MAXIMATOR®

Maximum Pressure.

Compressed air driven gas booster

DLE, 8DLE, 14DLE, MDLE, SDLE

Installation and operating manual

Key information!
Follow the manual for safe and proper use.
Keep the manual near the machine for later reference.

MAXIMATOR GmbH
Lange Straße 6
99734 Nordhausen
Germany
Phone: +49 3631 9533-0
e-mail: info@maximator.de
Internet: www.maximator.de

Warranty and liability:

As a general rule, the “General Terms and Conditions” of Maximator GmbH shall apply. These terms and conditions are available at http://www.maximator.de.

Warranty and liability claims shall not be accepted if they can be attributed to one or more of the causes mentioned in this manual or explicitly stipulated below:

– Any use other than the intended use indicated in this manual
– Improper commissioning, operation or maintenance
– Operation with faulty safety equipment or incorrectly installed safety equipment and safeguards
– Failure to observe the commissioning, operation and maintenance instructions in this manual
– Insufficient monitoring of wear parts
– Wear on seals, guiding elements, etc. due to ageing and operation

16/11/2023 Translation of the Original

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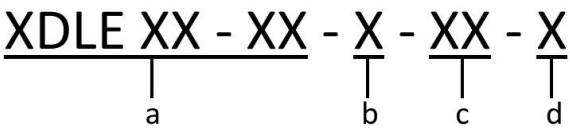
1 General information

1.1 Information regarding this manual

Maximator gas boosters can be used for a variety of applications. They are used to deliver gases and compress them to high pressures. This manual applies to all gas boosters with the following options in the order code: DLE, 8DLE, 14DLE, MDLE, SDLE and a serial number above 23000001.
The general drawing included is an integral part of this manual, and must be stored with it.

1.2 Order code

The order code for gas boosters is structured as follows:



a	**Model**
b	**Number of drive pistons**
	without = 1 drive piston
	2= 2 drive pistons
	3= 3 drive pistons
c	**Thread (gas inlet and outlet)**
	G = pipe thread (standard)
	U = high-pressure connection (UNF)
	N = NPT
d	**Option code**
	Additional codes for device options and/or variants may be entered here.

1.3 Rating plate

The rating plate is located on the drive cylinder of the gas booster and contains the following information:[1]:

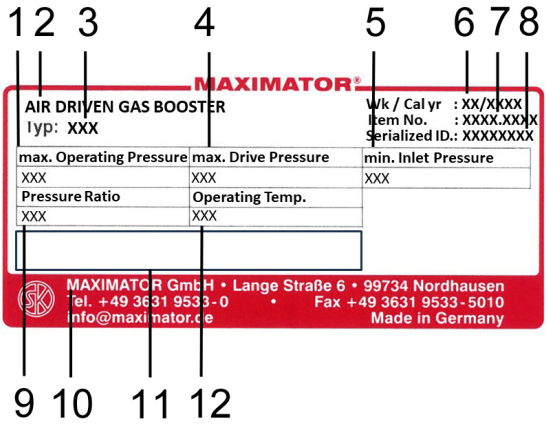


Fig. 1-1 Gas booster rating plate

1 Maximum permitted operating pressure
2 Compressed air driven gas booster
3 Type (specifications from the order code)
4 Maximum drive pressure
5 Minimum inlet pressure
6 Calendar week/year of manufacture
7 Article number
8 Serial number
9 Gear ratio
10 Manufacturer contact information
11 Label according to applied guidelines
12 Operating temperature range

[1] Individual gas boosters may have different rating plates, e.g. made of metal

1.4 Explanation of symbols

DANGER

This combination of symbol and signal word indicates a hazardous situation which - if not avoided - may lead to severe injuries or death.

WARNING

This combination of symbol and signal word indicates a potentially hazardous situation which - if not avoided - may lead to severe injuries or death.

CAUTION

This combination of symbol and signal word indicates a potentially hazardous situation which - if not avoided - may lead to light or minor injuries.

NOTICE

This combination of symbol and signal word indicates a potentially hazardous situation which - if not avoided - may lead to property damage or damage to the environment.

WARNING

This combination of symbol and signal word characterises contents and instructions for the intended use in potentially explosive areas. If failing to comply with instructions marked as such, an increased risk of explosion will be posed and may result in severe or fatal injuries.

1.5 List of abbreviations and formula signs used

Abbreviation	Description
Fig.	Figure
ATEX	EU explosion prevention directive
CE	EU mark of conformity
DGRL	EU pressure equipment directive
EPL	Equipment Protection Level
H2	Symbol for hydrogen
CET	Central European Time
PPE	Personal protective equipment
Tab.	Table

Tab. 1-1 List of abbreviations

Formula symbol	Description
i, i_1, i_2	Gear ratio
L_{eq}	Noise emission
p_A	Inlet gas pressure
p_B	Operating pressure
p_B max.	maximum permitted operating pressure
p_L	Drive pressure
T_A, T_B	Temperature
κ	Isentropic exponent

Tab. 1-2 Formula symbol

1.6 Qualification of the personnel

Only qualified personnel who are specialised and have been trained to do so must work on the product. Allowing unqualified personnel to work on the product or enter the danger zone creates hazards which could lead to death, severe injuries and significant property damage.

2 Safety and protection measures

The following sections stipulate the residual risks associated with the product, even when used as intended. In order to reduce the risk of personal injuries and material damage, and to prevent hazardous situations, you must observe the safety information listed in this section and the warnings in all other sections of this manual.

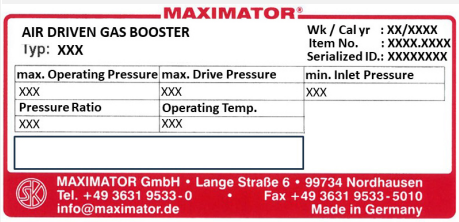
2.1 Personal protective equipment

Personal protective equipment (in other sections also referred to as PPE) protects personnel from occupational safety and health hazards while at work.

Wearing personal protective equipment may be required during work on the product. Wherever possible, this personal protective equipment is listed in these instructions for the individual work steps.
However, detailed specifications of the required protective equipment can only be determined with full knowledge of the system. The required personal protective equipment should therefore be determined by the user.

2.2 Signs and labels

The following signs are found on the gas booster.
Over time, labels can become unrecognisable due to dirt or other causes. As a result, hazards may be harder to identify, and important operating procedures may not be properly followed. Resulting errors can lead to severe injuries or death. Keep the labels in good, legible condition and replace any damaged labels.

Signs and labels	Graphic display
Rating plate: The rating plate is affixed to the drive cylinder of the gas booster. The rating plate indicates the operating characteristics of the gas booster.	

Tab. 2-1 Overview of labels

2.3 Work and danger zone

The danger zone comprises the entire area surrounding the product. The hazards associated with the product and the danger zone depend on the application and the installation location. The danger zone should therefore be determined by the user.

During assessment, check the following leak points:

Leak point	Leak type	Leak source
Bleed port HP side	Minor leakage	High pressure seal
Bleed port drive	Minor leakage	Rod seal drive side
Booster head / cylinder	Unexpected	Sealing on booster head and cylinder
Connection screw fitting	Unexpected	Loose screw connection
Connecting line drive / HP	Unexpected	Connecting line / fitting / O-ring
Drive housing parts	Unexpected	Seal in drive unit

Tab. 2-2 Leak point danger zone

2.4 Non obvious hazards

Using asphyxiant operating fluids, e.g. nitrogen, can lead to severe injuries or death by asphyxiation. Assess the risk for the equipment in the risk assessment. The following are some potential corrective actions:

- Operate the gas booster in an adequately ventilated space.
- Check the gas booster for leaks on a regular basis.
- Ensure that lines are connected in such a way as to remain leak-tight for a long time.
- If necessary, use connecting lines to remove the escaping operating fluids.

2.5 Residual risks

2.5.1 Start-up and shut down

During the restoration of the pneumatic energy supply, the gas booster may start up unexpectedly. This can lead to severe injuries or death.

Assess the risk for the equipment in the risk assessment.

There is no command device for safe shut-down (E-stop). This can lead to severe injuries or death.

Assess the risk for the equipment in the risk assessment.

2.5.2 Risk of injury posed by noise

The noise level emitted in the work area depends on the mounting and application.

Assess the risk for the equipment in the risk assessment.

2.5.3 Hazardous operating fluids

Improper use of operating fluids can lead to serious accidents resulting in death.

Assess the risk for the equipment in the risk assessment.

Active leaks can lead to serious accidents resulting in death.

