MICRO-EPSILON

Operating Instructions
turboSPEED DZ140

DS05(03)
DS05(04)
DS05(07)
DS05(14)
DS05(15)

DS1
DS1(04)
DS1/T

Speed measuring system for turbo chargers

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Contents

1. Safety

System operation assumes knowledge of the operating instructions.

1.1 Symbols Used

The following symbols are used in these operating instructions:

⚠ CAUTION	Indicates a hazardous situation which, if not avoided, may result in minor or moderate injury.
NOTICE	Indicates a situation that may result in property damage if not avoided.
➡	Indicates a user action.
i	Indicates a tip for users.
`Measure`	Indicates hardware or a software button/menu.

1.2 Warnings

⚠ CAUTION

Connect the power supply and the display/output device according to the safety regulations for electrical equipment.
> Risk of injury
> Damage to or destruction of the sensor and / or controller

The supply voltage must not exceed the specified limits.
> Risk of injury
> Damage to or destruction of the sensor and / or controller

NOTICE

Avoid shocks and impacts to the sensor and controller.
> Damage to or destruction of the sensor and controller

Protect the sensor cable against damage
> Failure of the measuring device

1.3 Notes on CE Marking

The following apply to the turboSPEED DZ140:

- EU directive 2014/30/EU
- EU directive 2011/65/EU, “RoHS” category 9

Products which carry the CE mark satisfy the requirements of the EU directives cited and the European harmonized standards (EN) listed therein. The EU Declaration of Conformity is available to the responsible authorities according to EU Directive, article 10, at:

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The measuring system is designed for use in industrial environments and meets the requirements.

1.4 Intended Use

- The system is designed for use in industrial and laboratory applications.
- It is used for speed measurement on turbo chargers.
- The system must only be operated within the limits specified in the Technical Data, see Chap. 2.4.
- The system must be used in such a way that no persons are endangered or machines and other material goods are damaged in the event of malfunction or total failure of the controller.
- Take additional precautions for safety and damage prevention in case of safety-related applications.

1.5 Proper Environment

- Protection class controller: IP 65
- Operating temperature
  - Sensor:
    - Models DS05(03), DS05(04), DS05(07), DS05(14), DS05(15): -40 ... +200 °C (-40 ... +392 °F)
    - Models DS1, DS1(04): -40 ... +235 °C (-40 ... +455 °F)
    - Model DS1/T: -40 ... +235 °C (-40 ... +455 °F), (short-term +285 °C, +545 °F)
  - Sensor cable: -40 ... +200 °C (-40 ... +392 °F)
  - Controller: -40 ... +125 °C (-40 ... +257 °F) (at max. 15 VDC power supply) [1)]
- Storage temperature
  - Sensor, sensor cable: -40 ... +200 °C (-40 ... +392 °F)
  - Controller: -40 ... +125 °C (-40 ... +257 °F)
- Humidity: 5 - 95 % (non-condensing)
- Ambient pressure: Atmospheric pressure
- Supply: 9 ... 30 VDC / briefly 36 VDC / max. 50 mA

[1)] If power supply is higher, the max. acceptable ambient temperature decreases, see Fig. 14.

2. Functional Principle, Technical Data

2.1 Applications

The non-contacting compact revolution counter is designed for industrial application for turbo charger monitoring on test benches and for measurements during driving tests.

2.2 Functional Principle

A very fast proximity sensor responds to turbo charger blades (depending on initial state) made of electrically conducting materials passing by. The eddy current loss principle effects impedance changes in a measuring coil (sensor). This change of impedance gives rise to an electric signal.

2.3 Structure of the Complete Measuring System

The non-contacting single-channel measuring system consists of:

- Sensor and sensor cable
- Controller (installed in a compact aluminum housing)
- Power supply and signal cable, see Chap. 4.3

Individual components of the measuring system can be changed without limiting the functionality.

