PICOTURN

Rotational Speed Measurement System
for Turbochargers

Manual

02 APR 2007

acam - solutions in time

Precision Time Interval Measurement

Index

1. Description

PICOTURN is built for sensing the rotational speed of turbochargers with the sensor mounted directly to the compressor wheel. The sensor is made of a simple coil with ferrite core. If a vane of the compressor wheel is brought in front of the sensor, its inductance is reduced by attenuation through eddy currents. This change of inductance is measured by a TDC (Time-to-Digital Converter) and the data are processed by a DSP, giving a signal proportional to the rotational speed. The system is capable of speed measurement up to 400.000 rpm. The minimum speed is 200 rpm.

The **PICO**TURN-BM V6 is our latest generation of **PICO**TURN. It is optimized with respect to similar sensitivity for the different kinds of sensors. **PICO**TURN is a universal speed measurement system for all standard compressor wheels (down to 32mm (1.3') wheels). The high sensitivity allows a large distance between sensor and the rotating vanes in the range of 1 mm at 0.6mm vane thickness. Even the rotational speed of compressor wheels made out of titanium can easily be measured. Also the use of an extension cable between the controller box and the sensor is possible.

The number of vanes is programmable between 1 - 15 / 16 – 31. The **PICO**TURN-BM offers two kinds of interface:

- Digital pulse interface
- Analog interface 0.5 V – 4.5 V

A measurement system requires at least a **PICO**TURN-BM V6 controller and a sensor from our **PICO**TURN-SMx.x series. Additionally, the system can be extended by the **PICO**TURN-DY display unit. The sensor is connected to the controller by a coaxial cable with two inner conductors and about 1.5m (59') length (max. 4m (157')). The connector is SMB type.
The controller as well as the display unit is mounted into an aluminum case.

2. PICOTURN-BM V6 Controller

2.1 Mechanical Dimension

2.2 Technical data

| Case size W x H x L	105 x 30 x 85 mm³ (4.1'*1.18'*3.35')
Supply voltage / current	8 to 30 V DC/ typ. 60 mA
Distance between vane and sensor	~ 1.0 mm (for vanes .6 mm thick)
Digital output	pulsed 5V CMOS, 50 % duty cycle Frequency precision 0.009 % of FS 1 pulse per N vanes, N = 1 to 31
Analog output	0.5 V to 4.5 V (80.000 rpm/V) Voltage precision 0.25 % of FS Update rate: N = 4 104 Hz N = 10 260 Hz 5 130 Hz 11 286 Hz 6 156 Hz 12 313 Hz 7 182 Hz 13 339 Hz 8 208 Hz 14 365 Hz 9 234 Hz 15 391 Hz
Number of vanes/pulse*	1 to 15 / 16 to 31
Operating temperature range sensor -SM5.1, -SM5.2 -SM5.3	 - 40 °C to + 180 °C - 40 °C to + 230 °C (250 °C max. 5 min)
Operating temperature range controller	- 40 °C .. +85 ˚C

If the analog output is used, the number of vanes is selectable between 4 – 31.

