



PICOTURN PTCM V1.0

Rotational Speed Sensor for Turbochargers

User Manual

Contact Information

Worldwide Offices

| | | | |
|--|--|---|--|
| United States +00 (1) 248 848 9200 | sales_us@accuratetechnologies.com support_us@accuratetechnologies.com | Japan +81 3 5325 6222 | sales_jp@accuratetechnologies.com support_jp@accuratetechnologies.com |
| China +86 138 1023 6357 | sales_cn@accuratetechnologies.com support_cn@accuratetechnologies.com | Sweden +46 (0) 31 773 7140 | sales_se@accuratetechnologies.com support_se@accuratetechnologies.com |
| France +33 (0) 1 72 76 26 10 | sales_fr@accuratetechnologies.com support_fr@accuratetechnologies.com | United Kingdom +44 (0) 1767 652 340 | sales_uk@accuratetechnologies.com support_uk@accuratetechnologies.com |
| Germany +49 (0) 89 9700 712 | sales_de@accuratetechnologies.com support_de@accuratetechnologies.com | Web Site | www.accuratetechnologies.com |
| India +91 80 41694218 | sales_in@accuratetechnologies.com support_in@accuratetechnologies.com | General +00 (1) 248 848 9200 | sales@accuratetechnologies.com support@accuratetechnologies.com |

Manufacturer/Supplier Information

Manufacturer

ams Sensors Germany GmbH
Friedrich-List-Strasse 4 76297
Stutensee Germany


Phone: +49 7244 74190
Fax: +49 7244 741929
Website: www.ams.com
Email: sales-europe@ams.com

Supplier

Accurate Technologies AB
Flöjelbergsgatan 14 C
431 37 Mölndal
Sweden

Phone: +46 (0) 31 773 7140
Email: sales_se@accuratetechnologies.com
support_se@accuratetechnologies.com

Documentation

| | | |
|---|--|------------------------------------|
|  | Document Category: User Manual | Document Version: 1.1 |
| | Release Type: Public | Status: Released |
| Document Number: DOC-474-1080 | Customer List: All | Publish Date: 11/30/2017 |
| Subject: User Manual for PICOTURN PTCM | | |
| Key words: PICOTURN | | |

ATI Copyright Information

© Copyright 2017 Accurate Technologies Inc. Novi, Michigan.

While Accurate Technologies, Inc. takes great care to ensure the accuracy and quality of these materials, all material is provided without any warranty whatsoever, including, but not limited to, the implied warranties of merchantability or fitness for a particular purpose.

The data in this document may not be altered or amended without special notification from Accurate Technologies Inc. Under no circumstances may any part of this document be copied, reproduced, transmitted, or translated into another language without the express written permission of Accurate Technologies, Inc.

Information in this document is subject to change without notice. The names and designations used in this document are trademarks or brands belonging to the respective owners. Published in the U.S.A

Contents

- Contact Information.....2**
- Contents4**
- 1 Important Safety Information5**
 - 1.1 Product Use.....5
 - 1.2 Installation5
 - 1.3 Signal Words and Symbols.....5
 - 1.4 Safety Messages.....5
- 2 Introduction6**
 - 2.1 PTCM V1.0.....6
 - 2.2 Set7
- 3 Technical Data8**
- 4 Mechanical Data.....9**
 - 4.1 PTCM Dimensions9
 - 4.2 Sensor Dimensions.....11
 - 4.3 Sensor Application11
- 5 PTCM Interface – Electrical Connections13**
 - 5.1 Analog Interface.....14
- 6 LED Display Functionality.....15**
 - 6.1 Diagnostics.....15
 - 6.2 Analog Signal for Optimal Sensor Positioning.....16
- 7 Internal Switches17**
 - 7.1 Number of Vanes – Code Switch.....17
 - 7.2 Measurement at High Signals Levels17
 - 7.3 Measurement Very High Rotational Speeds.....18
- 8 Ordering Information.....19**

1 Important Safety Information

1.1 Product Use

PICOTURN products are designed for industrial use. The intended use of the product is the measurement of speed of a turbocharger in a test bench environment or in driving tests. For proper installation and usage please follow the mounting instructions in this document. During operation of the test bench (including the motor and turbocharger), no persons must be present in the test room. For use in driving tests in which persons may be present, use the product in such a way that, in case of malfunctions or error, personnel and equipment are not endangered. Any use other than the one described above is considered as non-intended use and acam declines any liability with respect to such non-intended use.

