



Product Overview

August 2008

acam - messelelectronic

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, measure 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 TDC's 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

Capacitance-measurement tasks benefit from the speed and accuracy of precision time-interval measurement, as shown by acam's PICOCAP product family. acam's capacitance-to-digital converters demonstrate unsurpassed flexibility. Thanks to the underlying standard CMOS technology, PICOCAP products are highly suited for mass production in the consumer, automotive and industrial sectors.

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

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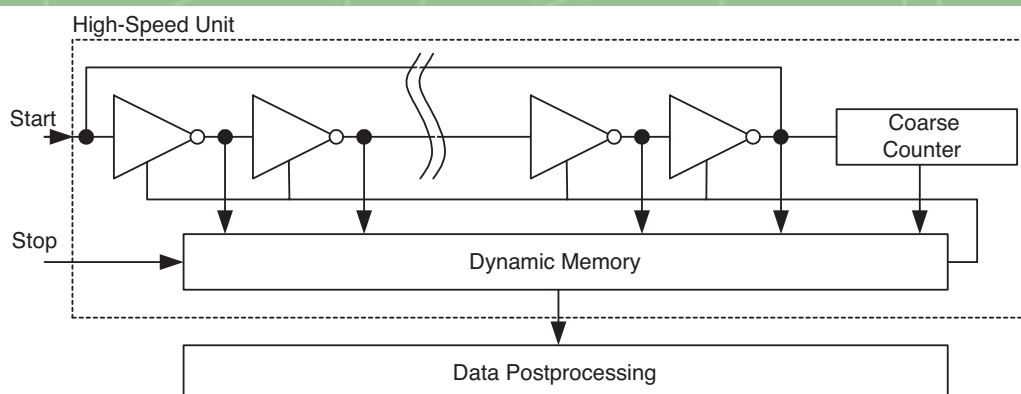
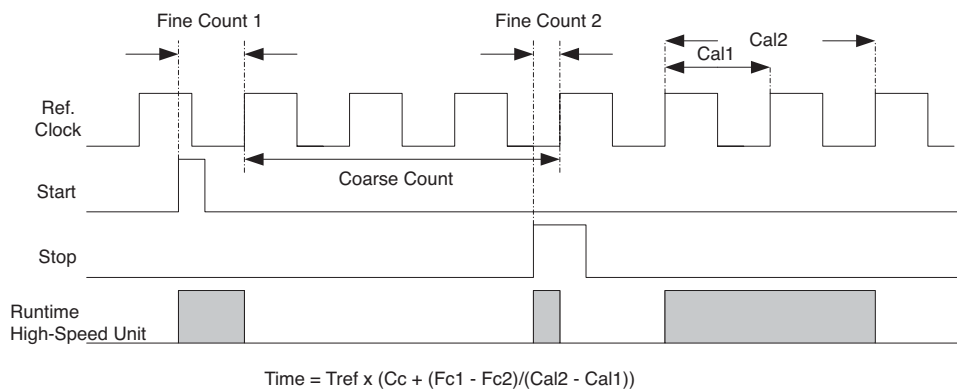
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1.1 Time-to-Digital Converters (TDCs)

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. In some cases, especially for high volume products, customers look for an optimized circuit that is specific to a dedicated application.

With acam's many years of experience in the design of customized TDCs and system-on-chip solutions, we are able to solve almost every application. The all-digital circuit design offers high flexibility in technology and high variability in design combined with high reliability and security.

Time-to-Digital Converters Overview

Integrated Circuits								
Product	Part No.	Package	Standard Pack Quantity	Package Carrier	No. of Channels	Resolution	Maximum Range	Features
TDC-GP1	278	TQFP44 in Trays	160	Tray	1, 2	250 ps, 125 ps	200 ms	Resolution adjust mode
TDC-GP2	1058 1248 1480	QFN32	492 1000 5000	Tray T&R T&R	1, 2	65 ps	4 ms	Temperature measuring unit, fire-pulse generator
TDC-GPX TDC-GPX -FG	975 1089	TQFP100 TFBGA120	50	Tray Tray	2, 8	10 ps, 27 ps, 41 ps, 81 ps	10 μ s or unlimited	200 MHz peak stop rate 40 MHz cont. rate

Systems			
Product	Part No.	Description	
ATMD-GP1 PCI-System 1	1530	Evaluation system based on TDC-GP1, including 1 AM-GP1 module, PCI-interface, cables and software	
ATMD-GP1 PCI-System 2	1531	Evaluation system based on TDC-GP1, including 2 AM-GP1 modules, PCI-interface, cables and software	
ATMD-GP2 PCI-System 1	1528	Evaluation system based on TDC-GP2, including 1 AM-GP2 module, PCI-interface, cables and software	
ATMD-GP2 PCI-System 2	1529	Evaluation system based on TDC-GP2, including 2 AM-GP2 modules, PCI-interface, cables and software	
ATMD-GPX PCI-System	1532	Evaluation system based on TDC-GPX, including a AM-GPX module, PCI-interface, cables and software	

Supplements		
Product	Part No.	Description
AM-GP1	890	Plug-in module based on TDC-GP1
AM-GP2	1063	Plug-in module based on TDC-GP2
AM-GPX	707	Plug-in module based on TDC-GPX
ATMD-PCI	478	PCI interface board for the PC

1.2 TDC-GP1

General Description

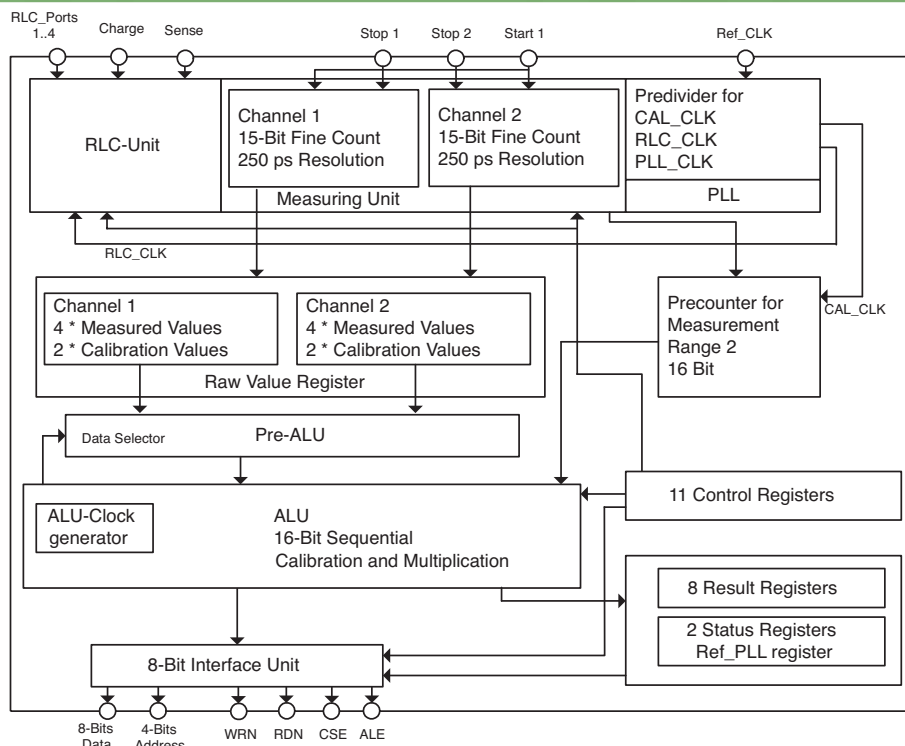
The TDC-GP1 is a universal 2-channel multihit Time-to-Digital Converter that has been proved into a wide range of applications for several years. The TDC-GP1 can be operated in calibrated mode or resolution-adjust mode, both offering results that are stable with temperature and voltage variations. Four 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 μ s (measurement range 1)
 - b. 60 ns to 200 ms (measurement range 2 with predivider)
 - c. -3.8 μ s ns to 3.8 μ s (resolution adjust mode)
- Resolution-adjust mode: quartz-accurate adjustment of resolution

