# INTERFACE DESCRIPTION
# MIP 4000 V2.2
## CABLING & SOFTWARE COMMUNICATON

**For Type Series 4000**

DK-SB-0002 / V03 / 08.04.2013

Original document was created in German.

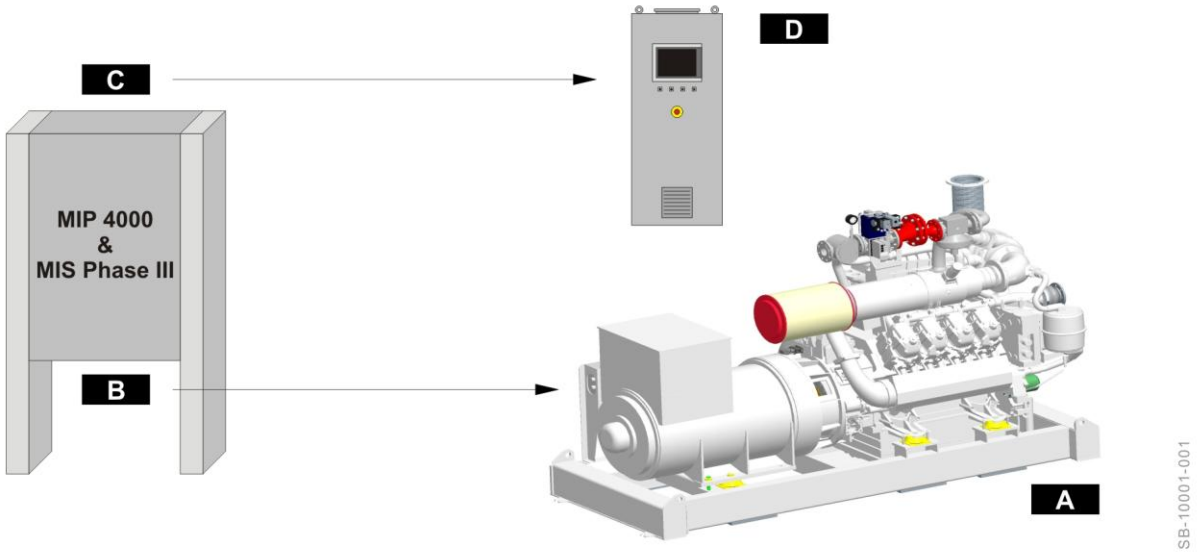


Subject to technical alterations in the interest of further development.

# Table of Contents

# 1 General

MTU Onsite Energy is responsible for interface clarification between engine and customer system.
All interface signals between engine and customer system are operated by the MIP 4000.




| No. | Description |
|---|---|
| A | Genset |
| B | Engine interface |
| C | Customer interface |
| D | Customer system controller |

## 1.1 Validity

This document, Interface Description - MIP 4000 is valid from circuit diagram version and software version V2.2.0.0

# 2 Advantages - MIP 4000

- Complete design expertise through MTU Onsite Energy
- Interface changes on the motor side (MIS) will be handled by MTU Onsite Energy:
  Minimal changes are required on the customer side.
- Customer desires (e.g. software communication) can be handled by MTU Onsite Energy.
- Software communication via Ethernet: „**Bidirectional**".
- Complete genset and protection integrated in the MIP 4000 and MIS:
  No guarantee restrictions.
- Synchronization of generator circuit breakers (GCB) is integrated in the MIP 4000.
- Synchronization of grid circuit breakers (MCB) integrated in the MIP 4000 - optional.
- Grid monitoring integrated in the MIP 4000:
  (No protective function, without certificates for certain countries) - optional
- Remote access for MTU Onsite Energy possible: Better product support.

# 3 Scope of Service

**Communication with the Motor Interface Cabinet (MIS) via hardware signals and CAN Open.**
**Communication with the customer system via hardware signals and Ethernet.**
**Generator protection**

- Generator overvoltage / generator undervoltage
- Generator over-frequency / generator under-frequency
- Generator overcurrent / generator undercurrent - stage 1 and stage 2
- Generator overload
- Generator reverse power
- Generator unbalanced load

**Generator monitoring**

- Generator effective power - P (kW)
- Generator reactive power - Q (kVAr)
- Generator apparent power – S (kVA)
- Generator frequency
- Generator voltage U12, U23, U31
- Generator current L1, L2, L3
- Generator cos phi
- Generator active energy (kWh)

**Busbar monitoring**

- Busbar voltage U12, U23, U31
- Busbar frequency

**Grid monitoring**

- Grid voltage U12, U23, U31
- Grid frequency

**Synchronization**

- Generator circuit breaker (GCB): Only floating contacts, power section in the customer system.
- Grid circuit breaker (MCB): Only floating contacts, power section in the customer system.

**Generator temperature monitoring**

- Winding temperature monitoring and protection
- Bearing temperature monitoring and protection

**Gas system (monitoring and protection)**

- Gas pressure min / max (protection)
- Activation of the gas leak test
- Activation of the gas valves

**General control functions - without power sections (only floating contacts or software signals)**

- Activation of the auxiliary drives
- Activation of the lubricating oil solenoid valves
- Activation of the pre-lubrication
- Activation of the engine pre-warming

# 4 Requirements of the Customer System

**Charging of the starter batteries**
(external location of the starter system, see installation guideline)

**Provision of 24 VDC power supply for the MIP 4000**
(a power failure under 21 V is not allowed; maximum voltage is 28.8 V.
For rated voltage 24 VDC, 25 A must be made available).

**Integration of safety relays** (emergency stop buttons, safety transducers, etc.)

**Integration of a grid protection device with the monitors**

- Grid over-frequency / grid under-frequency
- Grid overvoltage / grid undervoltage
- Vector shift
- Asymmetry
- Phase shift monitoring

**Optional integration of a differential protection device**

**Optional integration of a ground fault protection device**

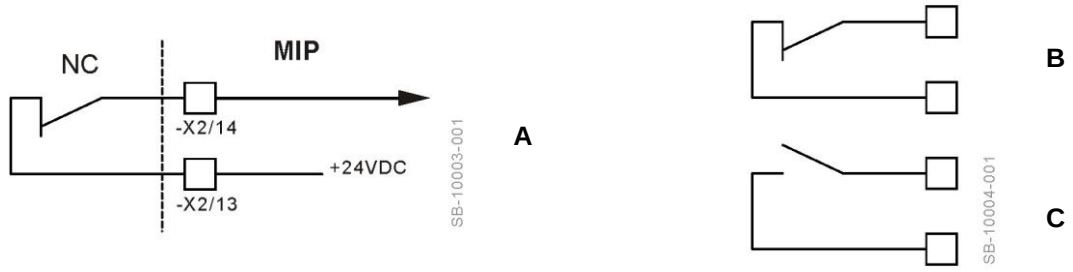
**Provision of the power sections for**

- Auxiliary drives
- Lubricating oil solenoid valves
- Fresh oil pump / old oil pump
- Pre-lubrication
- Engine pre-warming
- Generator circuit breaker

# 5 Hardware Signals

## 5.1 MIP - Digital inPuts

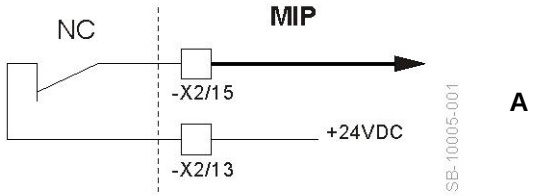
### 5.1.1 Emergency Stop of Customer System

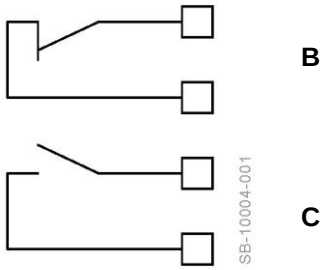



| | | | |
|---|---|---|---|
| **A** | Digital input | **B** | No emergency stop active |
| | | **C** | Emergency stop active |

The machine will be stopped without delay. The auxiliary drives continue to remain activated.

### 5.1.2 GCB is On

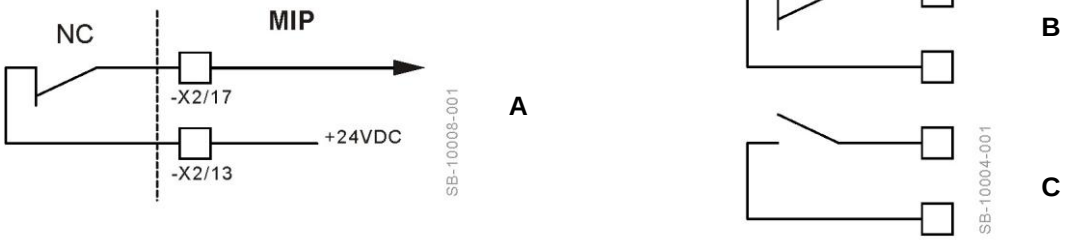



| | | | |
|---|---|---|---|
| **A** | Digital input | **B** | Generator circuit breaker (GCB) opened |
| | | **C** | Generator circuit breaker (GCB) closed |

| **NOTICE** | | |
|---|---|---|
| ! | A fast, direct checkback is required from the generator circuit breaker (GCB). | SH-H-156 |

### 5.1.3 Grid failure from the Customer System

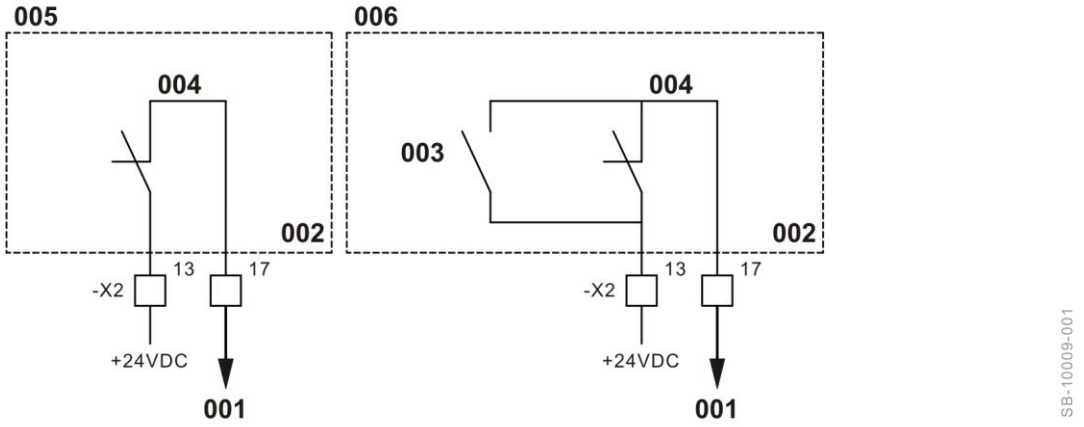



| | | | |
|---|---|---|---|
| **A** | Digital input | **B** | No grid failure active |
| | | **C** | Grid failure active |

If a grid failure in grid backup operation is detected via this input, the generator circuit breaker (GCB) of the MIP 4000 will be opened.

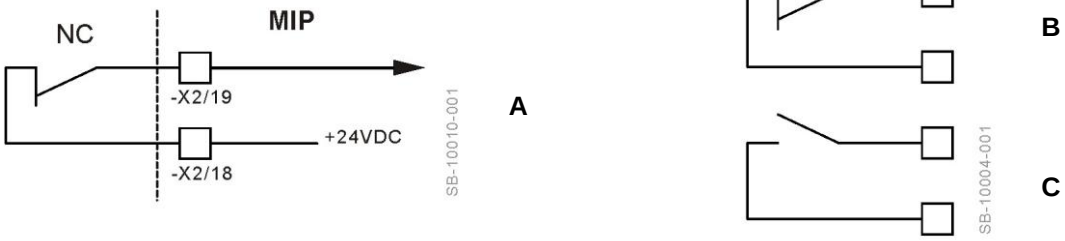
**Particularity in the event of grid disconnect via the grid circuit breaker (MCB) for uninterruptible grid backup operation:**

The grid disconnect via the grid circuit breaker (MCB) occurs through the customer system.
In this case the signal, "grid failure from the customer system" must not be activated, otherwise in grid backup operation the generator circuit breaker (GCB) will be opened without delay and uninterruptible grid backup operation is not possible.
For this mode it must be ensured that the grid disconnect is provided via the grid circuit breaker (MCB) in the customer system.
Malfunction can cause damage to the machine and the generator.




| No. | Description |
|---|---|
| 001 | Digital input |
| 002 | Customer system |
| 003 | Enable grid backup operation = contact closed:<br>Grid disconnect occurs through MCB in the customer system. |
| 004 | Grid monitoring device. Contact opens at grid failure. |
| 005 | Execution of pure grid backup operation or execution of grid backup operation with interruption. |
| 006 | Execution of grid backup mode without interruption.<br>Important: For this mode it must be ensured that the grid disconnect is provided via the grid circuit breaker (MCB) in the customer system. |

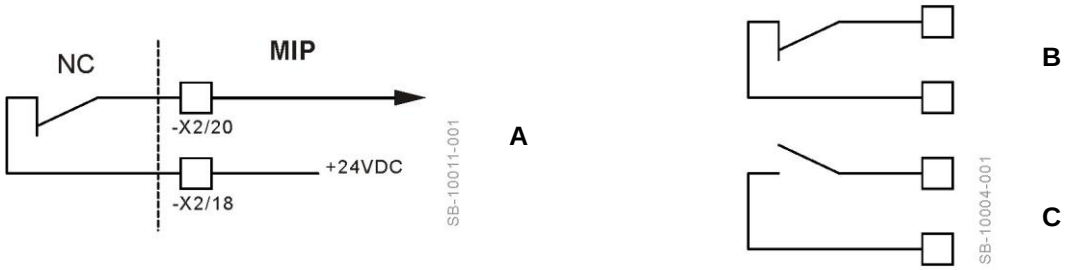
## 5.1.4 Checkback - Gas Valve 1




| | | | |
|---|---|---|---|
| **A** | Digital input | **B** | Gas valve 1 closed |
| | | **C** | Gas valve 1 open |

After activation of the output "Request gas valve 1" this checkback must be signaled by the end position switch of the gas valve.

