NOx Sensor

P/N 56.03.002

Installation Instruction

P/N 01.50.027-EN | Rev. 02/2021

Original installation instruction

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Table of Contents

1 General Information

Prior to use, read this installation instruction carefully and familiarize yourself with the product. Installation and start-up should not be carried out before reading and understanding this document. Keep this installation instruction readily available so that you can reference it as needed.

1.1 What Is the Purpose of this Installation Instruction?

This installation instruction serves as an aid for the installation of the product and supports the technical staff with all maintenance tasks to be performed. Furthermore, this instruction is aimed at preventing dangers to life and health of the user and third parties.

1.2 Who Is this Installation Instruction Targeted to?

This installation instruction provides a code of conduct for personnel tasked with the setup, operation, maintenance, and repair of gas engines. A certain level of technical knowledge with respect to the operation of gas engines and basic knowledge of the electronic components used are necessary. Persons who are only authorized to operate the gas engine shall be trained by the operating company and shall be expressly instructed concerning potential hazards.

1.3 What Symbols Are Used in the Installation Instruction?

The following symbols are used in this instruction and must be observed:

Example

This symbol indicates examples, which point out necessary handling steps and techniques. In addition, you receive additional information from the examples, which will increase your knowledge.

Notice

This symbol indicates important notices for the user. Follow these. In addition, this symbol is used for overviews that give you a summary of the necessary work steps.

Warning

This symbol indicates warnings for possible risks of property damage or risks to health. Read these warning notices carefully and take the mentioned precautionary measures.

1 General Information

Danger

This symbol indicates warnings for danger to life, especially due to high voltage. Read these warning notices carefully and take the mentioned precautionary measures.

1.4 Which Abbreviations/Acronyms Are Used in the Installation Instruction?

The following abbreviations/acronyms are used in the installation instruction.

Abb.	Term	Description	Explanation
CAN bus	Controller Area Network bus	Bus for control devices / networks	Asynchronous serial connection system for linking control units
DC	Direct Current		
EMC	Electromagnetic Compatibility		Compatibility of electrical or electronic equipment items with their surroundings
HB	Horizontal Burning		Flammability class as per UL 94
QR	Quick Response		
RoHS	Restriction of Hazardous Substances		

2 Safety Instructions

2.1 General Safety Instructions

MOTORTECH equipment is manufactured as state of the art and therefore safe and reliable to operate. Nevertheless the equipment can cause risks or damage can occur, if the following instructions are not complied with:

- The gas engine must only be operated by trained and authorized personnel.
- Observe all safety instructions of the system and all safety instructions of the system operator.
- Operate the equipment only within the parameters specified in the technical data.
- Use the equipment correctly and for its intended use only.
- Never apply force.
- For all work such as installation, conversion, adaptation, maintenance, and repair, all equipment must be disconnected from the mains and secured against unintentional reactivation.
- Perform only such maintenance and repair work as is described in this installation instruction, and follow the instructions given while working.
- Further work must only be performed by personnel authorized by MOTORTECH. Non-compliance with the instructions will void any warranties for the proper function of the equipment as well as the responsibility for the validity of the certifications.
- Safety devices must not be dismounted or disabled.
- Avoid all activities that can impair the function of the equipment.
- Operate the equipment only while it is in proper condition.
- Investigate all changes detected while operating the gas engine.
- Ensure compliance with all laws, directives, and regulations applicable to the operation of your system, including such not expressly stated herein.
- If the system is not entirely tight and sealed, gas may escape and result in explosion hazard. The inhalation of gas can also lead to death or severe health damages. Therefore, upon completion of all assembly works, always check the system's tightness.
- Always ensure adequate ventilation of the engine compartment.
- Ensure a safe position at the gas engine.
- There is a risk of burning on hot surfaces. Allow the gas engine to cool down before starting any work.
- Personal protective equipment (PPE), e.g. safety shoes and gloves, must be worn during all work on the gas engine.
- Noise from the system can cause permanent or temporary damage to your hearing. Wear suitable hearing protection at the system.
- Your behavior can reduce possible residual risks to a minimum. Observe responsible handling of the gas engine and the gas-carrying system.

