP1
- EN_STOP2

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### Clock Calibration Unit

- 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

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<table>
<thead>
<tr>
<th>Mode</th>
<th>Channels</th>
<th>Resolution</th>
<th>Range</th>
<th>No. of Hits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measure Mode 1</td>
<td>2</td>
<td>45 / 90 ps</td>
<td>0 ns to 2.4 μs</td>
<td>2 x 4</td>
</tr>
<tr>
<td>Measure Mode 2</td>
<td>1</td>
<td>22 / 45 / 90 ps</td>
<td>500 ns to 4 ms</td>
<td>1 x 3</td>
</tr>
<tr>
<td>Temperature</td>
<td>4</td>
<td>16 bit</td>
<td>PT500, PT1000 or higher</td>
<td></td>
</tr>
</tbody>
</table>

**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

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**Package Outline**

QFN32

- Original Size

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**Diagram**

- QFN32 package outline
1.5 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 measuring 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
- LVTT/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 async. parallel data bus (opt. 2 x 16 bit) with Chipselect, Read strobe, Write strobe
- 4-bit address range
- I/O voltage 3.0 to 3.6 V
- Core voltage 2.4 to 3.6 V
- Temperature range Tj -40°C to +125°C
- TQFP100, TFBGA120 package

Block Diagram
Applications:

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

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

**ATMD-GPX**

Get started with our PC-based evaluation system. For our most complex TDC, the TDC-GPX, we offer the ATMD-GPX. It is designed as an evaluation kit to assist designers and to shorten development time for this TDC. The modular system is shipped in an external metal case and connected and powered by means of a PCI interface board. It comes complete with all necessary software, hardware, cables, and manuals. The measuring performance varies from 2 channels with 10 ps rms to 8 channels with 81 ps, depending on the TDC mode. In polling mode, the PC communicates directly with the TDC chip on the module. In burst mode, the measure rate is increased by using the on-board FPGA for the measurement control together with FIFOs that are implemented on the motherboard.

The system is supplied together with a graphical user interface that allows simple setup of all the relevant registers of the TDC. In short, ATMD is a tool that provides a great opportunity to learn more about acam’s TDC-GPX in a very short time. Developers/users can see immediately the performance they can expect in their application without wasting time with software.

**Features**

- PC-supported system
- Communication via PCI interface
- Modular system design
- Graphical interface software
- Samples for writing custom C++ programs
- Two operating modes
  - a: Polling mode: up to approx. 10k measurements/s (without graphical display)
  - b: Burst mode: up to approx. 1 million measurements per second (peak), approx. 300k measurements/s continuous (without graphical display)
- On-board measurement cache as FIFO
- No additional power supply for the external motherboard
**GP2-EVA-KIT / GP21-EVA-KIT**

These evaluation kits offer easy and time-saving evaluation and measurement systems, allowing the user to test the full functionality and performance of the TDC-GP2 and TDC-GP21. The main board holds the TDC under evaluation and just the necessary external components. It gives the user a good idea of the compactness possible when working with those TDCs. The board has an SPI interface to connect it to acam's PICOPROG interface module. By the same interface, the user can connect it to its own microprocessor. The kit comes with a software that allows device configuration and measurements in a comfortable manner.

**Features**

- Compact in size
- SPI interface connector
- PICOPROG interface module to PC
- Software with comfortable GUI
- Powered via PICOPROG
PICOSTRAIN stands for an innovative digital concept to measure strain gages. It sets new benchmarks in weighing technology. The ultra-low current consumption, not only of the chip but of the sensor, opens up a wide range of new design options to the customer. Smaller batteries, solar cell, and wireless are the key-words that highlight the weighing applications which benefit from PICOSTRAIN.

Metal strain gages change their resistance value with mechanical deformation. The resistance variation is a measure of the weight or force. PICOSTRAIN transfers this variation into a time interval variation, contrary to the A/D converter where the variation in resistance is transformed into a variation in voltage.

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

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 production of load cells without the need to match or balance strain gages, thus further reducing costs.
The current consumption of the whole system is dramatically reduced compared to typical ADC systems as a consequence of the pulsed current into the strain gage. There is also no need for a separate supply of 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 (R_{Dson}), 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 measuring rate, high accuracy, as well as portable and battery-driven solutions with low current consumption.