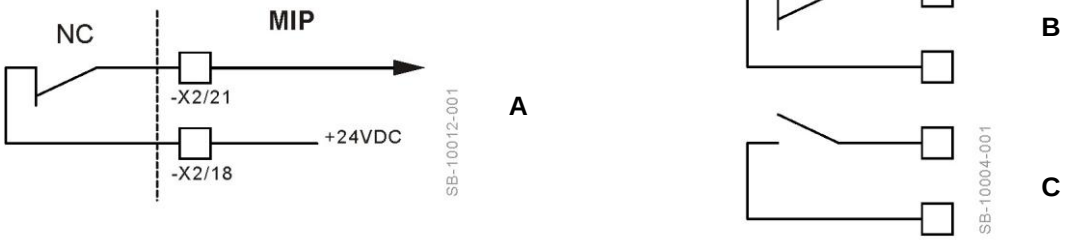
### 5.1.5 Checkback - Gas Valve 2




| | | | |
|---|---|---|---|
| **A** | Digital input | **B** | Gas valve 2 closed |
| | | **C** | Gas valve 2 open |

After activation of the output "Request gas valve 2" this checkback must be signaled by the end position switch of the gas valve.

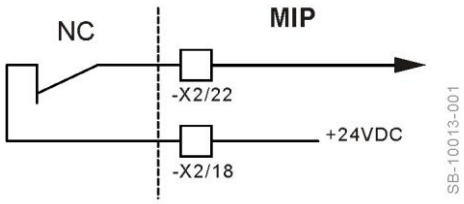
### 5.1.6 Checkback - Gas Pressure Min



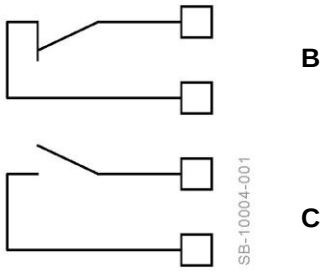

| | | | |
|---|---|---|---|
| **A** | Digital input | **B** | Gas pressure OK active |
| | | **C** | Gas pressure < min active |

The gas pressure switch "min" must be installed upstream of the gas valves.

### 5.1.7 Checkback - Gas Pressure Max



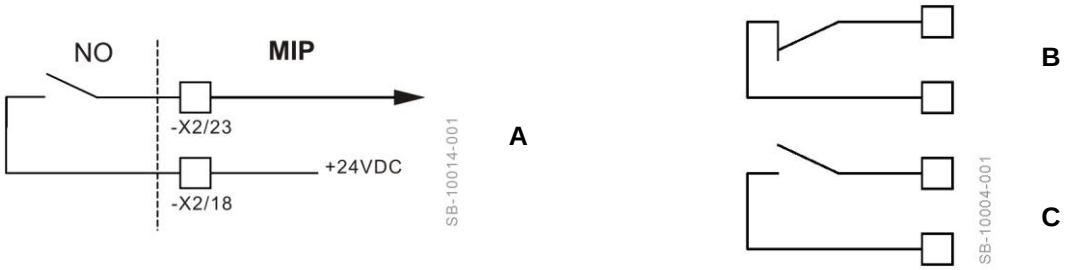

**A**




| | | | |
|---|---|---|---|
| **A** | Digital input | **B** | Gas pressure OK active |
| | | **C** | Gas pressure > max active |

The gas pressure switch "max" must be installed upstream of the gas valves.

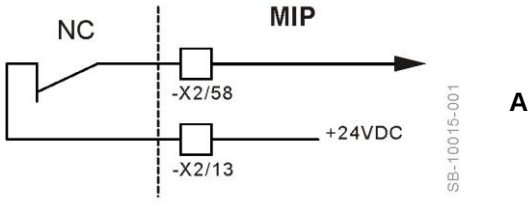
## 5.1.8 Checkback - Gas Leak Test OK

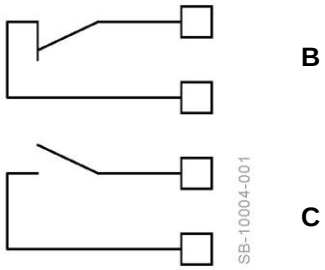



| | | | |
|---|---|---|---|
| **A** | Digital input | **B** | Gas leak test OK active |
| | | **C** | Gas leak test not OK active |

After request for the gas leak test by the MIP 4000, this checkback must be signaled within an adjustable time (e.g. 30 s, parameter is assigned in the MIP 4000) otherwise the start procedure will be interrupted.

### 5.1.9 MCB is On



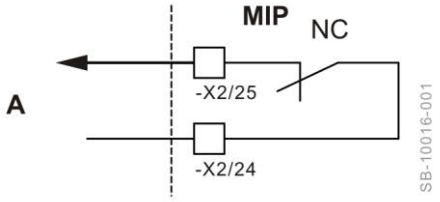



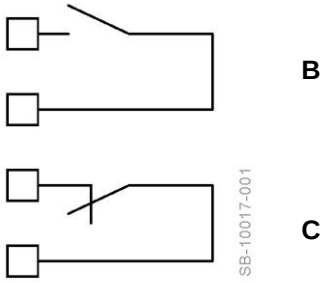

| | | | |
|---|---|---|---|
| **A** | Digital input | **B** | Main circuit breaker (MCB) open |
| | | **C** | Main circuit breaker (MCB) closed |

| **NOTICE** | | |
|---|---|---|
| ! | A fast, direct checkback is required from the main circuit breaker (MCB). | SH-H-158 |

# 5.2 MIP - Digital Outputs

## 5.2.1 Emergency Stop

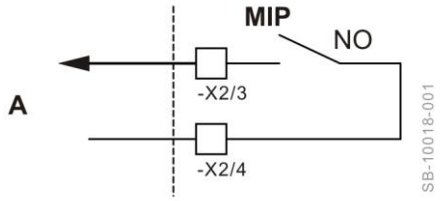


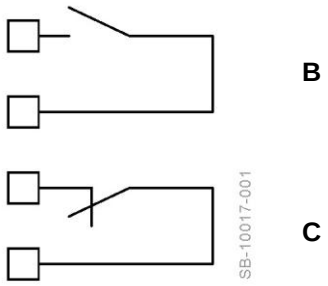




| | | | |
|---|---|---|---|
| **A** | Max. contact current capacity:<br>• 24 VDC 10 A<br>• 220 VDC 0.22 A<br>• 230 VAC 6 A | **B** | Emergency stop active |
| | | **C** | No emergency stop active |

In the event of an active emergency stop the generator circuit breaker (GCB) will be opened automatically by the MIP 4000.

## 5.2.2 GCB Command Close

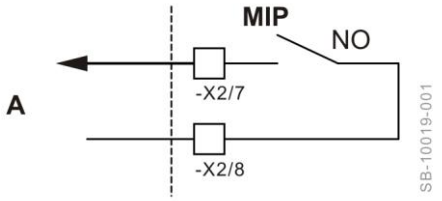


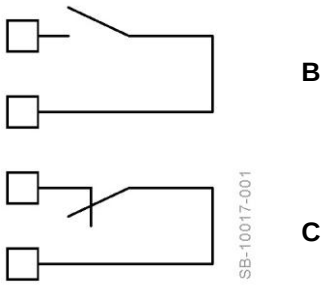




| | | | |
|---|---|---|---|
| **A** | Max. contact current capacity:<br>• 24 VAC 8 A<br>• 220 VDC 0.12 A<br>• 230 VAC 8 A | **B** | No "close" command is active |
| | | **C** | "Close" command is active |

After satisfying the connection requirements the MIP 4000 outputs a close pulse for the generator circuit breaker (GCB). Parameters can be assigned for the pulse length of the close contact (standard: 250 milliseconds).

## 5.2.3 MCB Command Close



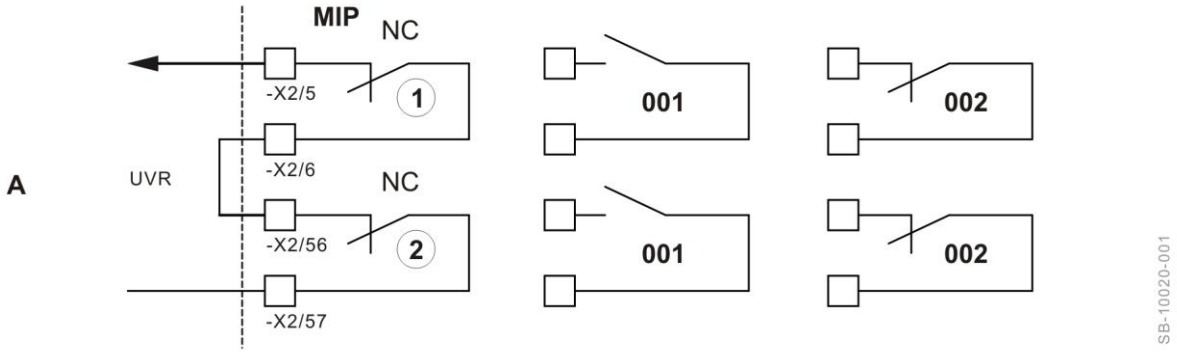




| | | | |
|---|---|---|---|
| **A** | Max. contact current capacity:<br>• 24 VAC 8 A<br>• 220 VDC 0.12 A<br>• 230 VAC 8 A | **B** | No "close" command is active |
| | | **C** | "Close" command is active |

After satisfying the connection requirements the MIP 4000 outputs a close pulse for the main circuit breaker (MCB).
Parameters can be assigned for the pulse length of the close contact (standard: 250 milliseconds).
This signal is required for a grid backup system for the return-synchronization of the MCB.
A black start for the MCB is possible from MIP 4000 version 2.

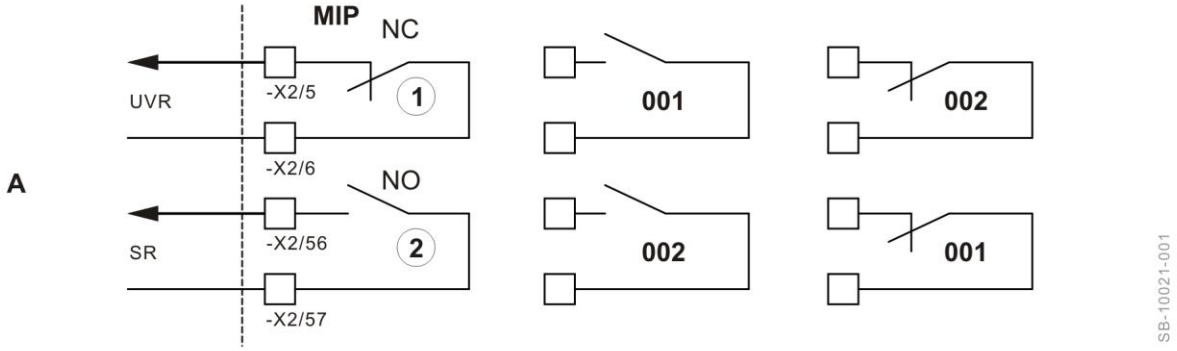
### 5.2.4 GCB Command Close

- Switch with undervoltage tripping device (UTD)




| No. | Description |
|---|---|
| A | Max. contact current capacity:<br>• 24 VDC 5.8 A<br>• 220 VDC 0.12 A<br>• 230 VAC 6 A |
| 001 | GCB "open" command active |
| 002 | No GCB "open" command active |

- Switch with undervoltage tripping device (UTD) and work current tripping device (WCTD)