2 Safety Instructions

2.2 Electrostatic Discharge Hazards

Electronic equipment is sensitive to static electricity. To protect these components from damage caused by static electricity, special precautions must be taken to minimize or prevent electrostatic discharge.

Observe these safety precautions while you work with the equipment or in its vicinity.

- Before performing maintenance or repair work, ensure that the static electricity inherent to your body is discharged.
- Do not wear clothing made from synthetic materials to prevent static electricity from building up. Your clothing should therefore be made of cotton or cotton mix materials.
- Keep plastics such as vinyl and Styrofoam materials as far away from the equipment as possible.
- Do not remove the circuit boards from the housing of the device.

2.3 Special Safety Instructions for the Device

Operational safety!

To prevent arcing or sparking and short circuits that can cause electric shock and serious damage to the connected equipment, always switch off the power supply to the NO_x sensor before disconnecting its electrical connections.

Explosion hazard!

Only use the NO_x sensor for measurement in non-explosive gas mixtures, as explosive gas mixtures can ignite on the hot sensing element. Especially in the case of engine malfunction, make sure that no unburned gas mixture enters the exhaust pipe.

Risk of burning!

There is a risk of burns when touching the sensing element of the NO_x sensor because the sensing element becomes hot during operation. Therefore, note the following points:

- Therefore, install the sensing element on the exhaust pipe at a suitable location at which people at the plant cannot be burned by it, or install an appropriate protection around the sensing element that prevents contact with it.
- The sensing element must have cooled down sufficiently at the end of operation before you can touch the sensing element again.

Risk of injury!

The NOx sensor is designed for operation in circuits with **protected extra-low voltage (PELV)**. The voltages in these circuits must not exceed 50 V AC or 75 V DC. To protect the circuit against overload and short circuits, the supply voltage cable must be secured with a suitable fuse.

Operational safety!

The chemical elements magnesium (Mg), silicon (Si), phosphorus (P), and sulfur (S) can change the measuring characteristics of the NOx sensor. Make sure that these chemical elements are not present in your application. Do not use sprays containing these chemical elements. Only use material in the exhaust pipe free of these chemical elements.

Operational safety!

To ensure proper functioning of the NOx sensor, the probe must not come into contact with condensation water and other liquid components. The sensor and its electronics must not be painted either. Do not open the cover of the evaluation unit's connector.

Operational safety!

The sensing element may be mounted and dismounted a maximum of two times. The electrical connection to the NOx sensor's evaluation unit may be established and disconnected a maximum of 20 times. After that, proper functioning of the sensor can no longer be guaranteed.

2.4 Proper Transport

Let the NOx sensor remain in its original packaging until it reaches its place of use. To prevent damage to the sensor, carry the NOx sensor separately by hand. Make sure that you do not twist the connection cable (max. 180°). Under no circumstances should you wrap the connection cable around the evaluation unit, but wrap the connection cable separately from the evaluation unit and maintain the minimum bending radius of 20 mm (0.79"). Do not remove the protective cap from the sensing element until you are instructed to do so within this installation instruction (see section *Mounting* on page 20).

2.5 Proper Disposal

After the expiration of its service life, MOTORTECH equipment can be disposed of with other commercial waste, or it may be returned to MOTORTECH. We will ensure its environmentally friendly disposal.

3 Intended Use

3.1 Functional Description

The NO_x sensor measures the nitrogen oxide and oxygen concentration in the exhaust gas of stationary gas engines in industrial environments and transmits the measured values via the CAN bus to a master control.

3.2 Applications

The NO_x sensor is designed for use with gas-powered stationary lean-burn and lambda-1 engines in industrial environments whose exhaust gases have an oxygen content › 1 vol%.

The NO_x sensor is suitable for exhaust gases and exhaust pipes that are free of ammonia, magnesium, silicon, phosphorus, and sulfur and may only be used for measurements in non-explosive gas mixtures.

The NO_x sensor is designed for use in a non-hazardous area.

Any use other than the one described in the installation instruction shall be considered improper use and will result in the voiding of all warranties.