Mode	Channels
Measurement range 1	2 1
Measurement range 2	1
Resolution-adjust mode	2 1

Block Diagram



Applications

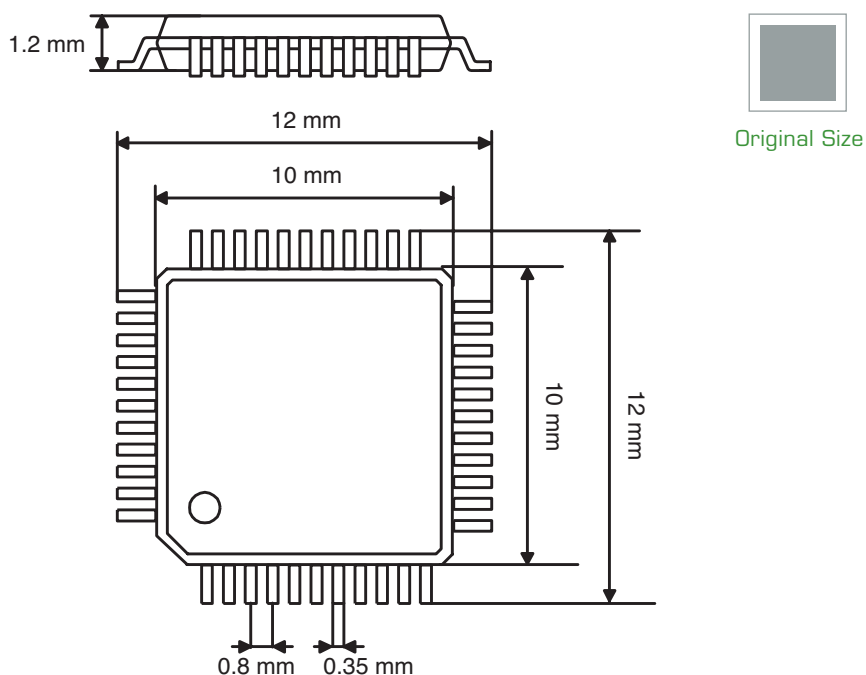
- 4 ports for the measurement of resistance, inductance, or capacitance
 - Programmable edge sensitivity
 - Stop enable pins
 - Up to 4 calibrated or 8 uncalibrated measurements
 - Reference clock input from 500 kHz to 35 MHz (100 MHz with internal predivider)
 - Operating voltage : 2.7 V to 5.5 V
 - Industrial temperature range: -40°C to +85°C
 - TQFP44 package
- Distance measurement
 - Positioning systems
 - ToF spectroscopy
 - Laser technology
 - Ultrasonic flow meters
 - Density metering
 - High energy physics



Resolution	Range	No. of Hits
250 ps 125 ps	3 ns to 7.6µs 3 ns to 3.8µs	2 x 4, 1 x 8 1 x 4
250 ps 125 ps	60 ns to 200 ms 60 ns to 200 ms	1 x 4 1 x 3
250 ps 125 ps	-3.8 µs to 3.8 µs 15 ns to 1.9 µs	1 x 4 1 x 3

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 μ s
- 15 ns pulse-pair resolution with 4-fold multihit capability
- 4 events can be measured arbitrarily against each other
- Windowing for precise stop enable

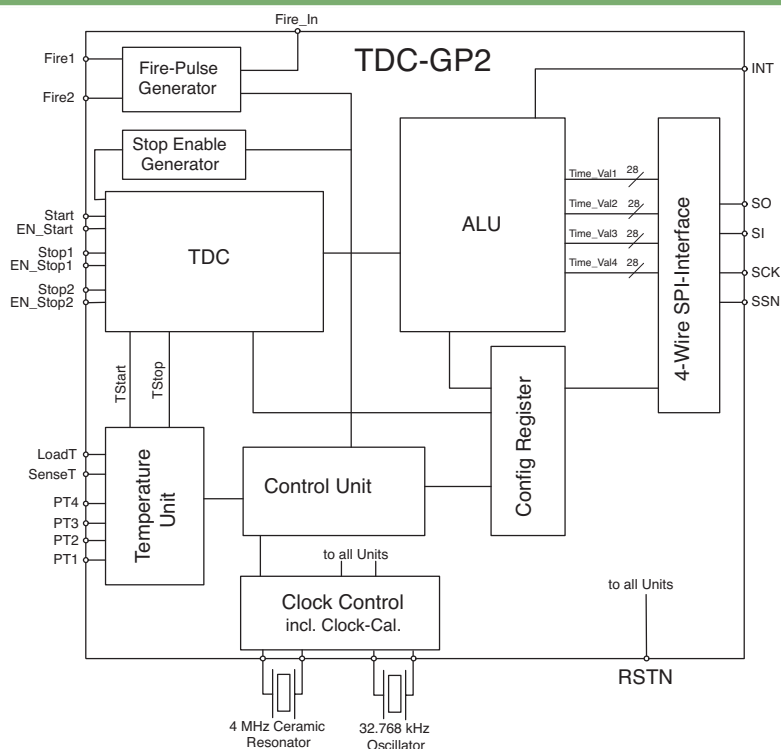
Measurement range 2

- 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 μ A 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

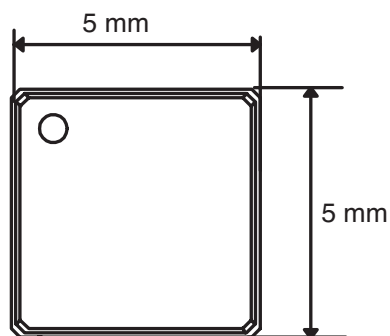
- Ultrasonic heat meters
- Ultrasonic flow meters
- Laser range finders
- Laser scanners
- Magnetostrictive positioning

Mode	Channels	Resolution	Range	No. of Hits
Measurement range 1	2	65 ps (50 ps rms)	0 ns to 1.8 μ s	2 x 4
Measurement range 2	1	65 ps (50 ps rms)	500 ns to 4 ms	1 x 3
Temperature	4	16 Bit (0.004°C with Pt-sensors)	Pt500, Pt1000	

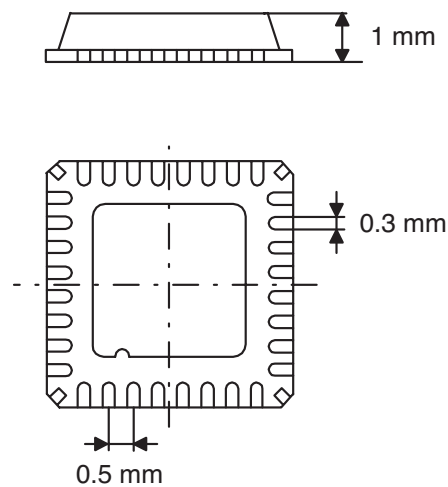
Package Outline

QFN32 Package

Top View



Bottom View



Original Size

Applications:

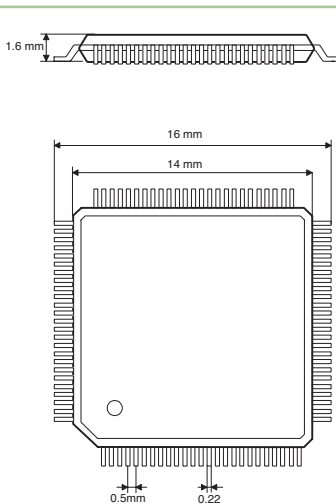
- Laser scanner
- Time-of-flight spectroscopy
- Time-of-flight measurement
- Biomedical technology
- Automated test equipment (ATE)