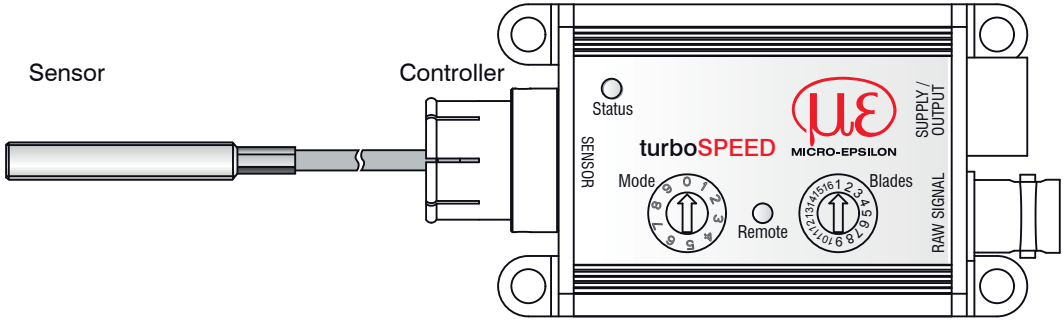


Fig. 1 Components for speed measurement

2.4 Technical Data

Model		**DZ140 (Controller)**							
Sensors		DS05(03)	DS05(04)	DS05(07)	DS05(14)	DS05(15)	DS1	DS1(04)	DS1/T
Measuring principle / Target (blade material)		eddy current principle / aluminum or titanium							
Maximum speed range (measuring range)		200 ... 400,000 RPM							
Operating temperature	Controller	-40 ... +125 °C, -40 ... +257 °F (at a maximum of 15 VDC supply voltage)[1)]							
	Sensor	-40 ... +200 °C, -40 ... +392 °F					-40 ... +235 °C, -40 ... +455 °F		-40 ... +235 °C, -40 ... +455 °F (short-term +285 °C, +545 °F)
	Sensor cable	-40 ... +200 °C, -40 ... +392 °F							
Integral sensor cable		0.5 m ±0.15 m					0.75 m ±0.15 m		0.8 m ±0.15 m
Number of blades		rotary switch (accessible from the outside) for 1 up to 16 blades							
Digital output		1 pulse / blade (switch `Blades` on 1, TTL level, variable pulse duration) or 1 pulse / revolution (switch `Blades` on 2...16, TTL level with 100 µs pulse duration)							
Analog output		Mode 1, 3, 5: 0 ... 5 V (200 ... 200,000 rpm) Mode 0, 2, 4: 0 ... 5 V (200 ... 400,000 rpm) mode rotary switch, adjustable, accessible from outside							
RAW signal		Analog measurement signal to control distance between sensor and blade by means of an oscilloscope, see Fig. 20; load resistance > 5 kOhm, load capacity max. 1 nF							
Output sensor temperature		0 ... 5 V (-50 ... +300 °C, -58 ... +572 °F)							
Power supply		9 V ... 30 VDC / max. 50 mA (short-term up to 36 VDC)							

[1)] If power supply is higher, the max. acceptable ambient temperature decreases, see Fig. 17.

Model		**DZ140 (Controller)**							
		DS05(03)	DS05(04)	DS05(07)	DS05(14)	DS05(15)	DS1	DS1(04)	DS1/T
Storage temperature	Sensor, sensor cable	-40 ... +200 °C, -40 ... +392 °F							
	Controller	-40 ... +125 °C, -40 ... +257 °F							
Cable		PC140-3 supply and output cable 3 m							
		PC140-6 supply and output cable 6 m							
		PC140-8 supply and output cable 8 m							
Weight		Controller DZ140: appr. 92 g							
Protection class		Controller DZ140: IP 65							

FSO = Full Scale Output

3. Delivery

3.1 Unpacking, Included in Delivery

1 Controller DZ140
1 Protection cover for the RAW SIGNAL output
1 Operating Instructions
1 Multi corrugated spring

Separately available:
Sensor DSx or Sensor DSx/T including integrated sensor cable
Power supply and signal cable PC140-x, see Chap. 4.3.

- Carefully remove the components of the measuring system from the packaging and ensure that the goods are forwarded in such a way that no damage can occur.
- Check the delivery for completeness and shipping damages immediately after unpacking.
- If there is damage or parts are missing, immediately contact the manufacturer or supplier.

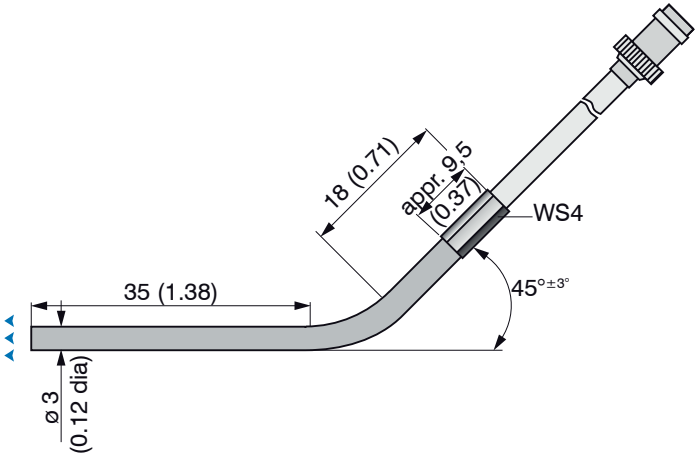
You will find further optional accessories in appendix, see Chap. A 1.

3.2 Storage

- Storage temperature:
  - Sensor and sensor cable: -40 ... +200 °C (-40 ... +392 °F)
  - Controller: -40 ... +125 °C (-40 ... +257 °F)
- Humidity: 5 - 95 % (non-condensing)

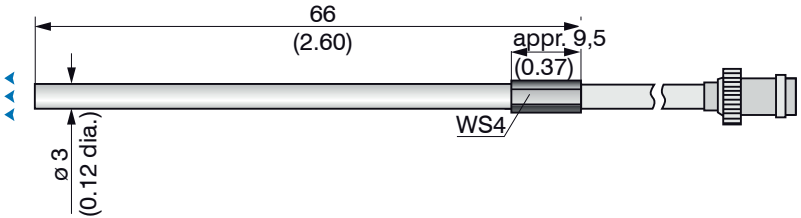
4. Installation

4.1 Sensor



Sensor cable
ø approx. 3.5 mm
Length 0.5 m (±0.15 m)
with BNC connector

Fig. 2 Dimensional drawing DS05(03)



Sensor cable
ø approx. 3.5 mm
Length 0.5 m (±0.15 m)
with BNC connector

Fig. 3 Dimensional drawing DS05(04)

