PICOTURN-2G

Smart Sensors For Turbo Chargers

User's Guide

05 March 2009

acam - solutions in time

Precision Time-Interval Measurement

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1- The System And Its Advantages

PicoTurn® is a system for measuring the revolution speed of turbo chargers. Its functional principle is one-megahertz pulse induction and eddy current discrimination, performed with a solenoid sensor that is mounted in the compressor housing, through a bore. The sensor detects and counts compressor vanes one by one. When compared to optical detection, this inductive method benefits from its lack of sensitivity to dirt, oil and dust. When compared to the magnetized nut method, the PicoTurn system is safer as there is no concern with nuts coming loose and destroying the charger and the engine. When compared to a competing, entirely analog inductive vane counting system, the fully digital PicoTurn device turns out to be rugged, reliable, simple to use and very cost-effective.

Since 2001 PicoTurn® in its original "first" generation has proven advantageous in prototype vehicles and on engine test benches. It has been successfully used in passenger cars and in commercial vehicles. Made up of discrete electronic components, it has been developed in a continuous improvement process up to its sixth version ("PTBM-V6"). To continue the improvement, it was necessary to achieve a higher degree of integration by creating a dedicated CMOS integrated circuit ("chip" or “ASIC”) and as a result of this chip, the PicoTurn® Second Generation ("PT2G") was developed.

In the PT2G, part of the remote electronics has now been placed close to the sensor body for under-hood operation. Consequently, cable length and placement of the box have ceased to be an issue. Passenger car engineers can now place the box in the trunk, while the commercial car engineers can now use a 10 meter cable and loop it around the cabin hinge.

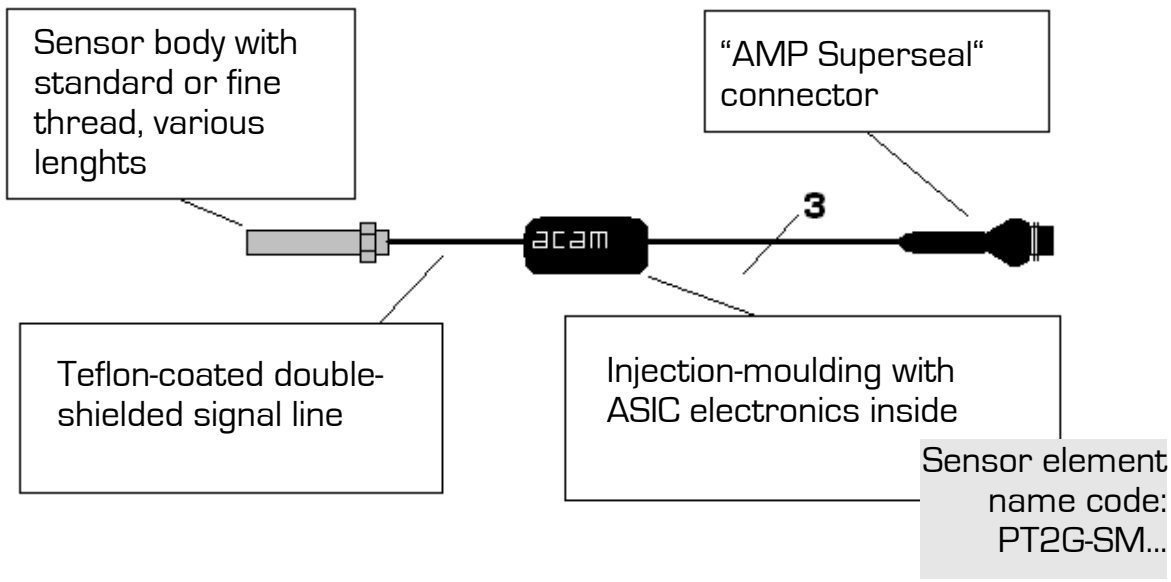
A further advantage of this new, Second Generation system is the wealth of interfaces available reducing the number of devices and cables needed. This is particularly useful in vehicles. When used in a bi-turbo environment, unique solutions occur that may be advantageous to many customers (i.e. directly connecting sensor elements to commercially available frequency counters providing two or more entry channels). This kind of counter solution is