4 Product Description

4.1 Technical Data

4.1.1 Certifications

The NO_x sensor is certified as follows:

CE

EMC Directive

- EN 61326-2-3 – Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 2-3: Particular requirements - Test configurations, operational conditions and performance criteria for transducers with integrated or remote signal conditioning
- EN 55011 – Industrial, scientific and medical equipment - Radio-frequency disturbance characteristics - Limits and methods of measurement
  - Group 1, Class A and B

RoHS Directive

4 Product Description

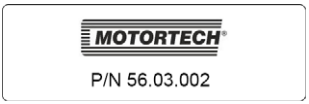
4.1.2 Mechanical Data

The NO_x sensor has the following mechanical characteristics:

Feature	Value
Dimensions	Length of probe: 25.4 mm (1") Length of sensing element: 96.9 mm (3.82") Evaluation unit (length x width x height): 148 mm x 65 mm x 35.4 mm (5.83" x 2.56" x 1.4") Length of connection cable: 900 mm (35.4")
Shape of device	See section *Overview Drawings* on page 16
IP protection rating	IP 6K9K with mating plug connected to evaluation unit and sensing element mounted in suitable welding boss from MOTORTECH
Climatic environmental conditions	Operating temperature evaluation unit: –40 °C to +115 °C (–40 °F to +239 °F) Operating temperature hexagon nut: –40 °C to +620 °C (–40 °F to +1,148 °F) Operating temperature sensor grommet and connection cable: –40 °C to +200 °C (–40 °F to +392 °F) Storage temperature in original packaging with protective cap never removed: –40 °C to +65 °C (–40 °F to +149 °F) for max. 2 years Exhaust gas temperature range: –40 °C to +800 °C (–40 °F to 1,472 °F) Operating pressure range: 800 mbar abs to 1,600 mbar abs
Flammability class as per UL 94	Plastic housing parts of the evaluation unit: HB
Mounting cycles	Max. 2
Mating cycles evaluation unit	Max. 20
Service life	6,000 h with average temperature of evaluation unit at +90 °C (+194 °F)

4.1.3 Product Identification – Labeling on the Device

The part number (P/N) of the NOx sensor can be found on the upper label on the bottom side of the evaluation unit.



The date of manufacture and the serial number of the NOx sensor can be read out via the two-dimensional matrix code (Data Matrix) on the connector of the evaluation unit. For this purpose you can use a QR scanner, for example, which can also read Data Matrix codes. You will find the relevant information at the following positions in the read-out 49-character long string:

Position	Meaning
22 + 23	Year of manufacture (3rd and 4th digit)
24 + 25	Month of manufacture
26 + 27	Day of manufacture
28 – 31	Serial number

4.1.4 Electrical Data

The NO_x sensor has the following electrical characteristics:

Feature	Value
Power supply	24 V DC (16 V DC to 36 V DC)
Maximum power consumption	20 W
Required current	Max. 1.5 A_{eff}, 6.2 A_{peak}
Connector evaluation unit	5-pole, connector

The measuring probe of the NO_x sensor has the following characteristics:

Feature	Value
Measuring range nitrogen oxide (NO_x)	0 ppm to 1,500 ppm
Measuring accuracy nitric oxide (NO)	See table 1 below
Response time nitrogen oxide (NO_x)	t_{10-90}: max. 5,300 ms
Cross sensitivity NO_x measurement	Ammonia (NH_3) typ. 100 %
Sensitivity NO_x measurement	Nitrogen dioxide (NO_2) typ. 80 %
Measuring range oxygen (O_2)	0 % to 20.9 %
Measuring accuracy oxygen (O_2)	See table 2 below
Exhaust gas velocity	Min. 10 m/s
Pressure pulsation	Max. 130 $mbar_{peak\text{-}to\text{-}peak}$ above 10 Hz
NO_2 correction factor (K_{NO2})	0.8 (set ex works)

Measuring accuracy

The measuring accuracy of the NO_x sensor can be affected negatively by pressure pulsations above 130 $mbar_{peak\text{-}to\text{-}peak}$ in the frequency range above 10 Hz. Therefore, only use the NO_x sensor outside this range.