Assess the risk for the equipment in the risk assessment.

3 Product description

3.1 Design and function

Structure

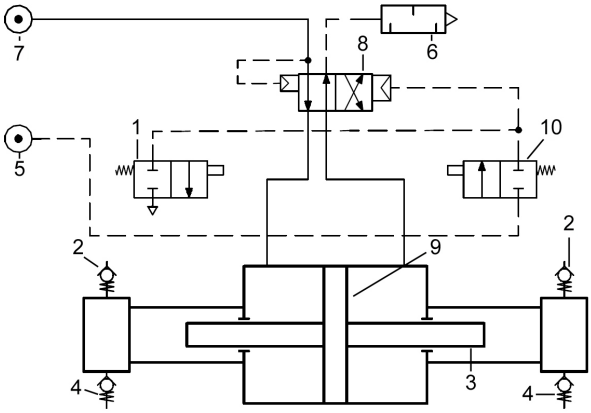


Fig. 3-1 Schematic circuit diagram of the double-acting gas booster

1	Pilot valve lower cap	6	Exhaust port
2	Gas inlet (A)	7	Drive air inlet (pL)
3	High pressure piston	8	Control slide valve
4	Gas outlet (B)	9	Air piston
5	Control air port (X)	10	Pilot valve top cap

Function description

The operating principle of a gas booster is similar to the one of a pressure intensifier. Low pressure is applied to the large area of the air piston (9) which applies high force to the small area of the high pressure piston (3).

The piston of the gas booster carries out oscillating movements until the stall pressure is reached. In doing so, the high pressure piston induces and compresses the compressed fluid by means of the check valves into the gas inlet (2) and gas outlet (4). The outlet pressure results from the set drive pressure, primary pressure and volume flow.

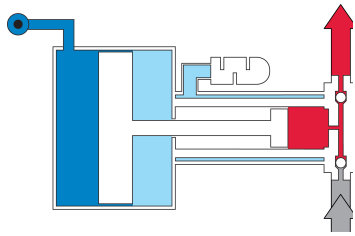
The continuous supply is achieved by means of an internally controlled directional valve, the spool valve (8). The spool valve alternately guides the drive fluid to the two sides of the air piston. The spool valve is controlled via two directional valves, the pilot valves (1; 10), which are operated mechanically by the air piston at its end positions. The pilot valves vent the operating area of the control slide valve.

An equilibrium of forces on the drive and high pressure side is generated as soon as the stall pressure is reached. The gas booster stops and no longer consumes drive fluid. A pressure drop on the high pressure side or a pressure increase on the drive side result in an automatic restart of the gas booster while the compressed fluid is compressed until an equilibrium of forces is restored.

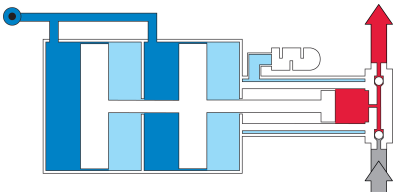
In most gas boosters with a gear ratio of > 5, the exhaust air is passed through the cooling cylinder and thus used to cool the high pressure cylinder.

The individual gas booster types are shown below:

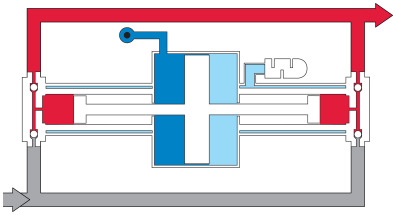
- Single-stage, single-acting with one drive part



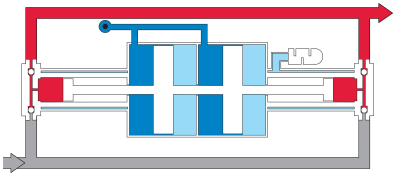
- Single-stage, single-acting with two drive parts



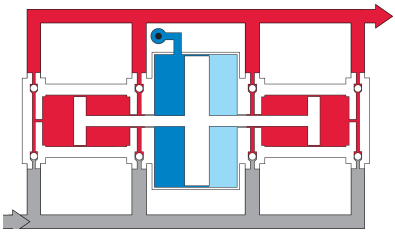
- Single-stage, double-acting with one drive part



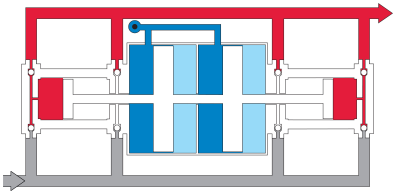
- Single-stage, double-acting with two drive parts



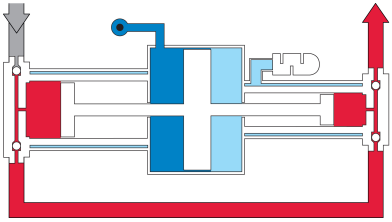
- Single-stage, quadruple-acting with one drive part



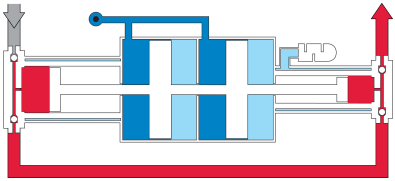
- Single-stage, quadruple-acting with two drive parts



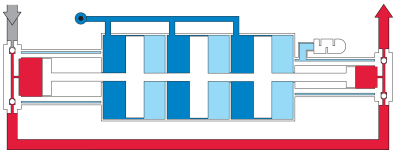
- Two-stage, double-acting with one drive part



- Two-stage, double-acting with two drive parts



- Two-stage, double-acting with three drive parts



3.2 Intended use

Within their technical limits, gas boosters are used to deliver and compress suitable types of gases.
If the gas booster bears an ATEX label and comes with a declaration of conformity, it is designated for use in corresponding potentially explosive areas.

3.3 Foreseeable misuse

The product may only be used in accordance with the indications in this manual.

The product cannot be used for:

- breathing air
- sealing containers
- producing / processing food with direct contact
- producing pharmaceutical products in direct contact

3.4 Misuse

Unauthorised modifications or technical changes to the product may lead to accidents with serious or fatal injuries.
Never carry out unauthorised modifications or technical changes to the product!

3.5 Ports

Comply with the connected load specifications for all interface connections. Refer to the enclosed general drawing for the connection ports available on the gas booster.

The following interfaces are standard on the gas boosters:

Drive air inlet "P_L"

Input of drive fluid.

Gas inlet "A"

Input of operating fluid.

Gas outlet "B"

Output of operating fluid.

Exhaust port "E"

Output of expanding drive fluid.

Control air port “X”

Port for control air. The gas booster only operates if the control air connection is pressurized. The pressure of the control air must always be larger or equal to the drive pressure to ensure proper function. The same requirements regarding compressed air quality apply to the control air as to the drive air.

Spool valve “V” ventilation port

Ventilation and bleeding of the spool valve. The port must not be obstructed.

Pilot valve "Y" exhaust port

Bleeding of the spool valve actuator chamber. An air pulse escapes here after each stroke. The port must not be obstructed.

This port can be used to connect a stroke counter.

Bleed port high pressure side “Z1” and “Z3”

Discharge of the leakage from the high pressure unit and ventilation of the piston back chamber. A bleed pipe can be connected. It is possible to safely discharge the operational leakage on the high pressure side via this line.

Bleed port air side “Z_2“, “Z_4“ and “Z_6“

Discharge of the leakage from the drive unit. A bleed pipe can be connected. It is possible to safely discharge the operational leakage on the drive side via this line.

“SFP” purge port

Port for purging the piston back chamber. The piston back chamber on the high pressure side can be purged with the appropriate gas via this port. The purging process must be carried out at very low pressure. The bleed lines must discharge the purge gas at zero pressure.

Alternatively, in single-stage double-acting gas boosters, the piston back chamber on the high pressure side can be filled with a suitable gas, for example to prevent the leakage from reacting with the ambient air.

Ports for the control system of the second pneumatic/air drive unit "F_1-F_4"

Connections that allow to switch off the second drive unit. Only in combination with the "Flexdrive" option.

3.6 Technical specifications

3.6.1 Operating conditions

Enviroment

Specification	Value	Unit
Temperature range	-20...+60	°C
Installation area	protected against climatic exposure	

Tab. 3-1 Environmental conditions

Operating fluids

Specification	Value	Unit
Operating temperature[a]		°C
Maximum mass concentration	5 (Class 6)[b]	mg/m³
Particle size, max.	10	µm

a. Depending on the design of the gas booster. Refer to the general drawing provided or rating plate

b. according to ISO 8573-1

Tab. 3-2 Operating fluids

The gas booster can be used with any operating fluids which do not chemically or physically corrode the booster materials. The operating fluids should not pose any danger to the personnel. The gas booster is not appropriate for use with unstable, ignitable or oxidising operating fluids. The materials used can be found on the enclosed general drawing. Certain gas booster designs can be suitable for other operating fluids. If you are unsure regarding the use of a special fluid, please don't hesitate to contact Maximator.

