

# Functional description

## POSITIVE DISPLACEMENT BLOWER

Series: F



RKR Gebläse und Verdichter GmbH  
Braasstraße 1  
31737 Rinteln  
Germany  
Telephone: +49 (0) 5751 40 04 0  
Fax: +49 (0) 5751 40 04 30  
Email: [info@RKR.de](mailto:info@RKR.de)  
Internet: [www.RKR.de](http://www.RKR.de)

000289840, 1, en\_GB

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# 1 Machine protection

The following operating parameters are permanently displayed and/or monitored on the machine:

- Intake pressure
- Discharge pressure
- Auxiliary devices for drive motor

Other operating parameters can optionally be displayed and/or monitored on the machine according to the order:

- Differential pressure
- Intake temperature
- Discharge temperature behind machine stage
- Discharge temperature behind aftercooler
- Acoustic hood interior temperature
- Machine stage housing vibration
- Machine stage bearing temperature
- Machine stage speed
- Sealing gas system pressure
- Sealing gas system flow rate

Exceeding or falling below the specified limit values as per the measurement points and instruments list leads to a shutdown of the drive motor and, consequently, to the shutdown of the machine.

### Applicable documents

The following supplementary documents also apply:

- Piping and instrumentation diagram (PID)
- Measurement points and instruments list

## 1.1 Power circuit breaker system

The power circuit breaker system (MCC) is included in the scope of delivery depending on the order and machine version.

In the case of a machine with an integrated power circuit breaker system, the safety valves, in addition to the drive motor and electrical consumers, are connected at the factory.

If installation of the power circuit breaker system occurs on site, the electrical lines for the drive motor and for the electrical consumers need to be laid and connected.

# Machine protection

Frequency converter

## Auxiliary electrical devices for drive motor



### NOTICE!

#### Material damage!

Auxiliary electrical devices of the drive motor must be connected and evaluated as per the specification of the motor manufacturer.

- Anti-condensation heater
- Temperature monitoring for storage and winding (e.g. PTC thermistors, Pt100)
- Vibrational monitoring

## 1.2 Control system

### Control system at the factory

The control system (PLC) is included in the scope of delivery depending on the order and machine version.

The control system is used to regulate and monitor the machine. The processes are integrated in the control system at the factory as per the functional description. The exchange of signals with the process control system (PCS) occurs as per the circuit diagram.

### On-site control system

A machine without an integrated control system must be integrated in an operationally reliable control system as per the functional description.

## 1.3 On-site remote switch

On-site remote switches (maintenance switches etc.) **must not** deactivate or bypass the shutdown conditions.

## 1.4 Frequency converter

### During use, observe the following

- If the motor is driven by a frequency converter, the motor must be approved for use with a frequency converter.
- Note the electrical and mechanical properties of the motor.
- To prevent bearing damage due to shaft currents being too high, the motor needs to be protected by means of current-insulated bearings on the B-side as of a certain size.  
Motors supplied by RKR with a nominal power of at least 90 kW are always equipped with current-insulated bearings. Note the specifications for the motor provided by the manufacturer.

- RKR recommends the use of input filters and output filters (dv/dt filter, motor throttle, sinusoidal filter or common mode filter).

These are specifically designed for the frequency converter. They reduce reactions in the power supply system and filter dangerous harmonics from the drive current. This prevents damage to the motor winding and to the motor bearings. The electromagnetic compatibility of the machine is improved.
- The maximum permissible slew rate (dv/dt) must not exceed the value 1350 V/μs. Similarly, the peak voltage at the connection terminals must not exceed 1,350 V.



### NOTICE!

Danger of insulation damage and motor failure if the motor throttle or motor filter coil are not used!



### NOTICE!

- Proper installation ensures improvement in electromagnetic compatibility and prevents failure susceptibility.
- Proper connection can only be ensured if shielded lines are used to connect the motor.
- Apply the shielding braid of the connection line at earth potential on both sides and over a large area.
- A low-impedance earthing of all metallic system parts is required.



### NOTICE!

- Use EMC cable glands and EMC shield clamps designed for the connection cable.
- Connect further connection cables (e.g. PTC) with shielded lines as well.