Table 1: Measuring accuracy nitric oxide (NO)

Measurement	Measuring accuracy at O_2 > 1 vol% and evaluation unit operating temperature	
	–40 °C to +105 °C (–40 °F to +221 °F)	+106 °C to +115 °C (+222.8 °F to +239 °F)
NO ≤ 100 ppm	± 10 ppm	± 15 ppm
100 ppm < NO ≤ 500 ppm	± 10 %	± 10 % ± 5 ppm_{offset}
500 ppm < NO ≤ 1,500 ppm	± 15 %	± 15 % ± 5 ppm_{offset}

Table 2: Measuring accuracy oxygen (O_2)

Measurement	Measuring accuracy at evaluation unit operating temperature
	–40 °C to +115 °C (–40 °F to +239 °F)
O_2 ≤ 5 %	± 2,500 ppm abs
5 % < O_2 ≤ 20.9 %	± 5 % rel

4.1.5 Interfaces

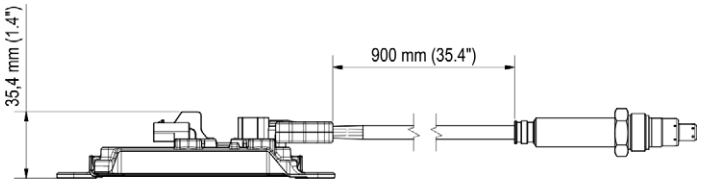
CAN Bus Interface

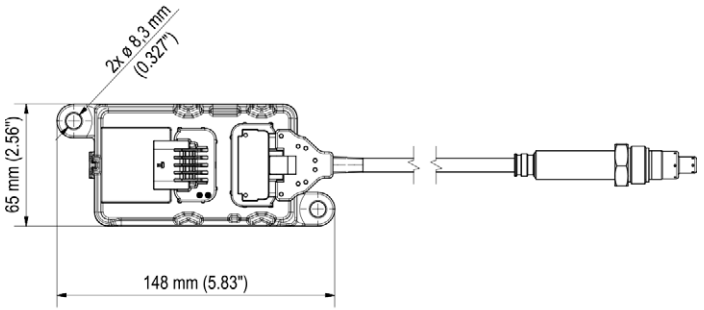
- Network protocol: SAE J1939
- Transmission rate: 250 kbit/s

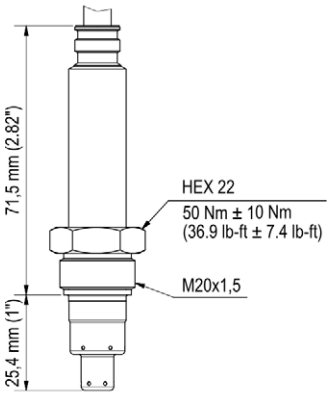
4 Product Description

4.1.6 Overview Drawings

Dimensions







5 Mounting Instruction

Replacement of NOx sensor in EasyNOx system

If you want to replace an identical NOx sensor from MOTORTECH in the exhaust pipe, read the section *Replacement of NOx Sensor* in the EasyNOx operating manual.

5.1 Preparation

Make sure that your application meets the following requirements.

5.1.1 External Power Supply

Risk of injury!

The NOx sensor is designed for operation in circuits with **protected extra-low voltage (PELV)**. The voltages in these circuits must not exceed 50 V AC or 75 V DC. To protect the circuit against overload and short circuits, the supply voltage cable must be secured with a suitable fuse.

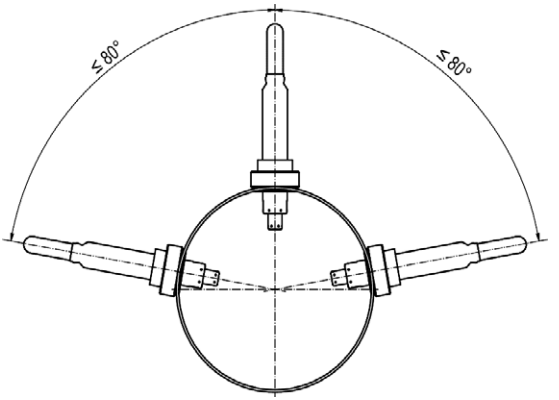
5 Mounting Instruction

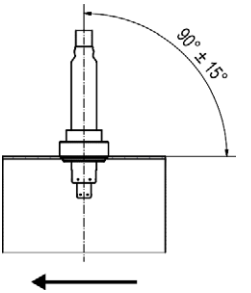
5.1.2 Mounting Position of Sensing Element

To obtain valid measured values, an oxygen content › 1 vol% must be provided permanently at the mounting position of the sensing element.