somewhat expensive, so most customers are likely to prefer the inexpensive, dedicated PicoTurn conditioner (called "box") offered by ACAM. The measuring chain will then comprise the sensor element, the box and two signal cables plus one supply cable. Alternatively, a combined cable may be used that integrates the supply line. A "combi connector" will then be used instead of the BNC connectors from the First Generation system, which are still present. Furthermore, the customer will choose between pulse-coded, analog voltage coded, or alphanumeric data output (for alphanumeric, opt for the "RS-232" version of the box).

As before, the sensor solenoid is housed in a M5 threaded sleeve with two different pitches and various lengths available. Unlike earlier First Generation versions (PTBM-V1 to V6), the Second Generation system is no longer compatible with earlier components. First and second generation components must be handled separately. Sensor placement and system operation in general, however, remain unchanged.

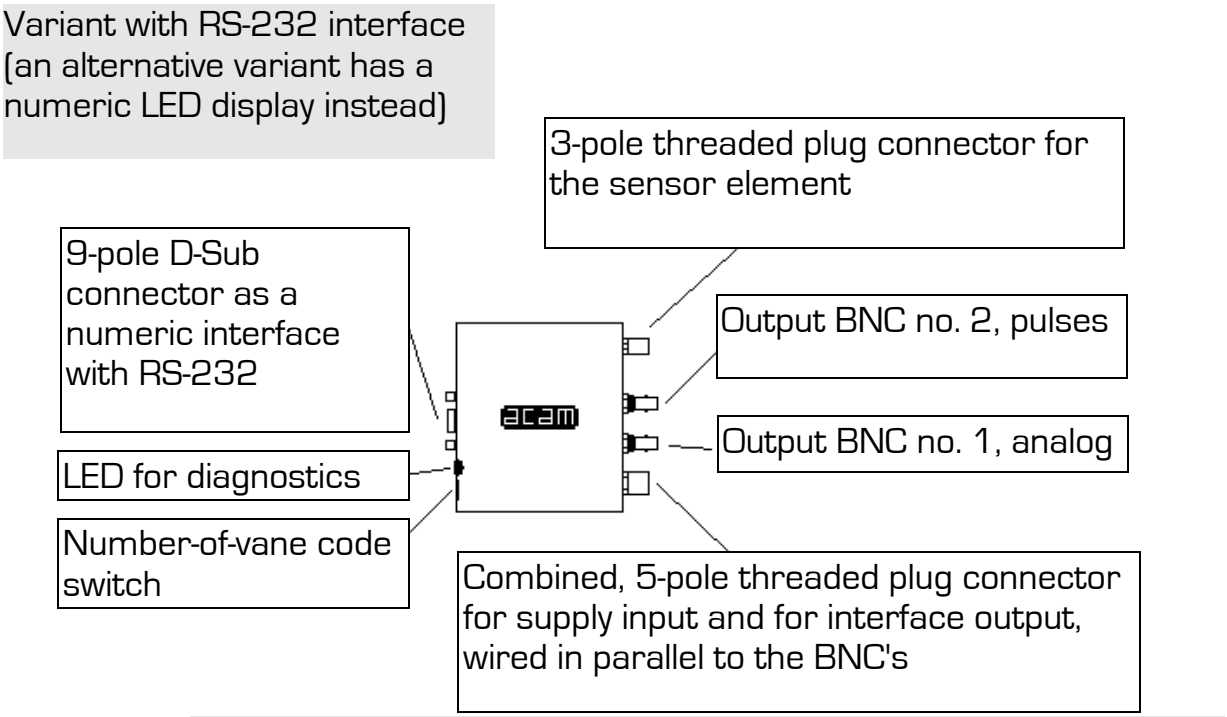