1.2 Installation

The speed sensor should be installed by a qualified automotive technician. Please carefully read and follow the instructions given in this manual for proper installation and use of the product. Furthermore, please pay attention to any installation instructions given by the turbocharger manufacturer, especially for the mounting of the sensor on the turbocharger and its safe operation. If you have any questions or doubts regarding the installation or operation, please contact the distributor from whom you purchased the sensor or alternatively contact acam directly.

1.3 Signal Words and Symbols

The following symbols and signal words are used in this manual:



CAUTION indicates a hazardous situation which, if not avoided, could result in minor or moderate injury



NOTICE is used to address practices not related to physical injury

1.4 Safety Messages

The following list provides an overview of potential damage that can occur if the turbocharger sensor system is not operated as outlined in this manual.



Connect an adequate power supply (meeting the specifications for supply voltage and current) in accordance with safety regulations for electrical equipment. Otherwise, there is risk of injury and/or damage or destruction of the sensor and controller box.



Mount the sensor according to the installation instruction in this data sheet and/or the installation instructions of the turbocharger manufacturer. If the sensor is mounted incorrectly, the sensor itself; the turbocharger housing or the turbocharger wheel (blades) can be damaged. Particularly in the case where the sensor goes too far into the turbocharger cavity, the wheel blades may be touched and thus the turbo wheel damaged. As a consequence, single blades of the turbo wheel could be detached and go into the motor and cause further damage there.

2 Introduction

PICOTURN is a system for measuring the rotational speed of turbochargers. Its functional principle is one-megahertz pulse induction and eddy current discrimination, done with a solenoid sensor 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.

The system is made of a sensor with 1.5m cable, a signal-conditioning box and a cable for output and power supply. It is capable of speed measurement up to 400,000 rpm. The minimum speed is 200 rpm. The high sensitivity allows a large distance between sensor and the rotating vanes in the range of 1 mm at 0.6mm vane thickness. The sensor and box are IP67 proof in case the sensor is connected and fixed correctly.

Various sensors are available. They differentiate by the length and thread of the sensor head. The PTSM-H series in addition is optimized for high sensitivity, targeting titanium wheel and other critical applications.

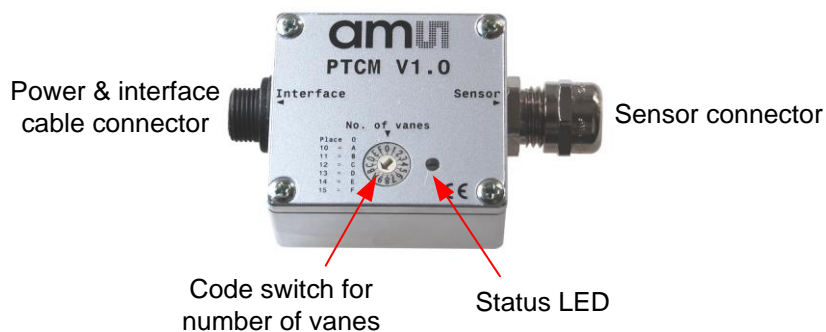
2.1 PTCM V1.0

The PTCM V1.0 signal-conditioning box drives the sensor, converts the sensor signal to rotational speed and provides this information as a digital pulse output or an analog output voltage. It is based on the PICOTURN-BM V6.2, reduced to a much smaller body size and now IP67 proof. It is compatible with PTSM sensors of the first generation.

PTCM has two interface connectors

- Sensor interface, internal SMB connector. Together with an elastic joint and an outer nut the sensor is additionally fixed and sealed to be IP67 proof.
- Power and signal interface. 8-pin connector for the power supply, the digital pulse interface and the analog interface with 0.5 V to 4.5 V.

The sensor detects every vane of the compressor wheel. Therefore, the number of vanes needs to be set according to the turbocharger in use to get the output voltage or, for the digital interface, to get one pulse per full turn. The number of vanes is programmable between 1 - 15 / 16 – 31. The 1 to 15 code switch and the switch for the higher number range are placed inside, but the position of the code switch can be seen through a window in the housing. The water-proof housing has to be opened to change the vane number.