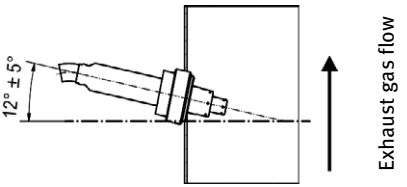
The mounting position of the sensing element must be defined in such a way that no condensation water is able to collect in the protective tube of the sensing element. The possible tilt angles depend on the course of the exhaust pipe. Mounting in a vertical exhaust pipe is not recommended by MOTORTECH.

Horizontal exhaust pipe tilt angles





Vertical exhaust pipe tilt angles



To ensure proper functioning of the connection cable, the minimum bending radius of the connection cable of 20 mm (0.79") must be observed at the mounting position and the angle of the cable outlet at the sensor grommet must be less than 15°.

The sensing element becomes hot during operation. Therefore, the sensing element must be installed on the exhaust pipe in a suitable location at which people at the plant cannot be burned by it, or an appropriate protection must be installed around the sensing element that prevents contact with it.

5.1.3 Mounting Position of Evaluation Unit

To prevent the formation of discharge sparks or electric shock when touching the housing, the evaluation unit of the NO_x sensor must be mounted on a grounded be mounted plate.

5.2 Unpacking

Before unpacking, please observe the instructions in section *Proper Transport* on page 9.

To prevent condensation from forming in the sensing element of the NO_x sensor, you should avoid any temperature shocks when opening the packaging. Before opening, allow the shipping unit to adjust to the mounting temperature by storing it at mounting temperature for at least one day.

After having opened the packaging, avoid temperature changes of more than ± 5 °C (9 °F). The NO_x sensor must not be taken out of its packaging in polluted air and under bad weather conditions (e.g. oil, water, snow, dust, sand, smoke).

Do not remove the protective cap from the sensing element until you are instructed to do so within this installation instruction (see section *Mounting* on page 20).

5.3 Material Needed

For mounting the NO_x sensor, you need the following material:

- Suitable welding boss from MOTORTECH
- Locking screw for welding boss from MOTORTECH
- Suitable harness from MOTORTECH for connecting the NO_x sensor to the master control

If you have any questions about the needed material, contact your MOTORTECH contact person (see *Customer Service Information* on page 25).

5 Mounting Instruction

5.4 Mounting

Operational safety!

To safely mount the NOx sensor, be sure to observe the following:

- To protect the NOx sensor and yourself, wear ESD-compliant work gloves. To protect the NOx sensor against electrostatic discharge, also comply with IEC 61340-5-1 and IEC TR 61340-5-2 in their respective valid versions.
- Under no circumstances touch the probe of the sensing element while mounting.
- If mechanical shock to the sensing element occurs (e.g. drop on the floor), the NOx sensor must not be used under any circumstances and must be disposed of. In cases of doubt, contact your MOTORTECH contact person (see *Customer Service Information* on page 25).

Operational safety!

The sensing element may be mounted and dismounted a maximum of two times. The electrical connection to the NOx sensor's evaluation unit may be established and disconnected a maximum of 20 times. After that, proper functioning of the sensor can no longer be guaranteed.

Replacement of NOx sensor in EasyNOx system

If you want to replace an identical NOx sensor from MOTORTECH in the exhaust pipe, read the section *Replacement of NOx Sensor* in the EasyNOx operating manual.

Before mounting, it is essential to observe the instructions in the section *Preparation* on page 17.

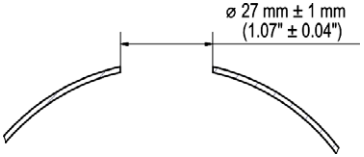
Make sure that the engine is switched off when mounting. Also make sure that the exhaust pipe has cooled down sufficiently and that there are no exhaust gases in the exhaust pipe.