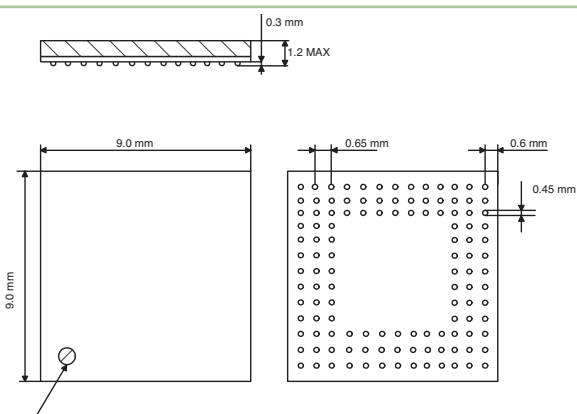
Mode	Channels	Resolution	Max. Rate	Range	No. of Hits
I-Mode	8	81 ps	Stop: 10 MHz/ch. (200 MHz peak) Start: 7 MHz	0 ns to 9.4 μ s or unlimited	≥ 32
G-Mode	2	41 ps	Stop: 20 MHz/ch. (200 MHz peak) Start: 5 MHz	0 ns to 64 μ s	≥ 32
R-Mode	2	27 ps	Stop: 40 MHz/ch. (200 MHz peak) Start: 9 MHz	0 ns to 40 μ s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

Package Outline

TQFP 100 Package



TFBGA 120 Package



Original Size



Original Size

1.5 ATMD Evaluation System

General Description

Get started with our PC-based evaluation system. The ATMD (Acam Time Measuring Device) is a universal measuring instrument for high precision time interval measurements. It is designed as an evaluation kit to assist designers and to shorten development time for TDCs and for small laboratory field tests. 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 various plug-in modules are all based on our integrated TDC chips. Therefore, the measuring performance varies from 2 channels with 10 ps rms to 8 channels with 120 ps, depending on which TDC is used. In polling mode, the PC communicates directly with the TDC chips on the modules. 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.

Each system is supplied together with a graphical user interface that allows simple setup of all the relevant registers of the TDCs. The measurement data can be displayed graphically as plot or histogram. A data export function is implemented for data postprocessing. Acam offers C++ sample code for a variety of applications to assist users in writing their own software. For LabView applications, drivers are also available to install the ATMD as a NI-VISA device.

In short, ATMD is a tool that provides a great opportunity to learn more about acam's TDCs in a very short time. Developers/users can see immediately the performance they can expect in their application without wasting time with software development and bread-boarding components.

Available Modules



Features

- PC-supported system
- Communication via PCI interface
- Modular system design with plug-in modules for each acam TDC
- Graphical interface software
- Samples for writing custom C++ programs
- Two operating modes
 - a: Polling mode: up to approx. 300k 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 (1k default, expandable to 32k)
- No additional power supply for the external motherboard

Available Modules

AM-GP1

Plug-in module based on TDC-GP1. 2 channels with 250 ps or 1 channel with 125 ps.

AM-GP2

Plug-in module based on TDC-GP2. 2 channels with 65 ps (50 ps rms). Temperature measurement port. Fire pulse generator port.

AM-GPX

Plug-in module with TDC-GPX. 8 channels with 81 ps, 2 channels with 41 ps to 10 ps resolution.

Module Accessory



2.1 PICO STRAIN – Innovative Front-End for

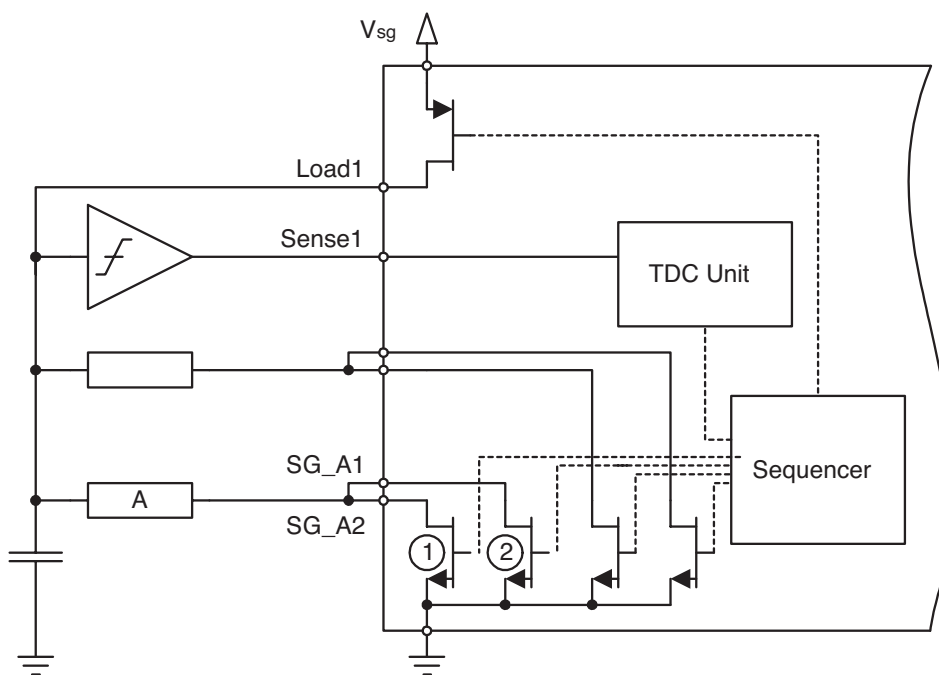
PICO STRAIN® stands for an innovative digital concept to measure strain gages. It sets new benchmarks in weighing technology. The ultra-low current consumption, not only of the chip but of the sensor, opens up a wide range of new design options to the customer. Smaller batteries, solar cell, and wireless are the key-words that highlight the weighing applications which benefit from PICO STRAIN.

Metal strain gages change their resistance value with mechanical deformation. The resistance variation is a measure of the weight or force. PICO STRAIN 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 PICO STRAIN, 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, PICO STRAIN 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.

Measuring Principle



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.

Integrated Circuits					
Product	Part No.	Package	Standard Pack Quantity	Package Carrier	Description
PSØ21	1002	TQFP48	250	Tray	Digital amplifier for strain gages
PSØ21FN	1001	QFN48	260		
PSØ8	1223	Dice/Wafer			System-on-Chip solution for weigh scales with MCU, LCD driver, ROM and EEPROM
PSØ8FN	1224	QFN56	4000	T&R	
Systems					
Product	Part No.	Description			
PSA21-STD	984	Evaluation system based on PSØ21 for PICOSTRAIN standard bridges			
PSA21-WSB	985	Evaluation system based on PSØ21 for Wheatstone bridges			
PSØ8-EVA-KIT	1489	Evaluation kit for PSØ8 System-on-Chip for weigh scales - including baseboard with 3 plug-in modules - Programmer - 10 kg loadcell - Assembler and evaluation software			
PICOPROG	1278	Programmer			
ALCS 350	1163	Load cell simulator			
Modules					
Product	Part No.	Description			
PSA21mini-STD	990	PSØ21 Plug-in module for PICOSTRAIN standard bridges			
PSA21mini-WSB	991	PSØ21 Plug-in module for Wheatstone bridges			
PSØ8-EVA-STD	1500	PSØ8 standard plug-in module 2-layer for PSØ8-EVA-Kit			
PSØ8-EVA-HR	1510	PSØ8 high resolution plug-in module 4-layer for PSØ8-EVA-Kit			
PSØ8-EVA-WH	1501	PSØ8 Wheatstone plug-in module 4-layer for PSØ8-EVA-Kit			

