



SSE
Version



Desktop
Version



19" Version

Frequency Converter SFU-0303

Content

- 1 Introduction**
- 2 Description and Features**
- 3 Block Diagram**
- 4 Technical Data**
 - 4.1 Version SSE**
 - 4.2 Version 19" and Desktop**
- 5 Safety Precautions and Warnings**
- 6 Connections, Interfaces and Pinout**
 - 6.1 Version SSE: Digital and Analogue Inputs X2**
 - 6.2 Version SSE: Digital und Analogue Outputs X3**
 - 6.3 Version SSE: Spindel Interface X4**
 - 6.4 Version SSE: Mains Connector, Spindle Connector**
 - 6.5 Version 19" and Desktop Version: Digital and Analogue In- and Outputs**
 - 6.6 Version 19" and Desktop Version Spindel Interface**
 - 6.7 Version 19" Mains Connector, Spindle Connector**
 - 6.8 Version Desktop: Mains Connector, Spindle Connector**
 - 6.9 Version SSE: RS232, RS485 X1**
 - 6.10 USB Connection**
- 7 Functions, Setup, Operation**
 - 8.1 Front panel of SSE, Desktop and 19"Version**
 - 8.2 Converter Start and Stop**
 - 8.3 Status LED Display**
 - 8.4 LCD-Operating Panel**
 - 8.5 Setup of Rotational Speed**
 - 8.6 Safety Functions**
 - 8.7 Safe Power Stage Pulse Lock according EN 954-1 K3**
- 8 Profibus**
- 9 Setup with Windows-Software**
- 10 Automatic Spindle Tuning**
- 11 Examples for Connection**
 - 11.1 Mains and Spindle Connection**
 - 11.2 Logic and Wiring for Safety**
- 12 EMC**
- 13 Troubleshooting**
- 14 General Hints**
- 15 Warranty**
- 16 Accessories**
- 17 Mechanics and Dimension**
 - 17.1 SSE Version for cabinet mounting**
 - 17.2 19" Version**
 - 17.3 Desktop Version**

1. Introduction

Due to its construction, the rotational speed of a 3-phase AC motor is directly dependent on the number of poles and the frequency of the network. In case of a 3PH 50Hz network and a 2-pole motor, the nominal speed would be $50 \text{ rps} \cdot 60 = 3000 \text{ rpm}$.

In case of BLDC motors (brushless dc), the speed is directly dependent on the voltage applied.

3-phase AC motors provide numerous benefits in industry, such as brushless operation, freedom from wear and tear, favourable capacity/weight ratio, high-speed capability, and much more. These motors can be used many different application areas, such as milling and grinding spindles, or with drilling machinery, for example.

The advantages of SFU0303 compared to similar converters:

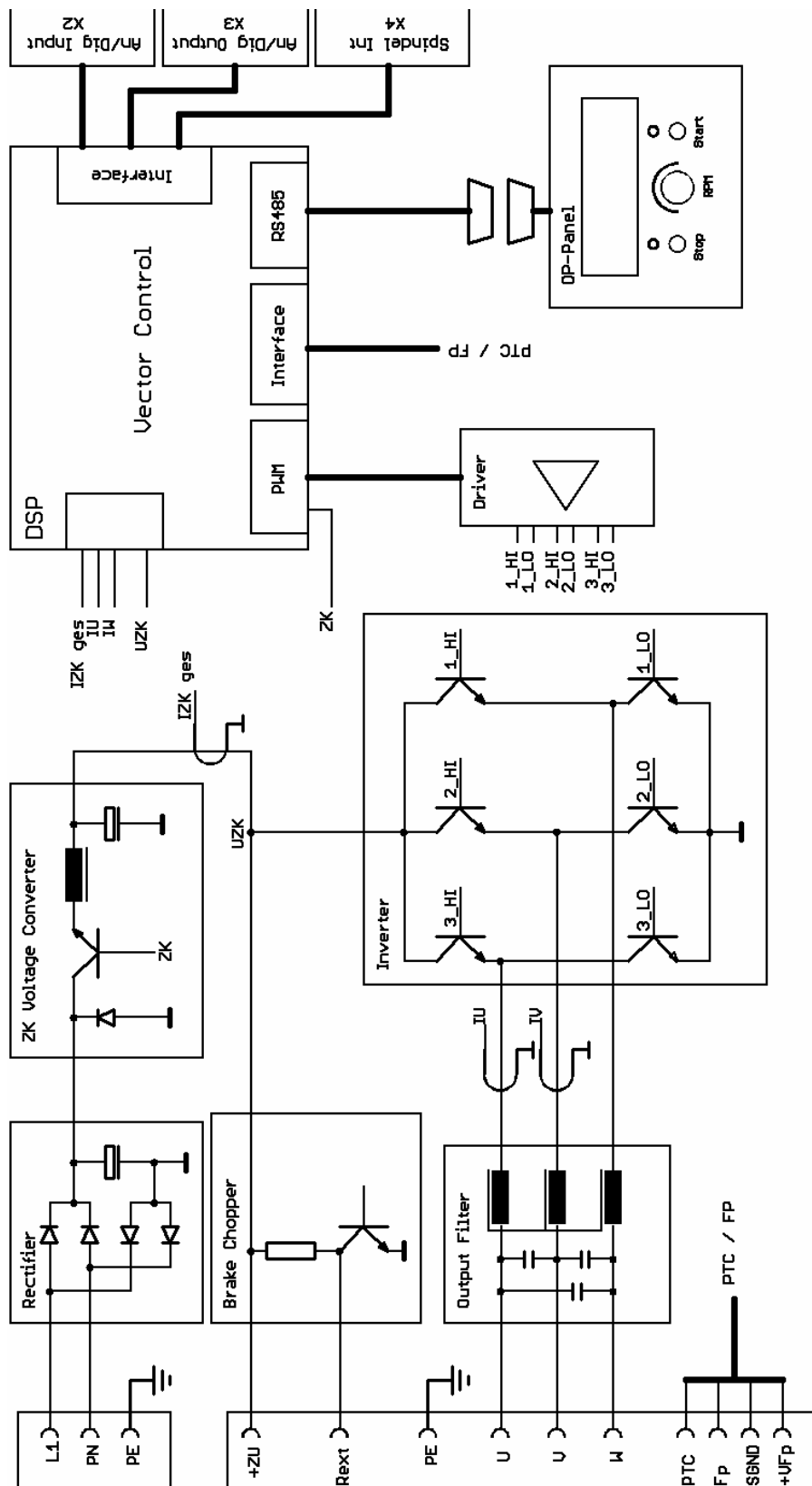
- Safe Power Stage Pulse inhibitor, authorized to current regulations EN 954_1 Categorie 3
- Maximum Power in industrial network up to 5kVA
- High efficiency by symmetrical PWM
- Real time vector control for sensorless operation
- Maximum Torque even at lowest rotational speeds
- High possible acceleration rates for short process times. For example 25.000rpm/sec with a 2,2 KW Motor (with robotic applications)
- Pulse-Amplitude (PAM / =Block-Modus) Control possible because of regulated intermediate voltage control (on option)
- Very slow rotational speeds (10rpm) possible for reaching tool changer positions.
- Very low current consumption because of real time power control
- Easy Integration into new and existing PLCs because of flexible I/O configuration
- Various interface options: Profibus, RS485, RS232, USB
- Easy reversing the direction of rotation by Software without loss of power.
- Autotuning function for spindle setup.
- Testrun with graphical documentation of voltages and currents of the spindle
- Up to 16 different spindle characteristics can be stored
- Very user-friendly debugging interface for setup control
- Start/Stop Interface for periodical tests or remote control
- Operating panel is detouchable and can be used as remote control together with an extension cable
- Designed for roughest use in industrial environment
- The housing of SSE is realized without ventilations slots and an outside mounted heatsink. preventing by this the intrusion of dirt and chips of tooling.
- Very compact case style makes easy cabinet mounting possible

- Several case options for cabinet mounting (SSE) , 19" rack style and desktop, or special designs on request
- User friendly Screw-plug connector system for power-, spindle- and I/O connectors.
- Wide range of operating voltage 115V-230V
- Automatic deceleration of the spindle down to standstill in case of mains failiure by "Back Energy" Function
- Plain text display in amber color
- Very user friendly operation menu.
- USB connection and RS232 with specific adapter cable
- Full functional without operation panel in remote configuration
- Remote control hand-terminal available
- Controlled fan
- Datalogger-Function on option available in combination with PC software SFU-Terminal. Records of all relevant parameters of the converter in nearly infinite lengths are possible down onto the PC- hard disc.