2.2 Set

A complete set is made of three parts:

- PTCM V1.0
- Any sensor out the collection of sensors of the PT1G series
- Power and interface cable



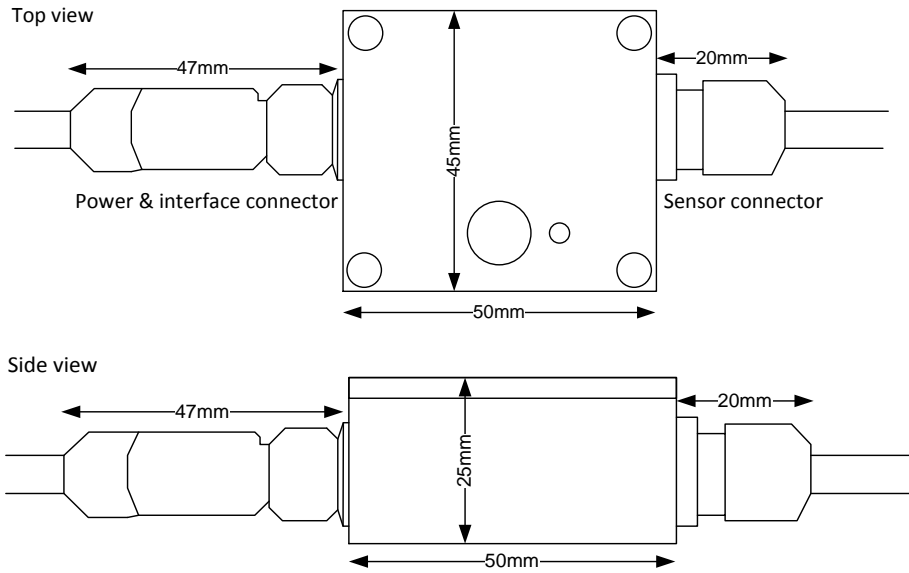
3 Technical Data

| | | | | | | | | |
|--|---|---|---|-------|----|-------|----|-------|
| Model | PTCM V1.0 | | | | | | | |
| Sensors | PTSM 5.3, PTSM 5.5, PTSM 5.6, PTSM 5F.2, PTSM 5F.3, PTSM 5F.5, | PTSM-H 5.3, PTSM-H 5.5, PTSM-H 5.6, PTSM-H 5F.2, PTSM-H 5F.3, PTSM-H 5F.5 | | | | | | |
| Target material | Aluminum | Aluminum, titanium | | | | | | |
| Operating temperature sensor tip | -40°C to 230°C, max. +250°C for 5 minutes | -40°C to 250°C, max. +280°C for 5 minutes | | | | | | |
| Operating temperature sensor cable | -40°C to 180°C | | | | | | | |
| Operating temperature PTCM | -40°C to 85°C | | | | | | | |
| Distance sensor tip to blade for AI | 1 to 2mm for passenger cars, 2 to 3mm for trucks. The maximum distance depends strongly on the turbocharger geometry, the vane thickness at the sensor tip and the alloy of the wheel. So only an indication can be given. | | | | | | | |
| Cable length sensor | 1.5m, no extension cable to be used | | | | | | | |
| Speed range | 200rpm to 400,000rpm | | | | | | | |
| Number of vanes | Digital out: 1 to 15, or 16 to 31, Analog out: 4 to 15, or 16 to 31, | | | | | | | |
| Digital output | Pulsed CMOS, 5V / 10 mA, 50% duty cycle, frequency precision 0.009% of full scale. One impulse per N vanes, N = 1 to 31 | | | | | | | |
| Analog output | Range 0.5 V to 4.5 V, 0.5 V = stand still, slope 80,000 rpm/V (subject to correct vane number setting) Measurement rate approximately 260 Hz, resolution 390 rpm when set to 10 vanes Voltage precision 0.5 % of full scale at 25°C Update rate at vane number N = | | | | | | | |
| | 4 | 104Hz | 7 | 182Hz | 10 | 260Hz | 13 | 339Hz |
| | 5 | 130Hz | 8 | 208Hz | 11 | 286Hz | 14 | 365Hz |
| | 6 | 156Hz | 9 | 234Hz | 12 | 313Hz | 15 | 391Hz |
| Power supply | 9 to 30V DC / typ. 45 mA | | | | | | | |
| Housing | 45mm x 50mm x 25mm, IP67 (when sensor connected) | | | | | | | |