2- The System And Its Components

2.1- The Sensor Element



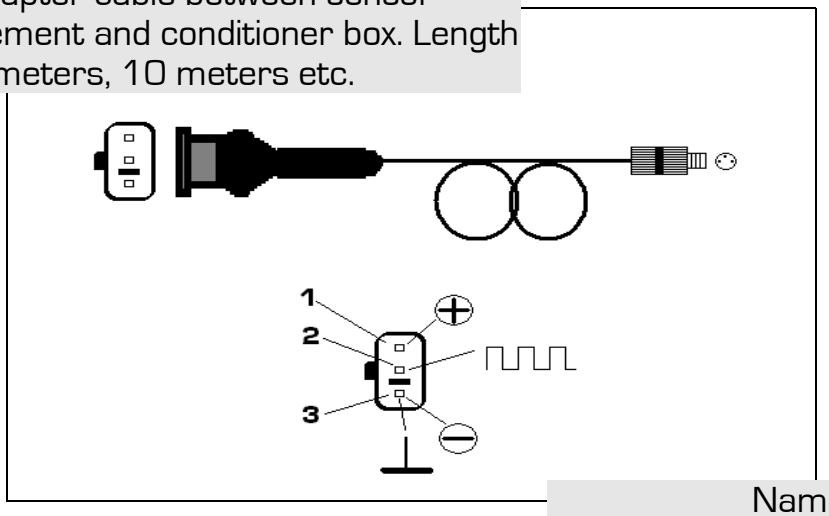
2.2- The "Box", Providing Signal Conditioning And Various Interfaces

Like in the PicoTurn First Generation system, the conditioner electronics has been placed in a light grey aluminium housing having the same BNC connectors and vane number selector as before. The female supply plugs have been removed for safety reasons. Instead, there is a 5-pole combination connector integrating power supply and interfaces, wired in parallel to the BNC connectors. Last but not least, the system still has a diagnostics LED, but with re-defined signal codes. Unlike the First Generation system, there is now an integrated seven-segment numeric display, which has the option of being replaced by a computer connector (9-pole D-Sub) for numeric data output.



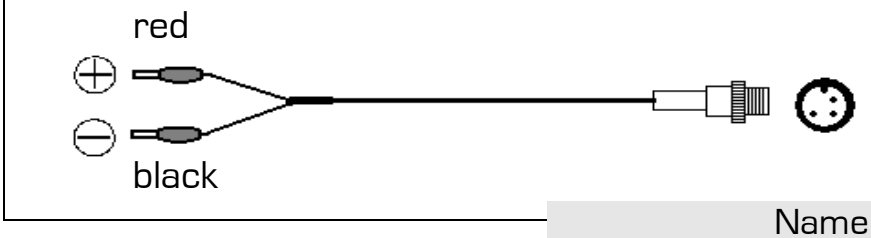
2.3- Standard Cables, Pin Assignment

Adapter cable between sensor element and conditioner box. Length 3 meters, 10 meters etc.



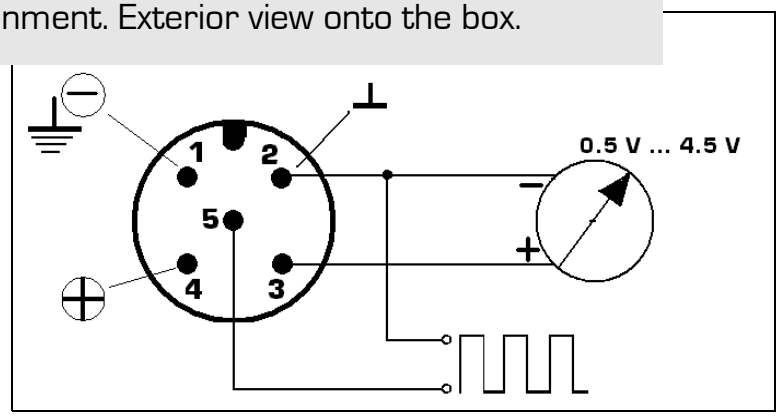
Name code: PT2G-CA...