2. Description and Features

- Operation of **Asynchronous AC und BLDC Motors**
 - The high frequency converter SFU-0303 makes possible **rotational speeds** with 2pole AC-Motors up to **500.000rpm** and with BLDC-Motors up to **100.000rpm**
 - **High output power (3,6kV @ 230V / 2kVA @ 115V)** in **compact style**
 - The core of SFU-0303 is a **Digital Signal Processor (DSP)** which produces all output signals and collects all input signals
 - All parameters like current, voltage and frequency are collected in **real time** and are regulated by the implemented vector control depending on the load condition.
 - **High precision sinusoidal** output signals with low distortion factor realize very high accuracy in rotational behaviour.
 - Allows highest **efficiency** of the spindles at **low and high frequencies**
 - High **operational safety**: All operating conditions like acceleration, operation with nominal rotational speed, deceleration is monitored and critical conditions are intercepted.
 - **Integrated braking resistance (brake chopper)**. Without brake chopper the deceleration times down to standstill can be longer.
 - **Transparency**: The user is always informed about the current status of the converter and the spindle on a plain text and detachable operating panel at the front panel.
 - **Control**: If needed, the converter can be controlled and parameterized manually with a pluggable operating unit.
 - Easy **reversing the direction of rotation** by Software **without loss of power**.
 - **Individual adjustment** to the current application and the connected spindle. Up to 16 different characteristics can be stored in the converter
- A variety of options for control and communication possibilities:** For communication with peripheral devices, such as PC, PLC or CNC, there are 3 ports available:
- **Easy and flexible integration** into existing equipments by free configuration of I/Os
 Control inputs: 2 Analog, 6 Digital
 Control Outputs: 2 Analog, 6 Digital (Relay)
 - **Galvanic separation** of all interfaces from each other and from mains / spindle potential
 - **Short circuit proof**
 - **Comfortable Configuration** und control with the help of a PC-Windows software "SFU-Terminal"
 - **Cloning-Function with operating panel**: Creating of clones of converters by individual read out of the SFU-parameters into the operation panel and download into another or multiple SFUs.
 - Automatic spindle calibration by **autotuning function**

3. Block diagram



picture 1

4. Technical data

4.1 Version SSE

| | | |
|-------------------------|---|-----------------|
| Mains connection | 115V, 60Hz, 1PH | 230V, 50Hz, 1PH |
| Output power | Max 2 kVA | Max 3,6 kVA |
| Motor connection | 10-polig: PE,U,V,W, PTC, FP, SGND pluggable screw clamps 4mm ² | |
| Output voltage | 3* 110V | 3* 220V |
| Output current / power | limited electronically | |
| Over-current | maximal duration adjustable 0...20sec | |
| Output frequency | AC: max 8,8kHz / 500.000 rpm DC: max 100.000 rpm | |
| Spindle characteristics | max. 16, stored internally | |
| Spindle Sensor inputs | PTC, Speed sensor / Hall sensor, Logic: 9 pin pluggable screw clamps X4 | |
| Control inputs | 2 Analog: 0-10V, separated galvanically: 10 pin pluggable screw clamps X2 | |
| Control inputs | 6 Digital: 0-24V, separated galvanically: 10 pin pluggable screw clamps X2 | |
| Control outputs | 2 Analog: 0-10V, separated galvanically 12 pin pluggable screw clamps X3 | |
| Control outputs | 5 x Digital, free to be setup 1 x Digital reserved for power stage pulse inhibitor outputs on Relays, 24VDC/1000mA, 125VAC/500mA 12 pin pluggable screw clamps X3 | |
| Interface | - USB on operating panel USB-Mini - RS232, RS485 am SFU 9 pin DSub male - Profibus on option as module, without operating panel | |
| dimensions | see chap 17 | |
| Weight | ca. 4 kg depending on option | |
| Protection | IP20 | |
| Operating conditions | max ambient temperature 40°C, no humidity | |



ATTENTION

The operation of a spindle with a wrong characteristic may harm the spindle severely!

Please ensure to have the proper characteristic selected always!

4.2 Version 19" und Desktop

| | | |
|-------------------------|--|----------------------------|
| Mains connection | 115V, 60Hz, 1PH | 230V, 50Hz, 1PH |
| Output power | Max 2 kVA | Max 3,6 kVA |
| Motor connection | 9-polig: U,V,W, PTC, FP, SGND 2xPE, screw clamps 4mm ² | |
| Output voltage | 3* 110V | 3* 220V |
| Output current / power | limited electronically | |
| Over-current | maximal duration adjustable 0...20sec | |
| Output frequency | AC: max 8,8kHz / 500.000 rpm DC: max 100.000 rpm | |
| Spindle characteristics | max. 16, stored internally | |
| Spindle Sensor inputs | PTC, Speed sensor / Hall sensor, Logic: | 15pin D-Sub female |
| Control inputs | 2 Analog: 0-10V, separated galvanically: | 25pin D-Sub female |
| Control inputs | 6 Digital: 0-24V, separated galvanically: | 25pin D-Sub female |
| Control outputs | 2 Analog: 0-10V, separated galvanically | 25pin D-Sub female |
| Control outputs | 6 Digital: outputs on Relays, 25pin D-Sub female | 24VDC/1000mA, 125VAC/500mA |
| Interface | - USB on operating panel used at the desktop, only - RS232, RS485 am SFU 9 pin DSub male - Profibus on option as module, without operating panel | |
| dimensions | see chap 17 | |
| Weight | ca. 4 kg depending on option | |
| Protection | IP20 | |
| Operating conditions | max ambient temperature 40°C, no humidity | |



ATTENTION

The operation of a spindle with a wrong characteristic may harm the spindle severely!

Please ensure to have the proper characteristic selected always!

5. Safety-Precautions and Warnings

- This device produces dangerous electrical voltages and is used for the operation of dangerous moving mechanical parts. For this reason, only professionally trained and qualified personnel should be allowed to install and repair this device!
- The operation with disconnected PE connection is not allowed.
- Any maintenance or repair work to the device must only be carried out after the supply voltage has been disconnected!
- Before the first commissioning can be carried out, it should be established that the motor is installed correctly and securely, to eliminate the possibility of uncontrolled movement of the motor.
- Safety regulations that are valid for the country where the device is used, have to be adhered to where any work is carried out on the device.
- Maintaining EMC (electromagnetic compatibility) limits is the responsibility of the manufacturer of the machine or device. The inputs and outputs on this device are fitted with filters, to increase the interference immunity and reduce emitted interference, making it possible to use this device in an industrial environment.
- The EMC of a machine or device is affected by all connected components (motor spindle, length and type of cables, wiring, etc). Under certain conditions the use of additional filters can be necessary to maintain the current laws.
- For the reasons listed above, installation and connection of the device should be carried out by qualified personnel only.