The sensing element of the NOx sensor is screwed into the exhaust pipe via a suitable welding boss made of stainless steel (material number 1.4301) from MOTORTECH and connected to the master control via a suitable harness from MOTORTECH. For welding in the welding boss, the locking screw of the welding boss can be used as welding aid.

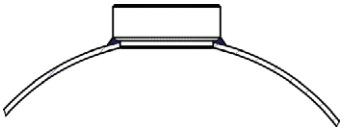
5 Mounting Instruction

Proceed as follows:

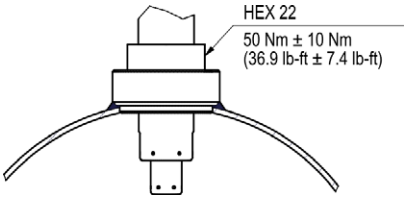
1. At the selected mounting position in the exhaust pipe, drill a hole with a diameter of 27 mm ± 1 mm (1.07" ± 0.04") into the exhaust pipe.



2. Screw the locking screw into the welding boss and weld the stainless steel welding boss (material number 1.4301) into this hole with a suitable welding filler.



3. Remove the protective cap from the probe of the sensing element. Do not pull on the connection cable, but hold the sensing element only by its metal body.
4. Check whether the thread of the sensing element is sufficiently greased. If necessary, re-grease it with high temperature grease. Also make sure that no dirt or dust gets deposited in or on the probe while mounting.
5. Insert the sensing element into the welding boss and screw the sensing element into the welding boss via its hexagon nut by hand first. The outgoing cables must not twist by more than 180°. Therefore counter the sensing element with your hand.
6. Then tighten the sensing element over its hexagon nut using a calibrated torque tool with a torque of 50 Nm ± 10 Nm (36.9 lb-ft ± 7.4 lb-ft). Make sure that the minimum bending radius of the connection cable of 20 mm (0.79") is observed at the mounting position and that the angle of the cable outlet at the sensor grommet is less than 15°.



7. Then mount the evaluation unit of the NOx sensor with two suitable screws onto a grounded mounting plate at a suitable place. The diameter of the mounting holes is 8.3 mm (0.33").
8. Make sure that there are no particles in the five-pin connector of the NOx sensor's evaluation unit and that the five-pin connector is dry.

9. Then connect the five-pin connector of the evaluation unit to the external power supply for the NOx sensor and via the CAN bus to the master control. Use a suitable harness from MOTORTECH for this purpose and observe the enclosed wiring diagram. The wiring harness should be laid in such a way that there is no pull on it. If you use cable fasteners, they should not exert any force on the wiring harness.

   ▸ The NOx sensor is mounted.

5.5 Setting CAN Identifier

Two CAN identifiers are predefined in the NOx sensor so that a maximum of two NOx sensors can be operated on one CAN bus. The CAN identifier is selected externally via pin 5 of the NOx sensor's connector.

– 0x18F00E51 = Parameter group number 61454, source address 81:
  Pin 5 is connected to ground.
– 0x18F00F52 = Parameter group number 61455, source address 82:
  Pin 5 is open.

5.6 Setting up Master Control

If you use a master control from MOTORTECH that is prepared for use with the NOx sensor (e.g. EasyNOx), you must in certain cases configure the control before you can carry out measurements with the NOx sensor. Further information on this can be found in the operating manual of the master control from MOTORTECH.

5.7 Dismounting

Operational safety!

To safely dismount the NOx sensor, be sure to observe the following:

- To protect the NOx sensor and yourself, wear ESD-compliant work gloves. To protect the NOx sensor against electrostatic discharge, also comply with IEC 61340-5-1 and IEC TR 61340-5-2 in their respective valid versions.
- Under no circumstances touch the probe of the sensing element while dismounting.
- The NOx sensor must not be live during dismounting and must have cooled down for at least 15 minutes after its last operation. Otherwise, touching the sensing element may cause burns, the sensing element may burn, and serious damage to the connected equipment due to arcing, sparking or short circuit may occur.
- If mechanical shock to the sensing element occurs (e.g. drop on the floor), the NOx sensor must not be used under any circumstances and must be disposed of. In cases of doubt, contact your MOTORTECH contact person (see *Customer Service Information* on page 25).