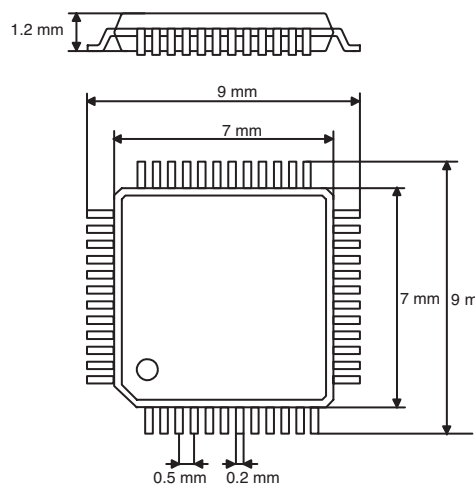
Applications

- 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

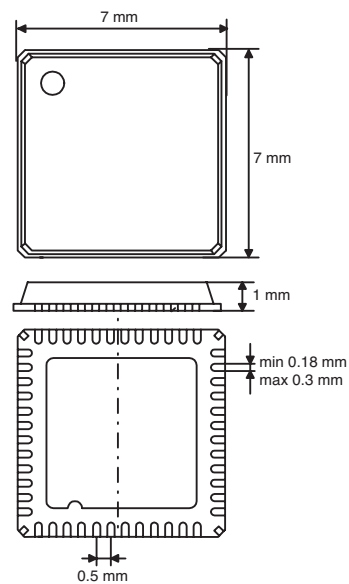


Package Outline

TQFP48 Package



QFN48 Package



2.3 PS08

General Description

PS08 is a System-on-Chip for ultra low-power and high resolution applications. It was designed especially for weigh scales but is also suitable for any kind of force or torque measurements based on metal strain gages. It takes full advantage of the digital measuring principle of PICO STRAIN. Thus it combines the performance of a 28-bit signal converter with a 24-bit microprocessor. Additional elements, such as an LCD driver, 3k ROM with many complex pre-defined functions, 1k EEPROM program memory, and an integrated 10 kHz oscillator, round off the device. A minimum quantity of external components is necessary to build a complete weighing electronic system.

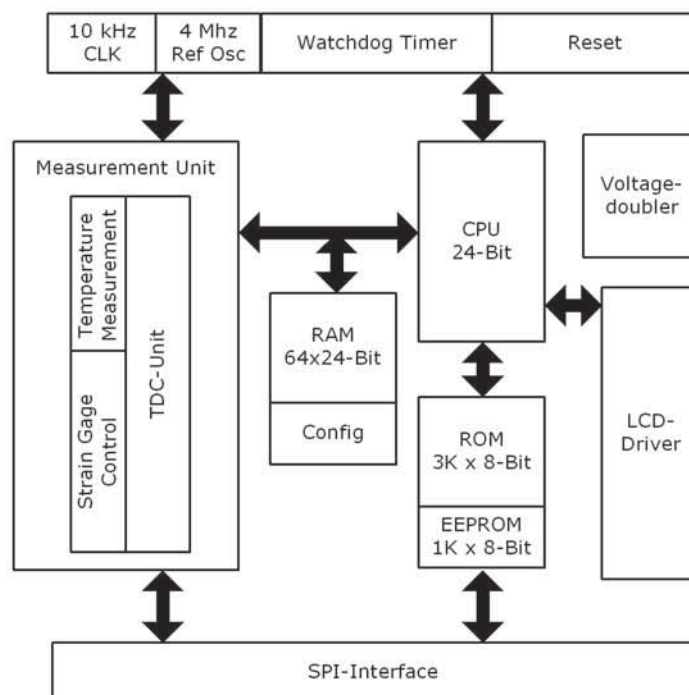
For the first time it is possible with the PS08 build solar-cell-driven weigh scales based on metal strain gages. A sophisticated power management and the special features of the PICO STRAIN measuring principle can reduce total system current down to 15 μA – including sensor current. As a result, the PS08 is perfectly suited for battery-driven or solar-cell-driven weigh scales.

On the other hand, the PS08 offers a high resolution comparable to high-end ADCs. It demonstrates top performance with a maximum of 1 million internal divisions (150,000 stable display divisions). However, it wins over ADCs when it comes to current consumption. With the PS08, you can build statutory compliant industrial scales that run on 2 AA batteries for over 1500 operating hours.

A look at other innovations, such as software adjustment of offset and gain compensation, reveals that the PS08 opens the door to new, innovative product solutions.



System Architecture



Features

- PICOSTRAIN front end with up to 1 million effective scale divisions (@2mV/V) = 150,000 Peak-Peak Div.
- 24-bit microprocessor
- 1k 8-bit EEPROM program memory, read protected
- 3k ROM powerful program code, e.g. 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 <math>< 1 \mu\text{A}</math>
- 5 programmable I/O ports
- 4 x 14, 3 x 15, 2 x 16 LCD driver
- Embedded charge pump for driving the LCD
- 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 2.2 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

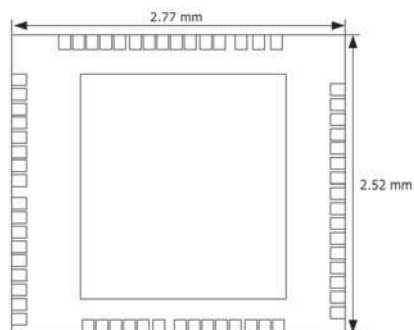
- Legal for trade scales
- Counting scales
- Torque indicators

Consumer

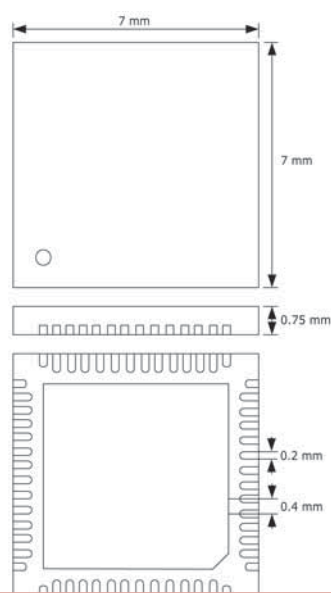
- Solar scales
- Body scales
- Kitchen scales
- Postal scales
- Package scales

Package Outline

DICE



QFN56 Package



■ Original Size

■ Original Size

2.4 PSØ8-EVA-KIT

General Description

Plug it, test it, and be convinced. That's the aim of the PSØ8 evaluation kit. Therefore this is not just a PCB but a complete weighing system with weighing platform and comfortable measurement software. The electronic system comprises a motherboard with three 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 PSØ8. The effect on the measurement quality can be immediately seen on the digital display or the alternate graphical display. Standard configurations can be loaded to obtain immediate measurement results.

The assembler and debugger tool is supplied so that you can write your 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. It is fully supported by an online help function and a set of samples speeds up the startup phase.



System Overview

PSØ8-EVAL-MB main board

- LCD display 22 x 51 mm²
- Power select by 3 jumpers:
- Solar panel 55 x 20 mm²
- Battery holder for CR2032
- Wall power supply, voltage selectable by on-board jumpers
- 4 pushbuttons
- Serial interface to PICOPROG programmer

PSØ8-EVA-HR high-resolution module

- For up to 100,000 stable scale divisions & solar applications
- 4 half-bridges
- 4 layer PCB