The most common operating fluids and gas booster designs are shown in the following table:

Compressed fluids (gases)	Formula symbol	Gas booster types	Special notes
Compressed air		DLE xxx[a]	p_B max. 100 bar
Compressed air		DLE xxx-S	p_B max. 350 bar
Compressed air			upon request
Sour/acid gas[b]		DLE xxx-HMR	
Argon	Ar	DLE xxx[a]	
Ethylene	C_2H_4	DLE xxx[a]	
Ethane	C_2H_6	DLE xxx[a]	
Propane	C_3H_8	DLE xxx[a]	
N-Butane	C_4H_{10}	DLE xxx[a]	
Freon (F-12)	CCL_2F_2	DLE xxx-CR	
Methane	CH_4	DLE xxx[a]	
Carbon monoxide	CO	DLE xxx-C	
Carbon dioxide	CO_2	DLE xxx-C	
Hydrogen	H_2	DLE xxx-H2	Max. compression ratio 1:4
Helium	He	DLE xxx[a]	
Nitrogen	N_2	DLE xxx[a]	
Nitrous oxide	N_2O	DLE xxx-S	Max. compression ratio 1:4
Oxygen	O_2	DLE xxx-S	Max. compression ratio 1:4
Sulphur hexafluoride	SF_6	DLE xxx-CR	
Xenon	Xe	DLE xxx[a]	

a. Standard design with PTFE and FKM seals

b. natural gas with amounts of hydrogen sulphide

Tab. 3-3 Approved operating fluids

Drive fluids

Specification	Value	Unit
Drive pressure p_L [a]		bar
Drive fluid	Compressed air or nitrogen	
Drive fluid temperature	-20...+60	°C
Maximum mass concentration	5 (Class 6)[b]	mg/m³
Particle size, max.	10	µm
max. pressure dew point	+3[c] (Class 4)[d]	°C
max. oil concentration	5 (Class 4)[e]	mg/m³

a. Dependent on the gas booster design. Refer to the general drawing provided or rating plate.

b. according to ISO 8573-1

c. For drive fluid temperature of 20°C. Depending on the temperature of the drive fluid, different values may be required in order to prevent ice formation on the gas booster.

d. according to ISO 8573-1

e. according to ISO 8573-1

Tab. 3-4 Drive fluid requirements

Drive with compressed air

Maximator gas boosters generally do not need a compressed air oiler as they are treated with special grease during installation. However, after the first time an oiler is used, the drive fluid should always be oiled, since the oil washes the special grease out. In case a compressed air oiler is used, the oil must comply with DIN 51524 - ISO VG 32 specifications.

If dry or very dry compressed air is used, a gas booster with FEC option is recommended.

Drive with nitrogen

As standard, all Maximator gas boosters can be operated with nitrogen. This is equivalent to operation with dry or very dry compressed air.

Drive with other gases

A drive using other gases or gas mixtures (e.g. natural gas) is principally possible. The gas mixtures used must not be ignitable. The gas mixtures used must not be chemically unstable. The suitability of the drive fluid must be checked. Special materials or drive variants must possibly be used (e.g. drive with exhaust air port line). Maximator will be happy to support you with this.

3.6.2 Dimensions and weight

The dimensions and weight of the gas booster are indicated on the general drawing.

3.6.3 Performance values

The performance values of the gas booster can be found on the rating plate and general drawing.

For more detailed information on the respective gas booster, including characteristic curve and connection diagram, please refer to the respective data sheet on the Maximator website at http://www.maximator.de.

Permissible leakage rate

The following leakage rate thresholds apply to the gas boosters in as-delivered condition. Leakage from the HP seal and leakage from the check valves are treated separately:

Leakage point	Leakage rate threshold	Unit
Drive unit	3[a]	cm^3/min
HP seal	60[b]	cm^3/min
Check valve	30[c]	cm^3/min

a. dynamic, 40 strokes/min, clear outlet

b. Static

c. Static, measured from port B to port A, both check valves in series.

Tab. 3-5 Permissible leakage rate in as-delivered condition

The following leakage rate thresholds must be observed to ensure operational safety. Lower leakage rate thresholds might apply, depending on the equipment:

Leakage point	Leakage rate threshold	Unit
Drive unit	6[a]	cm^3/min
HP seal	0.5% of the delivery rate[b]	-
Check valve	90[c]	cm^3/min

a. dynamic, 40 strokes/min, free outlet

b. Clear outlet, primary pressure according to application.

c. Static, measured from port B to port A, both check valves in series.

Tab. 3-6 Permissible leakage for operational safety

Inlet pressure of two-stage gas boosters

To ensure proper operation, the inlet gas pressure of two-stage gas boosters must not exceed the values specified in the following table.

Gas booster	max. P_A	Gas booster	max. P_A
DLE 2-5	0.8 x pL	DLE 2-5-2	1.6 x pL
DLE 5-15	1.6 x pL	DLE 5-15-2	3.2 x pL
DLE 5-30	0.5 x pL	DLE 5-30-2	1 x pL
DLE 15-30	7.5 x pL	DLE 15-30-2	15 x pL
DLE 15-75	2.5 x pL	DLE 15-75-2	5 x pL
DLE 30-75	12 x pL	DLE 30-75-2	24 x pL
		DLE 30-75-3	30 x pL

Tab. 3-7 Performance values of two-stage gas boosters

3.6.4 Service life

The service life of the product depends on the conditions of use. The service life should therefore be determined and defined by the user.

4 Transport, packaging and storage

4.1 Dimensions and weight

The dimensions and weight of the gas booster are indicated on the general drawing.

4.2 Delivery

Scope of delivery

Designation	Quantity
Gas booster	1
Installation and operating manual including Declaration of Incorporation and EU Declaration of Conformity	1
General drawing	1

Tab. 4-1 Scope of delivery

4.3 Packaging

The individual packages are packed according to the conditions expected for transport. Separate packaging should be used for transport and dust protection. The packaging is supposed to protect the individual components against transport damage, corrosion and other damage up to its place of use.

Do not remove the dust protection until shortly before installation.
Dispose of the packaging materials in an environmentally friendly manner.

4.4 Storage

Note the following with regard to package storage:

- Do not store the packages out of doors.
- Keep the packages dry and dust-free.
- Do not expose the packages to corrosive fluids.
- Keep the packages protected from sunlight.
- Prevent mechanical vibrations.
- Maintain a storage temperature of -20°C to +60°C.
- The relative humidity should not exceed 60%.

Storage instructions in addition to the specifications mentioned here may be attached to the packages.

Maintenance during storage

Even under the aforementioned storage conditions, the gas booster cannot be stored indefinitely.

– If in storage for longer than 3 months: Inspect the packaging and the gas booster for damage on a regular basis.
– Replace all the seals at least every 6 years.
– The gas booster must be briefly operated every 6 weeks. In doing so, connect drive air of at least 3 bar. A resistance of 2 bar at the outlet is sufficient to briefly activate the sealing element.

5 Installation

5.1 Prerequisites for installation

Comply with the manual and the general drawing of the product.
In addition, the following conditions apply:

- The product must be free of damage.
- Do not expose the product to any vibrations.
- The product must be easily accessible from all sides.
- Do not expose the product to any external heat or radiation sources.
- Install the product in a clean environment.

5.2 Gas booster installation

WARNING

Risk of injury posed by improper installation of the gas booster!

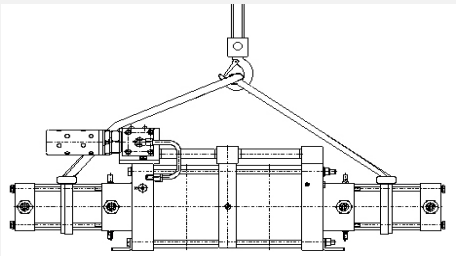
Improper installation of the gas booster can lead to accidents resulting in severe injuries or death.

- ► Permissible pressures at the inlet and outlet of the gas booster must not exceed the maximum permitted operating pressure of the gas booster.
- ► In case of two-stage gas boosters, the maximum permitted operating pressure of the first and second stage may be different.