Measuring direction

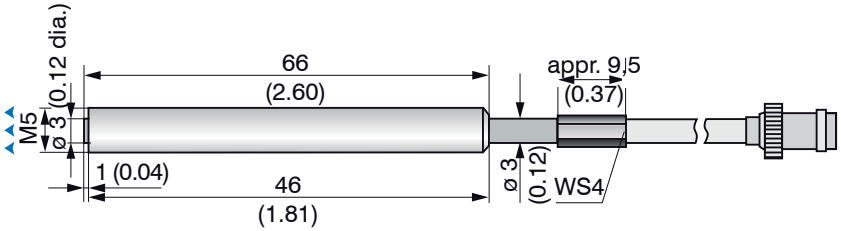


Fig. 4 Dimensional drawing DS05(07)

Sensor cable
ø approx. 3.5 mm
Length 0.5 m (±0.15 m)
with BNC connector

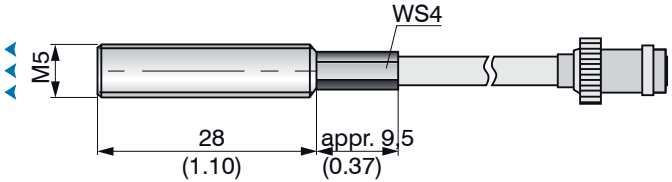


Fig. 5 Dimensional drawing DS05(14

Sensor cable
ø approx. 3.5 mm
Length 0.5 m (±0.15 m)
with BNC connector

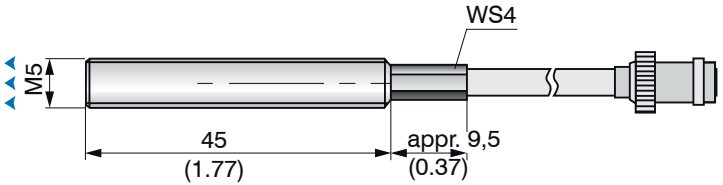


Fig. 6 Dimensional drawing DS05(15)

Sensor cable
ø approx. 3.5 mm
Length 0.5 m (±0.15 m)
with BNC connector

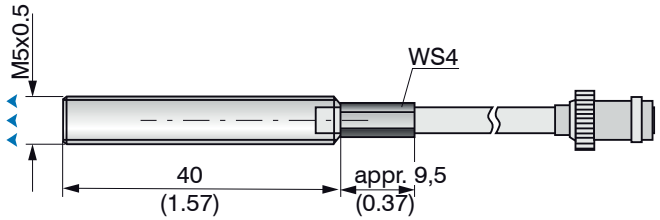


Fig. 7 Dimensional drawing DS1

Sensor cable
ø approx. 3.5 mm
Length 0.75 m (±0.15 m)
with BNC connector

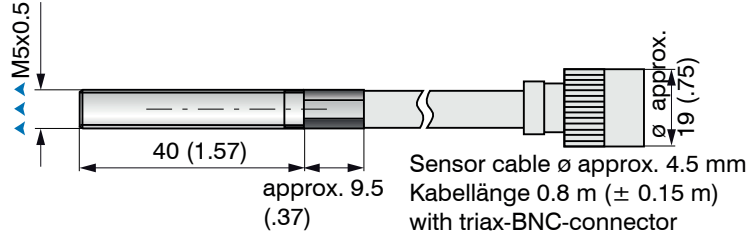


Fig. 8 Dimensional drawing DS1/T

Sensor cable with 2 shields
(triax cable)
ø approx. 5 mm
Length 0.8 m (±0.15 m)
with triax cable socket

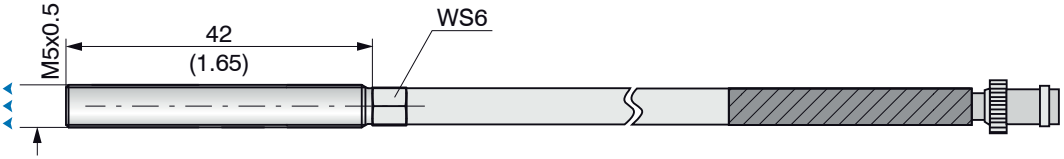


Fig. 9 Dimensional drawing DS1(04)

Sensor cable with metal protection hose
stainless steel IP 40
ø appr. 6.0; cable length 0.8 m
(± 0.15 m)
with BNC-connector

Dimensions in mm (inches), not to scale

Measuring direction

4.2 Sensor Cable

➡ Mount the sensor cable in such a way that the cable sheath is not exposed to any sharp-edged or heavy objects. Do not kink the cable.

i Never come below the proper bending radius of the sensor cable:
10 x diameter in the case of dynamic application,
5 x diameter in the case of static application.

➡ Make sure that the plug connectors at the sensor and at the controller fit tightly.

i As the capacity and the adjustment of the measuring system change, please do not shorten the matched sensor cables.

4.3 Supply and Signal Cable

i Never come below the proper bending radius of the supply and signal cable:
7.5 x cable outer diameter.

Fig. 10 Supply and signal cable, 3, 6 or 8 m long

4.4 Controller DZ140

The controller DZ140 is installed in an aluminum housing. The controller demodulates and amplifies the speed-dependent measuring signal.