2.3 Number of Vanes – Code Switch

On the back of the case there is a rotational code switch. This is to be used for setting the number of vanes. Setting an inside jumper, the range is shifted from 1 to 15 to 16 to 31. For setting the jumper the case must be opened. The place for the jumper can be seen from the photo below, marked by an arrow.
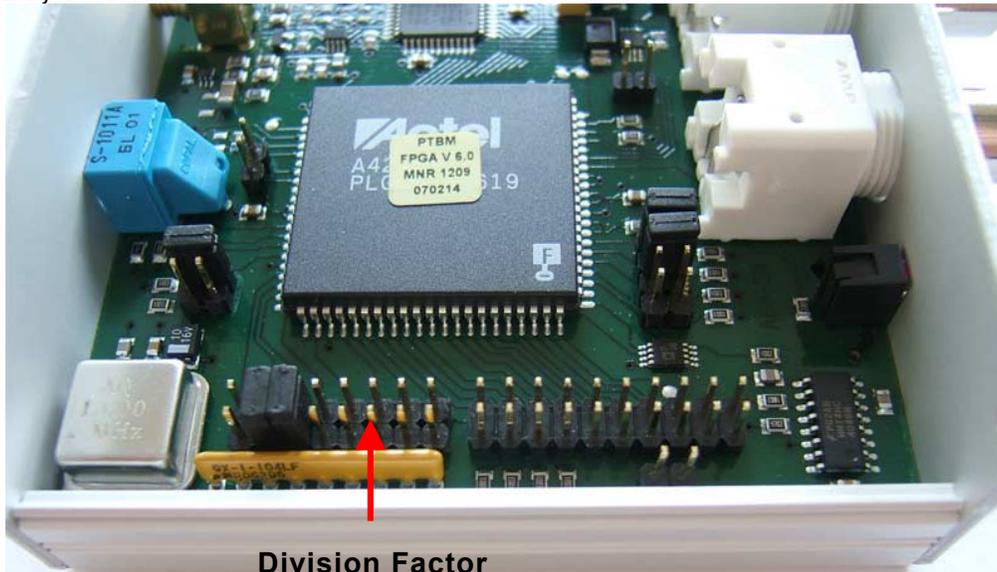
Division Factor
16 or 31

Table 1: division factors

code switch	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
without jumper	1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
with jumper	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31

2.4 Analog Interface

The analog output voltage covers 0.5 V to 4.5 V. The slope is 80.000 rpm/V, corresponding to 320.000 rpm at 4.5 V output voltage. The mentioned value of the slope is valid only if the number of vanes is correctly encoded.
When using the analog output, the possible numbers of vanes are 4 to 31 only!
Hint: If the measurement of a rotational speed higher than 320.000rpm is needed while using the analog output, this can be achieved by selecting a ‚wrong' number of vanes.

Example 1:
Real number: 10
Set number: 5
gives half the slope, 40,000 rpm/V and therefore a better resolution
Maximum speed is 160,000 rpm

Example 2:
Real number: 8
Set number: 12
gives a slope of 1.5*80,000 rpm/V = 120,000 rpm/V. The maximum range is 480,000 rpm

2.5 LED – Display Functionality

Mode	Kind of Light	Circumstance	Consequences
No. 1	LED flickers with about 8 Hz	Sensor not connected	Please connect the sensor.
		Sensor disconnected for device test	Device test. The controller is o.k. and the supply voltage sufficient.
		Sensor connected	The sensor, the sensor cable or the sensor connector is defect.
No. 2	LED flashes (short 200ms flashes at max. 4 Hz.)	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 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 closer to the wheel.
No. 3	LED is on with short breaks	Turbo rotates	The sensor signal is statistically proof and the controller can measure. But the signal strength is quite low. If possible, bring the sensor 0.1 to 0.2 mm closer to the wheel.
No. 4	LED on continuously	Turbo rotates	The system is optimized.
No. 5	LED stays black	Turbo rotates	The power supply of the system is broken. Please check it.
		Turbo rotates and power is on	The sensor is far away from the wheel (3 to 4 mm). To exclude that the controller is defect remove the sensor and check that the LED is blinking.
		Sensor removed for device test	The device is defect of the supply voltage is below 8 V.
		Turbo standing still, power o.k.	The rotational speed is zero, the controller is in wait state.

2.6 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". A voltmeter has to be connected to the analog output, being set to the right measurement range (e.g. 5 V).

The indicated voltages can bet interpreted according to the following table, assumed that the noise level is low (engine off):

| 1	2	3
Voltage	LED Light	Interpretation
Less than 0.20 V	Mode 2 – LED flashes	The sensor is too far away, bring it closer to the wheel
Between 0.20 V and 0.25 V	Mode 3 – LED is on with short breaks	Bring the sensor 0.1 mm closer to the wheel
More than 0.25 V but less than 4 V	Modus 4 – LED permanently on	Good signal. For gasoline engines it should be more than 1.5 V to have enough margin against noise
More than 4 V	Modus 4 – LED permanently on	Be carefull. The sensor is very close to the wheel and might touch it.