6. Connections, Interfaces and Pinouts

For embedding into PLC and controls the SFU0303 has several input and outputs. These are realized as pluggable screw terminals and lead out at front and rear panel (depending on case option). All contacts are separated galvanically from high voltage carrying circuits.

Operational parameters and outputs:

The **SFU-0303** covers all current important operational parameters and operating data. Up to 6 digital outputs can be used for signalling and up to 2 analogue values can be output to the analogue outputs (0-10V) .

Remote Control and Outputs:

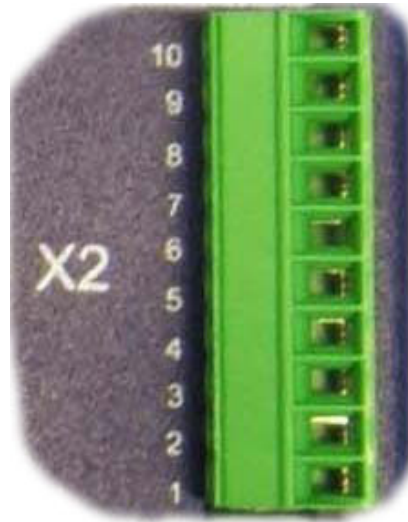
6 digital inputs (24V) and 2 analogue inputs (0-10V) are available for remote control of the **SFU-0303**.

These assignments can be configured freely. By using the optional Windows PC software "**SFU-Terminal**" the above mentioned assignments can be achieved easily, providing exceptional flexibility with each application.

Each operating parameter can be assigned as a signal and each control signal can be allocated the required I/O pin. In addition, the logic level (high or low active) can be individually defined. The same assignment is also possible for the analogue measured data and control data at the analogue I/O pin.

The standard allocations of operational parameters, their outputs, control signals and inputs, are listed in the following tables.

6.1 Version SSE: Digital and Analogue Input X2 (10 pin Pluggable screw terminal)



Picture 2

| Pin | Description | Direction | Function / default Setting | switching state |
|-----|--------------|-----------|--|---|
| 1 | Digital In 1 | Input | Start - Stop | "0" Stop / "1" Start |
| 2 | Digital In 2 | Input | Power Stage Pulse Lock | "0" activated / "1" released |
| 3 | Digital In 3 | Input | Power stage Off | "0" Aus / "1" On |
| 4 | Digital In 4 | Input | Locked / Emergency Stop | "0" released / "1" Emergency Stop |
| 5 | Digital In 5 | Input | Error reset | "0" Errors have to be reset, with Hi level on this Input or with any Start signal "1" Errors are reset automatically |
| 6 | Digital In 6 | Input | Direction of rotation | "0" unchanged / "1" inverted |
| 7 | Analog In 1 | Input | Set value Rotational speed Scaling 10V min/max | |
| 8 | Analog In 2 | Input | Set value Varioload | |
| 9 | GND | PWR | Ground reference for die Digital und Analog signals | |
| 10 | +24V/50mA | Output | Auxiliary voltage supply | |

The Default-settings of the functions for the outputs can be set up freely with the help of the PC-Software SFU-Terminal.

- Switching level digital inputs: Log"0" = 0...7V / Log"1" = 18....24V SPS Standard level
- Analogue input range: 0...10V
- The +24V at Pin 10 can be used as auxiliary voltage supply for Start / Stop signal with the help of a relay or for an electronic spindle interface.

6.2 Version SSE: Digital and Analogue Outputs X3 (12 pin Pluggable screw terminal)



Picture 3

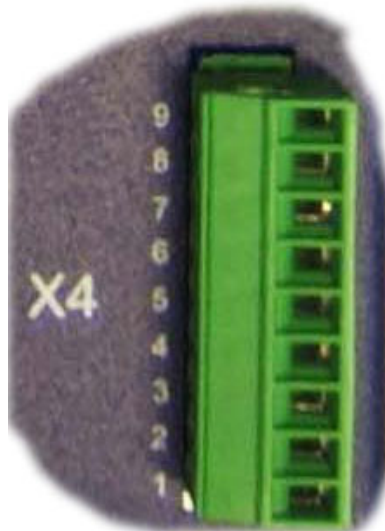
| Pin | Description | Direction | Function / Message / default Setting |
|-----|------------------------|-----------|---|
| 1 | RelayCommon | | Common Rail Relay 1..5 |
| 2 | Relay6 Normally closed | Output | Feedback signal for Power Stage Pulse Lock state |
| 3 | Relay5 Normally closed | Output | Excess temperature Converter or Spindle |
| 4 | Relay4 Normally closed | Output | Overload |
| 5 | Relay3 Normally closed | Output | Standstill Converter and Spindle |
| 6 | Relay2 Normally closed | Output | Spindle Ready |
| 7 | Relay2 Normally open | Output | |
| 8 | Relay1 Normally closed | Output | Converter Ready |
| 9 | Relay1 Normally open | Output | |
| 10 | Analog Out 1 | Output | |
| 11 | Analog Out 2 | Output | |
| 12 | Hall Sensor-Output | Output | modified signal square shape signal from encoder |

The Default-settings of the functions for the outputs can be set up freely with the help of the PC-Software SFU-Terminal.

An exception is the signal "Power Stage Pulse Lock", which is linked fix with Relay 6. According to the switch state it will be output 0V / GND or +24V via 10kΩ referring to GND (X2.9) (-> 8.2 / 8.7)
+24V: Power Stage released 0V: Power Stage locked.

- The digital outputs (Relay1...5) are galvanically separated (500V_{Isolation}).
DC: 24V / 1000mA AC: 125V / 500mA
- Output level Speed / Hall Sensor: 0-24V (24V Level)

6.3 Spindle Interface X4 (9 pin Pluggable screw terminal)



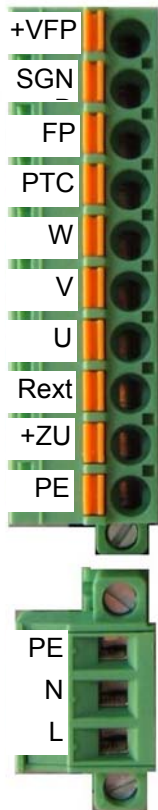
Picture 4

| Pin | Description | Direction | Function / default Setting |
|-----|--------------------|-----------|---|
| 1 | +12V/50mA | Output | Auxiliary voltage supply |
| 2 | Spindle GND | | Ground reference |
| 3 | NC | | Not connected |
| 4 | Speed sensor input | Input | Input for 2/3-wire speed sensors / Hall sensor from spindle |
| 5 | PTC | Input | Temperature signal from Spindle / KTY as Option |
| 6 | Bit 4 | Input | automatic Spindle detection |
| 7 | Bit 3 | Input | automatic Spindle detection |
| 8 | Bit 2 | Input | automatic Spindle detection |
| 9 | Bit 1 | Input | automatic Spindle detection |

The Default-settings of the functions for the outputs can be set up freely with the help of the PC-Software SFU-Terminal. The inputs of the encoder and the PTC are fix wired.