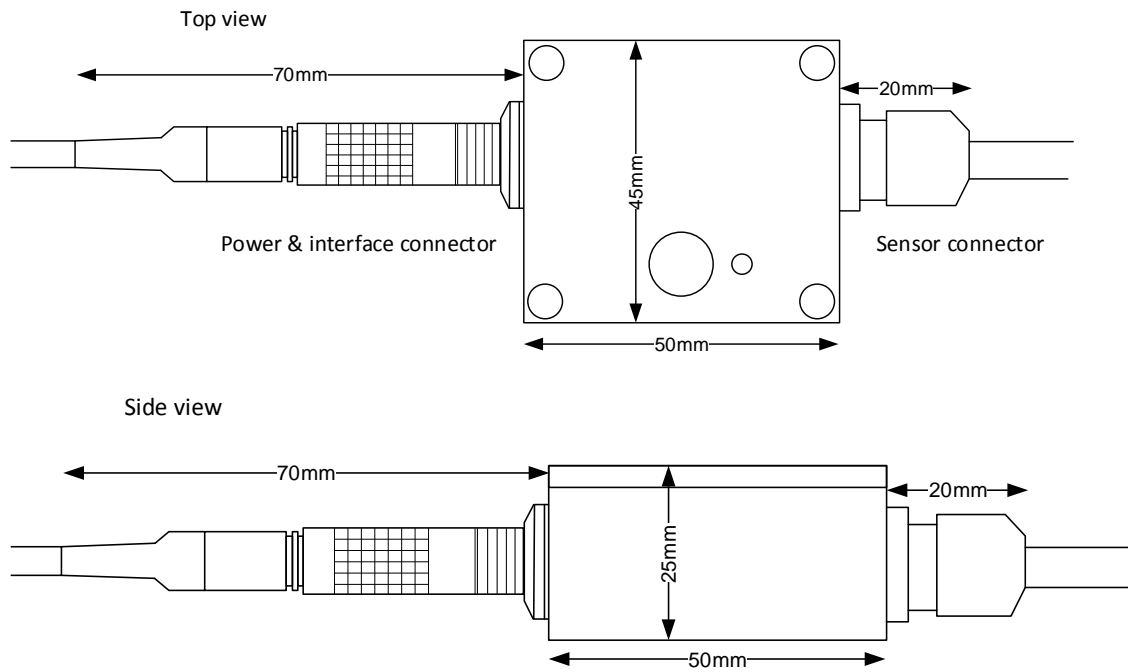
4 Mechanical Data

4.1 PTCM Dimensions

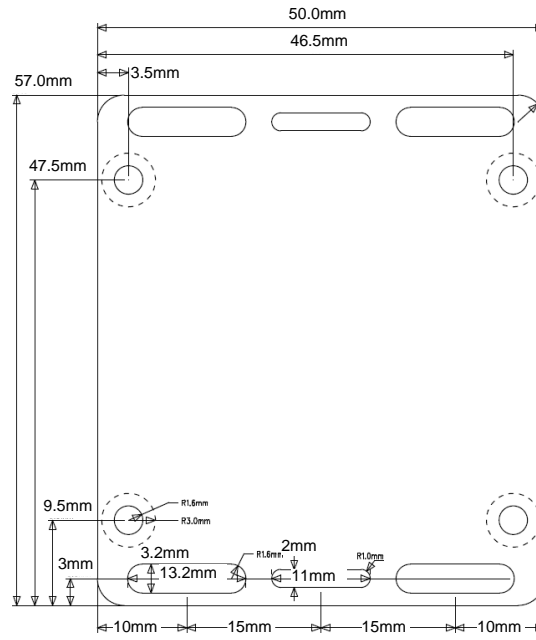
Standard version



LEMO version



Optional Fixing Plate



4.2 Sensor Dimensions

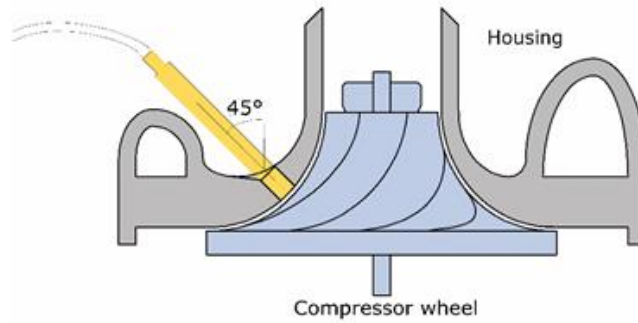
| Sensor | Drawing |
|------------------------|---------|
| PTSM 5.3, PTSM-H 5.3 | |
| PTSM 5.5, PTSM-H 5.5 | |
| PTSM 5.6, PTSM-H 5.6 | |
| PTSM 5F.2, PTSM-H 5F.2 | |
| PTSM 5F.3, PTSM-H 5F.3 | |
| PTSM 5F.5, PTSM-H 5F.5 | |

4.3 Sensor Application



Prior to the PICOTURN product installation, be sure that the turbocharger is cool.

In principle, the sensor body should be mounted as indicated (see sketch on the right). The compressor housing needs to be removed. Drill a hole into the case and cut a thread, according to the chosen sensor housing. Select the position of the hole so that every vane, both big and small, will be sensed. 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).