3.   PICOTURN-SM Sensors

MNR	Description	Sensor length/ thread length	Diameter	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 3.6mm Ø	1.5 m	-40 °C to +180 °C
933	PICOTURN-SM5.3	60 mm/54 mm	M5 x 0.8	1.5 m	-40 °C to +230 °C
998	PICOTURN-SM5.5 (*)	46 mm/40 mm	M5 x 0.8	1.5 m	-40 °C to +230 °C
1108	PICOTURN-SM5.5L (*)	46 mm/40 mm	M5 x 0.8	2.0 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 3.6 mm Ø	1.5 m	-40 °C to +230 °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
1109	PICOTURN-SM5F.3L (*)	56 mm/40 mm	M5 x 0.5	2.0 m	-40 °C to +230 °C
Accessories					
594	Extension cable	SMB Extension cable for sensors, 1.5 m length			
707	Extension cable	SMB Extension cable for sensors, 2.5 m length (not for "L" versions)			
696	Clamping nut	M5 fine thread nut for sensors –SM5F.x			

(*) on request

230 °C types: 250 °C for max. 5 min

PICOTURN-SM5.1, -5.3
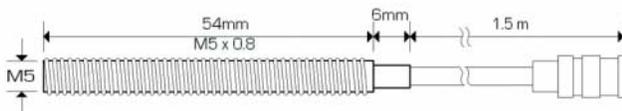
PICOTURN-SM5.5
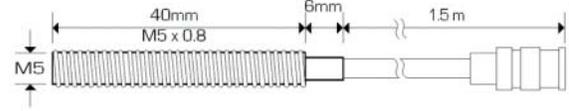
PICOTURN-SM5.2
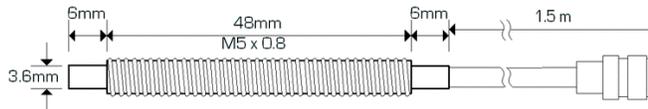
PICOTURN-SM5.7
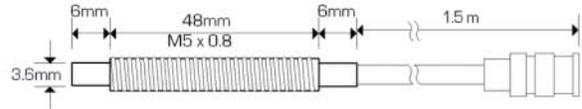
PICOTURN-SM5.6
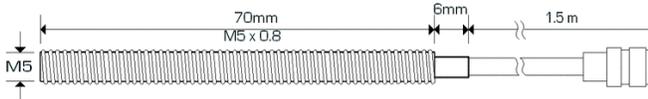
PICOTURN-SM5F.2
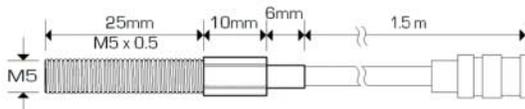
PICOTURN-SM5F.3
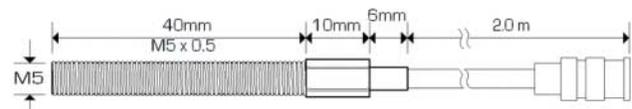
4. PICOTURN-DY Display Unit

The **PICO**TURN-DY 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) It 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 by a mechanical switch on the front of the device. Then the actual speed is displayed with an update rate of 6 to 10 Hz. The update is adjustable by internal jumper settings. The input of the **PICO**TURN-DY has to be connected to the digital output of the PICOTURN-BM controller.

### 4.1 Mechanical Dimensions

4.2 Technical Data

Case size W x H x L	105 x 30 x 85 mm³ (4.1'* 1.18'* 3.35')
Display Size W x H	63.5 x 19.1 (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 .. +85 ˚C
Display up date rate	6 Hz .. 10 Hz, adjustment by internal jumpers s0, s1, s2
Peak hold function	- Enabling or disabling via Jumpers p0, p1 - Additional on- / off switch-control by external switch - Hold-time adjustable within 1 – 3 s by jumpers f0, f1 - Fifth digital symbol operates as a trend display in case of a variable rotational speed or shows a stationary symbol (adjustable via jumpers d0, d1)