*These measures must be specially adapted to the respective frequency converter in accordance with the manufacturer's specification and be designed for the relevant requirements.*

## Machine protection

Soft starter (optional)



### NOTICE!

- The maximum current limit of the motor (nominal motor current) must not be exceeded. Observe the specifications on the motor's rating plate.
- Set the fixed minimum frequency specified by RKR. This frequency must not fall below the fixed minimum during operation.
- The maximum frequency is to be set by taking into account the maximum motor speed and the maximum machine speed.
- The changeover speed for the acceleration ramp and deceleration ramp must not exceed 1 Hz per second during normal operation.
- The frequency converter must be designed with a constant load torque for operation with a working machine.
- The machine must shut down without braking. Activation of a brake ramp or quick stop is not permissible. Free coastdown is required.
- To prevent operational faults, the "Interception circuit" function must not be parameterised in the control system of the frequency converter.
- A restart lock must be activated when shutting down the frequency converter.  
A restart should only be possible after the machine has come to a complete standstill.

## 1.5 Soft starter (optional)



*Note the manufacturer's documents.*

- The soft starter must be designed with a constant load torque for operation of a machine.  
The use of a 2-phase, controlled soft starter is not recommended.
- It is necessary to start the machine with reduced torque.  
This depends on the machine type and version. It can be done by a relief valve on the discharge side or with a start unloading device, for example.
- The soft starter must be designed in accordance with the machine's start-up curve.