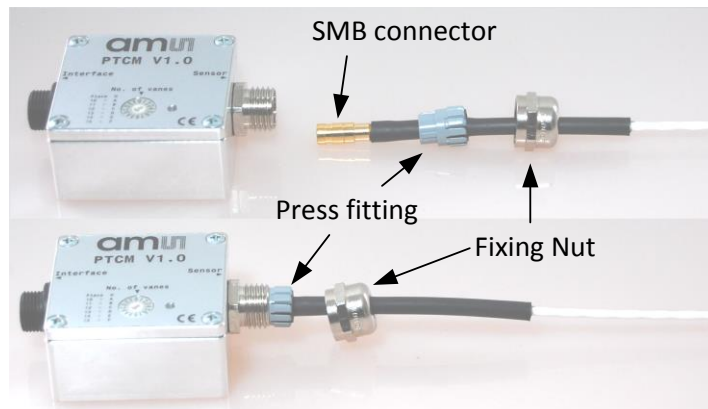


NOTICE The correct mounting position and method depends on the individual geometry and characteristics of the turbocharger in use. Contact the manufacturer of the turbocharger for information about details on possible positions and correct mounting instructions.

NOTICE **IMPORTANT:** Make sure the tip of the sensor is approximately flush with the inside contour of the housing. Otherwise, it may hit and damage the compressor wheel.

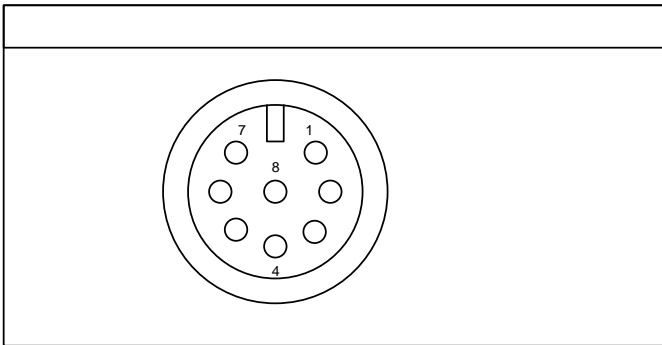
NOTICE Lock torque: The sensor body is not a 5 millimeter bolt but merely a sleeve with some 0.3 mm thick walls. Apply only a fraction of the torque you would with a solid bolt: 0.3 Nm maximum (finger force, not fist force).

The sensors connect with an SMB plug to the PTCM and are fixed and sealed with the press fitting.