- The spindle interface is separated with optocouplers from all other signals. It can be used for an automatic spindle detection, if activated. The logic levels are low-active by default: "HI" > PIN connected with Spindle-GND, "LO" > PIN open. In the menu "Digital Inputs" this can be changed.
- The input "PTC" is provided for detection of excess temperature of the spindle. If the resistance between PTC and GND is > 600Ω, the error message 'Excess temperature Spindle' is set and a safety shut down is carried out after expiring of the delay time.
- On option a temperature detection for KTY is possible. This requires a HW modification.
- The input 4 for the speed sensor works in the range of +/- 1V with a common mode range of 0..10V.
- The +12V at Pin 1 can be used as auxiliary voltage supply

6.4 Mains and Spindle connection at SSE



| Pin | Name | Direction | Function |
|-----|------|-----------|---|
| 1 | +VFP | Output | Auxiliary voltage supply for active speed sensor 12V/50mA |
| 2 | SGND | | Ground reference for signals FP, PTC |
| 3 | FP | Input | Input for 2/3-wire speed sensors / Hall sensor |
| 4 | PTC | Input | PTC Temperature signal from Spindle / on option KTY |
| 5 | W | Output | Spindle Phase W |
| 6 | V | Output | Spindle Phase V |
| 7 | U | Output | Spindle Phase U |
| 8 | Rext | Output | External Brake resistor / Chopper Resistor |
| 9 | +ZU | Output | Intermediate voltage (! Attention, High Tension !) |
| 10 | PE | | Connection for protective earth of the spindle. ! Safety ! |

| Name | Function |
|------|------------------------------------|
| PE | Protective Earth ! Safety ! |
| N | Null |
| L | Phase |

Picture 5



The device has no internal fusing. It has to be fused externally



Please ensure, that PE protective earth is connected at the mains side. The device must not be operated without properly connected PE!

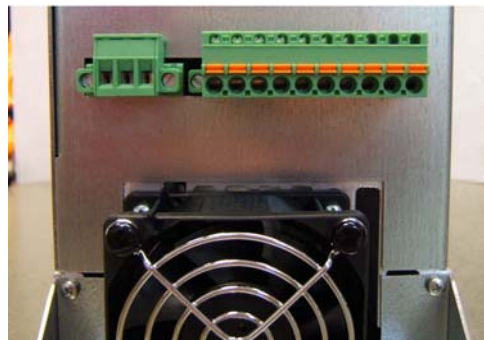


Please ensure, that PE protective earth is connected at the spindle side as well as at the mains side.



Control wires, Mains cables and spindle cables should be installed separately. For wiring, the use of shielded cables is recommended.

View at screw terminals at version SSE



Picture 6

6.5 Version 19" und Desktop: I/O Interface - Digital and Analogue In- and Outputs (D-Sub 25pin female)

| Pin | Description | Direction | Function / Message / default Setting |
|-----|-------------------------|-----------|---|
| 1 | Relay Common | | Common Rail for Relay contacts |
| 14 | Relay Common | | |
| 2 | Relay 1 Normally Closed | Output | |
| 15 | Relay 2 Normally Closed | Output | |
| 3 | Relay 3 Normally Closed | Output | |
| 16 | Relay 4 Normally Closed | Output | |
| 4 | Relay 5 Normally Closed | Output | |
| 17 | Relay 6 Normally Closed | Output | Feedback signal for Power Stage Pulse Lock state |
| 5 | Relay 1 Normally Open | Output | |
| 18 | +24V/50mA | | |
| 6 | +24V/50mA | | |
| 19 | GND | | |
| 7 | GND | | |
| 20 | Relay 2 Normally Open | Output | |
| 8 | Hall Sensor | Output | Modified signal from speed sensor |
| 21 | Digital In 2 | Input | Output Stage Pulse Blocking |
| 9 | Digital In 6 | Input | |
| 22 | Digital In 5 | Input | |
| 10 | Digital In 4 | Input | |
| 23 | Digital In 3 | Input | |
| 11 | Digital In 1 | Input | |
| 24 | Analog In 1 | Input | |
| 12 | Analog In 2 | Input | |
| 25 | Analog Out 1 | Output | |
| 13 | Analog Out 2 | Output | |

The Default-settings of the functions for the outputs can be set up freely with the help of the PC-Software SFU-Terminal.

An exception is the signal "Power Stage Pulse Lock", which is linked fix with Relay 6. According to the switch state it will be output 0V / GND or +24V via 10kΩ referring to GND (7, 19) (-> 8.2 / 8.7)
+24V: Power Stage released 0V: Power Stage locked.

- The digital outputs (Relay1...5) are galvanically separated (500V_{Isolation}).
DC: 24V / 1000mA AC: 125V / 500mA
- Analogue input range 0...10V
- Output level Speed / Hall Sensor: 0-24V (24V Level)
- +24V at Pin6, 18 may be used as auxillary power supply for e.g. an electronic spindle interface

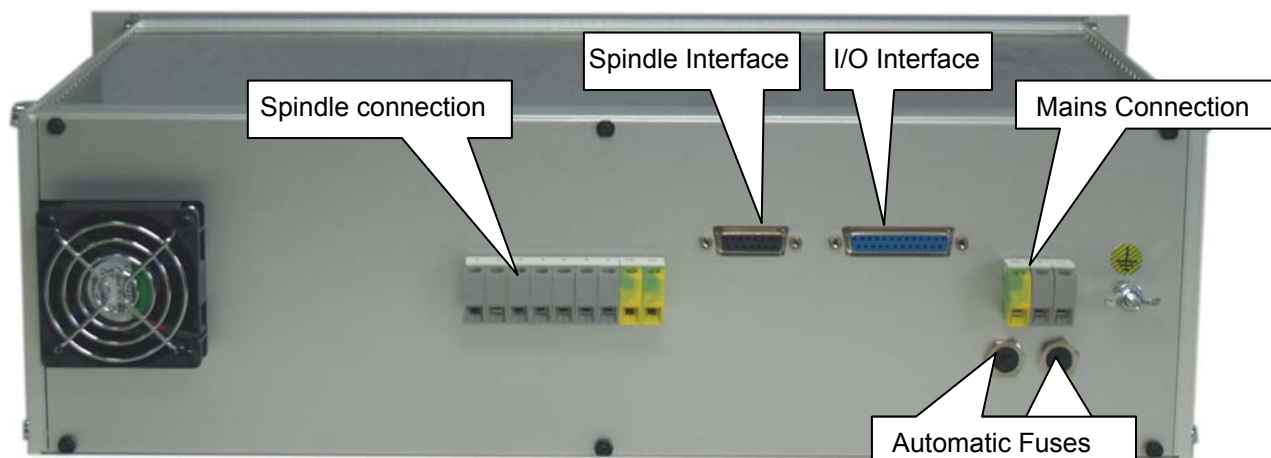
6.6 Version 19" und Desktop: Spindel Interface (D-Sub 25pin female)

| Pin | Name | Direction | Function / default Setting |
|-----|-------------|-----------|---|
| 1 | NC | | |
| 9 | +12V/50mA | | Auxiliary voltage supply |
| 2 | GND | | |
| 10 | GND | | |
| 3 | Bit 0 | Input | automatic Spindle detection |
| 11 | Bit 0 | Input | automatic Spindle detection |
| 4 | Bit 1 | Input | automatic Spindle detection |
| 12 | Bit 1 | Input | automatic Spindle detection |
| 5 | Bit 2 | Input | automatic Spindle detection |
| 13 | Bit 2 | Input | automatic Spindle detection |
| 6 | Bit 3 | Input | automatic Spindle detection |
| 14 | Bit 3 | Input | automatic Spindle detection |
| 7 | PTC | Input | Temperature signal from spindle |
| 15 | PTC | Input | Temperature signal from spindle |
| 8 | Hall Sensor | Input | Speed signal from speed sensor from spindle |

The Default-settings of the functions for the outputs can be set up freely with the help of the PC-Software SFU-Terminal. The inputs of the encoder and the PTC are fix wired.