## 2 Functional diagrams

### 2.1 Switch-on and restart conditions

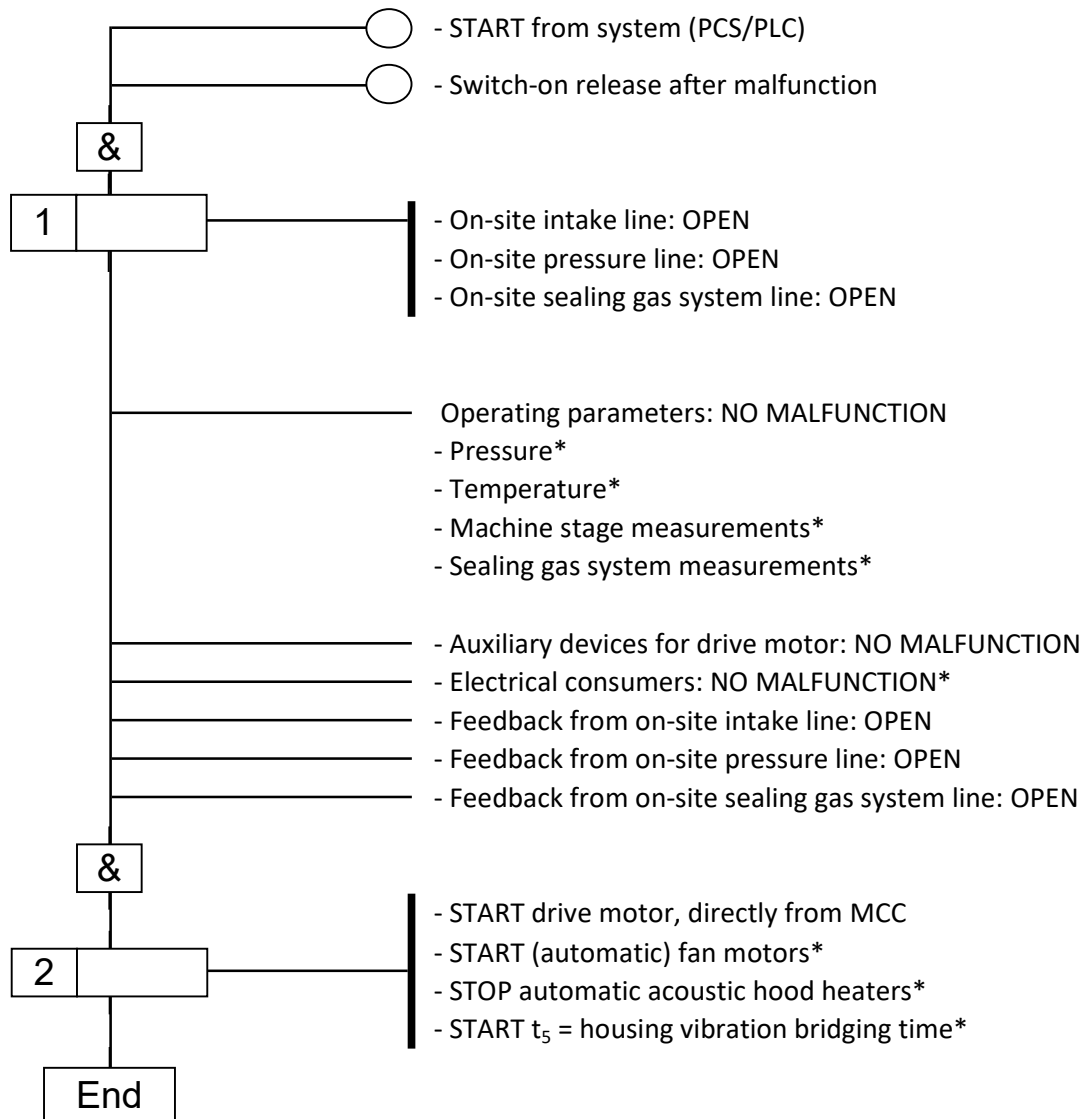


Fig. 1: Switch-on conditions

\* - if included in extent of supply

## Functional diagrams

Switch-off conditions

### 2.2 Switch-off conditions

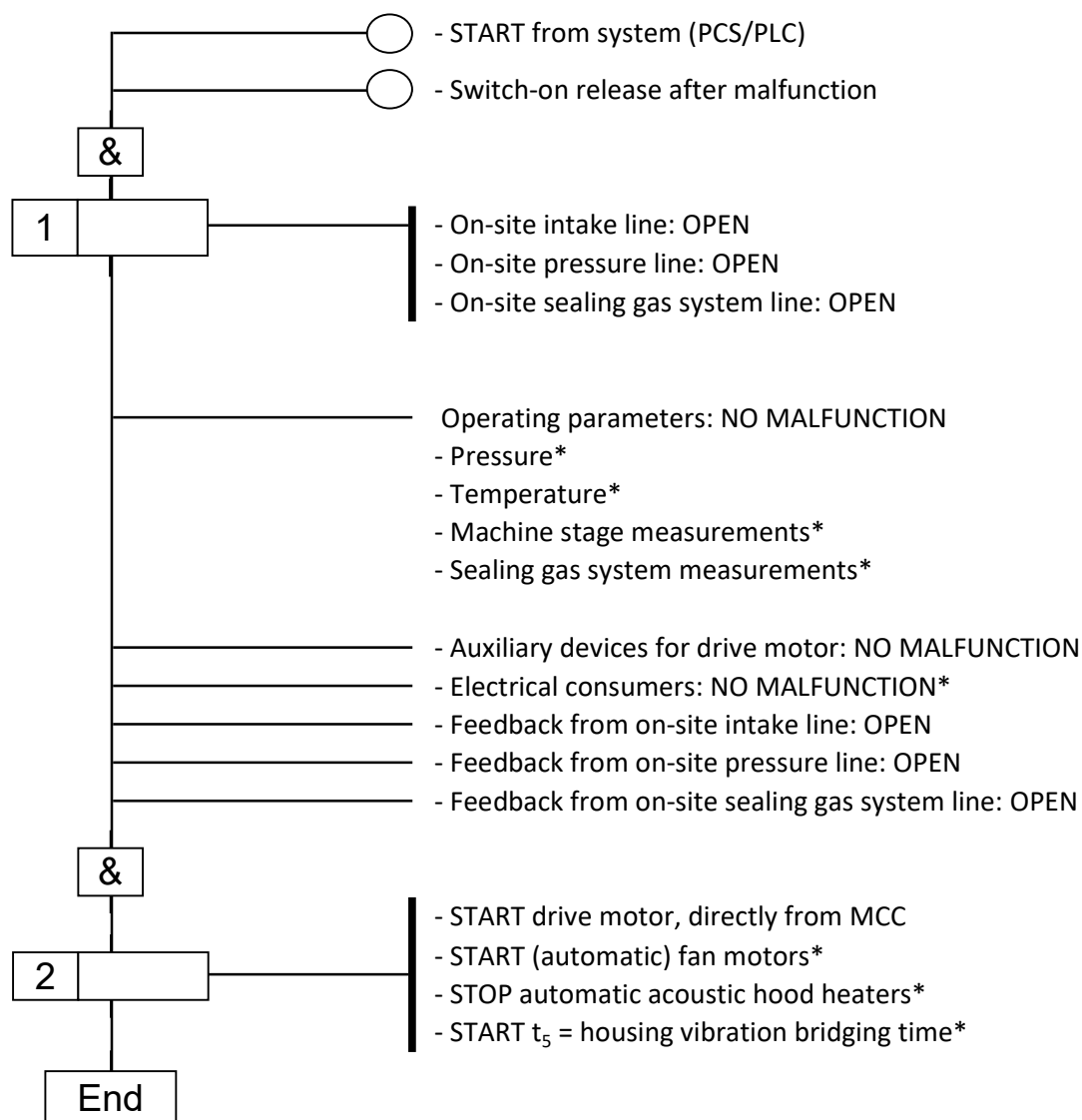



Fig. 2: Switch-off conditions

\* - if included in extent of supply

\*1 - See note  'Electrical consumer fault' on page 14

### 3 Functional description



See order-related measurement points and instruments list for specifications of the limit values (set values).

#### Switching on the machine

It is only possible to switch on the machine if the operating parameters are within the permissible limit values.