4.3 Jumper settings

The main functions of the **PICO**TURN-DY can be adjusted by internal jumpers. Therefore remove the upper four screws from the aluminum case and lift-off the housing cover. For groups of Jumpers on the PCB appear as shown in the picture below.
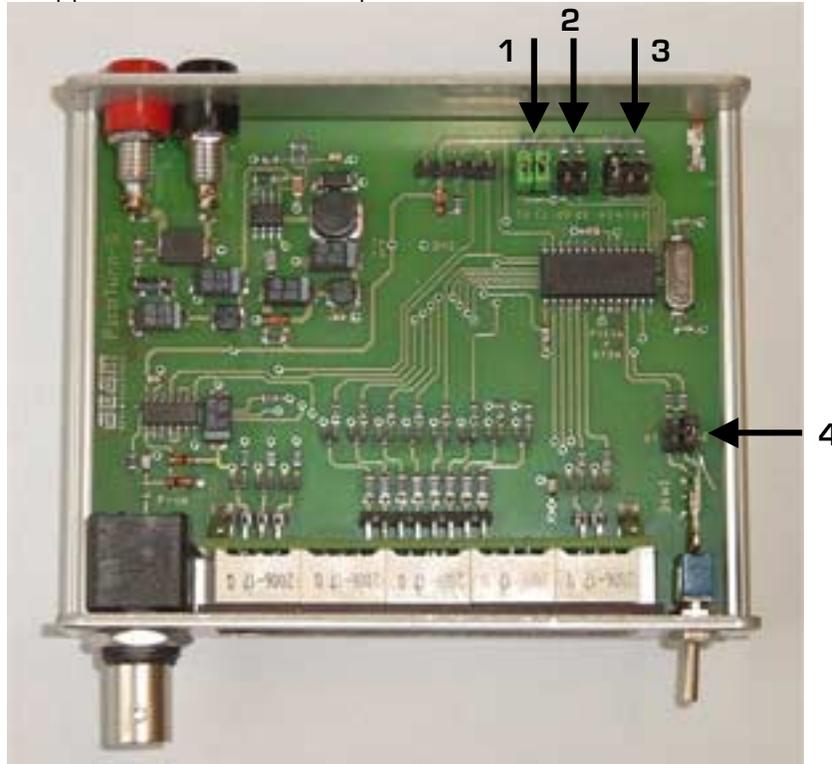
The settings of these jumpers are read before each new measurement cycle, so any change is immediately transferred and there is no need for a restart the device after changing this configuration.

1. Delay time adjustment (fallback delay in peak hold mode)
The delay time of the peak hold function is configured via jumper group 1. It requires that the **PICO**TURN-DY operates in peak-hold-mode and offers the following possibilities

Jumpers		Settings	Delay [ms]
f0	f1		
Off	Off		1000
Off	On		1500
On	Off		2000
On	On		3000

2. Display mode of the fifth digital symbol:

The adjustment of the fifth digital symbol, which appears on the last position of the seven segment display, depends from the jumper settings of group 2. It requires the "peak-hold-mode" and provides the following settings:

Jumpers		Settings	Displayed Symbol
f0	f1		
Off	Off		Shows a horizontal line (minus symbol) that operates as a upper/ lower trend display in case of a variable rotational speed
Off	On		1500 Shows capital "H" as a constant symbol
On	Off		Displays lower case "h" as constant symbol
On	On		Shows capital "P" as a constant symbol

3. Display update rate

The refresh rate of the display ranges between 6 Hz and 10 Hz and is configured by means of the following jumper settings:

Jumpers			Settings	Refresh rate (Hz)
s0	s1	s2		
Off	Off	Off		10
Off	Off	On		6
Off	On	Off		8

4. Peak hold mode configuration

The peak hold mode can be switched on / of by the external switched or permanently enabled / disabled by internal jumper settings as follows:

| Jumpers		Settings	Peak Hold Mode settings
p0	P1		
Off	Off		Peak hold mode is permanently disabled (external switch is deactivated)
On	Off		Peak hold mode can be manually switched on /-of by the external switch located on the front side of the device.
On	On		Peak hold mode is permanently enabled (external switch is deactivated)