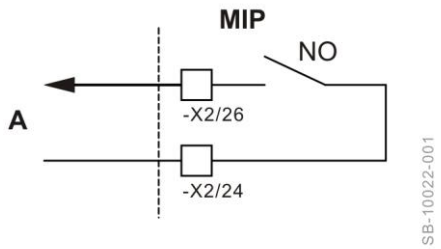


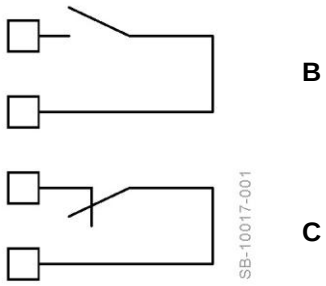

| No. | Description |
|---|---|
| A | Max. contact current capacity:<br>• 24 VDC 5.8 A<br>• 220 VDC 0.12 A<br>• 230 VAC 6 A |
| 001 | GCB "open" command active |
| 002 | No GCB "open" command active |

The GCB will be opened by the MIP 4000 at the conditions specified below:

| No. | Description |
|---|---|
| 1 | A generator protection monitor has been activated. |
| 1 | Input "grid failure from the customer system" has been opened in grid backup mode. |
| 2 | In grid backup mode the software signal "engine start" has been reset and the electrical power drops below a minimum value for which parameters can be assigned (default: 1%). |
| 2 | Red alarm (immediate stop) without ramp active. |
| 2 | Red alarm (controlled stop) with ramp active.<br>Electrical power drops below a minimum value for which parameters can be set (default: 1%). |
| 2 | Software signal "enable synchronization GCB" has been reset. |

## 5.2.5 Backup Protection - GCB cannot be Opened

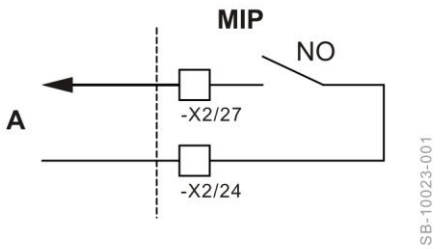


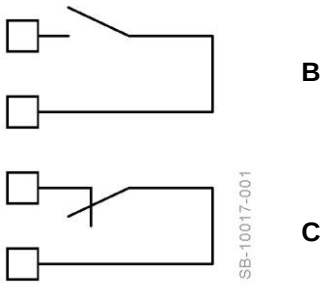




| | | | |
|---|---|---|---|
| **A** | Max. contact current capacity:<br>• 24 VDC 5.8 A<br>• 220 VDC 0.18 A<br>• 230 VAC 6 A | **B** | No backup protection active |
| | | **C** | Backup protection active |

Backup protection is activated when the generator circuit breaker (GCB) cannot be opened by the MIP 4000. In this case the customer system controller must open a higher-level switch.

## 5.2.6 Request Auxiliary Drives



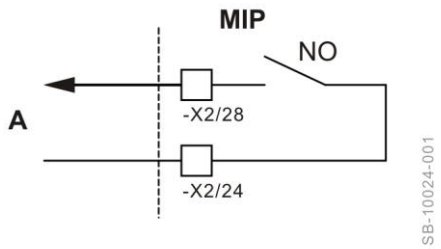



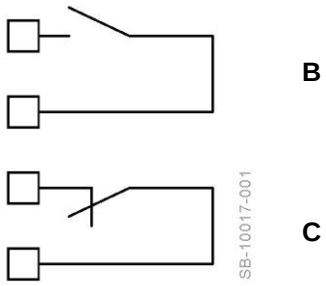

| | | | |
|---|---|---|---|
| **A** | Max. contact current capacity:<br>• 24 VDC 5.8 A<br>• 220 VDC 0.18 A<br>• 230 VAC 6 A | **B** | No request |
| | | **C** | Request for auxiliary drives active |

The contact is closed at a start command and will only be opened when the engine is at a standstill and the afterrun time has elapsed.

The customer system controller must activate the appropriate auxiliary drives (pumps, room ventilation, etc.).

## 5.2.7 Request Lubricating Oil Solenoid Valves



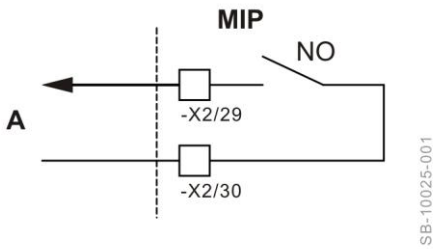



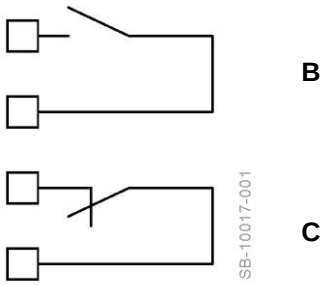

| | | | |
|---|---|---|---|
| **A** | Max. contact current capacity:<br>• 24 VDC 5.8 A<br>• 220 VDC 0.18 A<br>• 230 VAC 6 A | **B** | No request |
| | | **C** | Request for top up active |

The request for the lubricating oil solenoid valves is activated, if the oil top-up trips due to reduced oil level. The machine must be in operation for at least 5 minutes.

If the request for the lubricating oil solenoid valves is set too often, an alarm becomes active. The request is activated in a pulse/pause ratio (adjustable in the MIP 4000). The oil is topped up via a fresh oil pump or from a fresh oil tank in the appropriate installed height.

## 5.2.8 Request Gas Leak Test

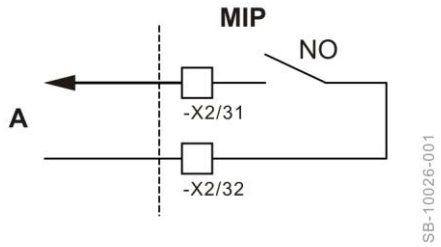


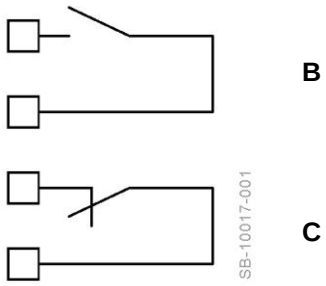




| | | | |
|---|---|---|---|
| **A** | Max. contact current capacity:<br>• 24 VAC 8 A<br>• 220 VDC 0.12 A<br>• 230 VAC 8 A | **B** | No request |
| | | **C** | Request gas leak test active |

The request is activated at every start.

### 5.2.9 Request Gas Valve 1

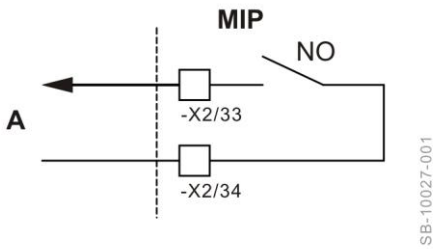


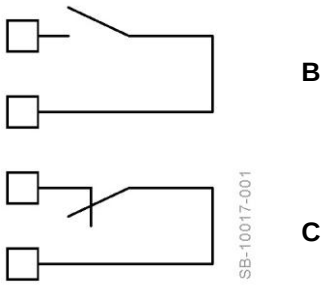




| | | | |
|---|---|---|---|
| **A** | Max. contact current capacity:<br>• 24 VAC 20 A<br>• 110 VDC 0.15 A<br>• 400 VAC 9 A | **B** | No request |
| | | **C** | Request gas valve 1 active |

With request the gas valve 1 must open.

## 5.2.10 Request Gas Valve 2

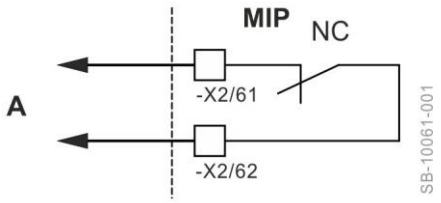


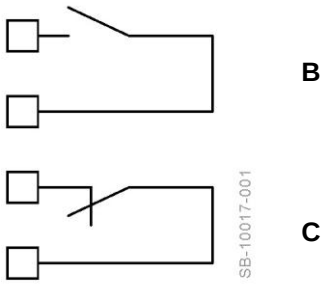




| | | | |
|---|---|---|---|
| **A** | Max. contact current capacity:<br>• 24 VAC 20 A<br>• 250 VDC 0.5 A<br>• 440 VAC 12 A | **B** | No request |
| | | **C** | Request gas valve 2 active |

With request the gas valve 2 must open.

## 5.2.11 Checkback - Emergency Stop



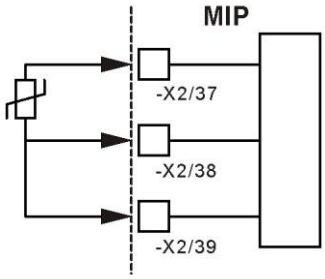

| | | | |
|---|---|---|---|
| **A** | Max. contact current capacity:<br>• 24 VDC 10 A<br>• 220 VDC 0.22 A<br>• 230 VAC 6 A | **B** | Emergency stop active |
| | | **C** | No emergency stop active |

This signal indicates the status of the emergency stop of the customer system.
The signal is intended for the return circuit of the emergency stop customer system controller.

# 5.3 MIP - Analog Inputs

## 5.3.1 Generator Winding Temperature - U1

- **Cabled in the MIP 4000 scope of delivery!**

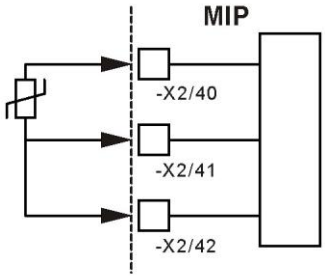



SB-10029-001

The generator winding temperature U1 can be designed as PT1000 or PT100 and is monitored for limit value overshoot and wire break.

## 5.3.2 Generator Winding Temperature - V1

- **Cabled in the MIP 4000 scope of delivery!**

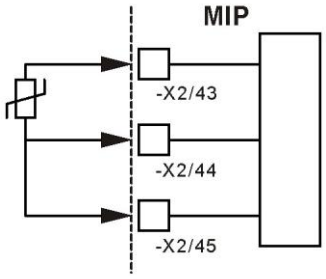



SB-10030-001

The generator winding temperature V1 can be designed as Pt1000 or Pt100 and is monitored for limit value overshoot and wire break.

### 5.3.3 Generator Winding Temperature - W1

- **Cabled in the MIP 4000 scope of delivery!**

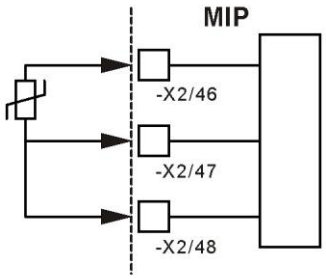



SB-10031-001

The generator winding temperature W1 can be designed as PT1000 or PT100 and is monitored for limit value overshoot and wire break.

### 5.3.4 Generator Bearing Temperature - Drive Side

- **Cabled in the MIP 4000 scope of delivery!**

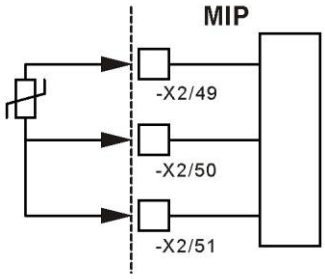



SB-10032-001

The generator winding temperature - drive side - can be designed as PT1000 or PT100 and is monitored for limit value overshoot and wire break.

### 5.3.5 Generator Bearing Temperature - Non-Drive Side

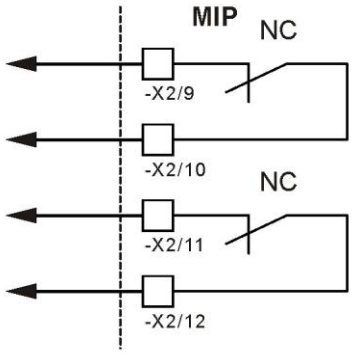
- **Cabled in the MIP 4000 scope of delivery!**




SB-10033-001

The generator winding temperature - non-drive side - can be designed as Pt1000 or Pt100 and is monitored for limit value overshoot and wire break.

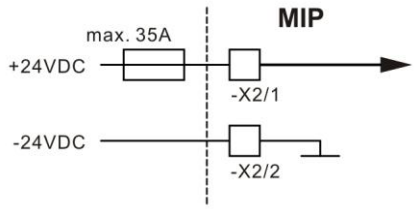
## 5.4 Manual Emergency Stop Buttons




SB-10034-001

A manual emergency stop button is attached on the MIP 4000.
The customer system controller must integrate this emergency stop switch in a tested safety chain.
By activating the emergency stop button the safety chain must be tripped without delay.
The digital "emergency stop from customer system" must also be opened.

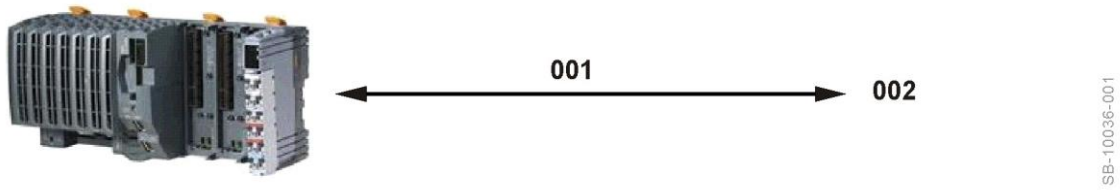
## 5.5 MIP 4000 Supply Voltage - 24 VDC




SB-10035-001

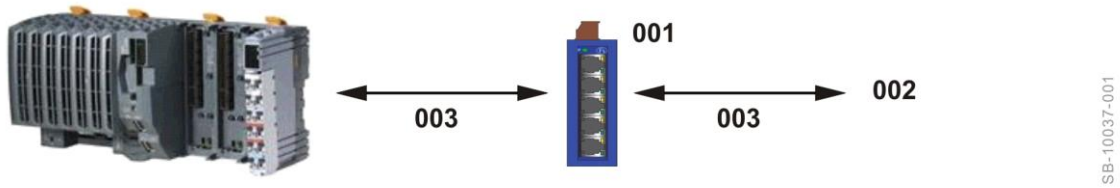
A voltage drop under 21 VDC is not permitted; the maximum permissible voltage is 28.8 VDC.
It must be provided at rated voltage 24 VDC 25 A.