Supply cable with or without 5 mm plugs, 2 meters in length



Name code: PT2G-CP

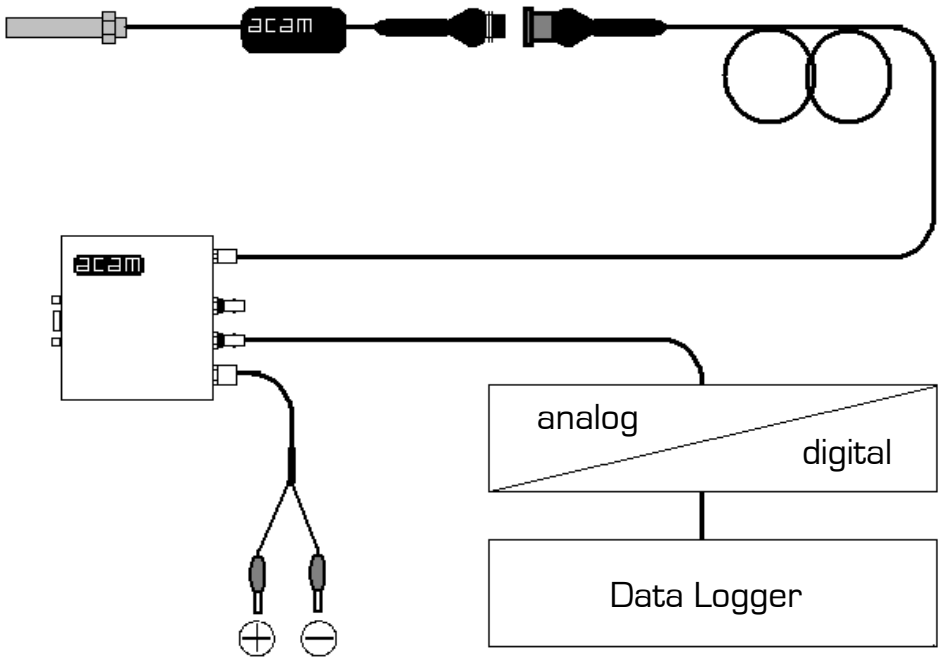
M12-thread 5-pole combi connector Pin assignment. Exterior view onto the box.