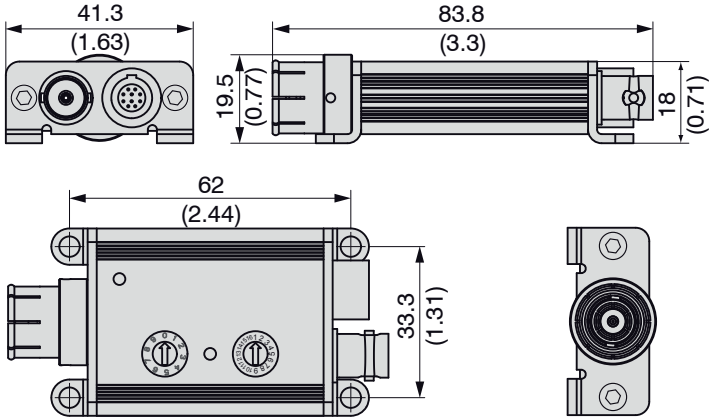
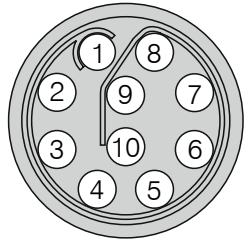


Fig. 11 Dimensions controller, dimensions in mm (inches), not to scale

4.5 Electrical Connections

4.5.1 Supply, Outputs

Supply/Output		Labeling and color PC140-x	
Pin	**Assignment**		
1	Analog output speed 0 ... +5 V	U_a	blue
2	Reserved, do not connect!		yellow
5	GND	GND	black
3	TTL-Impulse, digital	TTL	green
5	GND	GND	black
Housing		PE	black
4, 6	Reserved, do not connect!		
7	Supply -	SUPPLY-	white
8	Power supply + 9 ... 30 VDC	SUPPLY+	brown



View on solder cup side, 10-pole cable connector

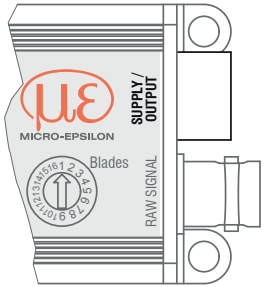


Fig. 12 Pin assignment female connector SUPPLY/OUTPUT and PC140-x

The connector housing / electronics housing is connected with the housing electronics and connector “PE”.

➡ Connect the PE connector (outer shielding braid) and the electronic housing with motor housing, test stand ground or protective earth.

An interior shielding braid (Pin 5) meshs the signals Pin 1 and the signal on Pin 3. PC140-x is a 3, 6 or 8 m long, pre-assembled 8-wired power and signal cable. It must be ordered as the sensor separately. The outputs are temporary short-circuit proof.
Pin 9 and 10 are not assigned.

4.5.2 Power Supply

Power supply U_V: +9 ... 30 VDC (temporarily up to 36 VDC)

Current consumption: I max < 50 mA

The controller is protected against voltage reversal and overvoltage.

Only use the power supply for measuring devices and not simultaneously for drives or similar pulse interference. MICRO-EPSILON recommends the power supply unit PS2020, see Chap. A 1. 12 V on-board power supply is possible.

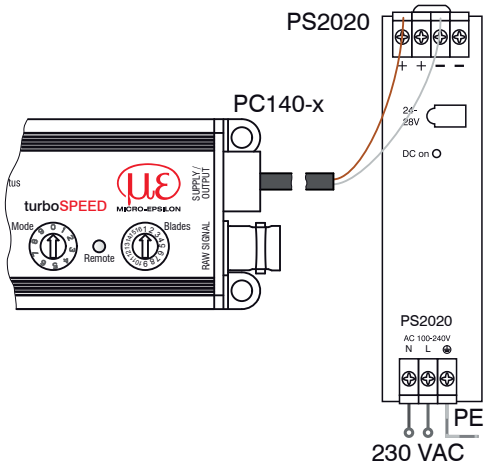


Fig. 13 Connection Power Supply

Wire color PC140-x		Assignment
SUPPLY +	brown	+9 … 30 VDC
SUPPLY -	white	Supply -

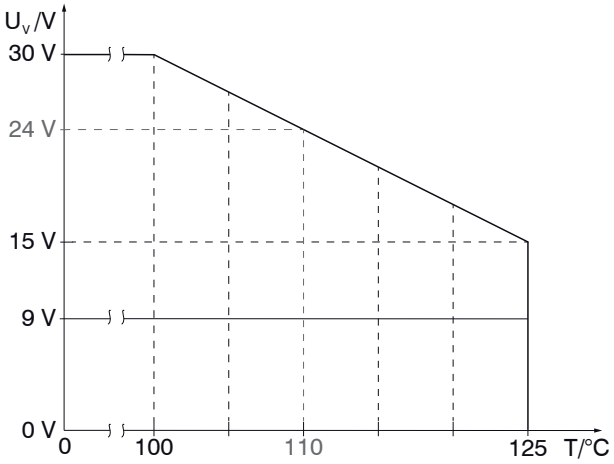


Fig. 14 Derating curve

The power supply U_V has to be limited at 100 °C ambient temperature and it must not exceed 15 VDC at 125 °C, see Fig. 14.