- The spindle interface is separated with optocouplers from all other signals. It can be used for an automatic spindle detection, if activated. The logic levels are low-active by default: "HI" > PIN connected with Spindle-GND, "LO" > PIN open. In the menu "Digital Inputs" this can be changed.
- The input "PTC" is provided for detection of excess temperature of the spindle. If the resistance between PTC and GND is > 600Ω, the error message 'Excess temperature Spindle' is set and a safety shut down is carried out after expiring of the delay time.
- On option a temperature detection for KTY is possible. This requires a HW modification.
- The input 4 for the speed sensor works in the range of +/- 1V with a common mode range of 0..10V.
- The +12V at Pin 1 can be used as auxiliary voltage supply

6.7 19" Version: Mains and Spindle connection



Back side SFU0303-19" with spindle connector clamp terminal Picture 7

Spindle Connector - 9pin clamp terminal



| Pin | Name | Direction | Function |
|-----|------|---|--|
| 1 | +VFP | Output | Auxiliary voltage supply for active speed sensors 12V/50mA |
| 2 | SGND | | Ground for signals FP, PTC |
| 3 | FP | Input | Input for two/three wire-speed sensors |
| 4 | PTC | Input | temperature signal of spindle or as option KTY |
| 5 | W | Output | Spindle phase W |
| 6 | V | Output | Spindle phase V |
| 7 | U | Output | Spindle phase U |
| PE | PE | Connection for protective earth of the spindle. ! Safety ! | |
| PE | PE | | |

Mains connection - 9pin clamp terminal

| Name | Function |
|------|------------------------------------|
| PE | protective earth ! Safety ! |
| N | Neutral |
| L | Phase |



Please ensure, that PE protective earth is connected at the mains side. The device must not be operated without properly connected PE!



Please ensure, that PE protective earth is connected at the spindle side as well as at the mains side.



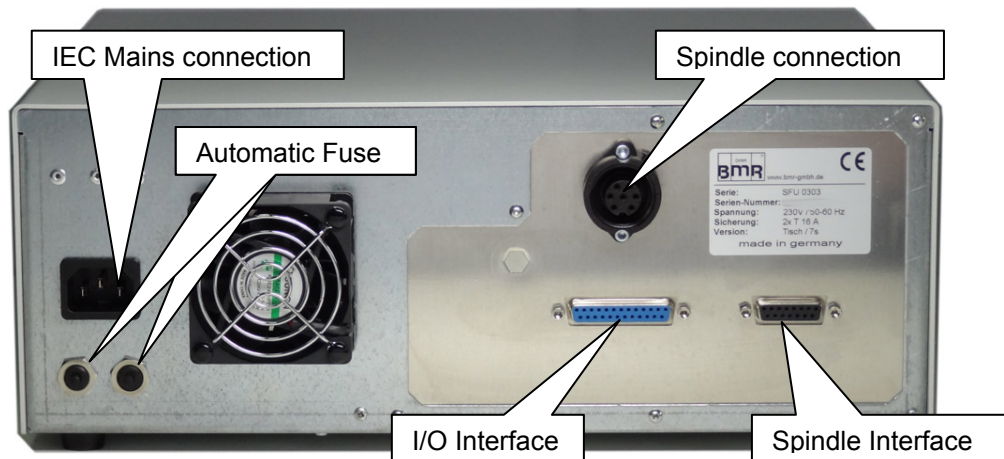
Control wires, Mains cables and spindle cables should be installed separately. For wiring, the use of shielded cables is recommended.

6.8 Desktop Version: Mains and Spindle connection

The connection with mains network is carried out with an IEC connector

The device is equipped with a Thermo-Automatic Fuse for each prong. They can be reset after tripping by pressing down the button

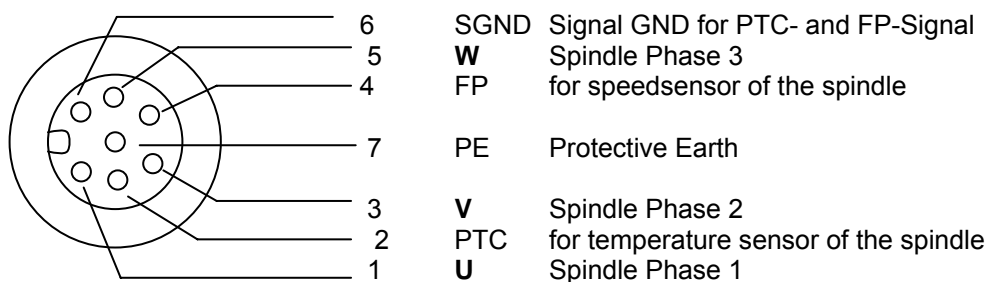
The spindle connection is realized on custom order and can be realized accordingly



Backside SFU0303-Desktop equipped with a 7pin circular spindle connection Picture 8

Spindle Connection

7pol. female Binder Series 693 or Amphenol C16-1



Control wires, Mains cables and spindle cables should be installed separately. For wiring, the use of shielded cables is recommended.

6.9 RS232, RS485 - X1 at Version SSE

At SSE devices the connection X1 INTERFACE is provided for the **operating panel**. A RS232 and a RS485 interface is wired to this connector. The 19" and desktop versions have built-in operating panels which are not detachable.

With disconnected operating panel a connection to a PC or any control can be established with a specific BMR cable. A standard cable wont work or may harm the device.

The operating panel is fixed with 2,5mm Allen screw to the SFU0303. After unfixing the operating panel can be removed. Additionally it can be used as a remote control in conjunction with a 1:1 cable.



| Pin | Function |
|-----|-----------|
| 1 | Release |
| 2 | NC |
| 3 | A-RS485 |
| 4 | RxD-RS232 |
| 5 | GND |
| 6 | +5V-RS |
| 7 | NC |
| 8 | B-RS485 |
| 9 | TxD-RS232 |

Picture 9

6.10 USB-Connection

For easy connection and communication, the device is equipped with a USB interface. At the version SSE it is located at the bottom side as USB Mini AB. At the 19" and Desktop devices, it is found at the front panel directly below the display.



Picture 10

7. Functions, Commissioning, Operation

7.1 Front panel SSE, Desktop and 19" Version



picture 11 front panel SSE



picture 12 front panel Desktop



picture 13 front panel 19" version

7.2 Starting of the Converter and Power Stage Pulse Lock

Spindle Characteristics

All converters of BMR need an information about the basic data of the spindle, such as maximum voltage, current, rotational speed, and many more. These are stored in so called "spindle characteristics". A BMR spindle characteristic has 16 setpoints within the range of the rotational speed. At every point data of voltage, current, load scaling, acceleration and deceleration ramp and many more data can be defined and this for idle load as well as for full load. And there are in total 16 places for different characteristics. The spindle characteristics are the key for any spindle and give a possibility to control the running behavior at every load condition.

In advance of start of a spindle first, it has to be ensured, that the proper characteristic is selected and activated. This is generally the case if the device is delivered together with a spindle and the required setup is done. If the converter and spindle are delivered separately, the proper spindle characteristic has to be loaded into the converter first. This can be achieved with the free setup software SFU-Terminal, easily.