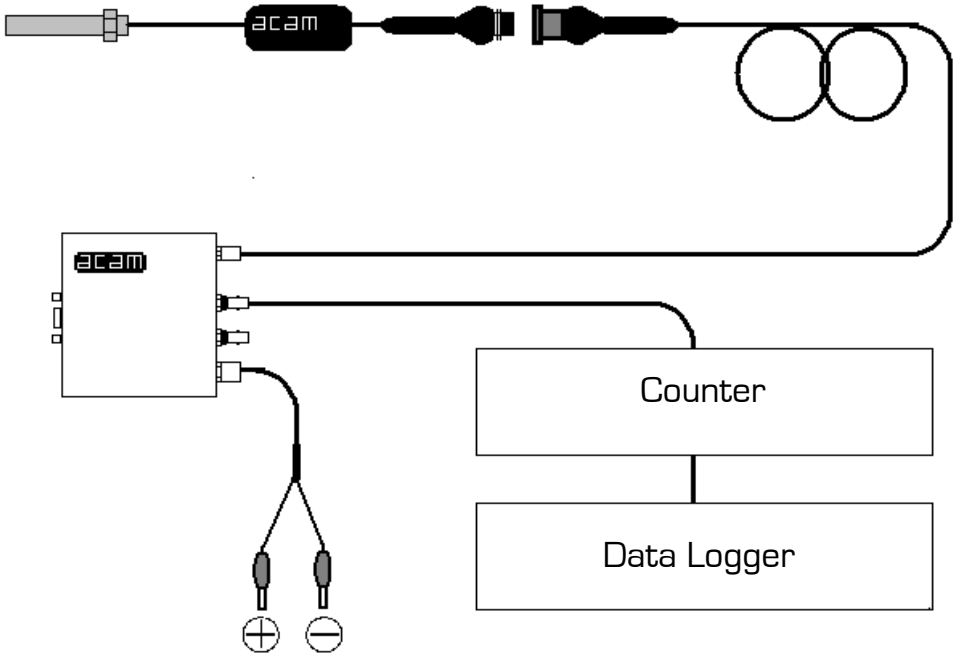


3- Connecting Possibilities

3.1- Standard Wiring

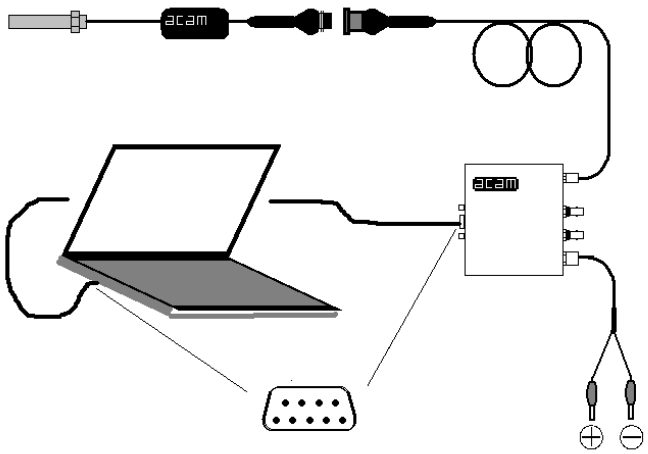
This wiring corresponds to the well-known PicoTurn First Generation system



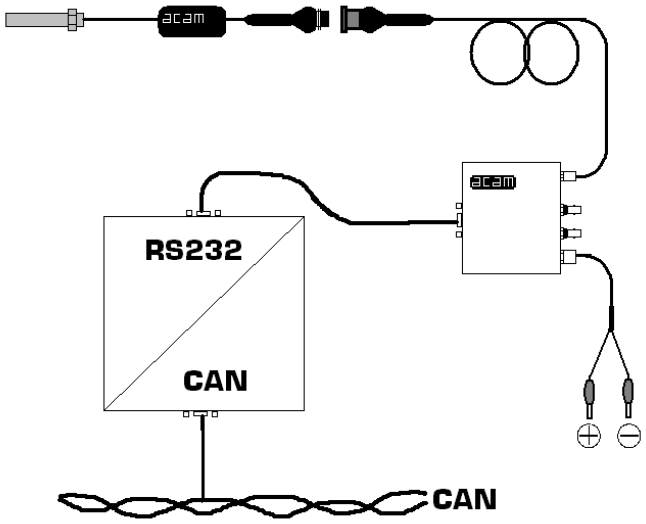


3.2- Other Connection Possibilities

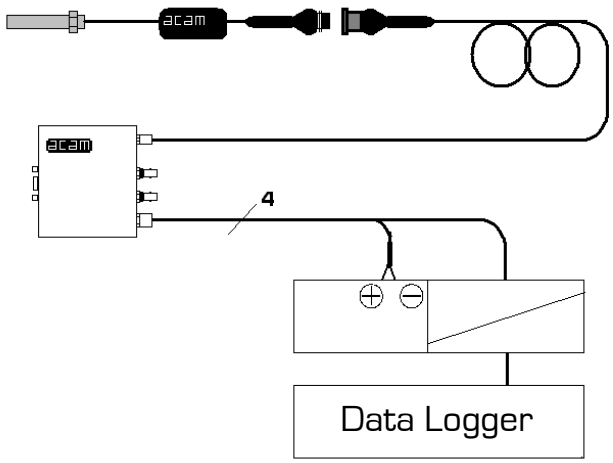
Laptop computer alone, via RS-232 at D-Sub 9-pole