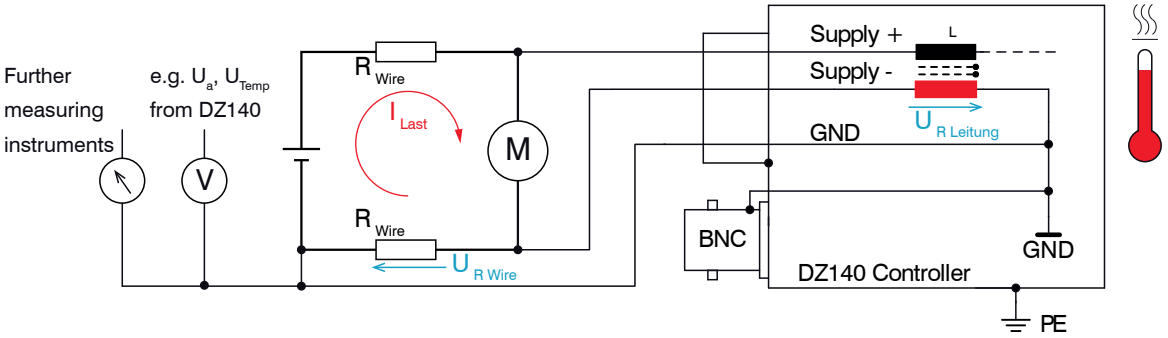


Fig. 15 Thermal overheating possible by measuring loop - avoid

If the GND line is connected to the negative pole of the power supply (e.g. due to connected measuring instruments), avoid connecting the controller to loads with high currents, e.g. starter.

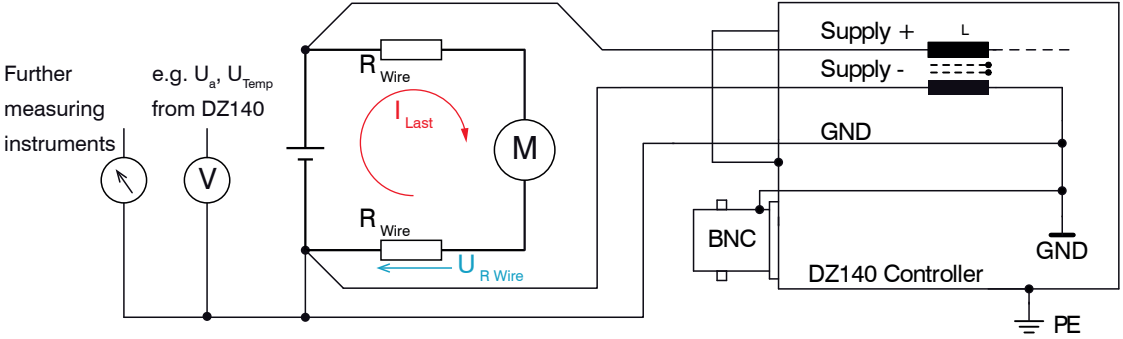


Fig. 16 Short connection leads directly to the supply - recommendation

i Also consider the possible ground loops, which can result from the use of the multi corrugated spring (connection between GND and PE), see Chap. 6.

4.5.3 RAW SIGNAL

Via a BNC socket `RAW SIGNAL` the controller provides an analog voltage of 2.8 ... 5 V to align the sensor, see Fig. 20, see Chap. 5.3.2. Load resistance > 5 kOhm.

➡ Disconnect the connected measuring devices after alignment of the sensor distance and close the female connector with the delivered protection cap.

4.5.4 Ground Concept

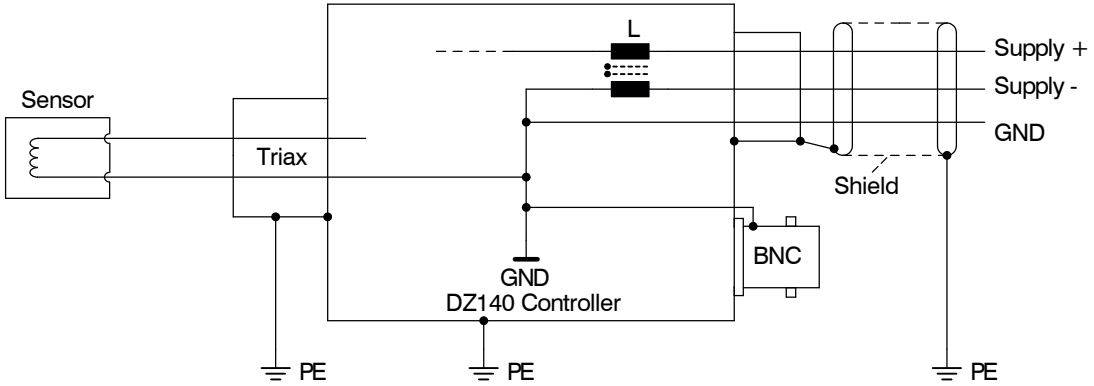


Fig. 17 Ground concept for DSx sensors

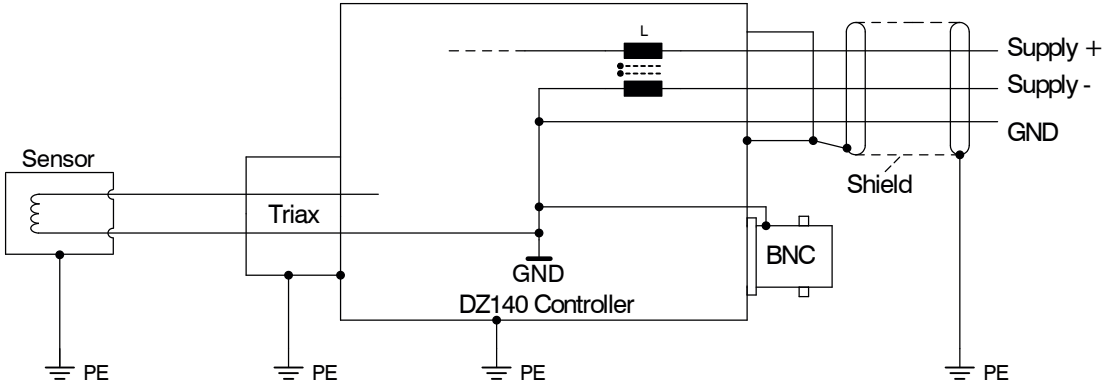


Fig. 18 Ground concept for DSx/T sensors

5. Operation

5.1 Connecting the Measuring System

By means of the female connector SUPPLY OUTPUT, the power supply for the controller is created and signals are output simultaneously.