In case of being unsure, characteristics for most common spindles are available at BMR.

Start and Stop

There are different possibilities for starting and stopping SFU0303, due to many different requirements, as follows below:

Generally, a STOP can be triggered by the source of START, with the exception of an Emergency Stop, activated Intermediate voltage lock or any other safety function.

- Start button at operating panel, Rotational speed with encoder potentiometer
- Pure serial control with commands via USB / RS232 / RS485 / Profibus interface
- Digital input in combination with an activated analogue input for control of rotational speed. In case of not being activated, the rotational speed is setup with encoder poti on operating panel or via serial commands.

Power Stage Pulse Lock

Precondition for proper starting is a released power stage pulse lock (Bridge X2.2 – X2.10), as well as a proper characteristic for the connected spindle.

The converter of the 0303 series are equipped with an safety power stage pulse locking circuit which has to be wired properly for operation. For activating the power stage a voltage with carrying a high signal should be applied to digital input 2 / PIN2. The voltage can be fed from PIN10. So, easy as possible simply a bridge between PIN2 and PIN10 will do this. The feedback signal about the status is displayed on the operating panel, if equipped, on LED6 and on relay output 6 at connector X3.

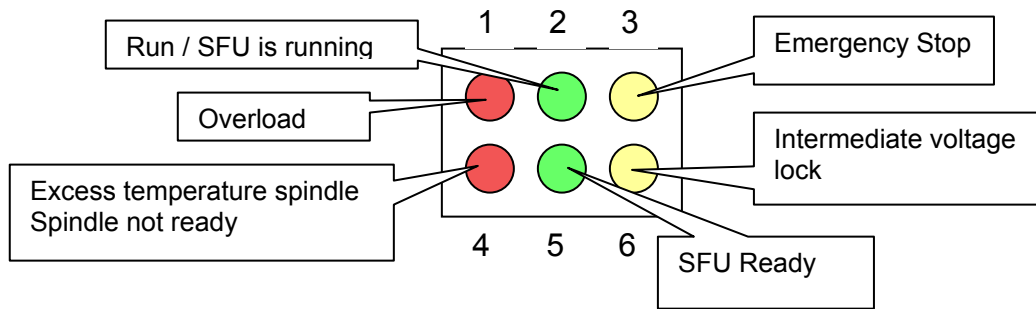
Attention! Without this connection the converter cannot be started.

The power stage pulse lock is realized according the requirements of EN954-1 Category 3 for safe stop of drives. (-> Chap 8.7) +24V: Power Stage released 0V: Power Stage locked.

Status

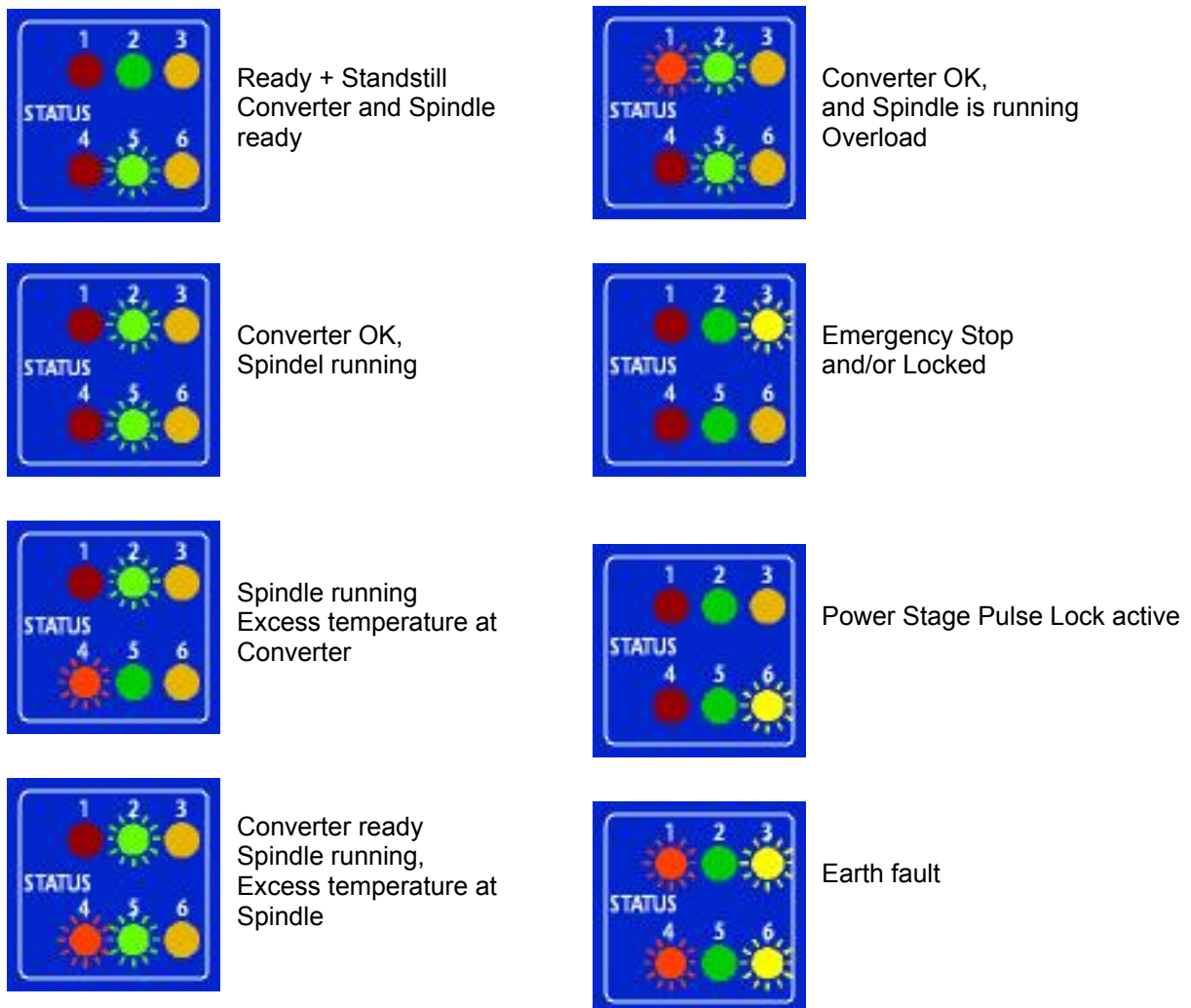
The current status of the converter is displayed on the status LED display and with mounted operating panel the status is displayed in plaintext on the LCD-display, additionally.

7.3 Status LED Display



Picture 14

Typical displays. Other combinations are possible due to status.