## 5.6 Ethernet Communication via RJ45




| No. | Description |
|---|---|
| 001 | Crossed cable - CAT5 |
| 002 | Customer CPU |

For direct cabling: Use CAT5, crossed cable

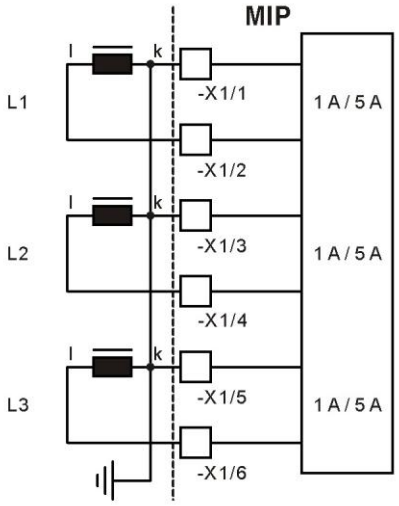



| No. | Description |
|---|---|
| 001 | Switch |
| 002 | Customer CPU |
| 003 | 1:1 cable CAT5 |

Cabling via switch: Use CAT5, 1:1 cable

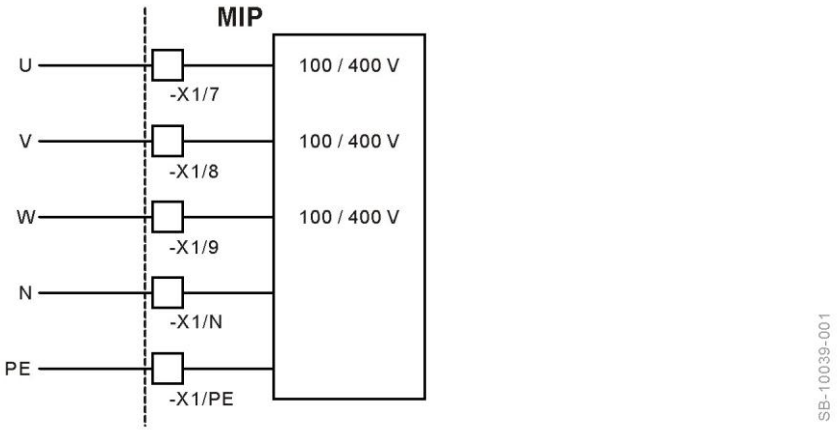
## 5.7 Generator Current Transformer 5 A

- **Cabled in the MIP 4000 scope of delivery!**




The current transformer terminals K are only grounded at a voltage greater than 1 kV.
Version 5 A or 1 A can be used as generator current transformers. Standard is 5 A.
If the current transformer is changed from 5 A to 1 A, cabling and parameters must be adapted in the MIP 4000.
The generator current converters are used to calculate the electrical effective power and for generator protection.

## 5.8 Generator Voltage



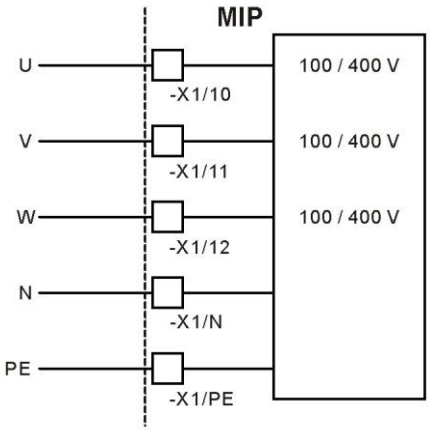

Version 400 VAC or 100 VAC can be used as generator voltage.

If the measurement voltage is changed from 400 VAC to 100 VAC, the parameters in the MIP 4000 must be adjusted.

The generator voltage is used to synchronize the generator circuit breaker (GCB) and for generator protection.

- Synchronization - GCB: Busbar voltage ↔ generator voltage

## 5.9 Busbar Voltage



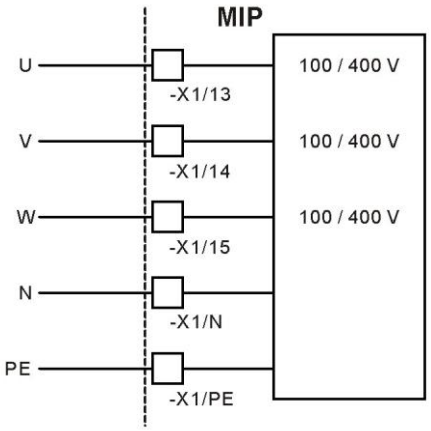

Version 400 VAC or 100 VAC can be used as busbar voltage.

If the measurement voltage is changed from 400 VAC to 100 VAC, the parameters in the MIP 4000 must be adjusted.

The busbar voltage is used to synchronize the generator circuit breaker (GCB) and for the grid circuit breaker (MCB).

- Synchronization GCB: Busbar voltage ↔ generator voltage
- Synchronization MCB: Busbar voltage ↔ grid voltage

## 5.10 Grid Voltage




Version 400 VAC or 100 VAC can be used as grid voltage.

If the measurement voltage is changed from 400 VAC to 100 VAC, the parameters in the MIP 4000 must be adjusted.

The grid voltage is used to synchronize the grid circuit breaker (MCB).

- Synchronization MCB: Busbar voltage ↔ grid voltage

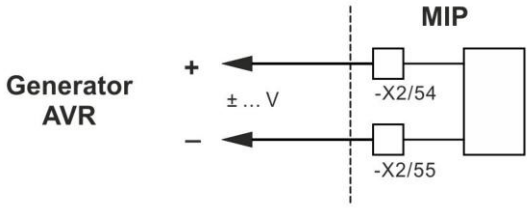
# 6 Generator - PFC and AVR

The generator is equipped with a voltage regulator and a cos phi regulator (AVR and PFC).

The connection between cos phi regulator (PFC) and voltage regulator (AVR) is disconnected. Thus the cos phi regulator no longer has a function. The voltage regulator (AVR) gets the setpoint via an analog output of the MIP.

## 6.1 Activation - Voltage Regulator

- **Cabled in the MIP 4000 scope of delivery!**




The voltage and the cos phi can be variably changed by the MIP. The MIP regulates the voltage or the cos phi of the generator with an analog signal. The setpoints for the regulator and the appropriate control parameters can be set via the MIP.

# 7 Generator Anti-Condensation Heating

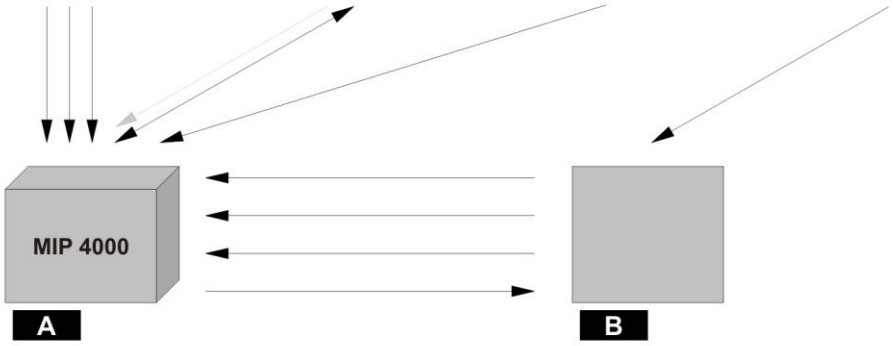
The generator is equipped with a heater (230 VAC, fuse: B6A).
This heater must be activated under the following conditions:

- Generator circuit breaker GCB opened
- and machine at a standstill.

**The cabling is not included in the MIP 4000: Execution occurs in the customer system!**

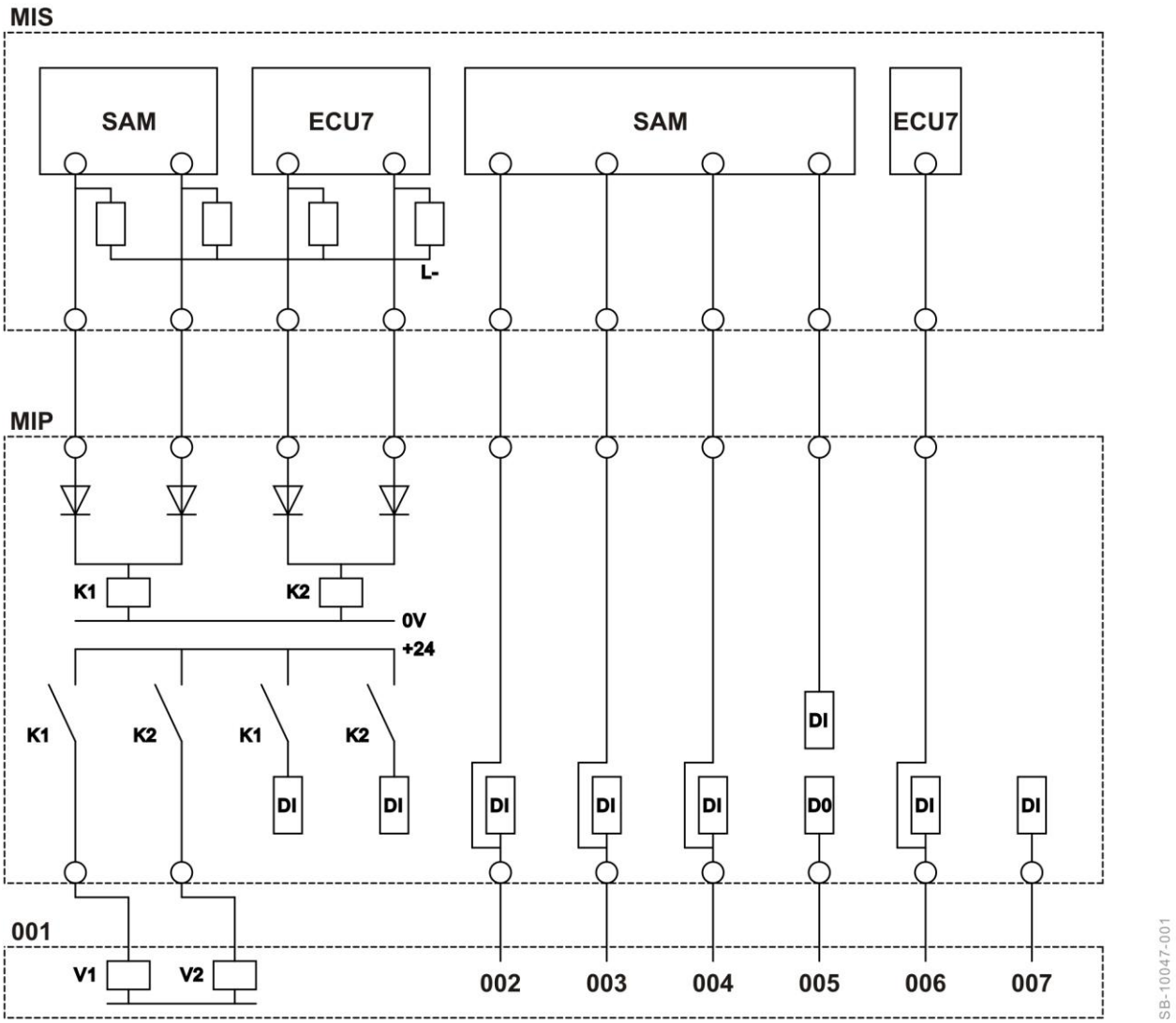
# 8 Overview - Cabling


| No. | Description |
|---|---|
| A | Remote access (DSL) |
| B | Customer system controller |




| No. | Description |
|---|---|
| A | Customer interface |
| A | Grid voltage, generator voltage, busbar voltage (100 VAC or 400 VAC) |
| A | 24 VDC supply |
| A | Software communication (Ethernet) |
| A | Checkbacks / specifications (from the customer) |
| A | Requests (to the customer) |
| B | Generator |
| B | Generator current transformers (1 A or 5 A) |
| B | Winding temperatures (U, V, W) |
| B | Bearing temperatures |
| B | Generator anti-condensation heater (230 VAC) |

# 9 Overview - Gas System




| No. | Description |
|---|---|
| 001 | Customer |
| 002 | Checkback - gas valve V1 (open) |
| 003 | Checkback - gas pressure min. |
| 004 | Checkback - leak test OK |
| 005 | Request leak test |
| 006 | Checkback - gas valve V2 (open) |
| 007 | Checkback - gas pressure max. |

# 10 Software Signals

## 10.1 Signals to the Customer System

### 10.1.1 Request Pre-Lubrication

High signal: Request pre-lubrication

### 10.1.2 Request Engine Pre-Heating

High signal: Request engine pre-heating

The request for engine pre-heating is set depending on the engine cooling water exit temperature.
The engine pre-warming is activated when the temperature limit value is underranged.
The customer system controller must activate the cooling water pump, so that a cooling water differential pressure of 0.7 bar is built up after 10 seconds.
If this differential pressure is not built up the alarm "fault engine oil pre-warming" will be output and the request for engine oil pre-warming will be reset.