**PICOSTRAIN Products Overview**

<table>
<thead>
<tr>
<th>Product</th>
<th>Part No.</th>
<th>Package</th>
<th>Standard Pack Quantity</th>
<th>Package Carrier</th>
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<tr>
<td>PSØ21</td>
<td>1002</td>
<td>TQFP48</td>
<td></td>
<td>Tray</td>
<td>Digital amplifier for strain gages. Up to 50 kHz measuring rate.</td>
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<td>PSØ21FN</td>
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<td>Dice QFN56</td>
<td>14000000000</td>
<td>Waffle pack T&amp;R</td>
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<td>PSØ81FN</td>
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<td>1783</td>
<td>Dice QFN32</td>
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<td>PSØ9FN</td>
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**Systems**

<table>
<thead>
<tr>
<th>Product</th>
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<th>Description</th>
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<tbody>
<tr>
<td>PSA21-STD</td>
<td>984</td>
<td>Evaluation system based on PSØ21 for PICOSTRAIN standard bridges</td>
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<tr>
<td>PSA21-WSB</td>
<td>985</td>
<td>Evaluation system based on PSØ21 for Wheatstone bridges</td>
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<tr>
<td>PSØ81-EVA-KIT</td>
<td>1525</td>
<td>Evaluation kit for PSØ81 System-on-Chip for weight scales - including baseboard with 3 plug-in modules, programmer, 10 kg loadcell, assembler and evaluation software</td>
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<tr>
<td>PSØ9-EVA-KIT</td>
<td>1785</td>
<td>Evaluation kit for PSØ9 System-on-Chip for weight scales - including baseboard with 1 plug-in module, programmer, 10 kg loadcell, assembler and evaluation software</td>
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<tr>
<td>DLC-EVA-KIT</td>
<td>1729</td>
<td>Evaluation kit for digital load cell, based on PSØ81 - including 10 kg digital loadcell, baseboard, programmer, 10 kg loadcell, assembler and evaluation software</td>
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<td>ALC5 350</td>
<td>1163</td>
<td>Load cell simulator</td>
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**Modules**

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<td>PSA21mini-STD</td>
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<td>PSØ21 Plug-in module for PICOSTRAIN standard bridges</td>
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<tr>
<td>PSA21mini-WSB</td>
<td>991</td>
<td>PSØ21 Plug-in module for Wheatstone bridges</td>
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<td>PSØ81-EVA-STD</td>
<td>1545</td>
<td>PSØ81 Standard plug-in module 2-layer</td>
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<td>PSØ81-EVA-HR</td>
<td>1544</td>
<td>PSØ81 High resolution plug-in module 4-layer</td>
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<tr>
<td>PSØ81-EVA-WH</td>
<td>1546</td>
<td>PSØ81 Wheatstone plug-in module 4-layer</td>
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<tr>
<td>PSØ9-EVA-HR</td>
<td>1786</td>
<td>PSØ9 High resolution plug-in module 4-layer</td>
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</table>
General Description

The PSØ21 is a digital front-end device for measuring strain gages. Using PICOSTRAIN measuring 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 to be achieved is better than with 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 offers the PSØ21 as an innovative front end for various strain gage applications.

Features

- Up to 4 half bridges, 2 full bridges, or 2 Wheatstone bridges
- Digital measuring principle in CMOS technology
- Internal TDC with 18 ps rms
- Programmable resolution up to 19 bit rms
- Measuring rate up to 50 kHz
- Extremely 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
- Stray capacitance compensation
- High temperature stability and low gain error (1ppm / K)

Block Diagram
Applications

- No separate supply of the strain gage
- No separate reference voltage
- SPI interface with separate supply voltage
- I/O supply voltage 1.8 to 5.5 V
- PSØ21 core voltage 1.8 to 3.6 V
- Temperature range -40°C to +120°C
- TQFP48 / QFN48 package, 7 x 7 mm² body

- Weigh scales, incl. calibrated
- Telemetric applications
- Force sensors/load cells
- General strain-gage amplifiers
- Pressure sensors (also 4 – 20 mA)
- Solar-cell driven equipment
- Battery-driven applications

Package Outline

TQFP48 Package

QFN48 Package

Original Size

Original Size
**General Description**

PSØ81 is a System-on-Chip for ultra low-power and high resolution applications. It was designed especially for weight scales but fits also to any kind of force or torque measurements based on metal strain gages. It takes full advantage of the digital measuring principle of PICOSTRAIN. Thus it combines the performance of a 28-bit signal converter with a 24-bit microprocessor. Additional elements like an LCD driver, 3k ROM with many complex pre-defined functions, 2k EEPROM program memory and an integrated 10 kHz oscillator round off the device. A minimum amount of external components is necessary to build a complete weighing electronic.