Easy, simple and inexpensive PicoTurn-to-CAN bus solution

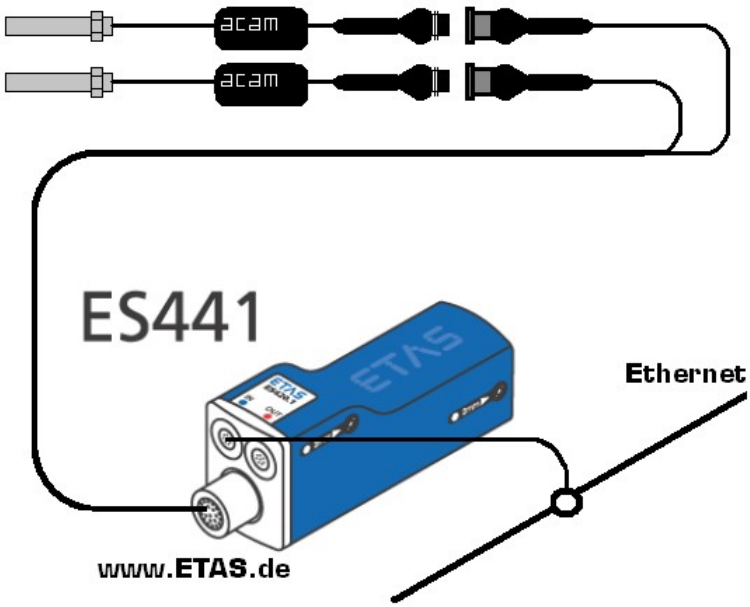


Combined-cable (anti-spaghetti) solution



3.3- Ultimate Connecting Possibility*

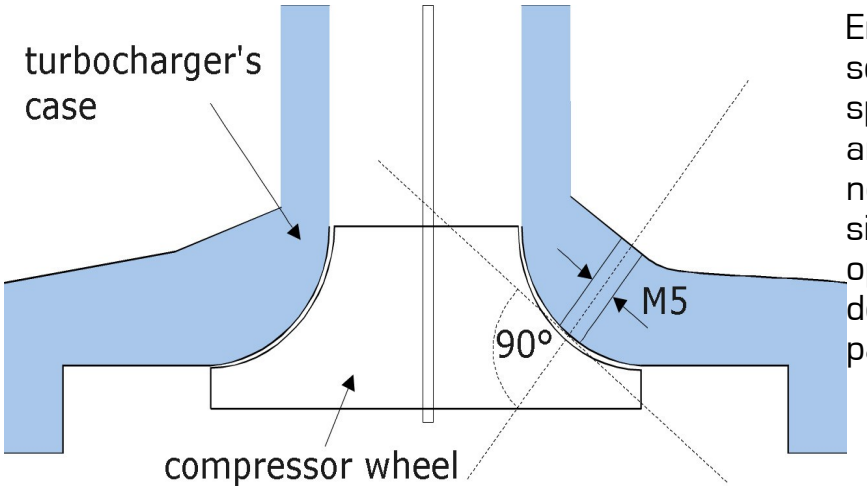
More expensive, but useful with bi-turbos



4- Sensor Application

The sensor body should be mounted as indicated (see photograph on page 2 and sketch below). Do not try to sense only every second vane. Instead sense all the vanes, both big and small. Place the sensor directly in front of the small vanes ("splitter vanes"), avoiding the vicinity of their upper edge (which could induce error into the system). The system is programmed to sense alternately thicker and thinner vanes. When the ninety-degree angle (see sketch) cannot be obtained due to adverse geometry, choose one of the reduced-tip sensors. Caution: reduced-tip sensors are less sensitive and less temperature-resistant than ordinary ones .

Lock torque: Important. The sensor body is not a 5 millimeter bolt, but merely a sleeve with some 0.3 mm thick walls. Apply only a fraction of the torque you would with a solid bolt, 0.3 Nm maximum (finger force, not fist force).