PSØ8-EVA-STD standard module

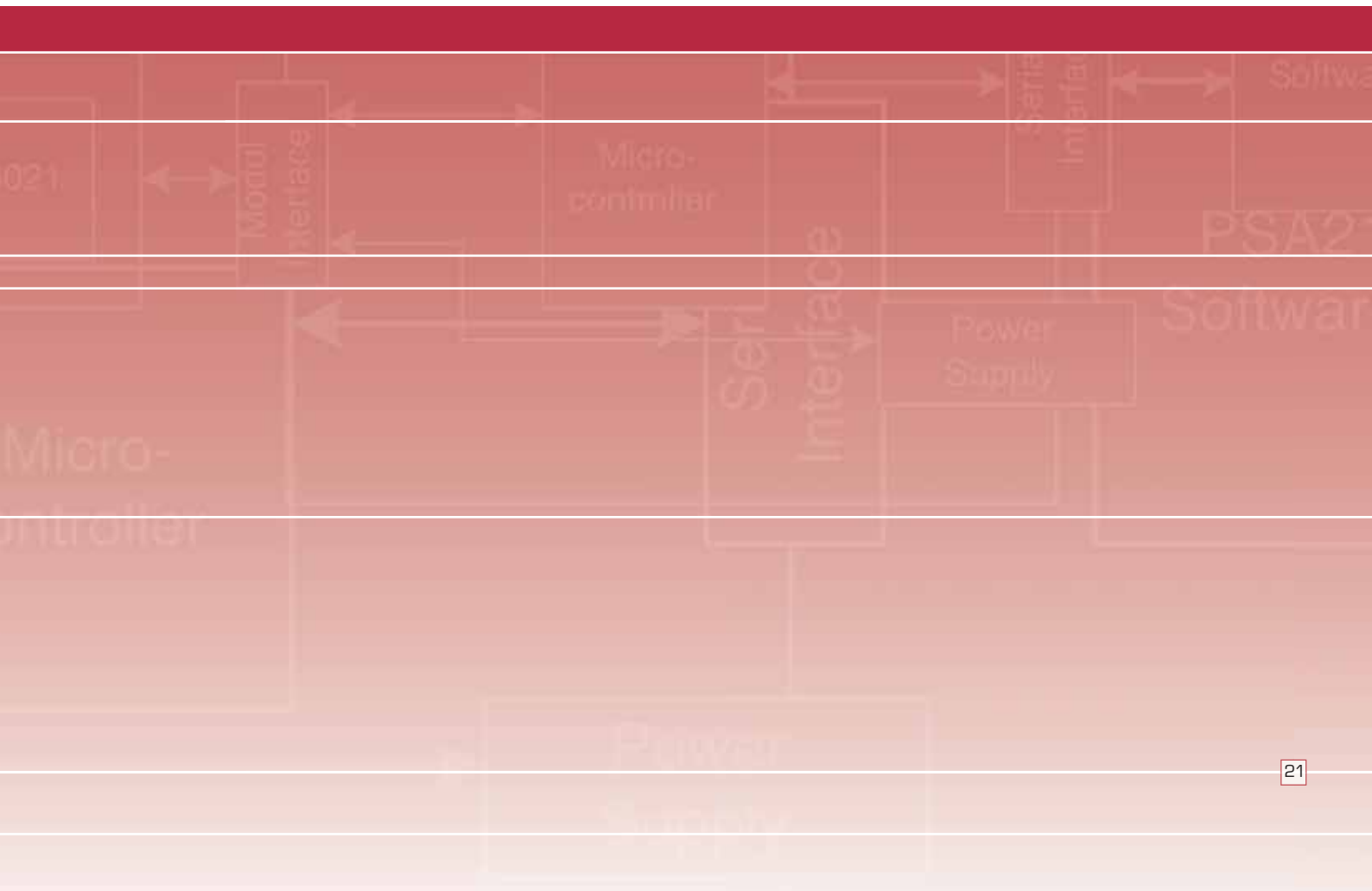
- For up to 10,000 stable scale divisions
- 4 half-bridges
- 2 layer PCB

PSØ8-EVA-WB Wheatstone module

- For up to 60,000 stable scale divisions with classical load cells
- 1 Wheatstone bridge
- 4 layer PCB

Accessories

- PICOPROG
- 10 kg load cell
 - 350 Ohm sensors
 - Mounted on platform
 - Wired as 2 half bridges with 1 span compensation resistor



2.5 PSA21

General Description

Get acquainted with the PSØ21 and its PICO STRAIN 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 PICO STRAIN-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

PSA21 mini-STD

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

PSA21 mini-WSB

Wheatstone plug-in module for measuring up to 2 Wheatstone bridges



2.6 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, PICO-STRAIN). The ALCS-350 simulates two separate half-bridges or one full-bridge. The full-bridge can be connected to a Wheatstone or PICO-STRAIN 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, PICO-STRAIN)
- 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. $\pm 0.02\%$ of F.S.

Zero point: typ. ± 0.002 mV/V

Drift offset: typ. < 0.2 $\mu\text{V}/\text{V}/\text{K}$, gain: typ. < 0.5 ppm/K

Applications

- Weighing electronics evaluation
- Systematic qualification tests
- Automated batch testing



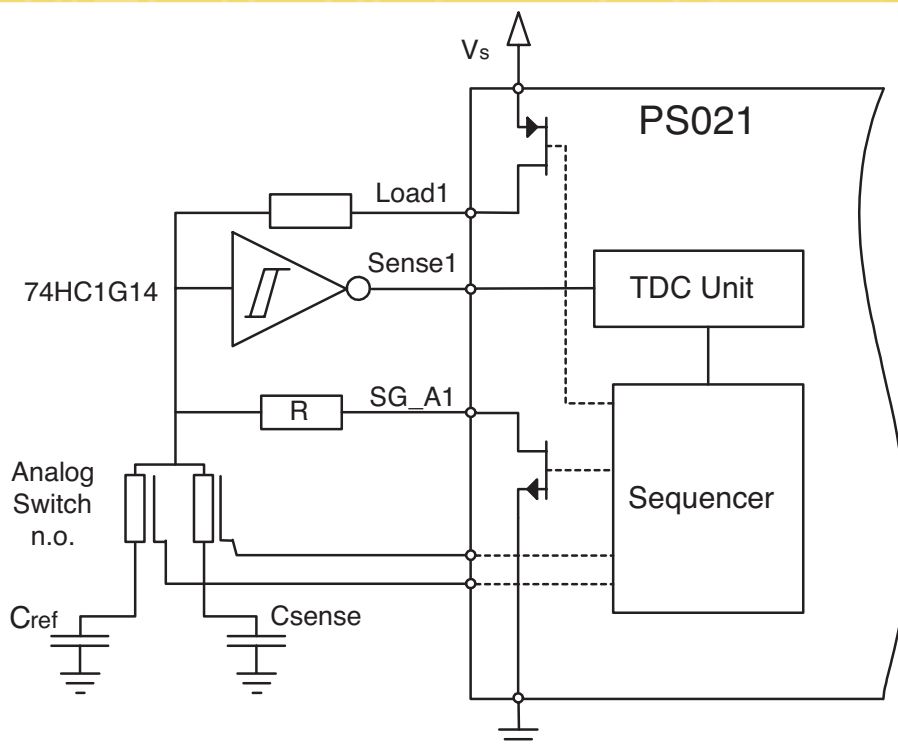
3.1 PICOCAP – Capacitance-to-Digital Converter

The 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 50 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 capacitor 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. Patent-pending algorithms provide an excellent suppression of parasitic capacities and ensure very good temperature stability.

Measuring Principle



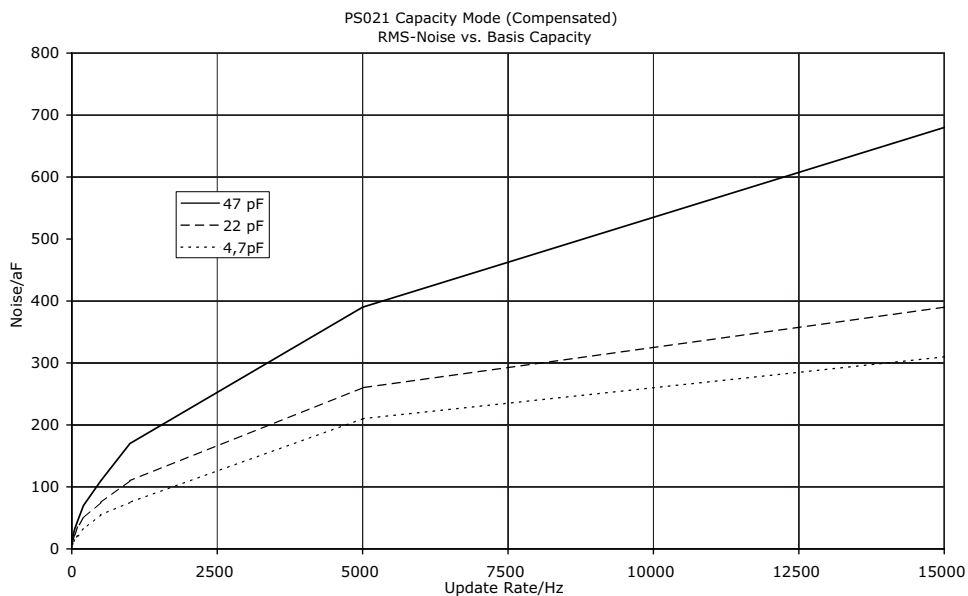
Applications

- Pressure sensors
- Acceleration sensors
- Motion sensors
- Position sensors
- Industrial control
- Thickness measurement