With PSØ81 it is possible for the first time to build solar cell driven weight scales based on metal strain gages. A sophisticated power management and the special features of the PICOSTRAIN measuring principle can reduce the total current of the system down to 15 μA – including the sensor current. This way the PSØ81 is perfectly suited for battery driven or solar cell driven weight scales.

On the other hand the PSØ81 offers a high resolution comparable to high-end ADC’s. With maximum 1 million internal divisions (150,000 stable display divisions) it shows top performance. But it beats ADC with respect to current consumption. With PSØ81 it is possible to build legal for trade scales that run with 2 AA batteries for more than 1500 operating hours.

Throwing a glance at further specialties like software adjustment of the offset and gain compensation reveals that the PSØ81 opens the door to new and innovative product solutions.

**Block Diagram**

![PSØ81 Block Diagram](image)
Features

- PICOSTRAIN front end with up to 1 million effective scale divisions (@2mV/V) = 150,000 Peak-Peak Div.
- 24-bit microprocessor
- 2 k 8-bit EEPROM program memory, read protected
- 3 k ROM powerful program code like 48-bit multiplication and division, or binary to 7-segment conversion
- 8-layer hardware stack
- Embedded very low current 10 kHz oscillator
- Driver for external 4 MHz ceramic oscillator
- Standby current <1 μA
- Up to 21 programmable I/O ports
- 4 x 14, 3 x 15, 2 x 16 LCD driver
- Embedded charge pump for driving the LCD
- Option to drive an external LCD driver
- Embedded band gap voltage reference for low battery detection
- Ports for temperature measurement with low-cost carbon/metal film resistors
- Watchdog timer
- Serial SPI interface
- Supply voltage 2.1 to 3.6 V at 120 dB PSRR
- System operational current down to 15 μA
- As dice (115 μm pitch) or packaged (QFN56, 7 x 7 mm²)

Applications

Industrial
- Legal for trade scales
- Counting scales
- Torque indicators

Consumer
- Solar scales
- Body scales
- Kitchen scales
- Postal scales
- Package scales

Package Outline

<table>
<thead>
<tr>
<th>DICE</th>
<th>QFN56 Package</th>
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<tr>
<td><img src="image1.png" alt="DICE Diagram" /></td>
<td><img src="image2.png" alt="QFN56 Package Diagram" /></td>
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<tr>
<td>Original Size</td>
<td>Original Size</td>
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General Description

The PSØ9 extends the PICOSTRAIN family as a very compact, space-saving solution. The use of modern 0.18 μ CMOS technology provides unprecedented functional density in the smallest space. Typical of PICOSTRAIN, PSØ9 combines highest resolution and accuracy at very low power consumption of the entire system. The integrated patented software calibration allows a fully automated correction of temperature errors of load cells. The quality of production is deep in range of OIML, which is ideal for high-end digital load cells. The PSØ9 is both a complete single-chip solution including everything, and a front-end chip with a lot of self-intelligence, contributing to relieve your processor in the measurement task decisively.

Another outstanding feature are the capacitive inputs for buttons or sliders that need only 1 μA operating current. As they are self-adaptive, users easily can implement buttons without any knowledge about capacitive switches. With little software even a slider functionality can be realized.

Equipped with these features, a variety of scale electronics can be served with PSØ9. On the resolution side, it allows to build scales with up to 150,000 stable peak-peak divisions at 2 mV/V. On the other hand, a sophisticated power management and the special features of the PICOSTRAIN measuring principle can reduce the total current of the system current, e.g. 40 μA with 3 Hz and 14 bit at 2 mV/V.