Environment: The sensor element with respect to its electronics and "superseal" connector has been designed for under-hood operation and is considered engine compartment tolerant.

*Please consult ETAS Inc. Stuttgart, Germany, www.etas.de

5- Technical Data For General Customers

Table 1: Sensor Tip To Compressor Vane Distance

Sensor/vanes distance	Passenger Cars	Commercial Vehicles
Minimum	not known, probably zero	approx. 0.5 mm
Maximum	approx. 1 mm	approx. 1.5 mm

These are approximate values for aluminium compressor wheels and for ordinary-tip sensors. Reduced-diameter tip yields 35% less sensitivity. Exact values depend on turbocharger geometry.

Table 2: Other Operating Conditions

Supply voltage (box)	9 to 36 volts DC	
Consumption (box)	RS-232 variant	36 mA @ 24 V
	LED display variant	59 mA @ 24 V
Temperature (box)	–40 °C to +85 °C (–40 °F to +185 °F)	
Dimensions (box)	105 mm x 85 mm x 30 mm	
Temperature (sensor element)	Cable and electronics	–40 °C to +125 °C (257 °F)
	Ordinary sensor tip	–40 °C to +230 °C** (446 °F)
	Reduced sensor tip	–40 °C to +180 °C (356 °F)
Dimensions (sensor body)	Fine thread M5x0.5 with various lengths 25 mm to 60 mm	
	Standard thread M5x0.8 with various lengths 40 mm to 70 mm	
Length of sensor element and its cable portions	From body to ASIC	approx. 0.75 meter
	From ASIC to "Superseal"	approx. 0.12 meter
	Total length sensor element	approx. 1.00 meter

** excess temperature tolerated for short periods

Table 3: Result Output And Metrological Characteristics

<table>
<tr><th>Interf.</th><th>Specification</th><th>Remarks</th></tr>
<tr><td>Analog-Out (voltage)</td><td>Analog voltage 0.5 to 4.5 volts
0.5 volts = standstill
4.5 volts = 320,000 r.p.m. subject to correct vane number setting</td><td>The output is set parallel between the BNC connector and the M12 combi connector
<table>
<tr><td>Range</td><td>0.5 to 4.5 volts</td></tr>
<tr><td>Slope</td><td>80,000 r.p.m./volt (subject to correct vane number setting)</td></tr>
<tr><td>Meas. Rate</td><td>approx. 260 Hz</td></tr>
<tr><td>Resolution</td><td>390 r.p.m. when set to 10 vanes</td></tr>
<tr><td>Precision</td><td>0.25 % end of scale</td></tr>
</table></td></tr>
<tr><td>Digital-Out (Pulses)</td><td>CMOS
5V / 10 mA
one impulse per revolution subject to correct vane number setting</td><td>The output is set parallel between the BNC connector and the M12 combi connector
<table>
<tr><td>Minimum speed</td><td>approx. 390 r.p.m.</td></tr>
<tr><td>Maximum speed</td><td>approx. 400'000 r.p.m.</td></tr>
<tr><td>Precision</td><td>approx. 390 r.p.m.</td></tr>
</table></td></tr>
<tr><td>Numeric output in ASCII over RS-232</td><td>Transfer rate 38400 baud,
8 bits,
no parity,
1 stop bit
("8N1")</td><td>Unidirectional interface, for measurement result output only. May be read with any port monitor including freeware (e.g. Putty.exe). Output format:
<table>
<tr><td>Time stamp</td><td><Tab></td><td>Measured value</td><td><CR> <LF></td></tr>
</table>
Subject to correct vane number setting, the output reads revolutions per minute. The time stamp is in multiples of T=38.4 ms. / Other: see Analog and Digital above.</td></tr>
</table>

Charging an interface with current may cause box to consume more than nominal value.