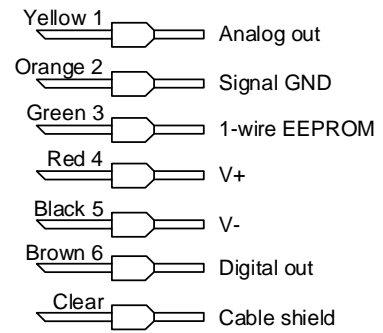


5 PTCM Interface – Electrical Connections

Standard version

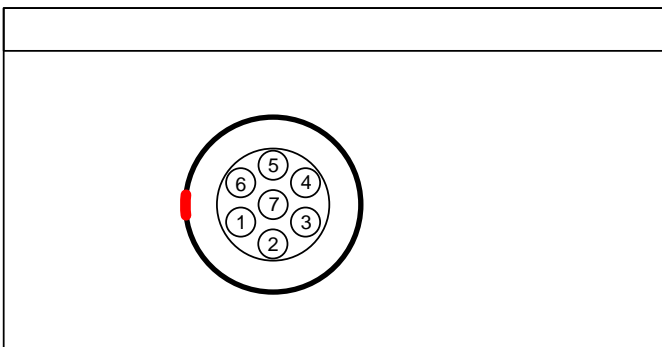


PTCM Side View: Power and Interface Connector

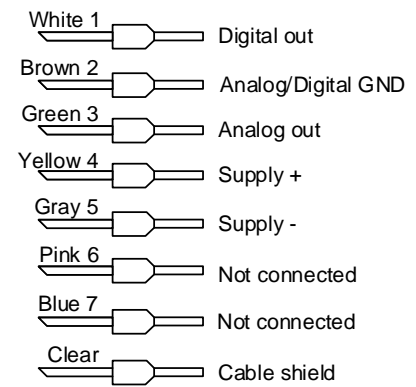


Power and Interface Cable Ends

LEMO version



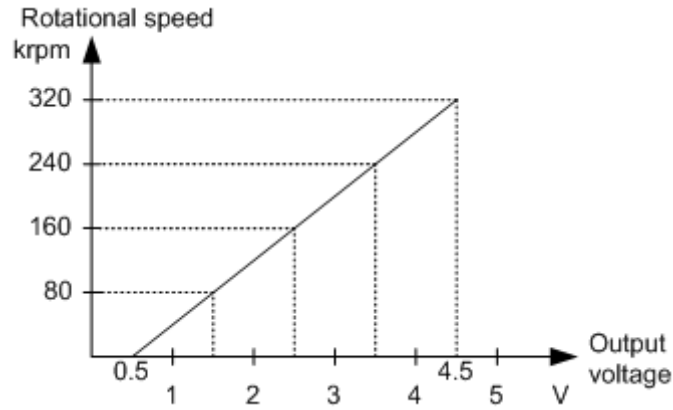
PTCM L Side View: Power and Interface Connector



Power and Interface Cable Ends

5.1 Analog Interface

The analog output voltage covers 0.5 V to 4.5 V. The slope is 80,000 rpm/V, corresponding to 0 rpm at 0.5 V and 320,000 rpm at 4.5 V output voltages, respectively. The above values are valid only if the number of vanes is correctly encoded. The analog output works correctly for vane numbers of 4 to 31, it is not applicable for settings of 1, 2 and 3.



Rotational Speed versus Output Voltage

Hint: If the vane number setting differs from the number of vanes on the wheel, the voltage slope and maximum speed at the analog output changes. This can be used to measure a rotational speed above 320,000 rpm at the analog output (setting a higher number, see example 1), or to increase resolution (setting a lower number, see example 2).

| Example 1: | Example 2: |
|---|--|
| Real vane number: 8 | Real vane number: 10 |
| Set number: 12 | Set number: 5 |
| -> Slope $1.5 \cdot 80,000 \text{ rpm / V} = 120,000 \text{ rpm / V}$ | -> Slope $0.5 \cdot 80,000 \text{ rpm / V} = 40,000 \text{ rpm / V}$ |
| Maximum speed: 480,000 rpm | Maximum speed: 160,000 rpm |