The product is enclosed in dust-protection packaging. Do not remove this packaging until shortly before installation. Dispose of this packaging in an environmentally friendly manner.

Attach the gas booster using the fastening holes provided using screws or bolts with a strength of at least 4.6. Determine the adequate screw or bolt size using the enclosed general drawing.

The preferred installation position is vertical.

Lifting points	
All double-acting gas boosters can be attached with 2 belt straps.	

Tab. 5-1 Lifting points double-acting DLEs

5.3 Installation of connecting lines

WARNING

Risk of injury posed by improper installation of the connecting lines!

Improper installation of the gas booster can lead to accidents resulting in severe injuries or death.

- ► Connecting lines must be hermetically sealed long-term.
- ► Check connecting lines for leaks.
- ► Replace any faulty components immediately.

WARNING

Risk of injury due to leaking check valves!

Leaking check valves can lead to accidents resulting in severe injuries or death.

- ► A return flow of the fluid via the check valves must not lead to the maximum operating pressure in the supply line being exceeded.
- ► The leakage rate thresholds must be observed.
- ► Assess the risk for the equipment in the overall risk assessment.

The gas booster is delivered without any connection screw fittings or connecting lines. For this purpose, observe the specifications in section “Connections” and on the general drawing. To prevent malfunctions, the cross-sections of the connecting lines must be designed for the corresponding volume flows.

5.3.1 Connecting the drive air

Connect the connecting line for the drive air to the drive air port (P_L) of the spool valve housing. Observe the connection specifications on the general drawing.

5.3.2 Control air connection

Using a tube or a pipe, connect the control air to the control air port (X) of the gas booster. Observe the connection specifications on the general drawing.

5.3.3 Connecting the inlet line and outlet line

Connect the inlet and outlet lines to the corresponding gas booster ports (A and B) in an appropriate manner. Observe the connection specifications on the general drawing.

5.3.4 Connecting a separate bleed pipe

If applicable, connect the bleed pipe to the bleed ports (Z_1 and Z_3) in an appropriate manner. Observe the connection specifications on the general drawing.

5.3.5 Purge line connections

If applicable, connect the purge line to the purge ports (SFP) in an appropriate manner. Observe the connection specifications on the general drawing.

If the piston back chamber of single-stage double-acting gas boosters are to be filled with an adequate gas, the bleed ports on the high pressure side Z_1 and Z_3 must be routed to a common bleed line over a short distance.

5.3.6 Exhaust silencer installation

Screw the supplied exhaust silencer into the exhaust port. It is permissible to connect a pipe to the exhaust port. Observe the connection specifications on the general drawing.
Connecting a pipeline to the exhaust port can significantly affect the noise level generated by the product.

5.4 Commissioning

5.4.1 Prerequisites for commissioning

Observe the manual and general drawing of the product.
In addition, the following conditions must be met:

- The product must be free of damage.
- The operating pressure has been calculated.
- The connections must be installed correctly.
- Connecting cables/pipes must be free from damage.
- The bleed ports must be unobstructed or connected to leakage drains.

WARNING

Risk of injury posed by improper installation of the gas booster!

Improper installation of the gas booster can lead to accidents resulting in severe injuries or death.

- ► Permissible pressures at the inlet and outlet of the gas booster must not exceed the maximum permitted operating pressure of the gas booster.
- ► In case of two-stage gas boosters, the maximum permitted operating pressure of the first and second stage may be different.

WARNING

Risk of injury posed by improper installation of the connecting lines!

Improper installation of the gas booster can lead to accidents resulting in severe injuries or death.

- ► Connecting lines must be hermetically sealed long-term.
- ► Check connecting lines for leaks.
- ► Replace any faulty components immediately.

WARNING

Risk of injury posed by improper installation of the gas booster!

Improper installation of the gas booster can lead to accidents resulting in severe injuries or death.

- ► The system-specific stall pressure of the gas booster must not exceed the maximum permitted operating pressure.
- ► The system-specific stall pressure must be calculated before commissioning
- ► If necessary, secure the system accordingly.

Prior to commissioning the gas booster, the system-specific stall pressure must be calculated. The stall pressure of the gas booster is calculated for the respective gas booster type using the following formulas:

Gas booster design	Standstill pressure
Single-stage, single-acting	$p_B = p_L * i$
Single-stage, double-acting / quadruple-acting	$p_B = i * p_L + p_A$
Two-stage	$p_B = i_2 * p_L + i_2 / i_1 * p_A$
Single-stage, single-acting with two drive parts	$p_B = p_L * i$
Single-stage, double-acting / quadruple-acting with two drive units	$p_B = i * p_L + p_A$
Two-stage with two / three drive units	$p_B = i_2 * p_L + i_2 / i_1 * p_A$

Tab. 5-2 Calculation of the stall pressure

Legend:

p_L = drive pressure
p_B = operating pressure
p_A = primary gas pressure
i = pressure ratio
i_1 = pressure ratio stage 1
i_2 = pressure ratio stage 2

5.4.2 Commissioning

WARNING

Risk of injury due to extreme temperatures!

The surfaces of the product can be very hot or very cold. This can lead to accidents resulting in severe injuries or death.

► Before working on the product, please ensure that the product is at ambient temperature.

Details about the commissioning of the gas booster are described below:

1) Check all connections for proper installation.
2) Check all connecting lines for mechanical damage.
3) Slowly open the supply line.
   – The compressed fluid flows in.
4) If applicable, open the control air line.
5) Slowly open the compressed air line of the compressed air line system to the gas booster.
   – The gas booster automatically starts to compress the gas.

We recommend slowly increasing the pressure of the drive air to keep the stress on the gas booster components low during commissioning.
The stroke frequency of the gas booster is kept low this way. Otherwise, during the ramp-up phase, until the required operating pressure is reached, operating phases with very high cycle frequencies can occur.

6 Operation

6.1 Prerequisites for operation

Follow the manual and general drawing for the product.
In addition, the following conditions are required:

- The product must be free of damage.
- The product must be securely attached.
- The product is not exposed to any vibrations.
- The product is not exposed to any external heat or radiation sources.
- A risk assessment has been compiled for the system, and all basic health and safety requirements have been met.

6.2 Normal, safe operation

WARNING

Risks of sustaining injuries are posed by improper handling of operating fluids!

Improper handling of operating fluids can lead to accidents resulting in severe injuries or death.

- ► Comply with the safety data sheets of the operating fluids.
- ► Dispose of operating fluid residues in an appropriate manner.
- ► Notify other people (for example: repair department) of hazardous operating fluids.

6.3 Abnormal situations during operation

Refer to the general system documentation for measures to consider or implement in case of abnormal operation.

6.4 Signs indicating the product is no longer safe to use

The following signs indicate that the gas booster is no longer safe to use. In such cases, the gas booster must be put into a safe state immediately.

- Leaking high pressure seal
- Leaking booster head
- Leaking high pressure cylinder
- Leaking connections
- Leaking drive unit
- Visible damage

6.5 Putting the gas booster in a safe state

In a safe state, the gas booster is depressurised on the drive and high pressure side. The steps necessary in order to achieve a safe state depend on the installation position in the system. Refer to the general system documentation for the required actions.

7 Maintenance

7.1 Maintenance intervals

To ensure safe and smooth operation, the gas boosters must be checked regularly and serviced, cleaned or repaired as necessary. The individual maintenance activities are described in the following section.

Maximator recommends the intervals listed below. These intervals are calculated based on 1,300,000 strokes / year.

The required maintenance intervals depend on the system and application. The intervals must be adjusted based on the given conditions of use.

Activity	before and after each use	daily	weekly	monthly	quarterly	semi-annually	annually	as needed
System inspection			x					
Leak-testing the connections			x					
Check screw fittings and connecting lines for damage			x					
Clean gas booster					x			
Check fastening elements and connecting elements					x			
Test for leakage						x		
Repair gas booster								x

Tab. 7-1 Maintenance intervals

7.2 Maintenance work

WARNING

Risks of sustaining injuries are posed by improper handling of operating fluids!

Improper handling of operating fluids can lead to accidents resulting in severe injuries or death.

- ► Comply with the safety data sheets of the operating fluids.
- ► Dispose of operating fluid residues in an appropriate manner.
- ► Notify other people (for example: repair department) of hazardous operating fluids.

WARNING

Risk of injury due to extreme temperatures!

The surfaces of the product can be very hot or very cold. This can lead to accidents resulting in severe injuries or death.

- ► Before working on the product, please ensure that the product is at ambient temperature.

WARNING

Risk of injury due to inappropriate spare parts!