Functional Block Diagram
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-bit temperature measurement
- Very low gain and offset drift
- Power supply voltage: 2.1 V to 3.6 V
- Available as dice (1.98 x 1.7 mm², 115 μm pitch) or packaged (QFN32, 5 x 5 mm²)

Advantages

- Small and compact solution for weighing applications
- Converter and microcontroller in one chip
- Extreme low total system current (down to 15 µA including strain gages)

Applications

- Digital Load Cells
- Torque wrenches
- Pressure indicators
- Legal for trade scales
- Solar driven scales
- Body scales
- Kitchen scales

Package Outline
2.5 **PSØ81/PSØ9-EVA-KIT**

### General Description

Plug it, test it, and be convinced. That’s the aim of the PSØ81/PSØ9 evaluation kits. Therefore these are not just PCBs but complete weighing systems with weighing platform and comfortable measurement software. The electronic system comprises a motherboard with one (PSØ9) or three (PSØ81) plug-in modules, one for very high resolution, one with simple 2-layer design, and one for classical Wheatstone bridges. On the motherboard, the user finds the LCD, a solar panel, and the power supply circuit. It is connected to the user’s PC by means of the PICOPROG programmer.

The software package includes an evaluation software and the assembler/debugger. The evaluation software comes with a graphical user interface that allows you to experiment with all the configuration options of the PSØ81/PSØ9.

The assembler and debugger tool enables the user to write his own programs. Syntax highlighting, include file handling, a debug mode, and the possibility to do all actions from a single interface make it easy to work with.

### 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 & solar applications
- PSØ81-EVA-STD for up to 40,000 stable scale divisions
- PSØ8-EVA-WB Wheatstone module
- PICOPROG
- 10 kg load cell, mounted on platform, with 350 Ohm sensors

**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
- PICOPROG
- 10 kg load cell, mounted on platform, with 350 Ohm sensors
General Description

Today’s digital load cells offer the advantage of great flexibility and replaceability, but they are expensive to produce. Tomorrow’s digital load cell will be produced more simple and at lower cost PICOSTRAIN. The DLC evaluation kit passes a complete solution to the hands of interested, based on PICOSTRAIN. The DLC includes a small sized PCB with SPI interface. Similar to the PS081-EVA-KIT, the kit comes with a PICOPROG interface module to control the DLC via PC. The included software package is a great tool to recognize and analyze the advantages PICOSTRAIN offers to digital load cells:

- PICOSTRAIN offers an innovate temperature compensation with no need for mechanical trimming. The wholly mounted cell can be adjusted. This makes calibration less expensive and easier.
- It increases production quality, OIML 6000 specification can be reached more easily thanks to simplified adjustment.
- PICOSTRAIN offers high flexibility by having just one board for high resolution, low current, or high speed.
- The single-chip solution saves components and allows design of very compact PCBs.
- The SPI interface makes it easy to connect to a processor or wireless transceiver.

System Overview

DLC-EVA-KIT

- 10 kg digital load cell, mounted on platform, with 350 Ohm sensors, wired as 2 half bridges with 1 span compensation resistor, SPI interface
- PICOPROG programmer and PC interface, cables
- Evaluation software and assembler

Evaluation Kit
2.7 PSA21

General Description

Get acquainted with the PSØ21 and its PICOSTRAIN measuring principle. The PSA21 evaluation system offers a convenient evaluation and measurement system so you can test the full functionality and performance of the PSØ21. In combination, this gives you an ideal measurement system together with a powerful graphical user interface that simplifies the handling of the various setup possibilities. The user can start with the sample configurations that are provided to do the first measurements within minutes. Experimenting with the various configuration parameters will provide better understanding of the measuring principle and demonstrate the high flexibility with respect to precision, update rate, and power consumption. Finally, the PSA21 is the right tool to find the best configuration for the customer’s specific application.

The PSA21 evaluation system includes the motherboard with one plug-in module, the power supply, the cable, and a CD-ROM with all the necessary software and manuals. With its modular system design, the PSA21 can be easily adapted to different measurement tasks.

Features

- PC-supported system
- Communication via serial RS232 interface
- Modular system design with plug-in modules for PICOSTRAIN-compliant sensors and traditional Wheatstone bridges
- Graphical interface for configuration, data representation, and data export to file
- Sample configuration files for typical applications
- 32.768 kHz and 4 MHz oscillators on board
- Programmable voltages for PSØ21 core (Vcc), PSØ21 I/O, and strain gage (Vio)
- Shorting plugs for current measurement on board

PSA21mini-STD
Standard plug-in module for measuring up to 2 full-bridges or 4 half-bridges.