Table 4: Number-of-Vanes Setting

<table>
<tr><th>Setting</th><th>0</th><th>1</th><th colspan="2">2 ... 9</th><th>A</th><th>B</th><th>C</th><th>D</th><th>E</th><th>F</th></tr>
<tr><td rowspan="2">Meaning</td><td rowspan="2">Place mode</td><td rowspan="2">Same as setting 2</td><td colspan="2" rowspan="2">Two to nine vanes on compressor wheel</td><td>10</td><td>11</td><td>12</td><td>13</td><td>14</td><td>15</td></tr>
<tr><td colspan="6">Ten to fifteen vanes on compressor wheel</td></tr>
<tr><td rowspan="2">Alternative Meaning</td><td>16</td><td>17</td><td rowspan="2">2- 18
3- 19
...
8- 24
9- 25</td><td rowspan="2">18 to 25 vanes on the wheel</td><td>26</td><td>27</td><td>28</td><td>29</td><td>30</td><td>31</td></tr>
<tr><td colspan="2">16 and 17 vanes on the wheel</td><td colspan="6">26 to 31 vanes on the compressor wheel</td></tr>
</table>

The Place mode is a particular mode for adjusting the sensor-object distance. The alternative meaning (lower half of the table) is obtained after setting a jumper inside the box, please consult ACAM for details.

Table 5: Diagnostics Light-Emitting Diode

Mode	LED colour	Sensor element connected ?	Turbocharger state	Meaning
Measure-ment mode	black	no	indifferent	Supply or box n.ok
		yes	idle	Sensor element ok (1)
		yes	spinning (2)	Distance too big (1)
	red	no	indifferent	Supply & box ok
	green	yes	spinning (2)	Whole chain ok
"Place"-mode	red	yes	spinning (2)	Signal too weak/noisy
	green			Distance & signal ok

(1) provided, the LED turns red upon disconnecting the sensor

(2) to get the compressor wheel spinning, drive it with compressed air. The speed and the sense of the rotation are indifferent.

6- Technical Data for Specialists

Table 6: Pin Assignment 3-Pole "Superseal"

The conditioner box takes care of all the aspects listed (adequate power supply; interpretation of the raw pulses). Same for ETAS's ES 441, but please provide for half, not full frequency (a factor of 2 in your vane number division).

Pin	Pin name	Explanation
1	VCC	see Table 8
2	Signal	CMOS 5 volts, 4 mA max. The signal is square and symmetric. Every up or down change symbolizes one vane, leading to a **half** frequency pulse as compared to the vane appearance frequency
3	GND	Common ground for supply and signal

Table 7: Pin Assignment M12-Thread Combination Connector 5-Pole

Pin	Pin name	Explanation
1	GND	This is the supply ground, connected to the aluminium box.
2	Signal-GND	Signal ground, separated from supply ground.
3	Analog-Out (Voltage)	see Table 3
4	VCC	Supply voltage 9 to 36 volts DC
5	Digital-Out (Pulses)	see Table 3

Table 8: Electrical Operating Conditions For The Sensor Element Alone

Supply voltage	+5 volts DC +/- 0.25 volts, from linear voltage regulator
Consumption	20 mA

Remark: ACAM conditioner box as well as ETAS's counter module ES441 render an optimum supply voltage quality. Other supplies may be judged from standstill condition: A good low-noise power supply is necessary for a correct indication of zero speed. A more stringent specification is difficult to define and is not available at present. Generally speaking, linear voltage regulators are satisfactory, switching regulators are not.

7- Your Contact

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Local distributors	http://www.acam.de/company/distributors/	

8- Change Log

07.11.2008 German original

03.02.2009 Complete Revision

05.03.2009 Native speaker editing

CE

The products PICOTURN-V6 comply with EMC directive 89/336/EEC, applied standard DIN EN 61326, Equipment for Control and Laboratory (For use in electromagnetically controlled environment).
Generic immunity standard part 2 (EN 61000-4-4: 0,5KV, -4-6: 1V), In case of strong electromagnetic disturbances there might be a deviation of the output signal from the specification, but only for the duration of the disturbance.