6 LED Display Functionality

6.1 Diagnostics

| Mode | LED behavior | Circumstance | Consequences |
|------|---|-------------------------|--|
| A | LED stays dark | | No power supply: the supply voltage is missing or below 8 V. Please check the power supply |
| B | LED on Continuously (green) | Turbo standing still | The rotational speed is zero. The controller is ok and in wait state. |
| | | Turbo rotates | The sensor head is too far away from the wheel. To check the controller, remove the sensor and check that the LED is blinking. |
| C | LED on Continuously (red) | Turbo rotates | The system is operating normally. |
| D.1 | LED shines red with short green breaks | Turbo rotates | The sensor signal is correctly captured most of the time and the controller can measure. But the signal strength is quite low. If possible, bring the sensor head 0.1 to 0.2 mm closer to the wheel. |
| D.2 | LED shines green with short red breaks | Turbo standing still | There are electromagnetic disturbances. On engine test stations this might be due to ground loops. Add an additional GND wire from the controller box to the engine. Otherwise the signal might be disturbed, especially at low rotational speeds. |
| | | Turbo rotates | The sensor signal is too weak. If possible bring the sensor head closer to the wheel. |
| E | LED blinking fast with about 8 Hz (red/green) | Sensor not connected | Please connect the sensor. |
| | | Sensor disconnected for | Device test. The controller is ok and the supply voltage sufficient. |
| | | device test | The sensor, the sensor cable or the sensor connector is defective or the power supply voltage is too small (below 8V). |

6.2 Analog Signal for Optimal Sensor Positioning

The measurement signal can also be tested quantitatively. This is helpful during application but may also be of interest during operation. It helps to achieve a higher signal-to-noise ratio of the measurement chain.

The number of vanes has to be set to 0 (code switch set to '0' and internal DIP switch DIVPULS off). A voltmeter has to be connected to the analog output, being set to the right measurement range (e.g. 5V). In contrast to all other settings, the output voltage is below 0.2V when the turbo is standing. Any other setting of the number of vanes results in an output voltage of 0.5V at standing turbo.

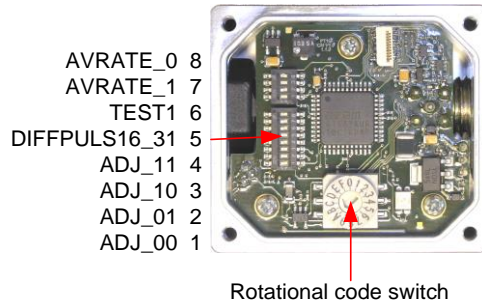
When the turbo wheel rotates, the indicated voltages can be interpreted according to the following table, assuming that the noise level is low (engine off):

| Voltage | LED Light | Interpretation |
|----------------------------------|---|---|
| Less than 0.20V | LED shines green permanently or with short red breaks | The sensor is too far away, bring it closer to the wheel. The LED is also permanently green if the wheel is standing still or too slow (below 200rpm). |
| Between 0.20V and 0.25V | LED shines red with short green breaks | Bring the sensor 0.1 mm closer to the wheel. |
| More than 0.25V but less than 4V | LED shines red permanently | Good signal. For gasoline engines it should be more than 1.5V to have enough margin against noise. |
| More than 4V | LED shines red permanently | Be careful. The sensor is very close to the wheel and might touch it. |

7 Internal Switches

7.1 Number of Vanes – Code Switch

The number of vanes of the turbo wheel is set by a rotational code switch which is placed inside the PTCM. The standard range is 1 to 15 vanes, which can be changed to 16 to 31 vanes by setting an inside DIP switch. Open the case and find the position of switch no. 5, DIFFPULS16_31, according to the figure below. Default setting is off, switch to on for having 16 to 31 vanes.



| Code switch | 0 | 1 | 2 | 3 | 4 | ... | 9 | A | ... | F |
|-----------------------|-------|-----|-----|-----|----|-----|----|----|-----|----|
| DIVPULS16_31 = off | 1 | 1 | 2 | 3 | 4 | ... | 9 | A | ... | F |
| | (1,2) | (1) | (1) | (1) | | | | | | |
| DIFFPULS16_31 = on | 16 | 17 | 18 | 19 | 20 | ... | 25 | 26 | ... | 31 |

(1): Not applicable to analog output

(2): Sensor positioning signal at analog output.