PSA21mini-WSB
Wheatstone plug-in module for measuring up to 2 Wheatstone bridges
2.8 ALCS-350 Load Cell Simulator

General Description

The ALCS-350 is a high-precision load cell simulator, based on accurate resistor networks with 350 Ohm base resistance. For this reason, it is suited for all kinds of weighing electronics for strain-gage load cells, whatever excitation principle is used (DC, AC, PICOSTRAIN). The ALCS-350 simulates two separate half-bridges or one full-bridge. The full-bridge can be connected to a Wheatstone or PICOSTRAIN bridge. It is ideal for testing, qualifying, and batching weighing instruments.

The simulator output is adjustable from 0 to 3 mV/V in steps of 0.1 mV/V with full-bridges (or 0.2 mV/V with half-bridges).

The simulator is set by 8 mechanical switches on the top of the housing. However, the simulator is also controllable by means of a PC connected via either RS232 or USB interfaces. In these 2 options, the ALCS-350 is a perfect tool for systematic, PC-controlled testing and batch control. It can be used in the laboratory as well as in production testing.

The ALCS-350 performs with very high precision and at a high temperature stability. In particular it can generate a very high precision analysis of converter electronics linearity due to the internal structure of the simulator.

Features

- High-precision resistor network based on 350 Ohm
- Simulates 0 to 3 mV/V output in steps of 0.1 mV/V
- Suitable for all kinds of excitation (DC, AC, PICOSTRAIN)
- Excitation voltage -10 V to +10 V, galvanically isolated
- Simulates 1 full-bridge or 2 separate half-bridges
- High temperature stability
- Very well suited for linearity analyses
- 3 interfaces: Human (switches), USB, RS232
- Powered by USB or separate 9 to 12 V power supply

Performance

- Strain precision: typ. ± 0.005% of F.S. (Wheatstone: 0.03%)
- Zero point: typ. ± 0.002 mV/V
- Drift offset: typ. < 0.5 μV/V/K, gain: typ. < 3 ppm/K

Applications

- Weighing electronics evaluation
- Systematic qualification tests
- Automated batch testing
The patented PICOCAP measuring principle shows a versatile approach to capacitance measurement. There is practically no limit for the capacitor value. This provides high flexibility to the user and allows the same chip to be used in a broad range of sensors from nearly 0 fF up to hundreds of nF. PICOCAP also provides a powerful combination of performance and accuracy with the option for ultra-low current applications in a single chip. Through software, the user can select between a high resolution in the 22 bit range, a high measuring rate of up to 500 kHz, or a low-power setup with only a few μA supply current.

PICOCAP transforms the capacitance measurement into a precision time interval measurement. For this purpose, the sense capacitors and a reference capacitor, or a second sense capacitor, are connected to a resistor, forming a low-pass filter. The capacitors are charged to the supply voltage and then discharged through the resistor alternately. The discharge times down to an arbitrary trigger level are measured with ultra-high precision using a TDC (Time-to-Digital Converter). The ratio of the capacities is given by the ratio of discharge times. Patended algorithms provide an excellent suppression of parasitic capacities and ensure very good temperature stability.

**Applications**
- Humidity sensors
- Pressure sensors
- Acceleration sensors
- Inclination sensors
- Freefall sensors
- Position sensors
- Touch sensors
- Angle sensors
- Level sensors
- Microphones
- MEMS

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**Measuring Principle**
PICOCAP Products Overview

### Integrated Circuits

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<tr>
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<th>Part No.</th>
<th>Package</th>
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<td>Tube</td>
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### Systems

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<th>Description</th>
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<td>Evaluation kit humidity measurement with PCap01 humidity module, PICOPROG and evaluation software</td>
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<td>PCapØ1-HUM-DEMO</td>
<td>1792</td>
<td>Demonstration kit humidity measurement with PCap001 humidity module and LCD base board</td>
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<tr>
<td>PCapØ1-PRES-EVA</td>
<td>1798</td>
<td>Evaluation kit pressure measurement with PCap01 pressure module, PICOPROG and evaluation software</td>
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<tr>
<td>PCapØ1-PRES-DEMO</td>
<td>1797</td>
<td>Demonstration kit pressure measurement with PCap01 pressure module and LCD base board</td>
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</tbody>
</table>

### Typical Resolution

![Typical Resolution Graph](image-url)

- Approx. 17-bit resolution at an update rate of 20 kHz
- Update rate vs. noise levels for different capacitance values (1 nF, 100 pF, 30 pF)
**General Description**