- Install the sensor into the turbocharger and place it flush with the inner wall of the loader.
- Connect the sensor, see Fig. 1.
- Setup the power supply for the controller by using the connecting and signal cable PC140-x, cable length x = 3, 6 or 8 m, see 4.5.2.

The connection and signal cable has a push-pull lock on the connector side. Push-pull connections have a very user-friendly locking mechanism. If the connector is plugged into the device, the lock claws on the connector in device snap and form a reliable connection between the two parts.
Disconnection is not possible when pulling on the connector cable.
By contrast, the connector can be easily separated from the device when the outer sleeve is retracted.

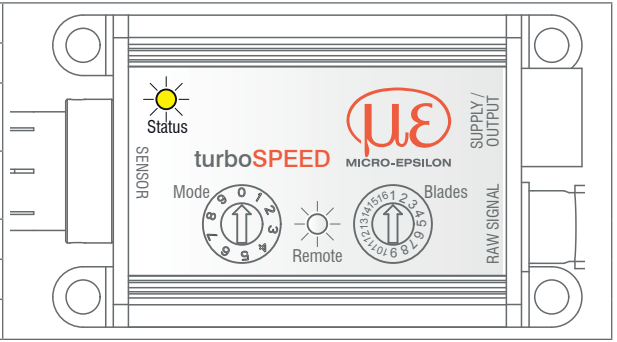
- Connect measuring signal displays or recorders also to the 10-pole cable socket on the controller resp. on the PC140-x cable.
- Switch on the power supply unit.

After applying the supply voltage, the controller initializes. It is shown by means of fast red-yellow-green flashing of the Status LED, see Chap. 5.2.

- Set the mode and the number of blades, see Chap. 5.5.1, see Chap. 5.5.2.
- Make sensor positioning, see Chap. 5.3.

5.2 LEDs on the Controller

Status	red, yellow, green	Initialization
	red	No sensor
	red, flashes (1 sec. Takt)	Teach to sensor
	red, flashes quickly	Error
	yellow	Controller ready
	green	Blade detected
	green, flares	Mode 8 (test pulse)



5.3 Positioning of the Sensor

5.3.1 Open Compressor Housing

The best method of positioning the sensor is, when the compressor housing is opened and you can see the front of the sensor.

➡ Fix the sensor so that the front of the sensor is in line with the compressor housing wall.

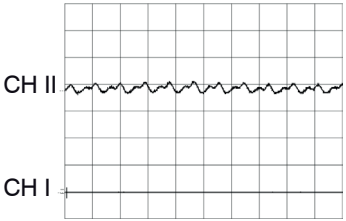
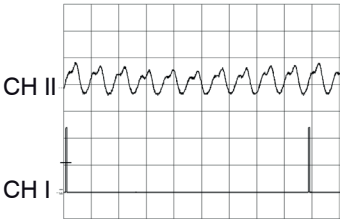
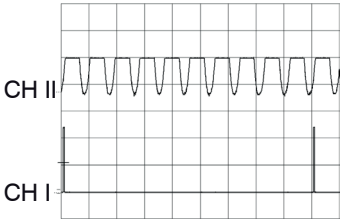
In this case you have the best signal and the best suppression of electromagnetic interference. The `RAW SIGNAL` signal is exclusively used for the sensor mounting. Signal range: 2.8 ... 5 V.

5.3.2 Closed Compressor Housing

With the help of the light-emitting diode `Status` on the controller the sensor can be positioned roughly.

➡ Connect the signal `TTL impulse` (pin 3, female connector supply/output) to an oscilloscope, channel I.

➡ Connect the `RAW SIGNAL` to an oscilloscope, channel II.

Step 1	**Step 2**	**Step 3**
➡ Start to set the compressor in slow rotation and carefully push or turn the sensor in to the mounting hole respectively in to the thread of the charger.		
---	➡ Continue to turn in the sensor.	➡ Turn in the sensor for max. one further thread turning.
CH I, `TTL impulse`: 2V/DIV; CH II, `RAW SIGNAL`: 1V/DIV; TB: 2 ms/DIV; trigger: CH I		
		
LED status: shines yellow	LED status: shines green	LED Status: shines green

5.4 Test Signal

The controller provides a test signal on pin 1 and 3 of the 10-pole male cable socket `SUPPLY OUTPUT` no matter a sensor is connected.
The signal can be used to check the wiring of the measurement setup without requiring the loader to be operated.

Procedure:

➡ Set the switch `Mode` to `8`.

The LED `Status` flares green.

Pin 1, analog output turbo charger speed: 2.5 VDC.

Pin 3, TTL impulse: The signal provides 100,000 pulse/revolution, this corresponds to a frequency of 1666.7 Hz.