Making repairs using inappropriate spare parts can lead to accidents resulting in severe injuries or death.

- ► Only use spare parts that comply with Maximator specifications.

WARNING

Risk of sustaining injury posed while handling lubricants!

Handling lubricants may lead to accidents resulting in severe or fatal injuries.

- ► Use protective gloves and goggles.
- ► Avoid contact with the skin.
- ► Observe the safety data sheet of the lubricant accordingly.

WARNING

Risk of injury due to dangerous system status!

Maintenance and inspection activities sometimes require that the gas boosters be operated with modified connection cables or without safety equipment. The operation of the gas booster can lead to accidents with serious or fatal injuries.

- ► When performing work, ensure that no hazards are created!

7.2.1 System inspection

The following section explains how to check the gas booster for proper function:

	Description
Qualifications	Operating the system
Type of maintenance	Check
Interval	weekly
PPE	– Safety goggles – Hearing protection
1.	Shut off the gas outlet and adjust p_B to a value that is standard for the system. The gas booster stops automatically when the final pressure is reached. (dwell time of 30s)
2.	Relieve p_L. P_B does not drop by more than 10%. (dwell time of 30s)
3.	Set P_L to approx. 50% of the value from the first step and slowly relieve P_B. The gas booster starts up automatically.
2.	If the inspection does not reveal any abnormalities, it is safe to continue using the gas booster. In case of abnormalities, consult with the maintenance staff.

7.2.2 Leak-testing the connections

The following section explains how to check the connections for leaks:

	Description
Qualifications	Operating the system
Type of maintenance	Check
Interval	weekly
Prerequisites	– The gas booster is easy to access. – All connections are pressurised.
Tools	– Torch – Cleaning cloth – Leak detection spray
PPE	Safety goggles
1.	Check connections for leaks. Use leak detection spray.
2.	If the inspection does not reveal any abnormalities, it is safe to continue using the gas booster. In case of abnormalities, consult with the maintenance staff.

7.2.3 Checking screw fittings and connecting lines for damages

The following section explains how to inspect the screw fittings and connecting lines:

	Description
Qualifications	Operating the system
Type of maintenance	Check
Interval	weekly
Prerequisites	The gas booster is easy to access.
Tools	– Torch – Cleaning cloth
1.	Visual inspection of the screw fittings and connecting lines. Is there any visible damage or other visible signs of wear?
2.	If the inspection does not reveal any abnormalities, it is safe to continue using the gas booster. In case of abnormalities, consult with the maintenance staff.

7.2.4 Clean gas booster

The following section explains how to clean the gas booster:

	Description
Qualifications	Clean gas booster
Type of maintenance	Cleaning
Interval	quarterly
Prerequisites	– The gas booster is easy to access. – The gas booster is depressurised.
Tools	– Cotton cleaning cloth – Solvent-free cleaning product
1. 	**WARNING** **Risk of injury due to static electricity** Cleaning the gas booster may cause a charge to accumulate in non-conductive layers. Explosions with severe injuries or death can result. ► Only clean the gas booster while damp. ► Use cotton cleaning cloth. Clean the gas booster.
2.	The cleaning process has been successful if: – the gas booster is free of dirt. – ports and silencers are free of dirt.

7.2.5 Check fastening elements and connecting elements

The following section explains how to inspect the fastening elements and connecting elements:

	Description
Qualifications	Repair and service gas booster
Type of maintenance	Check
Interval	quarterly
Prerequisites	– The gas booster is easy to access. – The gas booster is depressurised.
Tools	Torque spanner
1.	Check all fastening elements and retighten if necessary.
2.	Check all connecting elements and retighten if necessary.
3.	The inspection has been successful if: – all fastening elements are properly tightened. – all connecting elements are properly tightened.

7.2.6 Leak detection

The following section explains how to inspect for leaks:

	Description
Qualifications	Repair and service gas booster
Type of maintenance	Check
Interval	semi-annually
Prerequisites	The gas booster is easy to access.
Tools	– Torch – Leak detection system[a] – Jaw spanner
PPE	– Safety goggles – Hearing protection
1.	On a running gas booster (about 40 strokes/min, clear outlet): Test for leaks on the drive side (Z2, Z4, Z6).

	Description
2.	Shut off the gas outlet. Adjust p_B to a value that is standard for the system. Relieve p_L. Test for leaks on the high pressure side (Z1, Z3).[b]
3.	Carefully relieve the gas outlet until the gas booster piston has reaches its end position and the other cylinder is pressurized . Shut off the gas outlet. Test for leaks on the high pressure side (Z1, Z3).[c]
4.	Shut off the gas outlet. p_B to a value that is standard for the system. Relieve p_A. Relieve p_L. Measure leakage via the check valves.
5.	Relieve p_L. Relieve p_A. Relieve p_B. Disassemble the spool valve. Examine the spool valve. Are the seals worn? Is it still adequately lubricated?
6.	The inspection has been successful if: – all leak tests have been carried out successfully. – the spool valve is OK. If the gas booster does not pass the inspection, it must be repaired or replaced.

a. The most straightforward leak detection method is to test for leakage by means of water displacement in a measuring cup.

b. If the leakage is detected by means of water displacement: The gas booster must not suck in any water. The leak detector must not be connected if P_L is applied.

c. If the leakage is detected by means of water displacement: The gas booster must not suck in any water. The leak detector must not be connected if P_L is applied.

7.2.7 Repair gas booster

The following section explains how to repair the gas booster:

	Description
Qualifications	Repair and service gas booster
Type of maintenance	Repair
Interval	as needed
Prerequisites	Clean, even work area with ample lighting
Tools	– Cleaning rags – Cleaning product – Torch
PPE	– Safety goggles – Protective gloves
1.	Disassemble the gas booster.
2.	Clean the inside and outside of the gas booster.
3.	Replace all seals and guide elements.
4.	Replace damaged gas booster components as necessary.
5.	Reassemble the gas booster. Apply a thin and even layer of lubricant to the following surfaces: – Contact surfaces of seals and guide elements – Seals Specially designated areas must be treated according to drawing indications.
6.	Check the gas booster. This includes the following maintenance work: – 7.2.1 - System check – 7.2.6 - Leak test
7.	If the gas booster has passed all tests, the repair is complete.

Maximator devices can be sent in for repairs to your local Maximator representative. All the necessary details are available on the Maximator website http://www.maximator.de

7.3 Spare parts and consumables

WARNING

Risk of injury due to inappropriate spare parts!

Making repairs using inappropriate spare parts can lead to accidents resulting in severe injuries or death.

► Only use spare parts that comply with Maximator specifications.

A list of the available spare parts, spare part kits and consumables can be found on the general drawing.

7.4 Accessories and special tools

A variety of special accessories are available for the gas booster.
Please let our sales department advise you.

The tools used for the products are continuously being updated and supplemented.
An overview of the currently available tools is accessible upon request when contacting the Maximator customer service.

7.5 Customer service

Our customer service is also at your disposal for technical details and repairs:

Address	Maximator GmbH Ullrichstraße 1-2 99734 Nordhausen Germany
Customer service phone Mon. – Thurs.: 06:30 – 16:15 CET Fri.: 06:30 – 14:00 CET	+49 3631 9533-5444
Fax	+49 3631 9533-5065
Email	service@maximator.de
Website	www.maximator.de/service

Feedback and experiences resulting from the application of our products and potentially leading to an optimisation of such are appreciated.

8 Troubleshooting

The following is a list of typical gas booster faults, their causes and the corresponding solutions.

If you experience any other specific or unexpected faults, please notify us at service@maximator.de

8.1 Drive side

Fault	Cause of fault	Solution
The gas booster does not operate at low air pressure.	Friction of the O-rings on the spool valve is too high.	– Relubrication – Replace the O-rings on the spool valve.
The gas booster does not operate at low air pressure.	O-rings will swell if the wrong oil or lubricant is used.	– Replace the O-rings – Use a lubricant according to Maximator specifications.
The gas booster does not operate.	The control air is not connected.	Connect the control air.
The gas booster does not operate, or operates slowly only.	The control air is not properly pressurised.	The control air pressure must be equal to or higher than p_L.
The gas booster does not operate, or operates slowly only.	Ice has formed on the silencer or spool valve.	Use a dryer to dehumidify the compressed air.
The gas booster does not operate, or operates slowly only.	Formation of residue in the silencer.	Clean the silencer. Replace it if necessary.
The gas booster does not operate. Air escapes via the silencer.	The O-rings on the spool valve are defective.	Replace and lubricate the O-rings.
The gas booster does not operate. Air escapes via the silencer.	The O-ring on the air piston is defective or worn.	Replace and lubricate the O-ring.
The gas booster does not operate. Air escapes via the small borehole on the spool valve housing.	The spool valve is jammed.	– Clean the spool valve and sleeve. – Check the O-rings and sleeves, and replace them if necessary. – Lubrication
The gas booster operates with high frequency and short strokes.	The pilot valve in the top or bottom cap is defective.	Clean, lubricate and, if necessary, replace the pilot valve.