5.   Installation

Installation is done by following steps:

1. Connect the controller to a power supply (battery, stationary power supply), connecting Vc to the red connector (signed ‚8-30V'), GND to the black connector (signed ‚GND').
2. Set the number of vanes (for details see below)
3. Connect digital and/or analog outputs with your data recorder (e.g. frequency counter, scope). If the **PICO**TURN-DY display unit is used for you application you also have to connect it to the digital output of the **PICO**TURN-BM controller unit.
4. Mount the sensor near to the compressor wheel. The maximum distance between sensor and wheel depends on the shape of the vanes, especially their thickness. For vanes 0.6mm (0.024') thick the maximum distance is about 1 mm (0.039').
5. The mounting hole must be of M5-type and should be perpendicular to the surface.
6. Connect the sensor to the ‚Sensor'- input at the backside of the controller.

The sensor should be mounted as close as possible to the compressor wheel. Make sure that it doesn't touch the wheel (Danger of destroying the compressor wheel)! The maximum distance depends on the shape of the vanes and their thickness. For typical 0.6 mm thick vanes the maximum distance is 1 mm with the standard sensors and 1.9 mm with the fine thread sensors.
The signal quality is indicated by the controller's LED that should be shining continuously. For details see the LED section in this manual.
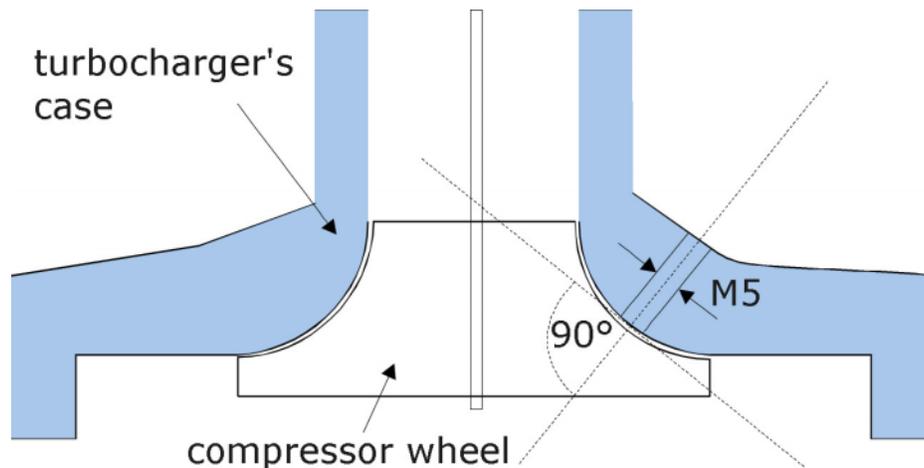
6. Practical Hints

a) On engine test stands add an additional GND wire from the GND input of the PICOTURN-BM controller (black connector) to the engine. This is not necessary in cars.

b) The cable length should be only as long as necessary. The shorter the better will be the sensor signal quality. On engine test stands, the 1.5 m sensor cable length should be sufficient. The maximum total cable length is 4 m.

c) Prefer the digital output if both output signals can be used. It shows higher dynamics and better precision. The analog output might need a re-calibration from time to time to fix the offset and slope. For re-calibration we offer the PICOTURN-CT calibration device.

d) When you want to open the controller box release the upper 4 screws. In case the screws fit very tough, apply the screw driver and give him a short, strong beat. This will loosen the screw.