Operational safety!

The sensing element may be mounted and dismounted a maximum of two times. The electrical connection to the NOx sensor's evaluation unit may be established and disconnected a maximum of 20 times. After that, proper functioning of the sensor can no longer be guaranteed.

Make sure that the engine is switched off while dismounting. Also make sure that the exhaust pipe has cooled down sufficiently and that there are no exhaust gases in the exhaust pipe.

To dismount the NOx sensor, proceed as follows:

1. Make sure that the NOx sensor is not live. Then disconnect the harness from the connector of the NOx sensor's evaluation unit.

5 Mounting Instruction

2. Dismount the evaluation unit from the mounting plate.

Risk of destruction!

To avoid destroying the NOx sensor, do not hit with a hammer when dismounting. In case the thread of the sensing element is stuck, use only oils without silicon or magnesium for loosening.

3. Make sure that the sensing element has not been in operation for at least 15 minutes. Then unscrew the sensing element from the welding boss using a 22 mm (0.87") wrench. The outgoing cables must not twist by more than 180°. Therefore counter the sensing element with your hand.
   - ► The NOx sensor has been dismounted.

If you do not screw a suitable sensing element into the welding boss after having removed the NOx sensor, you may only restart the engine after having sealed the opening in the exhaust pipe gas-tight. For this purpose, use the locking screw of the welding boss. Grease the locking screw sufficiently with high temperature grease before inserting it into the welding boss, and tighten the locking screw in the welding boss with a torque of 25 Nm (18.5 lb-ft).

6 Errors

6.1 Customer Service Information

You can reach our customer service during business hours at the following phone and fax number, or by email:

Phone: +49 5141 93 99 0

Fax: +49 5141 93 99 99

Email: service@motortech.de

6.2 Returning Equipment for Repair / Inspection

To return the device for repair and inspection, obtain a return form from your MOTORTECH contact person (see *Customer Service Information* on page 25).

After you have completely filled out the return form and returned it to MOTORTECH, MOTORTECH will send you back the return form and a delivery note with RMA number specified. Enclose the return form with your device and attach the delivery note to the packaging so that it is clearly visible from the outside. This will ensure a speedy and smooth processing of your repair order.

Send the device with delivery note and return form to one of the two addresses below or to the nearest MOTORTECH representative:

MOTORTECH GmbH
Hogrevestr. 21–23
29223 Celle

Germany

Phone: +49 5141 93 99 0
Fax: +49 5141 93 99 98

www.motortech.de
motortech@motortech.de

MOTORTECH Americas, LLC
1400 Dealers Avenue, Suite A
New Orleans, LA 70123

USA

Phone: +1 504 355 4212
Fax: +1 504 355 4217

www.motortechamericas.com
info@motortechamericas.com

6.3 Instructions for Packaging the Equipment

For return shipment, equipment should be packaged as follows:

- Use packaging material that does not damage the equipment surfaces.
- Wrap the equipment with sturdy materials and stabilize it inside the packaging.
- Use sturdy adhesive film to seal the packaging.

7 Maintenance

7.1 Cleaning the NO_x Sensor

The NO_x sensor must not be cleaned with mechanical means or cleaning agents, as this may destroy the sensor or mechanically damage the labels. The NO_x sensor including its electrical connection must not come into contact with liquids.

If necessary, clean the NO_x sensor with a soft, dry cloth. If you clean the NO_x sensor when it is not mounted, make sure that the probe remains free of dirt.

7.2 Spare Parts and Accessories

For spare parts and accessories, please refer to our current Product Guide, which is available for you to download on the internet at *www.motortech.de*.

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Fax: +49 (5141) 93 99 99
E-Mail: sales@motortech.de
Web: www.motortech.de

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GAS ENGINE TECHNOLOGY

- Ignition Systems
- Spark Plugs & Accessories
- Gas Engine Control Systems
- Sensor Systems
- Air/Fuel Ration Control Systems
- Exhaust Gas Aftertreatment
- Gas Engine Accessories