Tab. 8-1 Trouble shooting on the drive side

8.2 High pressure side

Fault	Cause of fault	Solution
The gas booster operates without delivering the gas, or it operates erratically. It does not reach the calculated discharge pressure.	The check valves fail.	Check, clean the check valves, and replace them if necessary.
Medium escapes via bleed port “Z1” and “Z3”	Worn packing ring or HP seal.	Replace seal sets.

Tab. 8-2 Troubleshooting on the high pressure side

9 Removal and disposal

9.1 Prerequisites for removal and disposal

Comply with the manual and the general drawing of the product.
In addition, the following conditions apply:

– The product must be free of damage.
– Do not expose the product to any vibrations.
– The product must be easily accessible from all sides.
– Do not expose the product to any external heat or radiation sources.
– Install the product in a clean environment.

9.2 Removal

WARNING

Risks of sustaining injuries are posed by improper handling of operating fluids!

Improper handling of operating fluids can lead to accidents resulting in severe injuries or death.

► Comply with the safety data sheets of the operating fluids.
► Dispose of operating fluid residues in an appropriate manner.
► Notify other people (for example: repair department) of hazardous operating fluids.

WARNING

Risk of sustaining injury posed while handling lubricants!

Handling lubricants may lead to accidents resulting in severe or fatal injuries.

► Use protective gloves and goggles.
► Avoid contact with the skin.
► Observe the safety data sheet of the lubricant accordingly.

To remove the gas booster, carry out the following steps:

– Shut down the gas booster.
– Depressurise the gas booster.
– Loosen the fastening screws and connections.
– Disassemble the gas booster.

9.3 Disposal

WARNING

Risks of sustaining injuries are posed by improper handling of operating fluids!

Improper handling of operating fluids can lead to accidents resulting in severe injuries or death.

- ► Comply with the safety data sheets of the operating fluids.
- ► Dispose of operating fluid residues in an appropriate manner.
- ► Notify other people (for example: repair department) of hazardous operating fluids.

If the service life has expired: Send the product back to Maximator, postage paid, for proper disposal.

10 Use in explosion-prone zones

10.1 General information

Gas boosters bearing an ATEX label and delivered with a declaration of conformity with 2014/34/EU are suitable for use in potentially explosive atmospheres. They conform with equipment group II, equipment category 2G, explosion group IIB or IIC, structural safety. The designation is indicated on the rating plate and on the general drawing.
The individual parts of the label are explained below.

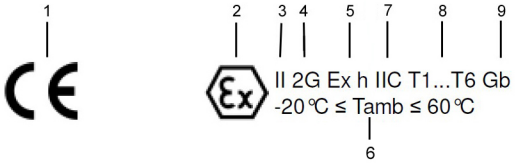


Fig. 10-1 Exemplary figure - ATEX label

1 CE symbol
2 Ex-symbol
3 Equipment group II: The gas booster may be used in potentially explosive atmospheres, except in mining.
4 Equipment category 2G: The device ensures a high level of protection and may be used in Zone 1 and Zone 2.
5 Ex h marking: Designated for use as per DIN EN ISO 80079-36/37.
6 Designation of ambient temperature: Permissible range of ambient temperature.
7 Equipment group: Designated for use in potentially explosive gas atmospheres, with gases from Group IIB or IIC.
8 Range of temperature class: Under compliance with the indications in the operating manual, device can be used in the temperature classes indicated.
9 EPL: Equipment in Group II for explosive zones generate vapours or mist due to mixing of air and gases; can be used in Zone 1 or 2; sufficient protection for normal operation and in case of foreseeable errors.

10.2 Temperature class

The temperature of the gas booster mainly depends on the temperature of the operating fluid.
The following table indicates the relationship of the operating fluid temperature and the temperature class of the gas booster:

Max. temperature of operating fluid	Temperature class
130°C	T4
195°C	T3
225°C	T2

Tab. 10-1 Temperature classes

For the compression of ideal gases, the maximum expected temperature can be calculated using the formula for adiabatic status change:

$$T_B = T_A \left(\frac{p_B}{p_A} \right)^{\frac{\kappa - 1}{\kappa}}$$

The isentropic exponent κ can be found in the corresponding tables for common gases.

Since the compression takes place as part of the heat exchange with the environment, the actual temperature will always be below the calculated temperature.

Consider the full range of operating conditions. A drop in the primary pressure p_A leads, for example, to an increase in the maximum expected temperature T_B

The gas booster should not be insulated. If it is insulated, the equipment manufacturer must determine the temperature class of the equipment accordingly.

10.3 Operation and maintenance

Static electricity on the product can lead to explosions. This may result in severe or fatal injuries.

Never use high-power mechanisms for charge generation on or near the product.

The possibility of an explosive atmosphere must be excluded before undertaking any and all work on the product – maintenance, cleaning or any other activity.

In order to ensure adequate safety during regular operation and in the event of foreseeable errors, the function of the gas booster and compliance with the thresholds specified in these instructions must be monitored accordingly.

In doing so, the maintenance activities must be carried out at intervals that are appropriate for the application.

For safe operation, the devices may no longer be used after the leakage thresholds have been exceeded.

10.4 Operation with combustible operating fluids

WARNING

Risk of sustaining injury due to explosion!

An ignitable gas mixture in the gas booster may cause explosions. This can lead to accidents resulting in severe injuries or death.

- ► Precautions must be taken to prevent the formation of ignitable gas mixtures in the gas booster during commissioning.
- ► Precautions must be taken to prevent the formation of ignitable gas mixtures in the gas booster during decommissioning.

When the gas booster is in operation, the leakage collects via the high-pressure seal in the back chamber of the high-pressure piston. In case of combustible operating fluids, this may cause the formation of an ignitable mixture.

Without further measures, the safety level will be adequate during regular operation of the gas booster (zone 2) if the gas has an ignition temperature of over 200 ° C.

If the gas booster requires an adequate safety level in the event of foreseeable faults (zone 1), the back chamber of the high pressure piston must be purged. How to purge the back chamber of the high pressure piston is explained below.

10.4.1 Purging plans for the compression of combustible gases

Purging plan for single-stage, double-acting gas boosters

1) Prior to commissioning the gas booster, connect nitrogen to the inlet pressure port (A) and to the purge port (SFP).
2) Switch on the gas booster for approx. 1 minute (based on the volume to be purged).
3) Switch off the gas booster after the purging process has been completed.
4) The inlet pressure line (A) may then be connected with the gas source. During the compression process, it is not necessary to continuously purge the purge port with nitrogen, since with single-stage, double-acting gas boosters, no ambient air is sucked in via the common bleed line.
5) After the compression process has been completed, purge the compression chamber again as described in step 2.

Purging plan for single-stage, single-acting and two-stage, double-acting gas boosters

1) Prior to commissioning the gas booster, connect nitrogen to the inlet pressure port (A) and to the purge port (SFP).
2) Switch on the gas booster for approx. 1 minute (based on the volume to be purged).
3) Switch off the gas booster after the purging process has been completed.
4) The inlet pressure line (A) may then be connected with the gas source. Continuously purge the purge port during the compression process.
5) After the compression process has been completed, purge the compression chamber again as described in step 2.

Volume flow for gas purging processes

To ensure an adequate purging performance, different volume flows must be ensured depending on the gas booster. The minimum required volume flow is shown in the table below.

Type	Volume flow l_N/ min	Type	Volume flow l_N/ min
DLE 2-1	190	DLE 15-1-2	30
DLE 5-1	90	DLE 30-1-2	20
DLE 15-1	40	DLE 75-1-2	10
DLE 30-1	20	DLE 2-2*	170
DLE 75-1	10	DLE 5-2*	80
DLE 2*	170	DLE 15-2*	30
DLE 5*	90	DLE 30-2*	20
DLE 15*	30	DLE 75-2*	10
DLE 30*	20	DLE 2-5-2	100
DLE 75*	10	DLE 5-15-2	60
DLE 2-5	110	DLE 5-30-2	70
DLE 5-15	60	DLE 15-30-2	20
DLE 5-30	70	DLE 15-75-2	20
DLE 15-30	20	DLE 30-75-2	10
DLE 15-75	30	DLE 30-75-3	10
DLE 30-75	10	8 DLE 1,65	-**
DLE 2-1-2	190	8 DLE 3	-**
DLE 5-1-2	90	8 DLE 6	-**

Tab. 10-2 Volume flows

* With these gas boosters, the volume flows are only required during commissioning and decommissioning.
** Purging is not possible with these gas boosters.