PCapØ1 is not just a capacitance-to-digital converter but a complete frontend thanks to the integrated digital signal processor and the various interface options. It offers a high degree in flexibility and can be configured to fit the various needs in capacitive sensing. Whether users look for lowest power consumption of only a few μA, whether they look for very high resolution up to 22 bit, or whether they want to measure as fast as possible like up to 500,000 measurements per second – PCapØ1 is the right choice. The sensor data can be linearized and filtered on-chip. PCapØ1 offers digital serial interfaces and also IO's for PWM/PDM signal outputs to generate analog signals. General purpose IO's can be used for interrupt and alarm level indication. Finally, the design can be very compact thanks to the small size packages and the small number of external components.

**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 bit at 2 Hz and 10 pF base capacitance
  - 25 aF or 22 bit 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 bit resolution
- High stability with temperature: low offset drift (down to 45 aF per Kelvin), low gain drift
- Dedicated ports for temperature measurement with Pt1000 sensors, reaching 0.005 K resolution
- RISC processor core using Harvard architecture
- 48 x 48-bit RAM Data
- 4 k x 8 bit volatile program memory 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 interface
- Single power supply (2.1 to 3.6V)
- Available in QFN24, QFN32 or as dice

Package Outline
General Description

Humidity measurement can be so easy – this evaluation kit with PCapØ1AK is the best proof. The complete humidity and temperature measurement is realized on a small 17 x 8 mm² sized PCB. Based on PCapØ1AK with firmware V0101, the humidity is measured by means of an IST humidity sensor with 0.008% r.H. precision, the temperature by means of a PT1000 sensor with 0.005 K precision. The measurements are linearized already on-chip with polynomials. The power consumption of the module is as low as 9 μA at 5 measurements per second. The module comes connected to a motherboard via an I²C interface connector. The motherboard has an LCD and the LCD-driver IC, a capacitive switch (PCapØ1-controlled) to select between temperature and humidity display, a battery with a jumper to measure the modules current consumption, and an LED to indicate an alarm level.

The evaluation board is connected via PICOPROG to the PC. It comes with a comfortable evaluation software to set the calibration parameters and to display the measured data.

Features

Humidity measurement:
- Capacitance range 1 to 1000 pF
- 0.008% r.H. standard deviation
- Update rate 1 to 25 Hz

Temperature measurement:
- PT500 or PT10000 sensors
- 0.005 K standard deviation
- Update rate 1 to 10 Hz
- Extremely low current consumption possible: Down to 9 μA at 5 Hz
- Polynomial linearization of temperature and humidity measurement
- 8 times re-calibration
- Serial peripheral interface (I²C or SPI compatible)
- Self-boot capability (OTP)
- Single power supply (2.1 to 3.6 V)
3.4 PCapØ1-PRES-EVA

**General Description**

This evaluation system for pressure sensing is made of a small, round shaped PCB with 15 mm diameter, mounted on a capacitive pressure sensor element. The PCB is connected via flat cable and a small adapter board to the PICOPROG programming and interface box which serves as PC interface.

The sensing board is based on PCapØ1-AJ in QFN24 package. The external circuit is made of 7 components only, including temperature measurement. The on-chip firmware includes linearization and filtering of the measured data.

The system comes with a software that allows to set the necessary parameters in a comfortable manner and offers a graphical display of the measured data as well as a data export functionality.

**Features**

Sample sensor:
- 23 pF base capacitance
- 2 bar maximum pressure
- Standard deviation < 0.2 mbar (about 130 aF)

PCapØ1 board:
- Electronic’s resolution with 22 pF base capacitance
  - at 25 Hz: 60 aF with 41 μA
  - at 100 Hz: 80 aF with 115 μA
  - at 800 Hz: 250 aF with 170 μA
- On-Chip linearization and filtering
- 15 mm PCB with flat cable connector
- PICOPROG as PC interface and programmer
- Software for configuration, graphical data display and data export
PICOTURN is an all-digital complete solution for sensing the rotational speed of a turbocharger compressor wheel. The modular and compact system is easy to mount and especially designed for easy sensor exchange. No modification of rotating parts is necessary. The second generation marks a further step towards compact design. The intelligent sensors have the signal processing electronics already integrated. They can be connected directly to the ECU or optionally to our signal conditioning boxes. The field of applications is extended from engine test benches and vehicle prototypes to small series applications. Thus the PICOTURN product family is a potential basis for cost-effective standard or customized solutions, well suited for the specific needs of measuring the rotational speed of turbochargers.