After a time for which parameters can be assigned, the request for engine pre-warming will be reactivated.

## 10.2 Signals from the Customer System

### 10.2.1 Engine Start

| | |
|---|---|
| High signal: | Start command |
| Low signal: | No start command, stop procedure is activated. |

To enable grid backup mode, in addition the "grid backup mode active" signal is required.

| NOTICE | | |
|---|---|---|
| ! | The start procedure will not be executed if stop messages from the engine (red alarm) are active.<br>The start procedure will not be executed if the digital input "emergency stop from customer system" is activated. | SH-H-159 |

### 10.2.2 Reset

| | |
|---|---|
| High signal: | To acknowledge active alarms, a pulse with a pulse length of at least 1 second is expected. |

### 10.2.3 Enable Synchronization (GCB)

High signal: Enable synchronization

After the machine has reached rated speed and is stabilized, synchronization will be started with the signal "enable synchronization (GCB).
The triggered synchronization can also be stopped again by the customer system controller by setting the signal to low.
If this signal is reset while the generator circuit breaker (GCB) is closed, then the GCB will be opened.

### 10.2.4 Enable Synchronization (MCB)

- **Is only required for a grid backup system!**

High signal: Enable synchronization (MCB)

The machine is in grid backup mode (GCB is closed, MCB is opened), no grid failure is active:
The return synchronization of the MCB will be triggered with the signal "enable synchronization (MCB)".
This sequence corresponds to the return synchronization without interruption.
The triggered synchronization can also be stopped again by the customer system controller by setting the signal to low.

### 10.2.5 Higher Speed

High signal: Higher speed (minimum pulse length 100 ms)

In grid backup mode the speed specification can be influenced by the customer system controller.
This is typically used for effective load distribution in isolated parallel operation or for return synchronization of higher-level circuit breakers.
The engine speed is increased automatically if this signal is activated.

### 10.2.6 Lower Speed

High signal: Lower speed (minimum pulse length 100 ms)

In grid backup mode the speed specification can be influenced by the customer system controller.
This is typically used for effective load distribution in isolated parallel operation or for return synchronization of higher-level circuit breakers.
The engine speed is decreased automatically if this signal is activated.

### 10.2.7 Grid Backup Mode Active

- **Is only required for a grid backup system!**

High signal: Grid backup mode is activated.

To enable grid backup mode this signal must be activated.
To trigger grid backup mode, in the event of grid failure the signal, "grid backup mod active" and "engine start" are used as the start command.

**Additional functions:**

If grid backup mode is triggered by engine standstill, then the auxiliary drives (cooling water pump, etc.) will not be supplied for certain time due to a lack of generator voltage / busbar voltage.

Consequently with this signal, certain alarms will be delayed for parameter-assignable time, to prevent engine shut-off due to temperature monitors / pressure monitors.

### 10.2.8 Black Start GCB

- **Is only required for a grid backup system!**

High signal: Black start GCB active

The following conditions must be satisfied to close the generator circuit breaker (GCB) without synchronization:

- Busbar is de-energized.
- MCB is open.
- GCB is open.
- Signal "enable synchronization (GCB)" is activated.
- Signal "black start GCB" is activated.
- The machine has reached rated speed and is stabilized.

### 10.2.9 Lack of Cooling Water

High signal: There is a lack of cooling water

The cooling water level drops under minimum. The machine will be stopped.

### 10.2.10 Setpoint - Effective Power

Range: 0.0 to 100.0%

In grid backup mode a setpoint is expected for the electrical effective power.
After the GCB is closed, the power ramp becomes active.
The parameters of the power ramp (load / offload in % / s) can be set in the MIP 4000.
A power ramp is not required in the customer system.

**Monitor - minimum power:**

It is not permitted to operate the machine for a longer period of time under minimum power (default is 30%).
If the external setpoint is specified under this minimum power, then after a period of time, the alarm "LO minimum load" will be active.
In this case the customer system must then specify a setpoint above the minimum power.

**Stop activated:**

At an activated stop the setpoint must not be set to 0%. Offloading of the power ramp will be executed automatically by the MIP 4000.

### 10.2.11 Black Start MCB

- **Is only required for a grid backup system!**
- **Possible from MIP 4000 version 2!**

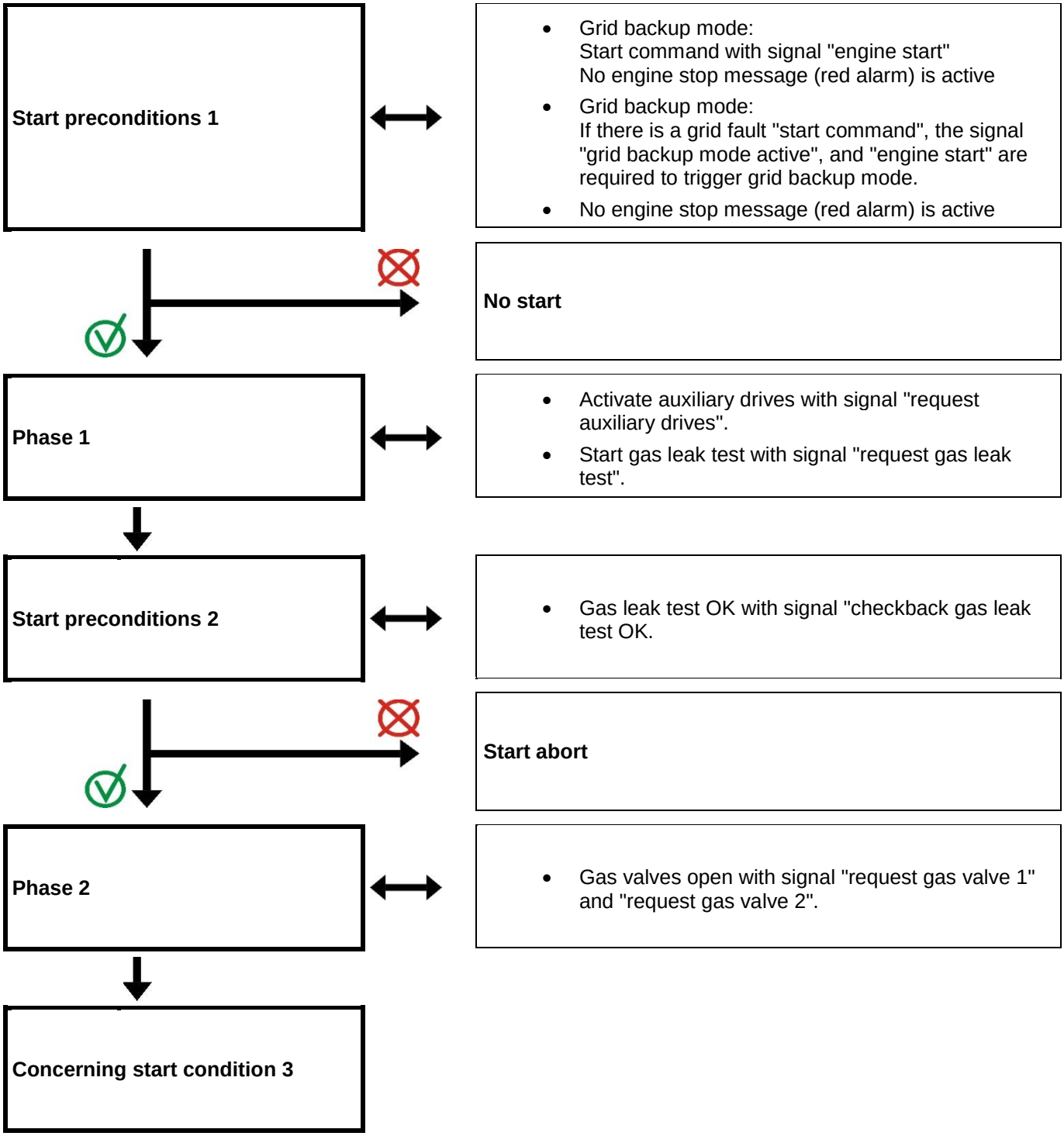
High signal: Black start MCB active

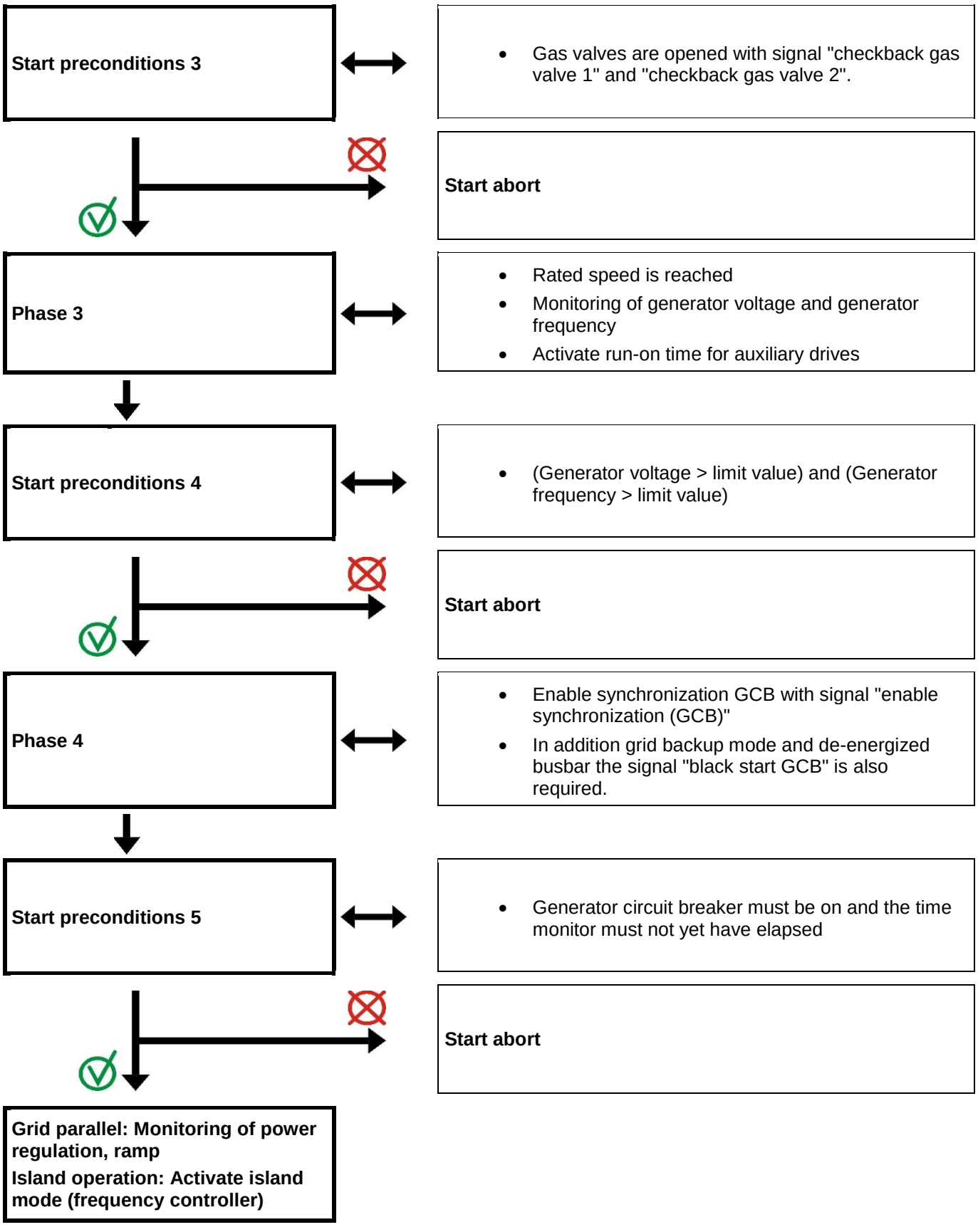
The following conditions must be satisfied to close the main circuit breaker (MCB) without synchronization:

- Busbar is de-energized.
- MCB is open.
- GCB is open.
- Signal "enable synchronization (MCB)" is activated.
- Signal "black start MCB" is activated.
- No grid failure active