In addition to the volume flow of the purging gas, the cross-sections of the purging line are also important. It is recommended that internal diameters are never below 4 mm. If this diameter is less than 4 mm, a risk will be posed that gas pressure will develop in the purging line. This may potentially cause damage to the high pressure part of the gas booster.

Furthermore, ensure that the outlet of the purge line is clear.

10.4.2 Alternative purging options for the compression of combustible gases

As an alternative to the process described for purging the gas booster with nitrogen, any other process with the properties listed below is suitable to ensure safe operation.

– Always purge the gas booster in a way that no ignitable mixture can form in the leakage chamber.
– No negative pressure may occur in the leakage chamber.
– A maximum excessive pressure of 0.5 bar must not be exceeded in the leakage chamber.

The space between the SFP connection and the leakage connections Z1 and, if applicable, Z3 is subject to a change in volume per stroke during operation. The stroke volume of the leakage chamber is specified in the table below:

Type*	Leakage chamber stroke volume
DLE 2-1	910 cm^3
DLE 5-1	360 cm^3
DLE 15-1	105 cm^3
DLE 30-1	42 cm^3
DLE 75-1	6 cm^3

Tab. 10-3 Leakage chamber stroke volume

* For two-stage equipment, the stroke volume must be selected according to the respective stage.

11 Summary of ignition hazards

Ignition hazard Source of ignition	Cause	Protective measure implemented
Hot surface	Heating by the operating fluid and compression	Calculation formula Temperature class definition Insulation prohibited
Friction	Friction in the drive unit	Selection of materials and operating parameters Definition of maintenance intervals Definition of the compressed air quality
Friction	Friction in the high pressure unit	Selection of materials and operating parameters Definition of maintenance intervals
Friction	Friction in the spool valve	Selection of materials and operating parameters Definition of maintenance intervals
Mechanically generated sparks	Impact from the outside on the device	Selection of the materials
Mechanically generated sparks	Ignition caused by foreign objects that have entered	Prevent foreign objects from entering
Mechanically generated sparks	Ignition caused by dust in the equipment	Definition of maintenance intervals
Mechanically generated sparks	Impact from breakage of spring	Selection of the springs
Flames	Ignition of a leakage in the piston back chamber	Restrictions of equipment category and EPL purging specifications
Flames	Ignition of lubricants	Selection of the lubricants
Static electricity	Charging of insulated metal parts	All parts are conductively interconnected
Static electricity	Charging of non-conductive equipment parts	Design in accordance with component size specifications

Ignition hazard Source of ignition	Cause	Protective measure implemented
Static electricity	Charging of non-conductive layers	Design in accordance with layer thickness specifications
Static electricity	Charging due to powerful charge generating mechanisms	Exclusion of powerful charge generating mechanisms
Adiabatic compression	Temperature increase due to adiabatic compression of the operating fluid	Temperature increase taken into account
Chemical reaction	Reaction between operating fluid and valve sections generates heat	Resistance of the valve materials must be checked.
External influence	Damage due to external influence	Impact test

Tab. 11-1 Summary of the applicable ignition hazards identified and the protective measures implemented

12 Applications with oxidising operating fluids

WARNING

Risk of sustaining injuries due to fire or explosion!

Self-ignition caused by oxygen may lead to accidents with serious or fatal injuries.

- ► Always observe all regulations and best practices regarding the handling of oxidising operating fluids, as well as the specifications and instructions in the manual.
- ► This risk must be considered in the overall risk assessment of the system.

WARNING

Risk of sustaining injuries due to fire or explosion!

Self-ignition caused by oxygen may lead to accidents with serious or fatal injuries.

- ► Always observe all regulations regarding the handling in potentially explosive areas, as well as the specifications and instructions in the manual.
- ► This risk must be considered in the overall risk assessment of the system.

Oxygen, oxidising gases and gas mixtures as operating fluid

Oxygen, oxidising gases and gas mixtures can be compressed with special gas boosters. The equipment is usually marked with the order code suffix “S”. The following thresholds must be observed for safe operation:

Specification	Value	Unit
Maximum operating pressure	350	bar
Maximum compression ratio	1:4	
Maximum temperature	60	°C
Particle size, max.	10	µm
Maximum flow rate[a]	8	m/s

a. Based on the line cross-section of the connecting pipes

Tab. 12-1 Oxygen, oxidising gases and gas mixtures as operating fluid

Most gas boosters are technically capable of exceeding the thresholds specified here. Therefore, observance of the thresholds specified here for all possible operating states must usually be ensured by implementing additional measures.

Drive fluids for oxygen applications

If oxygen or oxygen-containing gas mixtures are used as compressed fluid, the following specifications and instructions also apply to the drive fluid:

– The drive air must be free of oil and grease.
– Maintenance intervals have to be adjusted with regard to the increasing surface contamination caused by substances contained in the drive fluid.

Appendix

The appendix comprises the following documents:

- EU Declaration of Conformity for gas booster
- Declaration of Incorporation for gas booster
- Description of the basic safety and occupational health and safety requirements

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EU-Konformitätserklärung
Hiermit erklären wir, dass die Bauart von druckluftbetriebenen Kompressoren der Baureihen:
DLE X, DLE X-X, DLE X-1, DLE X-2, DLE X-1-2, DLE X-X-2, 8DLE X, 14DLE X, MDLE X, SDLE X
mit einer Seriennummer *von* **23000001** und höher
in der gelieferten Ausführung folgende einschlägige Harmonisierungsrechtsvorschriften der Union erfüllt:

EU-Richtlinie Explosionsschutz 2014/34/EU
Angewendete harmonisierte Normen und technische Spezifikationen:
EN ISO 12100:2010
EN ISO 80079-36:2016
EN ISO 80079-37:2016
Notifizierte Stelle eingeschaltet zur Aufbewahrung der Unterlagen nach 2014/34/EU:
0588 FSA GmbH (Dynamostraße 7-11, 68165 Mannheim)

Weitere einschlägige Bestimmungen: EG Maschinenrichtlinie (2006/42/EG) (Unvollständige Maschine)

Anschrift Hersteller: **MAXIMATOR GmbH, Lange Straße 6, 99734 Nordhausen / Deutschland**
Die alleinige Verantwortung für die Ausstellung dieser Konformitätserklärung trägt der Hersteller.
(Original)

EU Declaration of Conformity
Herewith, we declare that the model of air driven gas boosters type:
DLE X, DLE X-X, DLE X-1, DLE X-2, DLE X-1-2, DLE X-X-2, 8DLE X, 14DLE X, MDLE X, SDLE X
with a serialized ID of **23000001** and above
as supplied are in conformity with the relevant Union harmonisation regulations:

EU Explosion Protection Directive 2014/34/EU
Harmonised standards and technical specifications applied:
EN ISO 12100:2010
EN ISO 80079-36:2016
EN ISO 80079-37:2016
Notified body involved for preserving the documents in compliance with 2014/34/EU:
0588 FSA GmbH (Dynamostraße 7-11, 68165 Mannheim)

Further likewise applicable directives: Machinery directive (2006/42/EC) (partly completed machinery)

Name and address of manufacturer: **MAXIMATOR GmbH, Lange Straße 6, 99734 Nordhausen / Germany**
This declaration of conformity is issued under the sole responsibility of the manufacturer.
(Translation)

Nordhausen, den 04.12.2023 (Nordhausen, 04.12.2023)
MAXIMATOR GmbH Lange Straße 6 99734 Nordhausen
Stefan Gorsch (Abteilungsleiter Engineering) (Head of Engineering)

MAXIMATOR GmbH | Lange Straße 6, 99734 Nordhausen, Deutschland
Telefon +49 (0) 3631 9533 – 0 | Telefax +49 (0) 3631 9533 – 5010
www.maximator.de | info@maximator.de