The measurement technology is based on the attenuation of an inductance by eddy currents. Measuring the time constant of an R-L network, the system detects each vane of the aluminum compressor wheel. This makes the system perfectly suited for the rough environmental conditions that can be found in an engine.

PICOTURN-BM V6 is well established as a compact and easy-to-use rotational speed measurement system for turbochargers. It is characterized by high sensitivity and high signal-to-noise ratio. This allows a large sensor-to-wheel spacing and makes the system also suited for measuring other than aluminium-wheels (titanium, ferrous). The system is capable of speed measurements from 200 rpm up to 400,000 rpm. The number of vanes is programmable and the measurement result is provided by a digital pulse output and an analog output. With the PICOTURN measurement principle, no modification of rotating parts is necessary and the system will work properly in rough environment conditions typically found in engines.
Available Products

### First Generation

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Product Description</th>
<th>Sensor Length/Thread Length</th>
<th>Diameter</th>
<th>Cable Length</th>
<th>Temperature Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>1242 PTBM V6</td>
<td>Signal processor box 200 to 400,000 rpm, 8 to 30 V, -40 °C to +85 °C</td>
<td>60 mm / 54 mm</td>
<td>M5 x 0.8</td>
<td>1.5 m</td>
<td>-40°C to +180°C</td>
</tr>
<tr>
<td>1244 PTBM V6L</td>
<td>Signal processor box as above, but with 7-pole LEMO connector for signal and supply voltage</td>
<td>60 mm / 48 mm</td>
<td>M5 x 0.8 head 3.6 mm Ø</td>
<td>1.5 m</td>
<td>-40°C to +180°C</td>
</tr>
<tr>
<td>890 PICOTURN-CT</td>
<td>Calibration device for PICOTURN controller units</td>
<td>60 mm / 54 mm</td>
<td>M5 x 0.8</td>
<td>1.5 m</td>
<td>-40°C to +180°C</td>
</tr>
</tbody>
</table>

### Sensors

<table>
<thead>
<tr>
<th>Sensor Length/Thread Length</th>
<th>Diameter</th>
<th>Cable Length</th>
<th>Temperature Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>586 PICOTURN-SM5.1</td>
<td>60 mm / 54 mm</td>
<td>M5 x 0.8</td>
<td>1.5 m</td>
</tr>
<tr>
<td>607 PICOTURN-SM5.2</td>
<td>60 mm / 48 mm</td>
<td>M5 x 0.8 head 3.6 mm Ø</td>
<td>1.5 m</td>
</tr>
<tr>
<td>933(1126) PICOTURN-SM5.3(L)</td>
<td>60 mm / 54 mm</td>
<td>M5 x 0.8</td>
<td>1.5 m (2 m)</td>
</tr>
<tr>
<td>998(1108) PICOTURN-SM5.5(L)</td>
<td>46 mm / 40 mm</td>
<td>M5 x 0.8</td>
<td>1.5 m (2 m)</td>
</tr>
<tr>
<td>1059 PICOTURN-SM5.6</td>
<td>75 mm / 69 mm</td>
<td>M5 x 0.8</td>
<td>1.5 m</td>
</tr>
<tr>
<td>1065 PICOTURN-SM5.7</td>
<td>45 mm / 33 mm</td>
<td>M5 x 0.8 head 3.6mm Ø</td>
<td>1.5 m</td>
</tr>
<tr>
<td>934 PICOTURN-SM5F.2</td>
<td>41 mm / 25 mm</td>
<td>M5 x 0.5</td>
<td>1.5 m</td>
</tr>
<tr>
<td>1081 PICOTURN-SM5F.3</td>
<td>56 mm / 40 mm</td>
<td>M5 x 0.5</td>
<td>1.5 m</td>
</tr>
<tr>
<td>1574 PICOTURN-SM5F.5</td>
<td>76 mm / 60 mm</td>
<td>M5 x 0.5</td>
<td>1.5 m</td>
</tr>
</tbody>
</table>