PICOCAP Products Overview

Part No.	Product	Description	Package
Integrated Circuits			
1002	PSØ21	Capacitance-to-Digital Converter	TQFP48
1001	PSØ21FN	Capacitance-to-Digital Converter	QFN48
Evaluation System (incl. software and cables)			
986	PSA21-CAP	Evaluation system for PICOCAP capacitance measurement based on PSØ21	
Plug-in Modules			
992	PSA21mini-CAP	Plug-in module based on PSØ21 for capacitance measurements	

Typical Resolution



3.2 PS021 – Capacitance-to-Digital Converter

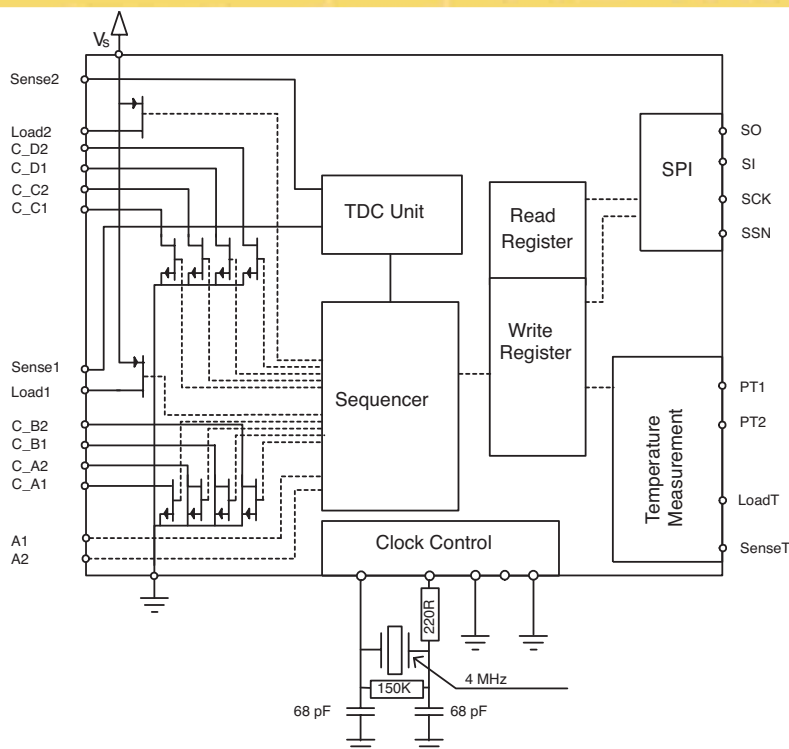
General Description

The PS021 provides a new digital concept for capacitance measurement based on TDC technology. With the innovative PICOCAP measuring principle, the PS021 provides a high degree of flexibility. It can be utilized with a wide capacitance range from nearly 0 pF up to hundreds of nF. It fits into applications with measuring rates up to 50 kHz as well as for extremely low power solutions down to 10 μ A. The PS021 is capable of measuring up to 4 sensors at resolutions up to 22 ENOB, depending on the measuring rate. An additional port for temperature measurement, patented compensation methods, and a serial SPI interface complete the PS021 as an innovative front end for various applications. The PS021 supports single and differential sensors. For single capacitance sensors, the linearizing mathematical calculation is already integrated in the PS021.

Features

- Up to 4 sensor pairs (4x2 C) without compensation
- One sensor pair (1x2 C) with compensation
- Digital measuring principle in CMOS technology
- For floating and grounded capacitors
- For single and differential sensors
- Internal TDC with 18 ps rms resolution
- Programmable resolution
(Up to 6 aF rms at 10 Hz and 5 pF C_{sense})
- Measuring rate up to 50 kHz
- Extremely low current consumption
(down to 10 μ A at 10 Hz and 500 aF rms resolution)
- High stability with temperature, low offset drift
- Separate temperature measurement port
- Serial interface (SPI-compatible)
- Very wide capacitance range from 0 fF to tens of nF
(no limitation)
- Extremely low gain error in compensated mode
(typ. 7 ppm / K)

Block Diagram



Applications

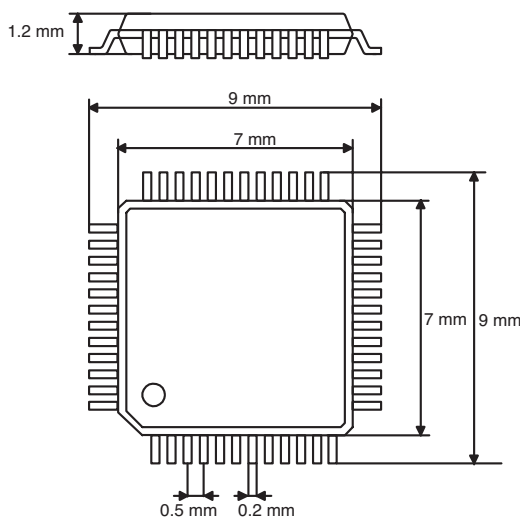
- Separate power supply for SPI interface with level shifter
- Wide temperature range -40°C to 125°C
- I/O supply voltage 1.8 to 5.5 V
- PS021 supply voltage 1.8 to 3.6 V
- TQFP48 / QFN48 package ($7 \times 7 \text{ mm}^2$ body size)

- Force sensors
- Pressure sensors
- Position sensors
- Solar-cell-driven devices
- Battery-driven devices
- Wireless applications
- Thickness measurement

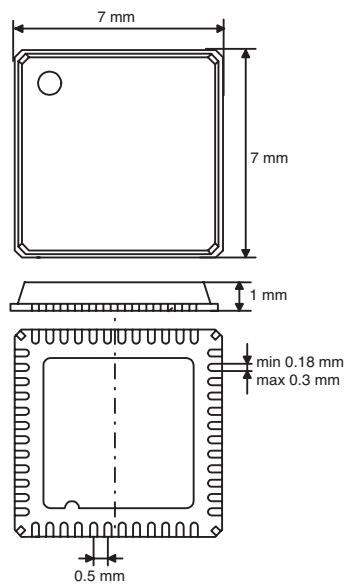


Technical Drawing

TQFP48 Package



QFN48 Package



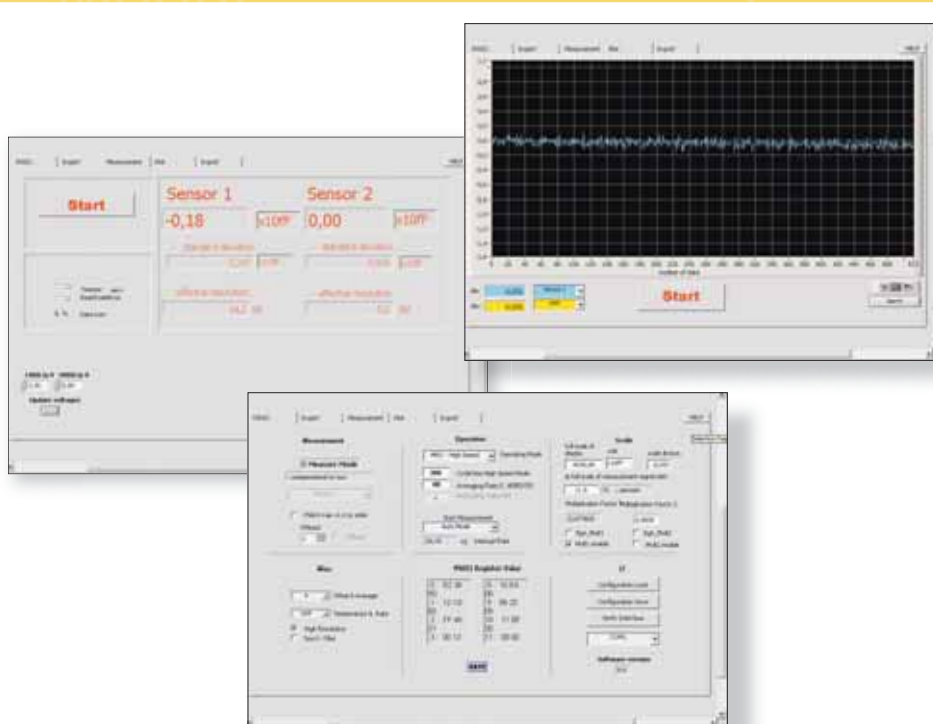
3.3 PSA21-CAP

General Description

The PSA21 evaluation system offers an easy and time-saving evaluation and measurement system, allowing the user to test the full functionality and performance of the PSØ21 in capacitance measurement applications. This provides an excellent 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 perform the first measurements within minutes. Experimenting with the various configuration parameters will accelerate understanding of the measuring principle and demonstrate the high flexibility with respect to precision, update rate, and power consumption. Finally, the PSA21 is an ideal tool to find the best configuration for the design engineer's specific application, thus shortening the design cycle.