7.2 Measurement at High Signals Levels

The default setting of PTCM is for medium and weak signals. The internal DIP switches for filter settings will be set as follows:

- TEST1 = On
- AVRATE1 = On
- AVRATE0 = Off

If the sensor provides a very high signal level (analog output voltage > 4 V at vane number = 0, see section 3.5), then you should make changes stepwise in the following order, until the signal voltage falls below 4V:

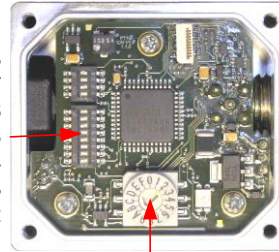
1. Screw back the sensor a little bit
2. Set AVRATE1 = AVRATE2 = Off
3. Set TEST1 = Off.

7.3 Measurement Very High Rotational Speeds

The default settings of the PTCM are optimized for rotational speed measurement up to 280,000 rpm. For measuring higher rotary speed, it could be helpful to adjust the internal filter settings to avoid interferences. In case of problems at high speed, the following can be tried:

Set DIP switch 'AVRATE_1' to OFF

- AVRATE_0 8
- AVRATE_1 7
- TEST1 6
- DIFFPULS16_31 5
- ADJ_11 4
- ADJ_10 3
- ADJ_01 2
- ADJ_00 1



Rotational code switch

This adjustment tunes the internal filter for a wider range and improves the system for measuring higher speed frequency.

With this measure the system supports a safe detection up to 100,000 vanes per second. Please consider the increased sensitive of the system towards external disturbances due to the extended sensitivity range of the internal filter. Therefore we recommend to apply this measure only as far as required for a stable high speed measurement.

8 Ordering Information

| PTCM Ordering Code | Part No. | Description |
|--------------------|-----------|---|
| PTCM V1.0 | 220340001 | Signal conditioning box with standard interface |
| PTCM V1.0L | 220390001 | Signal conditioning box with LEMO interface connector |

| Sensors Ordering Code | Part No. | Sensor/thread length | Ø | Description |
|-----------------------|-----------|----------------------|----------|---|
| PTSM 5.3 | 220150008 | 60 mm/54 mm | M5 x 0.8 | Cable length 1.5m Temperature range sensor head -40°C to + 230°C |
| PTSM 5.5 | 220150006 | 46 mm/40 mm | | |
| PTSM 5.6 | 220150012 | 75 mm/69 mm | | |
| PTSM 5F.2 | 220150004 | 41 mm/25 mm | M5 x 0.5 | |
| PTSM 5F.3 | 220150014 | 56 mm/40 mm | | |
| PTSM 5F.5 | 220150016 | 76 mm/60 mm | | |
| PTSM-H 5.3 | 220180003 | 60 mm/54 mm | M5 x 0.8 | High sensitivity version Cable length 1.5m Temperature range sensor head -40°C to + 250°C 280°C peak for 5 minutes |
| PTSM-H 5.5 | 220180004 | 46 mm/40 mm | | |
| PTSM-H 5.6 | 220180005 | 75 mm/69 mm | | |
| PTSM-H 5F.2 | 220180006 | 41 mm/25 mm | M5 x 0.5 | |
| PTSM-H 5F.3 | 220180007 | 56 mm/40 mm | | |
| PTSM-H 5F.5 | 220180008 | 76 mm/60 mm | | |

| Accessory Ordering Code | Part No. | Description |
|-------------------------|-----------|--|
| PTSM 5F.x Clamping nut | 220030002 | Clamping nut for fine thread sensors |
| PTCM-1.5-nc | 220320001 | System interface & power cable, 1.5m length, open ends |
| PTCM-3.0-nc | 220320002 | System interface & power cable, 3.0m length, open ends |
| PTCM-1.5-BNC | 220320003 | System interface & power cable, 1.5m length, BNC connectors for signals, banana connectors for power |
| PTBM/PTCM-2.0-nc | 220130002 | PTBM/PTCM Lemo system cable 2 m open ends |
| PTCM Cover foil | 220360001 | Spare foil for cover |
| PTCM Cover seal | 220370001 | Spear seal for cover |
| PTCM Cover screws | 220380001 | Spear safety screws for cover |
| PTCM Mounting plate | 220330001 | Mounting plate incl. screws |