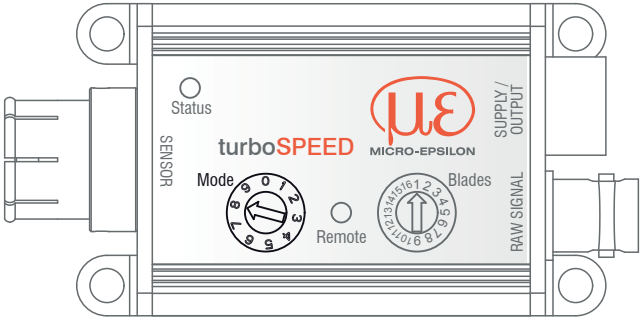


Fig. 19 Settings for the test signal

i The temperature signal is output independently from the test signal. If no sensor is connected, no temperature signal is output (respectively 5 VDC).

5.5 Settings

5.5.1 Mode (Turbo Charger Speed, Sensitivity, Test Signal)

The maximum measurable speed depends on the measuring distance. The smaller the measuring distance, the higher the measurable speed. The digital output may exceed 400,000 rpm, but my also fall below if the distance is too large.

The electronic controls the internal RAW voltage at infinite distance, thus between the individual blades, to approximately 2.8 V. The sensitivity of the electronics can be increased in order to detect a blade at a greater distance between the sensor and the turbocharger blade. In the example the turbocharger blades 2 and 3 were reliably detected at a `Med` sensitivity setting. A `Low` sensitivity setting guarantees the best immunity to interference.
Ex factory the controller is delivered with a `High` (mode 0) sensitivity setting.

$$T_{meas}\,[°C] = U_{temp}\,[V] * \frac{350\ °C}{5\ V} - 50\ °C$$

Fig. 20 Sensitivity setting for detecting single turbocharger blades, RAW SIGNAL

➡ Set the maximum speed to be measured using the switch `Mode` on the controller, see Fig. 21.

- Mode 0: 400k high (400.000 rpm, high sensitivity)
- Mode 1: 200k high (200.000 rpm, high sensitivity)
- Mode 2: 400k med (400.000 rpm, medium sensitivity)
- Mode 3: 200k med (200.000 rpm, medium sensitivity)
- Mode 4: 400k low (400.000 rpm, low sensitivity)
- Mode 5: 200k low (200.000 rpm, low sensitivity)
- Mode 8: test signal, see Chap. 5.4

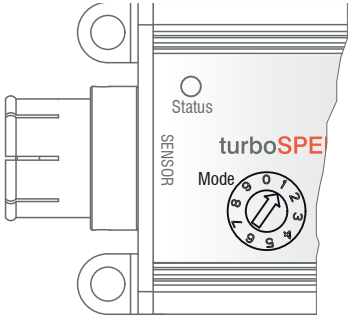


Fig. 21 Rotary switch for speed, sensitivity and test mode

The list of modes is fixed as a quick guide on the back side of the turboSPEED DZ140 and can be also printed separately if it is covered during the measurement, see Chap. A 2.

5.5.2 Number of Blades

Set the number of blades of the turbo charger using the switch `Blades` on the controller, see Fig. 22.

- Blades 1 ... 16 (number of blades)

The settings for a turbo charger with 8 blades are shown, see Fig. 22.

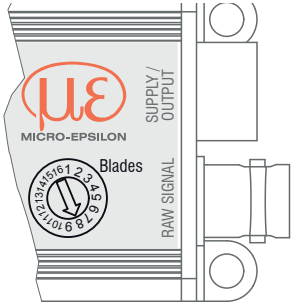


Fig. 22 Rotary switch for the number of blades

One pulse per blade with variable duration

- Impulse duration depends on compressor rotation speed
- Amplitude: LOW = 0 V, HIGH = 5 V

Set the number of blades of the turbo charger with the switch `Blades` on the controller to value 1, see Fig. 22.

Also detects up to 16 blades at a maximum speed of 400,000 rpm.

One pulse per revolution

- Duration about 100 µsec
- Programming of the number of blades with the corresponding position of the switch `Blades`. Number of blades: 2 ... 16; Amplitude: LOW = 0 V, HIGH = 5 V

5.6 Analog Output

- Range 0 ... +5 V
- Linear, depends on rotation speed

Mode 1, 3, 5

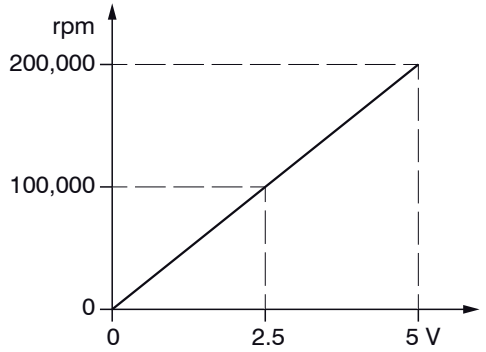


Fig. 23 Analog signal for max. 200,000 rpm

Mode 0, 2, 4

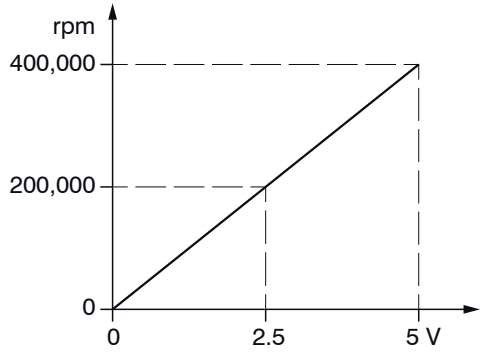


Fig. 24 Analog signal fo max. 400,000 rpm

6. Troubleshooting

Try the following options if during the measurements (possibly also only at different speeds) faults occur despite the above noted points:

- Adjust the sensitivity (mode switch).
- Connect the controller with its own power supply.