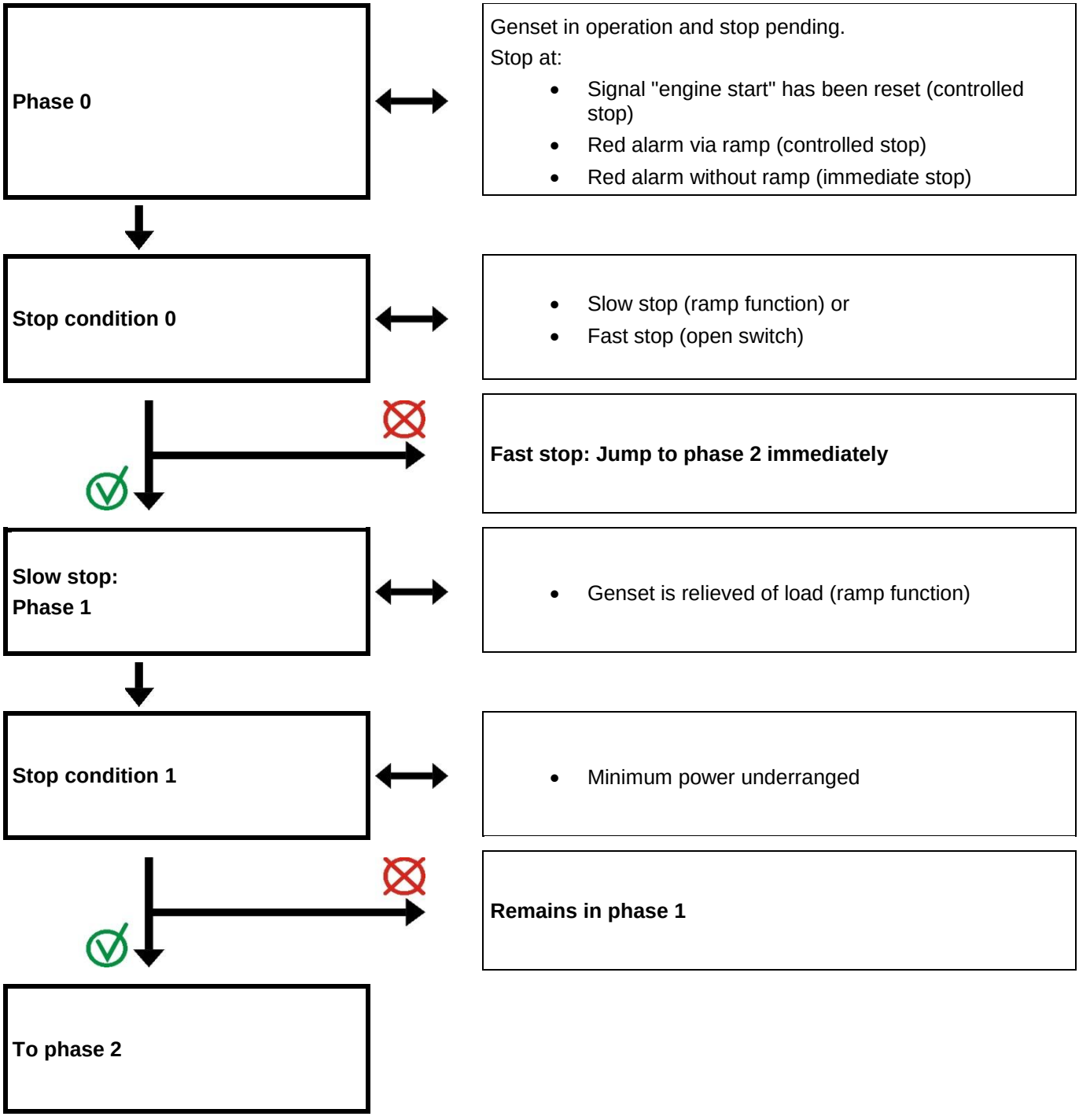
# 11 Start- / Stop Procedure

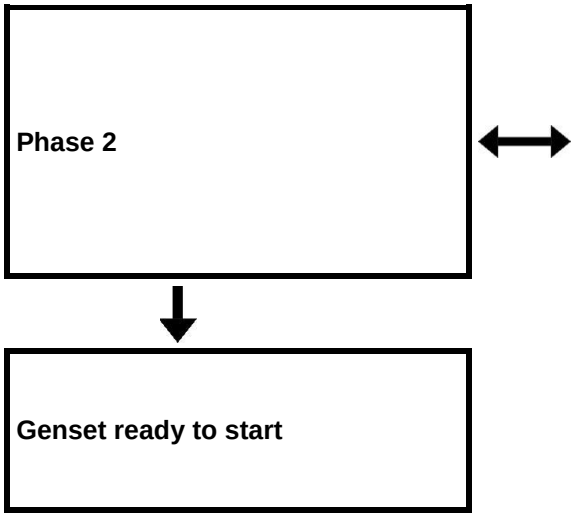
## 11.1 Start Sequence




Start preconditions 3
Gas valves are opened with signal "checkback gas valve 1" and "checkback gas valve 2".
Start abort
Phase 3
Rated speed is reached
Monitoring of generator voltage and generator frequency
Activate run-on time for auxiliary drives
Start preconditions 4
(Generator voltage > limit value) and (Generator frequency > limit value)
Start abort
Phase 4
Enable synchronization GCB with signal "enable synchronization (GCB)"
In addition grid backup mode and de-energized busbar the signal "black start GCB" is also required.
Start preconditions 5
Generator circuit breaker must be on and the time monitor must not yet have elapsed
Start abort
Grid parallel: Monitoring of power regulation, ramp
Island operation: Activate island mode (frequency controller)

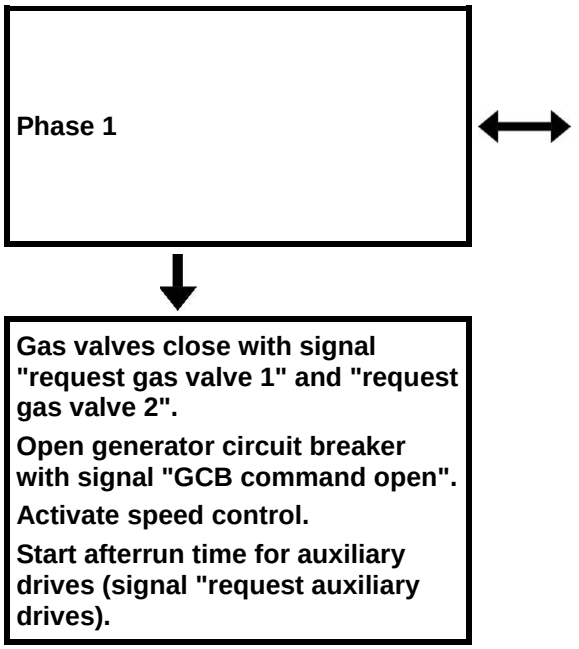
## 11.2 Stop Sequence






- Open generator circuit breaker with signal "GCB open".
- Activate speed control.
- Gas valves close with signal "request gas valve 1" and "request gas valve 2".
- Start afterrun time for auxiliary drives (signal "request auxiliary drives)

## 11.3 Emergency Stop Sequence




Genset in operation and emergency stop pending.
Emergency stop if:

- Emergency stop button has been activated
- Emergency stop of the engine is active
- Signal "emergency stop from customer system" is activated.

## 11.4 Mains Parallel Operation

### 11.4.1 Engine Start

1. To start, the signal "engine start" must be set to high.
2. After the genset has reached the rated speed, the signal, "enable GCB" must be set to high.
   The generator circuit breaker will then be synchronized. The triggered synchronization can also be stopped again by the customer system controller by setting the signal to low.
   If this signal is reset when the generator circuit breaker (GCB) is closed, then the GCB opens.
3. After the generator circuit breaker closes mains parallel operation is immediately active.
   The electrical effective power is specified via the signal, "setpoint effective power".

### 11.4.2 Stopping the Engine

1. In mains parallel operation, the signal "engine start" must be set to low. The engine will now be offloaded via power ramp.
   Important: The signal "enable synchronization (GCB)" must continue to remain on high, otherwise the generator circuit breaker GCB will be activated.
2. With a parameter-assignable power value (default 1%) the generator circuit breaker GCB will be opened.
   After the generator circuit breaker has been opened, the signal, "enable GCB" must be set to low.
   The engine will be stopped.

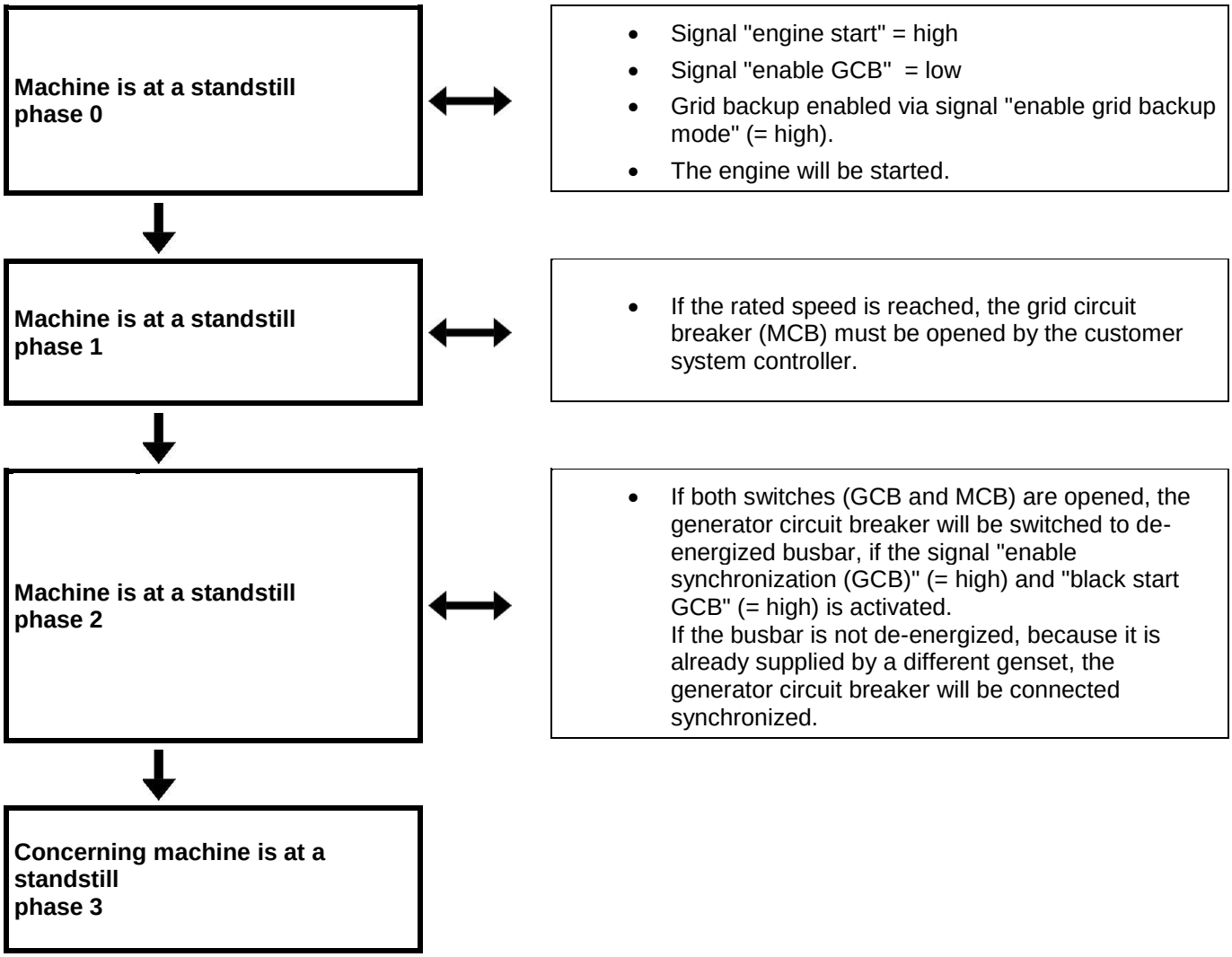
### 11.4.3 Grid Failure in Mains Parallel Operation

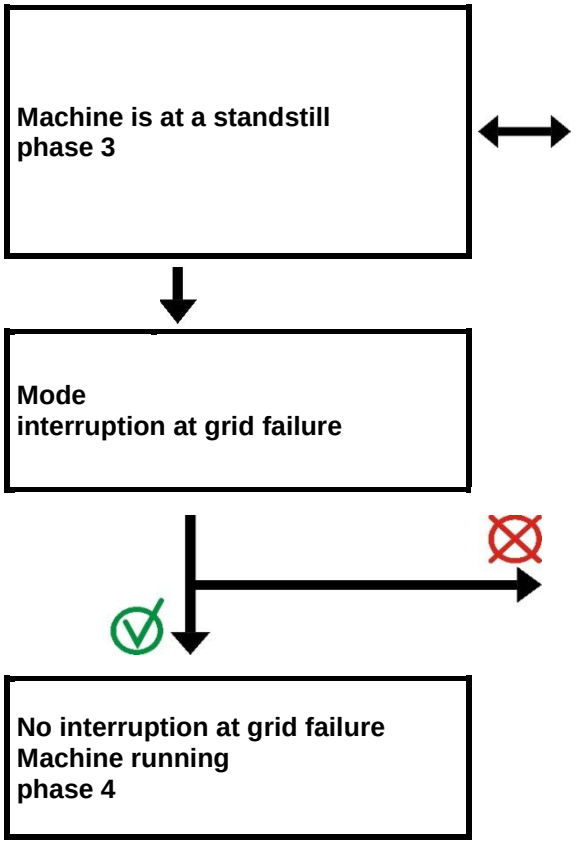
The following procedure applies when grid backup mode is not enabled via the signal "grid backup mode active".