7. Measuring very high Rotational Speeds

The default settings of the **PICO**TURN-BM V6 are optimized for rotational speed measurement up to 280.000 rpm. For measuring higher rotary speed, it could be necessary to adjust the internal filter settings to avoid interferences. In this case, the following steps must be executed:

1) When using an extension cable between the sensor and the **PICO**TURN-BM V6 evaluation box the cable should be removed to connect the sensor directly to the evaluation box.
2) If this step is not sufficient, or there is no possibility to connect the sensor directly to the evaluation box, an opening of the box will be necessary. Remove the upper four screws from the aluminum case and lift-off the housing cover. Then affix an addition1al jumper to PIN 7 of the edge connector J2 (see picture below). This adjustment tunes the internal filter for a wider range and improves the system for measuring higher speed frequency.
3) If the second step doesn't achieve the required result, additionally remove J3 (see picture be-low) which is set by default.
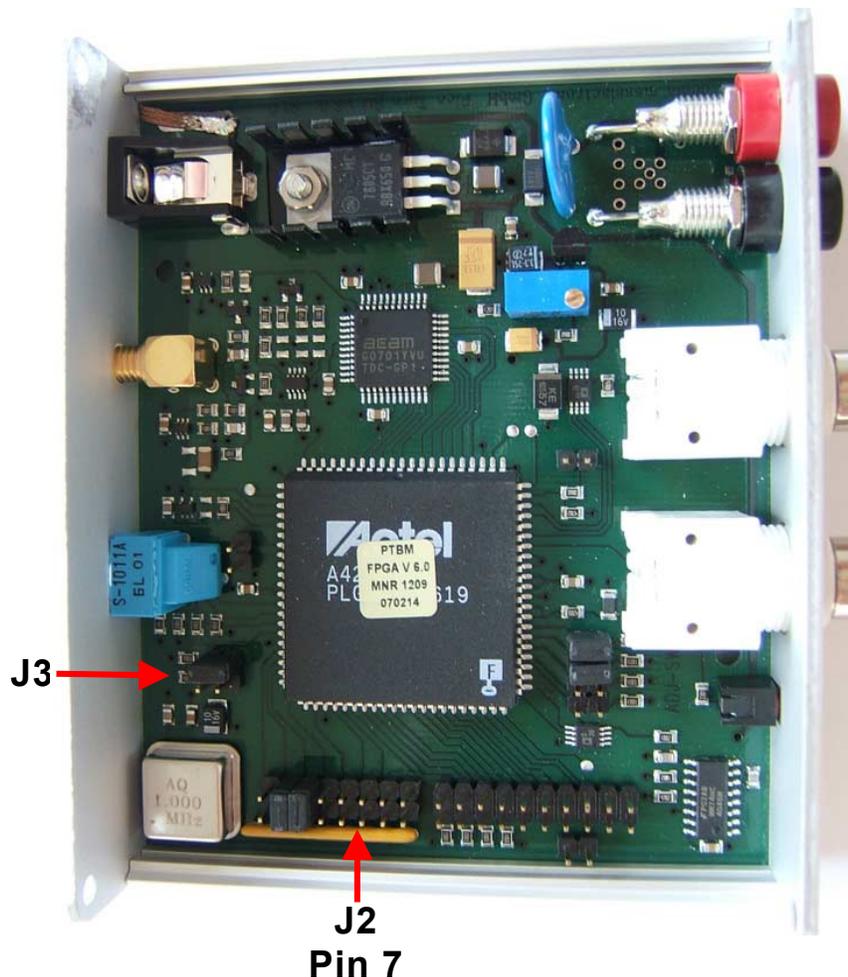
After this steps the system supports a safe detection up to 100.000 vanes per second. Please consider the increased sensitive of the system towards external disturbances due to the ex-tended sensitivity range of the internal filter. Therefore we recommend to accomplish only as many steps as required for a safe measurement.

8. Ordering Numbers

Electronic Devices

Type	No.	Description
PICOTURN-BM V6	MNR 1242	Controller 8 - 30 V
PICOTURN-CT	MNR 890	Calibration device for controller units
PICOTURN-DY	MNR 1155	Display unit