Alternatively, you may also perform a galvanic separation.

- If you are using the `RAW SIGNAL` via the BNC socket, disconnect and plug the female connector with the supplied protective cap.
- If you are using measuring devices (e.g. an oscilloscope), in which the signal ground (GND) is connected to the protective earth conductor of the mains socket, add a galvanic separation (e.g. by means of an isolating transformer).
- Make sure that any possible interference from other components are minimized (e.g. by shielding).
- Connect the signal ground (GND) with the housing ground (PE), e.g. by clamping the supplied multi corrugated spring ring between controller housing and BNC cap (or BNC connector), see Fig. 25, see Fig. 26, see Fig. 27.

i Note that the spring ring rests entire surface on both sides.

NOTICE

First remove any contamination on the contact surfaces of the fire ring (housing, BNC plug, etc.)
> Bad connection between GND and PE

Fig. 25 Multi corrugated spring ring

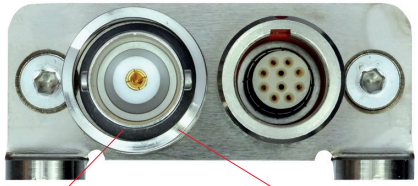


Fig. 26 Front view controller turboSPEED with multi corrugated spring ring

NOTICE

Note also if the ground supply (supply -) is already connected to the housing ground (PE) e.g. in the vehicle via the negative pole of the car battery since the signal (GND) and housing ground (PE) are connected together by the spring ring.
> Unwanted ground loops

The improved shielding of the Triax line against a coaxial line can be impaired.

Fig. 27 Side view controller turboSPEED with multi corrugated spring ring

7. Liability for Material Defects

All components of the device have been checked and tested for functionality at the factory. However, if defects occur despite our careful quality control, MICRO-EPSILON or your dealer must be notified immediately. The liability for material defects is 12 months from delivery.
Within this period, defective parts, except for wearing parts, will be repaired or replaced free of charge, if the device is returned to MICRO-EPSILON with shipping costs prepaid. Any damage that is caused by improper handling, the use of force or by repairs or modifications by third parties is not covered by the liability for material defects. Repairs are carried out exclusively by MICRO-EPSILON.
Further claims can not be made. Claims arising from the purchase contract remain unaffected. In particular, MICRO-EPSILON shall not be liable for any consequential, special, indirect or incidental damage. In the interest of further development, MICRO-EPSILON reserves the right to make design changes without notification. For translations into other languages, the German version shall prevail.

8. Service, Repair

If the sensor, sensor cable, supply and signal cable or controller is defective please send us the affected parts for repair or exchange.
If the cause of a fault cannot be clearly identified, please send the entire measuring system to:

MICRO-EPSILON MESSTECHNIK
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94496 Ortenburg / Germany

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Fax +49 (0) 8542 / 168-90
info@micro-epsilon.de
www.micro-epsilon.com

9. Decommissioning, Disposal

➪ Remove the power supply and signal cable on the sensor.

Incorrect disposal may cause harm to the environment.

➪ Dispose of the device, its components and accessories, as well as the packaging materials in compliance with the applicable country-specific waste treatment and disposal regulations of the region of use.

Appendix

A 1 Optional Accessories

PS2020

Power supply unit for mounting on DIN-rail,
Input 230 VAC,
Output 24 VDC/2.5 A

DD241PC(11)-U

Digital process display,
Display of a selected measuring value,
Connection to the analog output 0 - 10 V

A 2 Labels on Rear Side of Controller for Printing

The list of modes, see Chap. 5.5.1, is fixed as a quick guide on the back side of the turboSPEED DZ140.

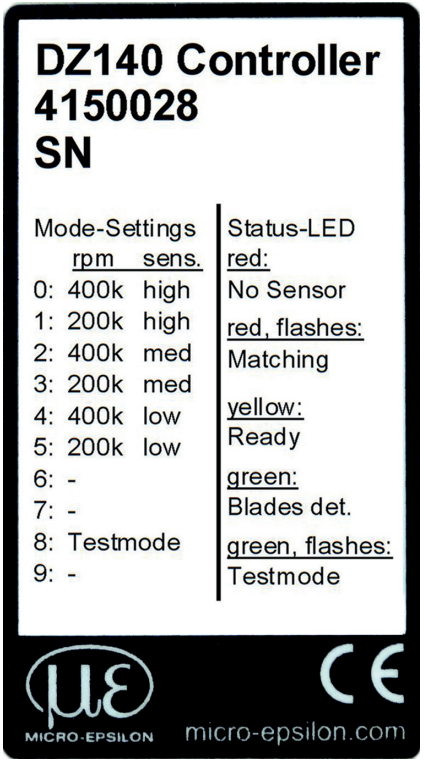

Fig. 28 Label - big

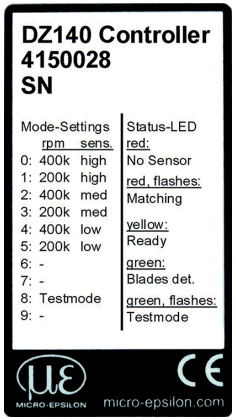

Fig. 29 Sticker - small

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