1. In mains parallel operation the signals "engine start" and "enable GCB" are set to high.
   A grid failure is detected via the signal "grid failure from customer system".
   The generator circuit breaker (GCB) will be opened.
2. If this only involves a brief interruption (SI), then the generator circuit breaker GCB will connected resynchronized.
   If an actual grid failure is involved the engine will be stopped.
   After the grid failure has ended, the grid stabilization timer is started (adjustable timer). After the grid stabilization timer has elapsed, the engine is enabled.

## 11.5 Grid Backup Mode

### 11.5.1 Engine is at a Standstill and a Grid Failure Occurs

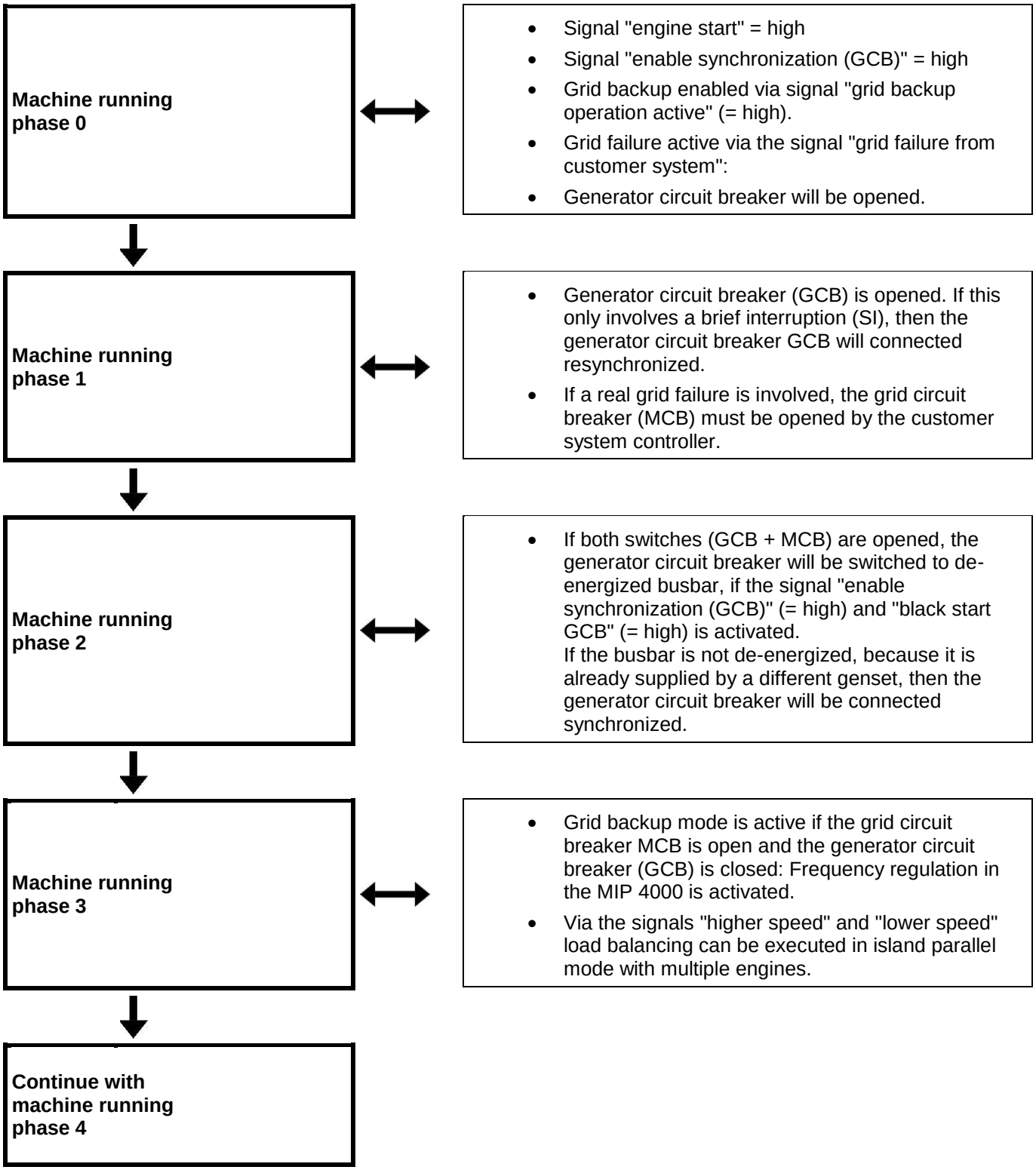





- Grid backup mode is active if the grid circuit breaker GCB is open and the generator circuit breaker (GLS) is closed => frequency regulation in the MIP 4000 is activated.
- Via the signals "higher speed" and "lower speed" load balancing can be executed in island parallel mode with multiple engines.

**No interruption at grid failure**
**Machine running**
**phase 2**

### 11.5.2 Operating Mode: Interruption at Grid Failure - Machine is running and a Grid Disturbance Occurs



**Machine running phase 4**

Grid failure no longer active via the signal "grid failure from customer system":

Return synchronization of the grid circuit breaker MCB occurs in two ways:

**Interruption-free**

- Variant 1: When the grid failure is resolved, the grid stabilization time will be started (adjustable timer). After the grid stabilization time has elapsed and the signal "enable synchronization (MCB)" (= high) has been activated, the grid circuit breaker (MCB) will be synchronized. If within this time another grid failure occurs, the return synchronization will be interrupted and grid backup mode will be continued. After the generator circuit breaker has been opened, the signal, "enable synchronization (GCB)" must be set to low.
- Variant 2: The grid circuit breaker MCB can be return synchronized by the customer system controller. To do this, the signals "higher speed" and "lower speed" must be used.

**With interruption:**

When the grid failure is resolved, the grid stabilization time will be started (adjustable timer). After the grid stabilization timer has elapsed, the signal, "enable synchronization (GCB)" (= low) must be withdrawn. The generator circuit breaker (GCB) will be opened through this measure.

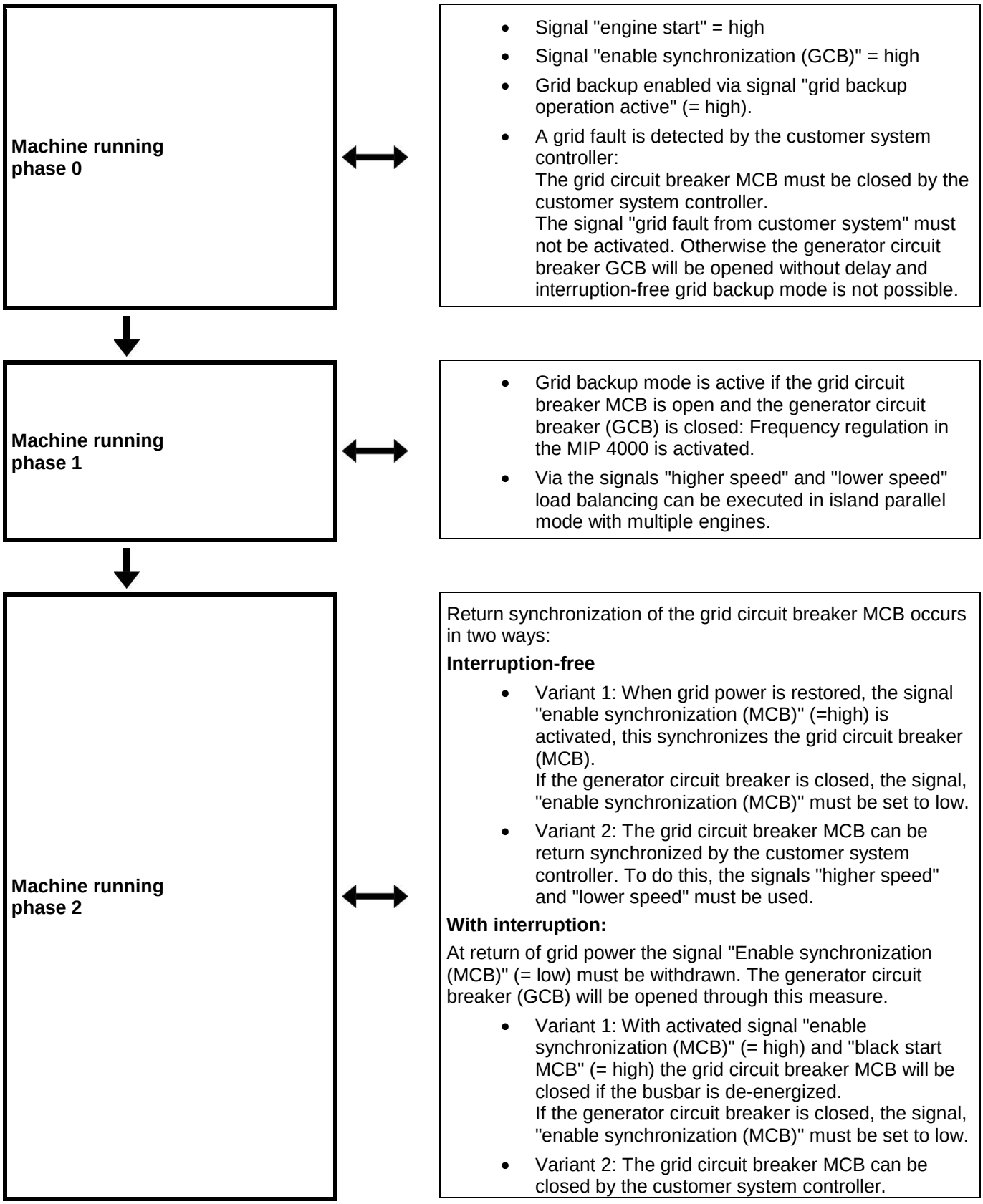
- Variant 1: With activated signal "enable synchronization (MCB)" (= high) and "black start MCB" (= high) the grid circuit breaker MCB will be closed if the busbar is de-energized.
  If the grid circuit breaker MCB is closed, the signal, "enable synchronization (MCB)" must be set to low.
- Variant 2: The grid circuit breaker MCB can be closed by the customer system controller.

The generator circuit breaker MCB will now be re-synchronized with the signal "enable synchronization (MCB)" (= high).

**Grid backup mode**

- If both circuit breakers (GCB + MCB) are closed, at activated signals ("engine start" (= high) and signal "enable synchronization (GCB)" (= high), grid backup mode will be continued.

### 11.5.3 Operating Mode: No Interruption at Grid Failure - Machine is running and a Grid Disturbance Occurs




- Signal "engine start" = high
- Signal "enable synchronization (GCB)" = high
- Grid backup enabled via signal "grid backup operation active" (= high).
- A grid fault is detected by the customer system controller:
  The grid circuit breaker MCB must be closed by the customer system controller.
  The signal "grid fault from customer system" must not be activated. Otherwise the generator circuit breaker GCB will be opened without delay and interruption-free grid backup mode is not possible.

- Grid backup mode is active if the grid circuit breaker MCB is open and the generator circuit breaker (GCB) is closed: Frequency regulation in the MIP 4000 is activated.
- Via the signals "higher speed" and "lower speed" load balancing can be executed in island parallel mode with multiple engines.

Return synchronization of the grid circuit breaker MCB occurs in two ways:

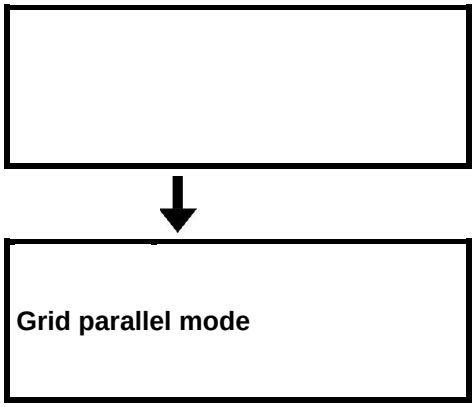
**Interruption-free**

- Variant 1: When grid power is restored, the signal "enable synchronization (MCB)" (=high) is activated, this synchronizes the grid circuit breaker (MCB).
  If the generator circuit breaker is closed, the signal, "enable synchronization (MCB)" must be set to low.
- Variant 2: The grid circuit breaker MCB can be return synchronized by the customer system controller. To do this, the signals "higher speed" and "lower speed" must be used.

**With interruption:**

At return of grid power the signal "Enable synchronization (MCB)" (= low) must be withdrawn. The generator circuit breaker (GCB) will be opened through this measure.