The PSA21-CAP evaluation system includes the motherboard together with the capacitance plug-in module, the power supply, the cable, and a CD-ROM with all the necessary software and manuals. The PSA21 mini-CAP plug-in module offers 2 ways to measure a pair of grounded capacitors: uncompensated and compensated. It can be used for differential sensors or sensors with one variable capacitor and a reference capacitor.

System Overview



Features

- PC-supported system
- Communication via serial RS232 interface
- Modular system design with a plug-in module for capacitive sensors (further modules for strain gage measurements are available)
- 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 PS021 core (Vcc), PS021 I/O, and sensor (Vio)
- Shorting plugs for current measurement on board

Available Modules

PSA21 mini-CAP

Plug-in module for measuring a differential or a single capacitance sensor in compensated or uncompensated mode.



Micro-
controller

PSA2
Softwa

PSA2

4.1 PICOTURN – The Successful Solution To

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. This makes the system perfectly suited for the rough environmental conditions that can be found in an engine. The sensor is made of a simple coil with a ferrite core. Together with a resistor, this forms an R-L network; the time constant of this network is measured by a TDC (Time-to-Digital Converter). Placing a vane of the compressor wheel in front of the coil will change the time constant of the R-L network by the appearance of eddy currents. A DSP unit following the TDC measurement unit processes the time data and calculates the rotational speed. The time measurement is performed with very high precision, which allows a very small time constant of the R-L network. Therefore, the sampling rate can be as high as 800,000 samples per second.



Available Products

First Generation					
Part No.	Product	Description			
Electronic Devices					
1242	PICOTURN-BM V6	Signal processor box 200 to 400,000 rpm, 8 to 30 V, -40 °C to +85 °C			
1244*	PICOTURN-BM V6L *	Signal processor box as above, but with 7-pole LEMO connector for signal and supply voltage			
890	PICOTURN-CT	Calibration device for PICOTURN controller units			
1238	PICOTURN-DY	Display unit in rpm for PICOTURN-BM signal processor			
Sensors					
		Sensor Length/ Thread Length	Thread	Cable Length	Temperature Range
586	PICOTURN-SM5.1	60 mm / 54 mm	M5 x 0.8	1.5 m	-40°C to +180°C
607	PICOTURN-SM5.2	60 mm / 48 mm	M5 x 0.8 head 3.6 mm Ø	1.5 m	-40°C to +180°C
933(1126*)	PICOTURN-SM5.3(L*)	60 mm / 54 mm	M5 x 0,8	1.5 m (2 m)	-40°C to +230°C
938*(1127*)	PICOTURN-SM5.5*(L*)	46 mm / 40 mm	M5 x 0,8	1.5 m (2 m)	-40°C to +230°C
1059*	PICOTURN-SM5.6*	75 mm / 69 mm	M5 x 0.8	1.5 m	-40°C to +230°C
1065*	PICOTURN-SM5.7*	45 mm / 33 mm	M5 x 0.8 head 3.6mm Ø	1.5 m	-40°C to +180°C
934	PICOTURN-SM5F.2	41 mm / 25 mm	M5 x 0.5	1.5 m	-40°C to +230°C
1081	PICOTURN-SM5F.3	56 mm / 40 mm	M5 x 0.5	1.5 m	-40°C to +230°C
Accessories					
594 707**	Extension cable	Extension cable for sensor SMB/SMB 1,5 m			1,5 m length 2,5 m length**
647*	Adapter Cord L/O *	7-pole LEMO connector versus seven open ends, for controller unit PICOTURN-BM V6L			
1129	Fixing plate	Metal plate with bores, riveted to the box, for fixing purposes			

Second Generation – Available Q4/2008					
Part No.	Product	Description			
Intelligent Sensors with integrated signal processing and TTL output					
		Sensor Length/ Thread Length	Thread	Cable Length	Temperature Range
1537	PT2G-SM5.3	60 mm / 54 mm	M5 x 0.8	0.95 m	-40°C to +230°C
1538	PT2G-SM5F.3	56 mm / 40 mm	M5 x 0,5	0.95 m	-40°C to +230°C
Accessories					
1526	PT2G-BX	Signal conditioning box with RS232 interface			
1527	PT2G-BD	Signal conditioning box with display			
1539 1540	PT2G-CA02 PT2G-CA10	Cable connecting sensor and signal conditioning box			2 m length 10 m length
1541	PT2G-CP2B	Cable for power supply, Banana connectors, 2 m length			
1542	PT2G-CP2U	Cable for power supply and signals, unconnected cable end 2 m length			
1543	PT2G-CCT	Cable connecting sensors to PICOTURN-CT calibration device			

(*) on request

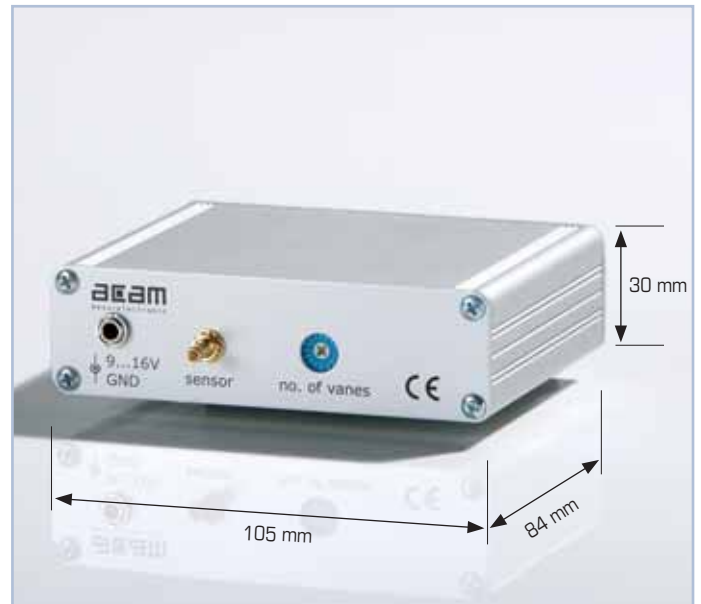
(**) not suitable for "L"-type sensors (with extra long cable), generally not recommended (keep cable short!)

4.2 PICOTURN-BM V6

General Description

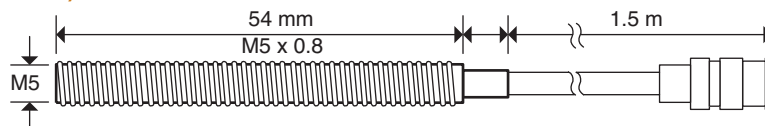
PICOTURN-BM V6 is well established as a compact and easy-to-use rotational speed measurement system for turbochargers. It is characterized by high sensitivity and high signal-to-noise ratio. This allows a large sensor-to-wheel spacing and makes the system also suited for measuring other than aluminium 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.