Exceeding or falling below the limit values prevents the machine from starting.

#### Switching off the machine

During operation, the machine is protected by adherence to the limit values.

Exceeding or falling below the limit values leads to the machine shutting down.

#### Malfunctions

In the event of a malfunction, the cause must be eliminated and the malfunction must be acknowledged in the control system.

For better fault analysis, it is recommended that you record malfunctions and compile a fault message list.

#### Shutdown command

In the event of a malfunction, the resulting shutdown command of the drive motor must be implemented **without delay** (< 1 second). In the event of a shutdown, the contacts must remain in the self-holding position. The contacts may only return to the acceptable limits after fault rectification and acknowledgement in the control system.

#### Switching conditions



#### NOTICE!

Specifications subject to order-related changes.

The specifications in the measurement points and instruments list are binding.

Tab. 1: Example of switching conditions due to malfunctions

Operating parameters	Condition	Delay times [seconds]
Intake pressure	< min.	1
Discharge pressure	> max.	2
Intake temperature	< min., > max.	2

## Functional description

Operating parameters	Condition	Delay times [seconds]
Discharge temperature behind machine stage	> max.	2
Discharge temperature behind aftercooler	> max.	2
Acoustic hood interior temperature	< min., > max.	2
Machine stage housing vibration	> max.	5
Sealing gas system pressure	< min.	2
Sealing gas system flow rate	< min.	2
Auxiliary devices for drive motor	as per the specification of the motor manufacturer	

### Delay times

If the limit values for the individual measured values are only exceeded or undershot briefly – i.e. within the permissible delay time – while the machine is running, then this does not necessitate the shutdown of the drive motor and thus the machine. In the control system, the brief limit value exceedance is treated as an acceptable signal and the power circuit breaker system does not receive a fault signal from the control system, which would otherwise lead to a machine shutdown.

If the limit values for the individual measured values are exceeded or undershot for longer than the specified delay times, then the control system must generate a fault signal and a shutdown signal must be sent to the power circuit breaker system. The power circuit breaker system must stop the drive motor immediately.

### Machine run-down time $t_1$

The machine stage runs on after the drive motor has been stopped. Before closing the lines, you must observe the waiting period  $t_1$  until the machine has run down fully.

The machine's run-down time is **30 seconds**.

### Restart lock $t_2$

After the machine has been switched off, the drive motor may only be restarted once the restart lock ( $t_2$ ) has elapsed, and not beforehand.



#### NOTICE!

##### Material damage!

The permissible start-up frequency for the machine stage and the drive motor is limited.

The starts must be distributed evenly across one hour. Observe the duration of the restart lock ( $t_2$ )!

Nominal power	Starts	Duration of restart lock $t_2$
up to 160 kW	6 starts per hour	10 minutes
from 200 kW	3 cold starts per hour	20 minutes
	or 2 warm starts per hour	30 minutes



### **Operation with a frequency converter:**

*As the maximum nominal motor current flows during start-up with a frequency converter (soft start), a restart lock is not required.*

### **Fan**

For versions with an acoustic hood, the fan is used for ventilation of the acoustic hood.

The fan motor starts when the machine is started.

### **Fan run down time $t_3$**

The acoustic hood fan must be equipped with a run down time of **20 minutes**.

### **Automatic fan**

The fan motor starts and stops according to the monitored acoustic hood interior temperature.

Only possible if the acoustic hood interior temperature is monitored.

Switching points:

- ON = +20 °C
- OFF = +5 °C

### **Automatic acoustic hood heating**

For versions with an acoustic hood, the heating is used to pre-heat the machine stage and lube oil.

Only possible if the acoustic hood interior temperature is monitored.

Switching points:

- ON = -5 °C
- OFF = +5 °C

### **Machine stage housing vibration**

The “Alarm” and “Trip” settings stated in the measurement points instrument list are provisional. In accordance with guideline VDI 3836, these values must be validated during commissioning at the installation site.

## Functional description

Increased vibrations – above the limit values – could occur when the machine is started and switched off.

To prevent a shutdown of the machine during start-up, the housing vibration limit value must be suppressed for the duration of the bridging time  $t_5$ .

The housing vibration bridging time  $t_5$  is **15 seconds**.

To prevent a machine shutdown signal when stopping, the housing vibration limit value must be suppressed for the duration of the run down time  $t_1$ .

### Electrical consumer fault

If the electrical consumer (e.g. fan motor, heating, etc.) fails, the machine does not necessarily need to shut down immediately. When the fault is recognised by the power circuit breaker system, a signal must be sent to the control system for the fault to be displayed.

The fault must be rectified immediately.