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Einbauerklärung nach 2006/42/EG, Anhang II, Nr.1 B
Inhalt gemäß 2006/42/EG, Anhang II, Nr.1 B.
Anschrift Hersteller: MAXIMATOR GmbH
Lange Straße 6
99734 Nordhausen / Deutschland
Der Dokumentationsbeauftragte ist bevollmächtigt, die speziellen technischen Unterlagen nach Anhang VII B zusammenzustellen: dokumentationsbeauftragter@maximator.de / Tel.: 03631-9533-0
Die Bauart von druckluftbetriebenen Kompressoren der Baureihe:
DLE X, DLE X-X, DLE X-1, DLE X-2, DLE X-1-2, DLE X-X-2, 8DLE X, 14DLE X, MDLE X, SDLE X
mit einer Seriennummer *von* **23000001** und höher
ist eine unvollständige Maschine nach Artikel 2g und ausschließlich zum Einbau in oder zum Zusammenbau mit einer anderen Maschine oder Ausrüstung vorgesehen.
Grundlegende Sicherheits- und Gesundheitsschutzanforderung gemäß Anhang I dieser Richtlinie kommen zur Anwendung und wurden eingehalten :
Auflistung siehe separate Anlage
Die speziellen technischen Unterlagen gemäß Anhang VII B wurden erstellt und sie werden der zuständigen nationalen Behörde auf Verlangen in elektronischer Form übermittelt.
Diese unvollständige Maschine darf erst dann in Betrieb genommen werden, wenn festgestellt wurde, dass die Maschine, in die unvollständige Maschine eingebaut werden soll, den Bestimmungen der Maschinenrichtlinie entspricht.

Declaration of Incorporation acc. to 2006/42/EC, Annex II, Nr.1 B
Contents acc. to 2006/42/EC, Annex II, Nr.1 B.
Name and address of manufacturer: MAXIMATOR GmbH
Lange Straße 6
99734 Nordhausen / Germany
The documentation officer is authorised to compile the relevant technical documentation as set forth in Annex VII B: dokumentationsbeauftragter@maximator.de / Tel.: +49(0)3631-9533-0
The model of air driven gas booster type:
DLE X, DLE X-X, DLE X-1, DLE X-2, DLE X-1-2, DLE X-X-2, 8DLE X, 14DLE X, MDLE X, SDLE X
with a serialized ID of **23000001** and above
is a partly completed machinery as defined in Article 2g and exclusively envisaged for installation into or assembly with other machinery or equipment.
Essential health and safety requirements (EHSR) acc. to Annex I to this directive have been applied and complied with:
See separate Appendix
The relevant technical documentation according to Annex VII B was compiled and will be forwarded to the competent national authority in electronic format upon request.
The partly completed machinery must not be put into service until the final machinery into which it is to be incorporated has been declared in conformity with the provisions of the Directive on Machinery.

Nordhausen, den 04.12.2023 (Nordhausen, 04.12.2023)
MAXIMATOR GmbH Lange Straße 6 99734 Nordhausen
Stefan Rüger (Abteilungsleiter Engineering) (Head of Engineering)

MAXIMATOR GmbH | Lange Straße 6, 99734 Nordhausen, Deutschland
Telefon +49 (0) 3631 9533 – 0 | Telefax +49 (0) 3631 9533 – 5010
www.maximator.de | info@maximator.de
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Appendix for the Declaration of Incorporation according to 2006/42/EC Appendix II, No. 1 B

Description of the basic safety and occupational health and safety requirements according to 2006/42/EC Appendix I to be applied and observed.

No.	Basic requirement	Applicable	Met	Comment
1.1	General information			
1.1.1	Definition	Yes	Yes	
1.1.2	Safety integration principles	Yes	Yes	
1.1.3	Materials and products	Yes	Yes	
1.1.4	Lighting	No		
1.1.5	Machine design regarding handling	Yes	Yes	
1.1.6	Ergonomics	No		
1.1.7	Operator's console	No		
1.1.8	Seats	No		
1.2	Controls and control devices			
1.2.1	Control safety and reliability	Yes	No	Unintended start-up
1.2.2	Actuators	No		
1.2.3	Starting the system	Yes	No	Unintended start-up Changing the operating state
1.2.4	Shut-down			
1.2.4.1	Normal shut-down	Yes	No	No control device for shut-down
1.2.4.2	Operational shut-down	No		
1.2.4.3	Emergency shut-down	Yes	No	No emergency stop
1.2.4.4	Completeness of machines	No		
1.2.5	Selection of control or operating modes	No		
1.2.6	Fault in the energy supply	Yes	No	Unintended start-up
1.3	Protective measures against mechanical hazards			
1.3.1	Risk of stability loss	Yes	No	Transport, repair
1.3.2	Risk of breakage during operation	Yes	Yes	
1.3.3	Risks posed by dropping or ejected objects	Yes	Yes	

No.	Basic requirement	Applicable	Met	Comment
1.3.4	Risks posed by surfaces, edges and corners	Yes	Yes	
1.3.5	Risks posed by multiple machines combined	No		
1.3.6	Risks posed by changed usage conditions	No		
1.3.7	Risks posed by movable parts	Yes	Yes	
1.3.8	Selection of protective equipment against risks posed by movable parts	No		
1.4	Protective equipment requirements			
1.4.1	General requirements	No		
1.4.2	Special specifications for guards	No		
1.4.3	Special specifications for protective devices	No		
1.5	Risks posed by other hazards			
1.5.1	Electrical energy supply	No		
1.5.2	Static electricity	Yes	Yes	
1.5.3	Non-electrical energy supply	Yes	No	
1.5.4	Assembly fault	Yes	Yes	
1.5.5	Extreme temperatures	Yes	No	Equipment may heat up or cool down
1.5.6	Fire	Yes	No	O2 fire cannot be ruled out
1.5.7	Explosion	Not applicable or separately certified		
1.5.8	Noise	Yes	No	Depending on installation and application
1.5.9	Vibrations	Yes	Yes	
01/05/2010	Radiation	No		
01/05/2011	Radiation from the outside	Yes	Yes	
01/05/2012	Laser radiation	No		
01/05/2013	Emission of hazardous materials and substances	Yes	No	Release and leakage of operating fluid

No.	Basic requirement	Applicable	Met	Comment
01/05/2014	Risk of being locked into the machine	No		
01/05/2015	Risk of slipping, tripping or falling	No		
01/05/2016	Lightning strike	No		
1.6	Maintenance			
1.6.1	Machine maintenance	Yes	No	In context of the overall system
1.6.2	Access to the operator stations and access points for maintenance	No		
1.6.3	Disconnection of energy sources	Yes	No	Unavailable
1.6.4	Operating personnel interventions	Yes	Yes	
1.6.5	Cleaning of machine parts in the interior	No		
1.7	Information			
1.7.1	Information and warnings on the machine	No		
1.7.2	Warning of residual risks	Yes	No	In context of the overall system
1.7.3	Machine labels	Yes	Yes	
1.7.4	Operating manual	No		Installation manual
2-6	Additional requirements for specific machine types and hazards	No		


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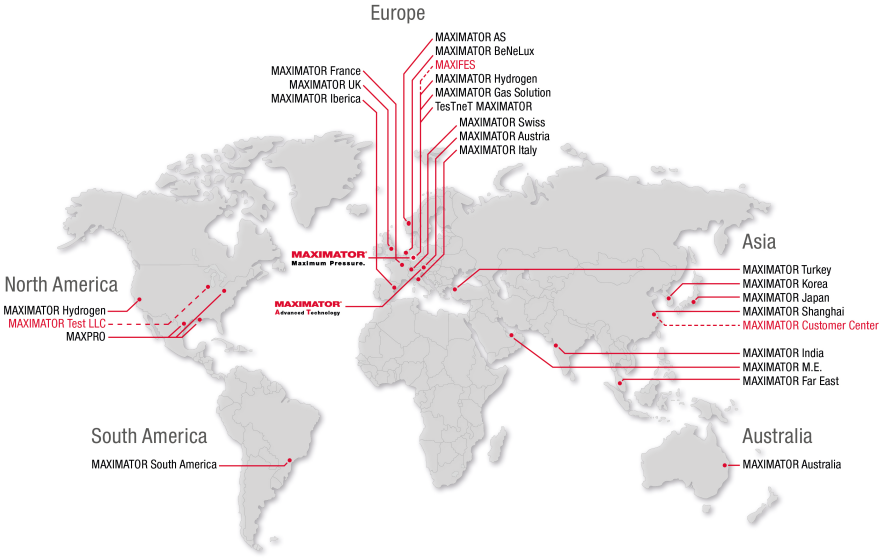

Visit our website at: www.maximator.de

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