### Accessories

<table>
<thead>
<tr>
<th>accessory</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>594 707** Extension cable</td>
<td>Extension cable for sensor SMB/SMB 1.5 m 1.5 m length 2.5 m length**</td>
</tr>
<tr>
<td>647* Adapter Cord L/O</td>
<td>7-pole LEMO connector versus seven open ends, for controller unit PICOTURN-BM V6L</td>
</tr>
<tr>
<td>1129 Fixing plate</td>
<td>Metal plate with bores, riveted to the box, for fixing purposes</td>
</tr>
</tbody>
</table>

(*) on request
(***) not suitable for “L”-type sensors (with extra long cable), generally not recommended (keep cable short!)
4.2 PICOTURN – 2nd Generation

General Description

The application of PICOTURN in the engine bay is much easier with the second generation. The intelligence in the sensors is the key. They include the signal processing electronics and provide a standard TTL/CMOS output signal. Each edge of the pulsed signal corresponds to one vane. The distance between the sensors and a data logger, or one of acam’s signal conditioning boxes, may easily reach 15 meters. The sensors are IP67 proof thanks to the sealed electronics and the AMP SuperSeal connectors and can thus be used inside the engine bay. The sensor heads work up to 230°C while the sealed electronic works up to 125°C.

Two different signal conditioning boxes are available, one is named “PT2G-BD” with a numeric LED display indicating the speed, the other is named “PT2G-BX” without display.

In many cases, a direct one-cable, one-plug, four-wire connection to a datalogger will be the customer’s preferred solution with power supply included.

The display-less PT2G-BX has advantages in terms of power consumption and ruggedness. It additionally provides an RS232 interface permitting read and record of speed on a computer which may be connected either directly or via an RS232-to-CAN-bus transceiver. Customers eager to use both display and RS232 interface are invited to use the PT2G-BX plus the PICOTURN-DY display box.

The well-known PICOTURN-CT device, used for calibrating, adjusting, and testing the signal conditioning box, continues to be useful for the same purpose on PT2G boxes.
### Available Products

#### Second Generation

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Product</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><strong>Intelligent Sensors with integrated signal processing and TTL output</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Sensor Length/ Thread Length</strong></td>
</tr>
<tr>
<td>1590</td>
<td>PT2G-SM5F.2</td>
<td>41 mm / 25 mm</td>
</tr>
<tr>
<td>1537</td>
<td>PT2G-SM5.3</td>
<td>60 mm / 54 mm</td>
</tr>
<tr>
<td>1538</td>
<td>PT2G-SM5F.3</td>
<td>56 mm / 40 mm</td>
</tr>
<tr>
<td>1591</td>
<td>PT2G-SM5.5</td>
<td>46 mm / 40 mm</td>
</tr>
<tr>
<td>1666</td>
<td>PT2G-SM5F.5</td>
<td>76 mm / 60 mm</td>
</tr>
<tr>
<td>1660</td>
<td>PT2G-SM5.6</td>
<td>75 mm / 69 mm</td>
</tr>
</tbody>
</table>

#### Accessories

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Product</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1526</td>
<td>PT2G-BX</td>
<td>Signal conditioning box with RS232 interface</td>
</tr>
<tr>
<td>1527</td>
<td>PT2G-BD</td>
<td>Signal conditioning box with display</td>
</tr>
<tr>
<td>1771</td>
<td>PT2G-XS-01.5</td>
<td>Cable connecting sensor and signal conditioning box</td>
</tr>
<tr>
<td>1569</td>
<td>PT2G-XS-03</td>
<td>3 m length</td>
</tr>
<tr>
<td>1539</td>
<td>PT2G-XS-05</td>
<td>5 m length</td>
</tr>
<tr>
<td>1540</td>
<td>PT2G-XS-10</td>
<td>10 m length</td>
</tr>
<tr>
<td>1541</td>
<td>PT2G-C-2B</td>
<td>Cable for power supply, 2 m length</td>
</tr>
<tr>
<td>1559</td>
<td>PT2G-C-2B&amp;2BNC</td>
<td>Power: Banana connectors/Signals: BNC open ends</td>
</tr>
<tr>
<td>1542</td>
<td>PT2G-C-2U</td>
<td></td>
</tr>
<tr>
<td>1767</td>
<td>PT2G-CA-BNCM8</td>
<td>Connecting cable PT2G-BD with PTBM-V6, to offer a display for first generation products.</td>
</tr>
<tr>
<td>1543</td>
<td>PT2G-X-CT</td>
<td>Cable connecting sensors to PICOTURN-CT calibration device</td>
</tr>
</tbody>
</table>
## 5. Contact

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