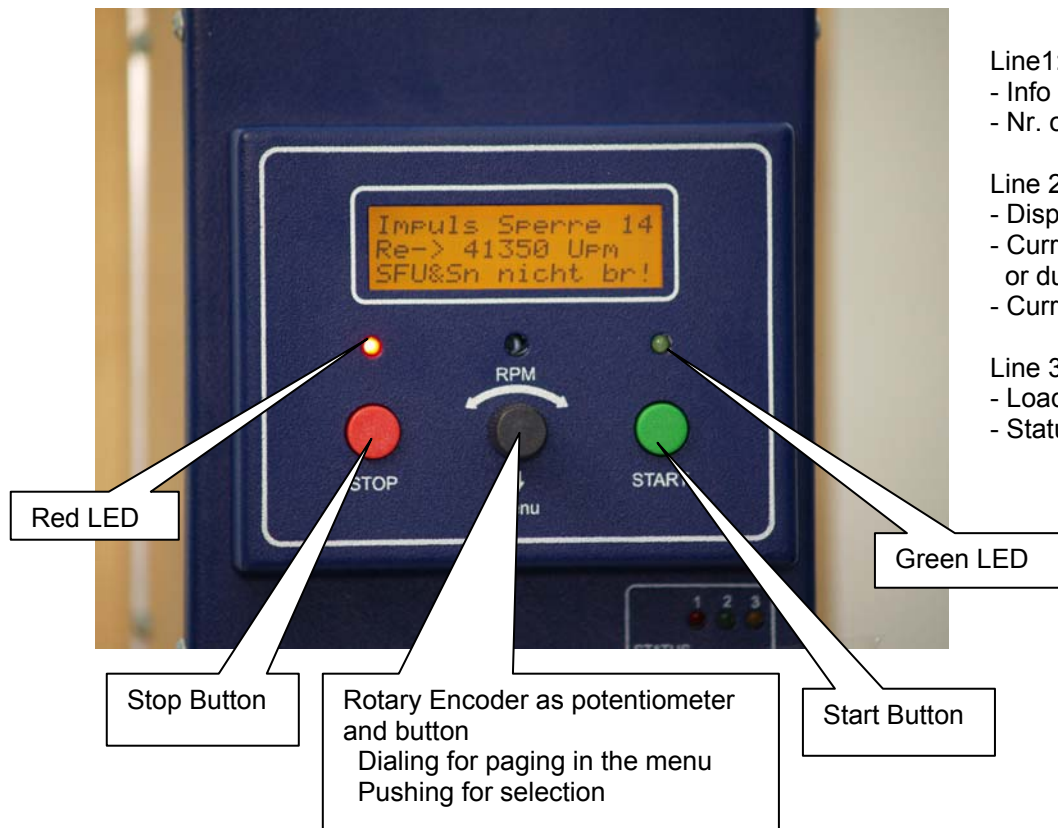


Picture 15

A Start can be initiated with display "Converter and Spindle". There are different means for solving errors which are listed in Chap "Troubleshooting"

The most probable reason for problems is a not properly wired input for "Emergency Stop" or "Intermediate Lock". In this case it is recommended to check the setting in the menu "Digital Inputs" in SFU-Terminal

7.4 LCD-Operating Panel



Line1:
 - Info
 - Nr. of the selected characteristic

Line 2:
 - Display of direction of rotation
 - Current rotational speed of SFU or duty value preset "rpm"
 - Current Real-Speed "rpmSP"

Line 3:
 - Load display in %,
 - Status display

Picture 16

Operating Elements:

Start-Button
 For Starting the Spindle

Stop-Button
 For Stop of Spindle or ending the Menu function

Encoder Potentiometer und Menu-Button with multifunction
 During standstill and run mode the duty value for speed can be setup by dialing
 Short pushing during run mode switches on the debug mode.

Long pushing during standstill opens the setup menu
 Dialing selects the menu item and
 Short pushing selects the function.

Automatic ending of the menu after 10sec without manipulation or
 short pushing of the Stop-Button

LED green
 for indication of *Ready for Operation* or of *Run mode* und *Spindle is spinning*

LED red
 for indication of *Standstill* or of *Stop mode* or *Error*

Start and Stop

In the simplest case, a connected and appropriately set up spindle can be started by pressing the Start-Button. The desired speed can be adjusted by dialing with the rotary encoder either as preset value during standstill or in Run mode. The preconditions for a correct Start can be looked up under 7 and 7.1 .

Any error or malfunction is displayed as plain text

All relevant system messages on rotational speed, load or problems are displayed on the LCD display

The current power output is displayed in the lower part as analogue load bar as % and absolute. An overload condition will be displayed as well.

The pre selected and current speed, the selected characteristic are displayed



Attention:

The operation of a spindle with an incorrect spindle characteristic may harm the spindle severely!

Please ensure that the correct characteristic is selected



If several spindles are operated simultaneously, it has to be ensured that they are of the same type and that a specific characteristic is selected.

Otherwise this may harm one or more spindles or the converter severely!

Setup-Menu:

To enter the menu, the Menu-Button in the rotary encoder should be kept pressed for more than 1sec. After that and releasing the button the following menu items can be selected by dialing.

- Direction of Rotation CW/CCW
- Selection of spindle characteristic Characteristics 1..16 are displayed
- Debug Mode Display of Mains voltage, current and spindle voltage for 30sec
- Firmware Version Current Version Nr. at line2 for 5sec
- Language Selection of display language: German, English, French
- Contrast Adjusting the contrast
- Read Config Read out the SFU project data into the operating-panel (→ Cloning)
- Write Config Download of stored project data into the SFU (→ Cloning)
- ESC Quit menu

With the rotary encoder a menu item can be selected which will flash if it is active.

By pushing the Menu-Button, the current item or the final entry is selected.

With ESC or pressing the Stop-Button or after approx. 10sec without activity the menu is quit without changes. The display returns to standard operating mode.

The adjustment of direction of rotation and the selection of the characteristic are possible during standstill, only.

In case of activating the menu during run mode, the spindle will be stopped after 5sec. for safety reasons.

Attention: Selecting the function Write Config the currently stored project data of the SFU will be overwritten without warning. By this a cloning of several SFUs can be carried out easily. Please verify, if this is really intended and if there are loaded proper project data into the memory by a previously Read Config operation.

Characteristic 3 is selected
preset speed 25.000rpm
Standstill

```
Standstill !      3
CW →  25000 rpm
Conv & Spin ready !
```

Converter is accelerating
Power output 67%

```
Outp. 7830 rpm      3
||||| 67%
```

Spindle is running at set value duty speed
Power output 20%

```
Duty speed OK 3
CW →  25000 rpm
|| 20%
```

Any error is displayed in plaintext in line 1

```
Overload 3
Outp. 25000 rpm
Conv. not ready !
```


Adjustments:**Rotational speed:**

dialing right or left with rotary encoder pot. Current value is displayed steadily. This can be the setup value before start or the current value during run.

Start/Stop:

with Start/Stop button. If the operating unit is removed during the start process the converter automatically turns into stop condition.

Debug Mode

During operation the debug mode can be entered by shortly pressing on the Menu-Button. It will be displayed the rectified mains voltage, spindle current and spindle voltage.

After 30sec of inactivity it will be returned to the standard mode, automatically.

With an additional pressing the debug mode is ended and it will be returned to the normal mode, but with displaying of the real spindle speed in place of the set value of the converter speed. This is indicated with "rpmSP". This persists permanently unless a further pressing of Menu-Button, which will return to the display of set value of the converter speed ("rpm")

**Cloning**

With the menu-item "Read Config" the configuration of a converter can be read out into and stored within the non volatile EEPROM memory of the operating panel. By swapping this panel to another converter this configuration can be copied into this converter with the menu item "Write Config". This is a very easy method to copy one configuration to many other converters (cloning) without any PC. But it has to be taken care that, this is not carried out without having read out any configuration before, because transferring an empty or corrupted configuration into the converter, will cause severe problems!