- Variant 1: With activated signal "enable synchronization (MCB)" (= high) and "black start MCB" (= high) the grid circuit breaker MCB will be closed if the busbar is de-energized.
  If the generator circuit breaker is closed, the signal, "enable synchronization (MCB)" must be set to low.
- Variant 2: The grid circuit breaker MCB can be closed by the customer system controller.



The generator circuit breaker MCB will now be re-synchronized with the signal "enable synchronization (MCB)" (= high).

**Grid parallel mode**

- If both circuit breakers (GCB + MCB) are closed, at activated signals ("engine start" (= high) and signal "enable synchronization (GCB)" (= high), grid backup mode will be continued.

# 12 Software Communication

## 12.1 General

All data (temperatures, alarm messages, status messages, etc.) is available in the interface protocol. The communication interfaces are set up to **bidirectional operation**.

- Deviations from the standard protocol (e.g. special commands, setpoint specifications, etc.) must be clarified as needed. Adaptations will be billed based on time and materials.
- The software in the external system will not be adjusted by MTU Onsite Energy.
- The data length in MIP 4000 interface protocol version 1 is 320 bytes.
- The data length in MIP 4000 interface protocol version 2 is 640 bytes.
- All data is data type "INTEGER (-32768 to + 32767).
  For the binary values, the data point is queried for status 0/1 bit by bit:
  16 binary values (BOOL) per data point.

## 12.2 Data Protocol

The protocol is divided into several areas:

**MIP 4000 interface protocol version 1:**

**Actual values (status) - 280 bytes (140 words):**

- Alarm messages
- Status messages
- Analog values / process values (actual values)
- Control values to the outside

**Setpoints (control) - 40 bytes (20 words):**

- Control values from the outside
- Setpoints / actual values from the outside

**MIP 4000 interface protocol version 2:**

**Actual values (status) - 600 bytes (300 words):**

- Alarm messages
- Status messages
- Analog values / process values (actual values)
- Control values to the outside

**Setpoints (control) - 40 bytes (20 words):**

- Control values from the outside
- Setpoints / actual values from the outside

The data protocol is provided in a separate Excel list!

## 12.3 Alarm Messages

The alarm messages are evaluated via the status 0/1.
If there is a queued alarm message the appropriate bit is set to "1".

**Example:**
Fault messages 8 and 14 are active:
The data point has the status "00100000 10000000".
Thus the individual fault messages can be easily masked (AND link).

**Only MIP 4000 interface protocol version 1:**

There are up to 1232 fault messages.
These are transferred in 24 data words.
24 words for the fault messages and 1 word for the multiplexer are necessary to transfer all 1232 alarm messages:

| **Value - multiplexer (word 0)** | **Alarm message number (word 1 - 24)** |
|---|---|
| 1 | 1 - 384 |
| 2 | 385 - 768 |
| 3 | 769 - 1152 |
| 4 | 1153 - 1232 |

## 12.4 Status Messages

The status messages are evaluated via the status 0/1.
If there is a queued status message the appropriate bit is set to "1".

**Example:**
Status messages 8 and 14 are active:
The data point has the status "00100000 10000000".
Thus the individual status messages can be easily masked (AND link).

## 12.5 Scaling of Values

Most values are provided with a so-called "scaling factor" (e.g. x 10).
Thus it is possible to simulate a real number (floating point) on the opposite station.

**Example:**

| | |
|---|---|
| Grid frequency | 49.99 Hz |
| Unit / scaling factor | Hz x 100 |
| Data value: | 4999 |

The receiving station reads out the value and must divide it by 100. Then the system can continue to work with a real number.

## 12.6 Error Evaluation - External Communication

**MIP 4000 interface protocol version 1:**

To check the function of the interface, in the last status value (word 140), a value is written cyclically that is expected back on the setpoints in the last word (word 20).
If this does not happen, after approx. 1 second the controller will be deactivated via the interface and a alarm message will be output.

**MIP 4000 interface protocol version 2:**

To check the function of the interface, in the last status value (word 300), a value is written cyclically that is expected back on the setpoints in the last word (word 20).
If this does not happen, after approx. 1 second the controller will be deactivated via the interface and a alarm message will be output.

## 12.7 Ethernet (RJ45) with UDP Protocol - Standard

With this interface data can be read from an Ethernet UDP station or data can be sent to an Ethernet UDP station.

- As opposed to the other interfaces for Ethernet UDP at the beginning of the send and receive telegram a header with 2 bytes is added.
- This headed contains the number of the module
  (module 1 has the number 1; module 2 has the number 2, etc.)

| **Designation** | **Standard set value** |
|---|---|
| Baud rate (external): | e.g. 100 Mbit/s |
| Protocol: | UDP (User Datagram Protocol) in accordance with RFC 768, Internet protocol |
| Transmission mode<br>(viewed from the MMC) | 1 = receive mode<br>2 = transmit mode<br>3 = receive and transmit mode<br>The MIP uses receive and transmit mode. |
| Cable: | CAT 5<br>Cable 1:1: A switch must be used.<br>Direct communication with external CPU: A crossed cable must be used. |
| IP address (B&R CPU): | 192.168.10.211.<br>Additional CPUs have an offset of 1 (e.g. 192.168.10.212). |
| Port (B&R CPU): | 21101<br>Additional CPUs have an offset of 1 (e.g. 21102). |
| IP address (receiving station): | Must be reachable with the subnet mask 255.255.254.0. |
| Port (receiving station): | Same port as for CPU (21101) |
| Telegram header: | 2 bytes (module number) |
| Receive data as viewed from the MMC: | • MIP interface protocol version 1:<br>280 bytes<br>(data is written from the MIP) + 2 byte header.<br>• MIP interface protocol version 2:<br>600 bytes (data is written from the MIP) + 2 byte header. |
| Transmission data as viewed from the MMC: | 40 bytes<br>(data is written from the MIP) + 2 byte header. |
| Send/transmit cycle: | 50 ms |

### 12.7.1 Presentation - UDP Protocol

**Receive data as viewed from the MMC:**

**MIP 4000 interface protocol version 1:**

Payload data bytes (282 bytes)

| | | | | |
|---|---|---|---|---|
| **Telegram header (2 byte)** | **Fault messages (50 bytes)** | **Status messages (30 bytes)** | **Analog values / process values (196 bytes)** | **Control commands to the outside (4 bytes)** |

**MIP 4000 interface protocol version 2:**

Payload data bytes (602 bytes)

| | | | | |
|---|---|---|---|---|
| **Telegram header (2 byte)** | **Fault messages (154 bytes)** | **Status messages (30 bytes)** | **Analog values / process values (410 bytes)** | **Control commands to the outside (6 bytes)** |

**Transmission data as viewed from the MMC:**

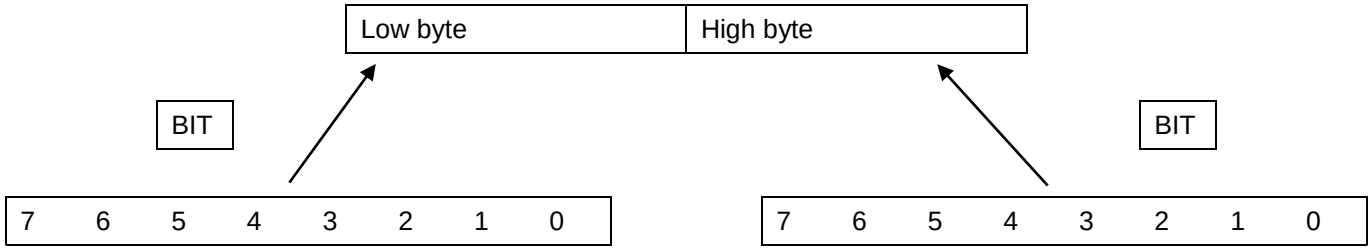
Payload data bytes (42 bytes)

| | | |
|---|---|---|
| **Telegram header (2 bytes)** | **Control commands to the MIP (4 bytes)** | **Setpoints to the MIP (36 bytes)** |

**Data stream:**

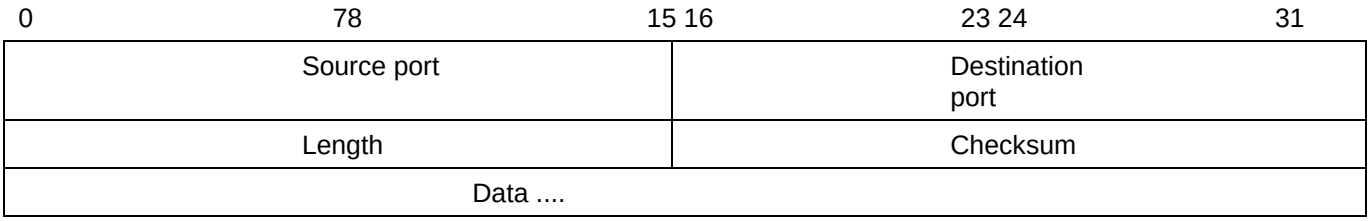
| | | | |
|---|---|---|---|
| **Low byte** | **High byte** | **Low byte** | **High byte** |

**Binary signal**



## 12.7.2 RFC 768 - Standard: User Datagram Protocol (UDP)

The User Datagram Protocol (UDP) enables packet-switched communication in a contiguous computer network. The prerequisite for this protocol is that the Internet protocol (IP) must be used as the underlying protocol. With this protocol messages from user programs can be sent to other programs; in this process only a minimum protocol is used.
The protocol works without connection. There is no guarantee that packet, once sent, will also arrive. Applications that require a reliable provision of data streams should use the transmission control protocol, (TCP).

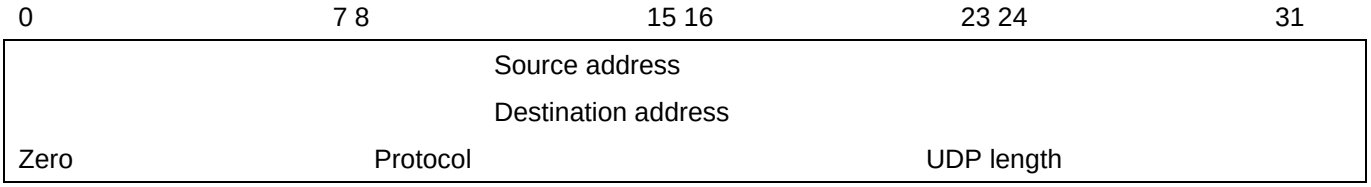



User data header format

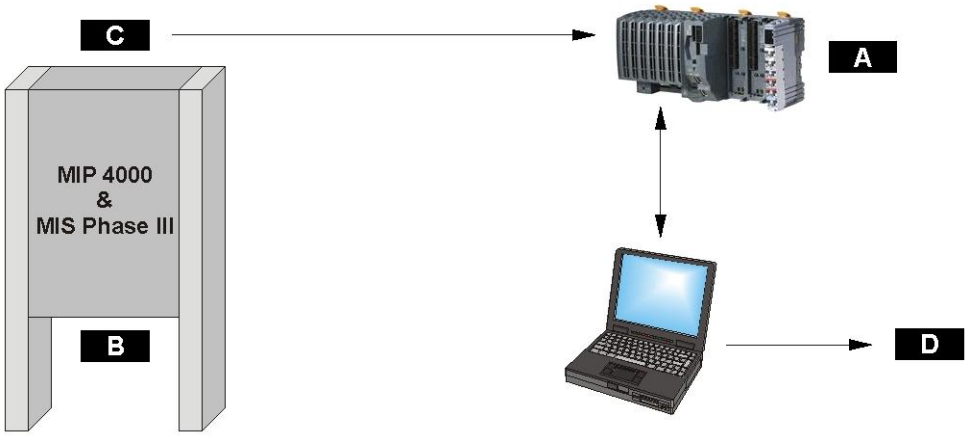
**Fields:**

| | |
|---|---|
| Source port: | The source port indicates the port number of the sending process. This information is required so that the receiver can respond to the packet. Because UDP is connectionless, the source port is optional and can be set to the value "0". |
| Destination port: | The destination port specifies which process the packet should receive. |
| Length: | The length indicates the size of the packet, consisting of the data and the header, in octets. The smallest possible value is 8 octets. |
| Checksum | The checksum is a 16-bit checksum and is formed via the so-called pseudo header and the data. |

The pseudo header is conceptually placed in front of the UDP header and contains the source address, the destination address and the UDP length. This information provides protection against incorrectly routed packets. This checksum procedure is the same as used in TCP.



# 13 Configuration and Service Wizard




| No. | Description |
|---|---|
| A | MIP-CPU with 2 Ethernet interfaces |
| B | Engine interface |
| C | Customer interface |
| D | Customer PC / wizard<br>• Setting the Ethernet IP address<br>• Setting MIP values (parameters, time, etc.)<br>• Online values<br>• Alarm logger<br>etc. |

There are 2 Ethernet interfaces available on the CPU:

- The first interface is provided for communication with the customer system controller.
- The second interface can be used for remote access.

The wizard pages can be called up via the installed VNC server in the MIP CPU.
For this shared use of the first interface via a switch is standard.
On the customer side, a VNC viewer is required on the computer.

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