Sensors

PICOTURN-SM5.1	MNR 586	Sensor M5
PICOTURN-SM5.2	MNR 607	Sensor M5, reduced head
PICOTURN-SM5.3	MNR 933	Sensor M5, High temperature
PICOTURN-SM5.5	MNR 998	Sensor M5, High temperature
PICOTURN-SM5.5L	MNR 1108	Sensor M5, High temperature
PICOTURN-SM5.6	MNR 1059	Sensor M5, High temperature
PICOTURN-SM5.7	MNR 1065	Sensor M5, High temperature
PICOTURN-SM5F.2	MNR 934	Sensor M5 fine, High temperature
PICOTURN-SM5F.3	MNR 1081	Sensor M5 fine, High temperature

Accessories

Clamping nut	MNR 696	Fine thread nut for ..-SM5F.x sensors
Extension cable	MNR 594	1,5m extension cable sensor, (SMB-SMB)
Extension cable (*)	MNR 707	2,5m extension cable sensor, (SMB-SMB)

(*) not suitable for "L"-type sensors (with extra long cables)

Serial number

SN aaaa.bbbbbb.ccc   a = Material no., b = Datecode YYMMDD, c = running no.

Last changes:

02 Apr. 07: First edition

9. Contact

Headquarter Germany:	acam-messelectronic gmbh	Am Hasenbiel 27 D - 76297 Stutensee-Blankenloch	Tel: +49-7244-7419-0 Fax: +49-7244-7419-29 email: support@acam.de www.acam.de
Distributors :			
France	microel (CATS S.A.)	Immeuble "Oslo" - Les Fjords 19, avenue de Norvège Z.A. de Courtaboeuf - BP 3 91941 LES ULIS Cedex	Tél. : +33 1 69 07 08 24 Fax : +33 1 69 07 17 23 commercial@microel.fr www.microel.fr
Great Britain	2001 Electronic Components Ltd.	Stevenage Business Park, Pin Green Stevenage, Herts SG1 4S2	Tel. +44 1438 74 2001 Fax +44 1438 74 2001 a.parker@2k1.co.uk www.2k1.co.uk
India	Brilliant Electro-Sys. Pvt. Ltd.	4, Chiplunker Building, 4 Tara Temple Lane, Lamington Road, Bombay – 400 007	Tel: +91 22 2387 5565 Fax: +91 22 2388 7063 www.brilliantelectronics.com besimpex@vsnl.net
Israel	ArazimLtd.	4 Hamelacha St. Lod P.O.Box 4011 Lod 71110	Tel: 972-8-9230555 Fax: 972-8-9230044 email: info@arazim.com www.arazim.co.il
Japan	DMD–Daiei Musen Denki Co., Ltd.	10-10, Sotokanda, 3-Chome, Chiyoda-Ku Tokyo 101-0021	Tel: +81 (0)3 3255 0931 Fax: +81 (0)3 3255 9869 www.daiei-dmd.co.jp sales@daiei-dmd.co.jp
P.R. China	Broadtechs Technology Co. Ltd.	Shanghai Office: 3C JinHuan Building, 489 Xiang Yang Road South Shanghai, 200031	Tel.: +86-21-54654391 Fax: +86-21-64454370 http://www.acam-china.com/ Email: info@acam-china.com
South Korea	SamHwa Technology Co., Ltd.	#4 4F Kyungwon building, 416-6 Jakjeon-dong GYEYANG-GU, INCHEON 407-060	Tel: +82 32 556 5410 Fax: +82 32 556 5411 www.isamhwa.com minjoonho@isamhwa.com
Switzerland	Computer Controls AG	Neunbrunnenstr. 55 8050 Zürich	Tel.: +41-1-308 6666 Fax: +41-1-308 6655 email: roeschger@ccontrols.ch www.ccontrols.ch
United States of America	Transducers Direct, LCC	264 Center Street Miamiville, Ohio 45147	Tel: 513-583-9491 Fax: 513-583-9476 email: sales@acam-usa.com www.acam-usa.com
Russia	Galant Electronics, Ltd.	100, Prospekt Mira, Moscow, 129626, Russia	Tel\Fax: +7-495-987-42-10, Tel: +7-095-107-19-62 Mobile +7-916-993-67-57 Email: leonid-k@galant-e.ru www.galant-e.ru

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.

acam®, PICOTURN® are registered trademarks of acam-messelectronic gmbh.