Dimensions

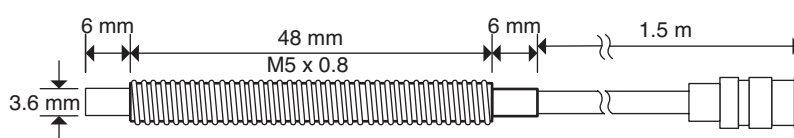


PICOTURN-SM Sensor Series

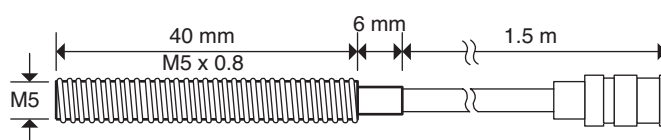
-SM5.1/ -SM5.3



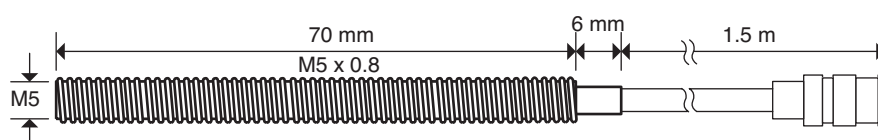
-SM5.2



-SM5.5

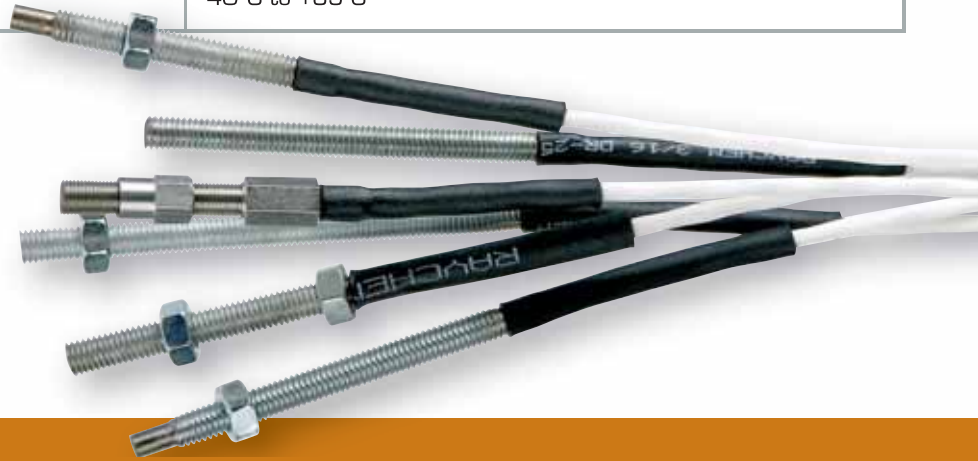


-SM5.6

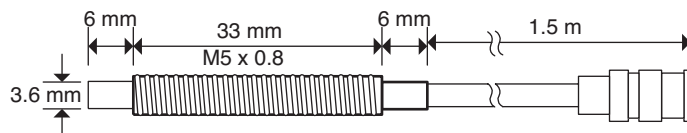


Technical Data

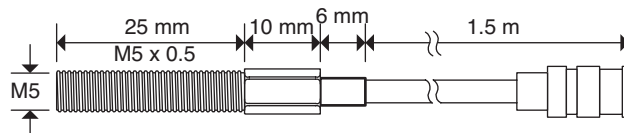
Case size W x H x L	105 x 30 x 85 mm ³ (4.1" x 1.18" x 3.35")
Supply voltage	8 to 30 V DC
Supply current	typ. 60 mA
Distance between vane and sensor (for vanes .6 mm thick)	~ 1.0 mm
Digital output	pulsed CMOS, 50% duty cycle, BNC type
Analog output	0.5 V to 4.5 V (80,000 rpm/V), BNC type
Number of vanes/pulse*	1 to 15 / 16 to 31 selectable by jumper If the analog output is used, the minimum vane number is 4
Operating temperature range controller	- 40°C to +85°C



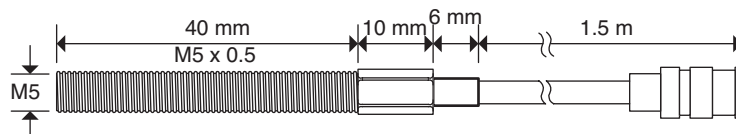
-SM5.7



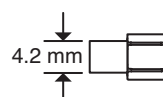
-SM5F.2



-SM5F.3



Clamping nut



4.3 PT2G – Second Generation PICOTURN

General Description

The application of PICOTURN in the engine bay is much easier with the second generation. The key to this are the intelligent sensors. 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.



Technical Data

<p>PT2G-SM...</p> <p>-SM5.3 -SM5F.3</p>	<p>Intelligent sensors Supply: 5 V/ 20 mA Output: CMOS 5V / 4 mA Temperature range: -40°C to +230°C (sensor head)/ +125°C (electronics) Total length: 0.95 m, Connector: AMP SuperSeal M5 thread, sensor head length 54 mm M5 fine thread, sensor head length 40 mm and various other variants on request</p>
<p>PT2G-B...</p> <p>-BX -BD</p>	<p>Signal conditioning boxes to relay rotational speed in rpm Size: 105 x 30 x 85 mm³ Supply: 9 to 36 V Power: -BX: 36 mA @ 24 V, max. 74 mA @ 9 V -BD: 59 mA @ 24 V, max. 120 mA @ 9 V Temperature range: -40°C to +85°C Digital out: CMOS 5V/20 mA, typ. 50% duty cycle, BNC connector Analog out: 0.5 to 4.5 V, 80,000 rpm/V, 260 Hz update rate, resolution typ. 390 rpm at 10 vanes</p> <p>RS232 interface, 38400 Baud, 5 digits time stamp, 6 digits speed in rpm Digital display in x1000 rpm, 4 digits, resolution 500 rpm</p>



4.4 PICOTURN-CT

General Description

The PICOTURN-CT is a calibration unit for the PICOTURN-BM controller. It simulates the behavior of a sensor mounted to a turbo charger. The calibration unit is connected to the PICOTURN-BM controller instead of a sensor. A very precise selectable vane frequency (revolution speed) is reproduced and allows the verification and calibration of the analog and digital output signals over the entire measurement range.

The PICOTURN-CT is designed for revolution speeds up to 360,000 rpm. The number of vanes on a virtual compressor wheel and its simulated revolution speed are selected by push-button and code switches. The adjustable number of virtual vanes ranges from 4 to 32.

The calibration unit itself does not measure revolution speed and can only be operated in combination with a PICOTURN-BM device.

Technical Data

Case size W x H x L	105 x 30 x 85 mm ³ (4.1' * 1.18' * 3.35')
Supply voltage / current	9 to 15 V DC / typ. 20 mA
Output signal	Digital pulsed CMOS signal simulates revolution speeds from 0 to 360,000 rpm in steps of 40,000 rpm
Operating temperature range	-40°C to +85°C
Number of vanes/pulse*	Adjustable in the range of 4 to 31 vanes
Pushbutton to adjust the simulated revolution speed	0 to 9 (0 rpm to 360,000 rpm)

PICOTURN-CT V1



General Description

The PICOTURN-DY is a display unit for the PICOTURN-BM controller which is used to display the rotational speed. The 4-digit display shows the speed in units of 1000 revolutions per minute (rpm) with three integer digits and one fractional digit. The precision of the display is 0.5 digits (500 rpm). The display

offers a peak hold function to keep the maximum speed value displayed for 1 to 3 seconds after an acceleration. This option can be switched off to display the actual speed with an update rate of 6 to 10 Hz. The input of the PICOTURN-DY has to be connected to the digital output of the PICOTURN-BM controller.

Technical Data

Case size W x H x L	105 x 30 x 85 mm ³ (4.1'*1.18'*3.35')
Display size W x H	63.5 x 19.1 mm ² (2.5'*0.75')
Supply voltage / current	8 to 35 V DC / typ. 100 mA@12V
Input signal	CMOS Schmitt trigger
Operating temperature range	-40°C to +85°C

PICOTURN-DY



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