The following error displays are possible:

| Display | Error |
|--------------------|--|
| • Pulse blocking ! | Power stage lock active |
| • Overload Stop | Overload stop! |
| • Overtemp conv. | Excess Temperature Converter |
| • Overtemp spindle | Excess Temperature Spindle |
| • Overvoltage trip | Mains voltage too high |
| • Undrvoltage trip | Mains voltage too low |
| • Undervolt.stop | Mains voltage too low |
| • Pwr stage off! | output stage switched off |
| • Emgcy stp active | Emergency input engaged |
| • No spindle ! | Without spindle or cable defect |
| • RS232 Error ! | Timeout serial interface |
| • Diagram Error! | Invalid characteristic |
| • EncoderError ! | Error with speed sensor / hall sensor |
| • Back engy trip | Error Power Stage switch off because of deceleration ramp to high |
| • GND fault ! | Error PE is connected with a spindle line or converter is defective |

7.5 Adjustment or rotational speed

The preset of the rotational speed can be achieved by two ways:

- **manually preset with menu keys**

For this, the Option-Button **0** in the line **Duty speed** in the grey field in the menu "**Analogue-Inputs**" of SFU Terminal Software has to be activated. By this all analogue inputs were switched to inactive and no analogue signal is selected for Start.

The duty value for rotational speed is displayed at the LCD-Display and can be adjusted with the rotary encoder. The speed of change is dependent on the speed of dialing. The rotational speed can altered during operation, also.

- **preselection with a voltage applied to the analogue input SetValue Rotational speed**

For this, an analogue input has to be assigned to this function, which can be done in SFU Terminal Software in the menu "**Analogue-Inputs**". Additionally it has to be selected a scaling for the analogue voltage in the listbox field at left. 3 scalings are possible: 1V/10.000rpm or 1V/1.000rpm or 0-10V min/max).

The value of the rotational speed according the scaling is displayed on the LCD-display and can be altered as wanted.

An input voltage of 0V leads to Standstill and a voltage > min voltage will make the spindle start up to the speed according to the current scaling.

A scaling 1V/10.000 and a voltage of 4V will cause a speed of 40.000 rpm.

All settings made in SFU-Terminal have to downloaded into the SFU before they are valid with the button **Write only I/O (F6)**.

7.6 Safety functions

The below mentioned adjustments refer to settings made in SFU-Terminal

The following incidents lead to a **controlled braking and decelerating** to standstill of the spindle according to its acceleration times defined in the spindle characteristic.

- Stop because of **excess temperature at the spindle**, in case this function is activated and if its corresponding delay time is exceeded, which can be adjusted in the menu "Delays..excess temperature spindle"
In the "Spindle characteristic" this function can be activated with the Check-Button **Temp. sensor** and according delay time can be setup in the menu "Delays"
- Stop because of **excess temperature of the converter**, in case this function is activated and if its corresponding delay time is exceeded, which can be adjusted in the menu "Delays..excess temperature converter"
- Stop because of **overload** and if its corresponding delay time is exceeded, which can be adjusted in the menu "Delays..overload" The limit values for overload are determined in the spindle characteristic. Generally for S1 operation the current value will be 100% and overload condition is about 10% more and for S6 operation about 30% more. The default delay value is 20sec.
- Immediate stop because of **exceeding the maximum admissible current** of the converter
- **Emergency Stop** because of a valid signal at input **Emergency Stop** setup in menu "digital inputs"

The following incidents lead to a shut off of the output stage. the spindle will not be braked and will decelerated by its internal losses and friction. This can take quite a long time until standstill depending on its rotary mass. For a safe detection of standstill a speed sensor would be recommended.

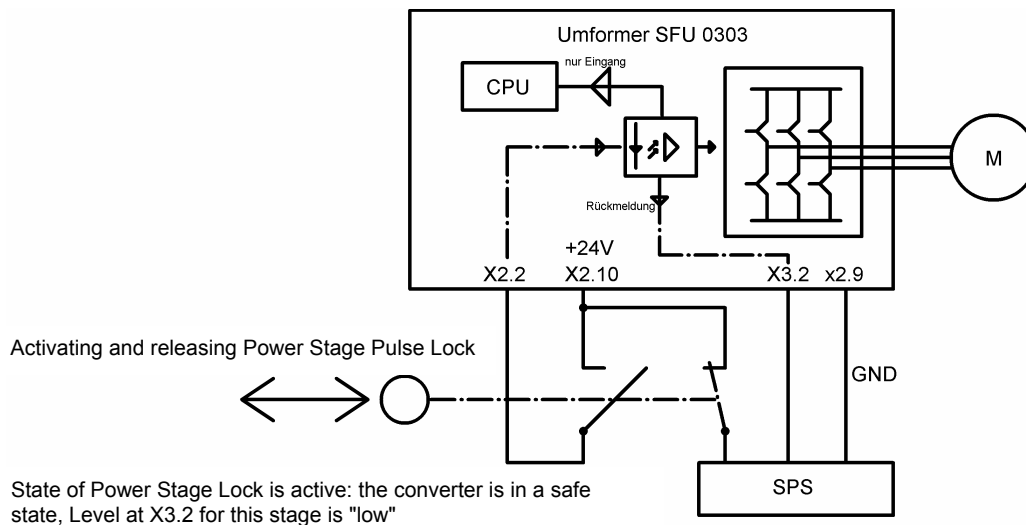
- Stop because of **short circuit** at spindle connector. The value is defined by internal limits.
- Stop because of signal at digital input **Power Stage Off** setup in menu "digital inputs"
A restart can only be achieved with a systematic Stop/Start-Sequence or with a valid signal at the input "Error Reset". This can be setup in the menu "digital inputs" the power stage will be activated again after 4 sec.

7.7 Safe Power Stage Pulse Lock according EN 954-1 K3

The SFU0303 is equipped with a safe power stage pulse inhibitor circuit according Category 3. This requires that an independent circuit besides the microprocessor circuit grants that the power stage can be activated with an external signal, only. This is realized in the SFU0303.

The feedback is realized via Relay 6 SSE: (X3.2) , Desktop/19": (Dsub25.17)
 According to the switch state it will be output 0V / GND or +24V via 10kΩ referring to SSE: (X2.9) , Desktop/19": (Dsub25.7,19) (-> 8.2)
 +24V: Power Stage released 0V: Power Stage locked.

Picture 15 shows the basic principle for wiring with a PLC



For testing purpose a bridge between X2.2 and X2.10 can be wired. Herewith the converter is activated for running, but this must not be realized in applications which have to be certified according EN954-1!

Safe Power Stage Pulse Lock according EN 954-1 K3

Picture 17

8. Profibus

For operating the SFU0303 within a profibus dp fieldbus a separate module is available as option. This ensures an implementation according standards.

It will be mounted instead of the operating panel on interface X1.



Picture 18

The setup of the address is carried out with RS232, a specific connection cable and SFU-Terminal.

The require files including the description of the commands and gsd-files are available on the BMR website.

It has the same basic setup possibilities as with the standard operating panel.

9. Setup, Parameterization and Configuration with SFU-Terminal

The software SFU-Terminal is a tool for the configuration of BMR frequency converters of the series SFU0102....SFU0601. Moreover it offers the possibility to read out system data and to modify them. To achieve this, the following steps should be taken:

1. Install the setup file according the installation software.
2. Power On the converter and establish the connection via USB / RS232.
3. Launch the program *SFUTerminal.EXE*
4. If the connection is established correctly, the program detects the converter automatically. In this case, the firmware of the converter is displayed in SFU-Terminal.
5. By click on **Start** it will at first carried out an upload of all parameters of the converter, a so called "project".
6. The program can be started "Offline" without a connected converter, too. The required converter can be selected manually from a list.

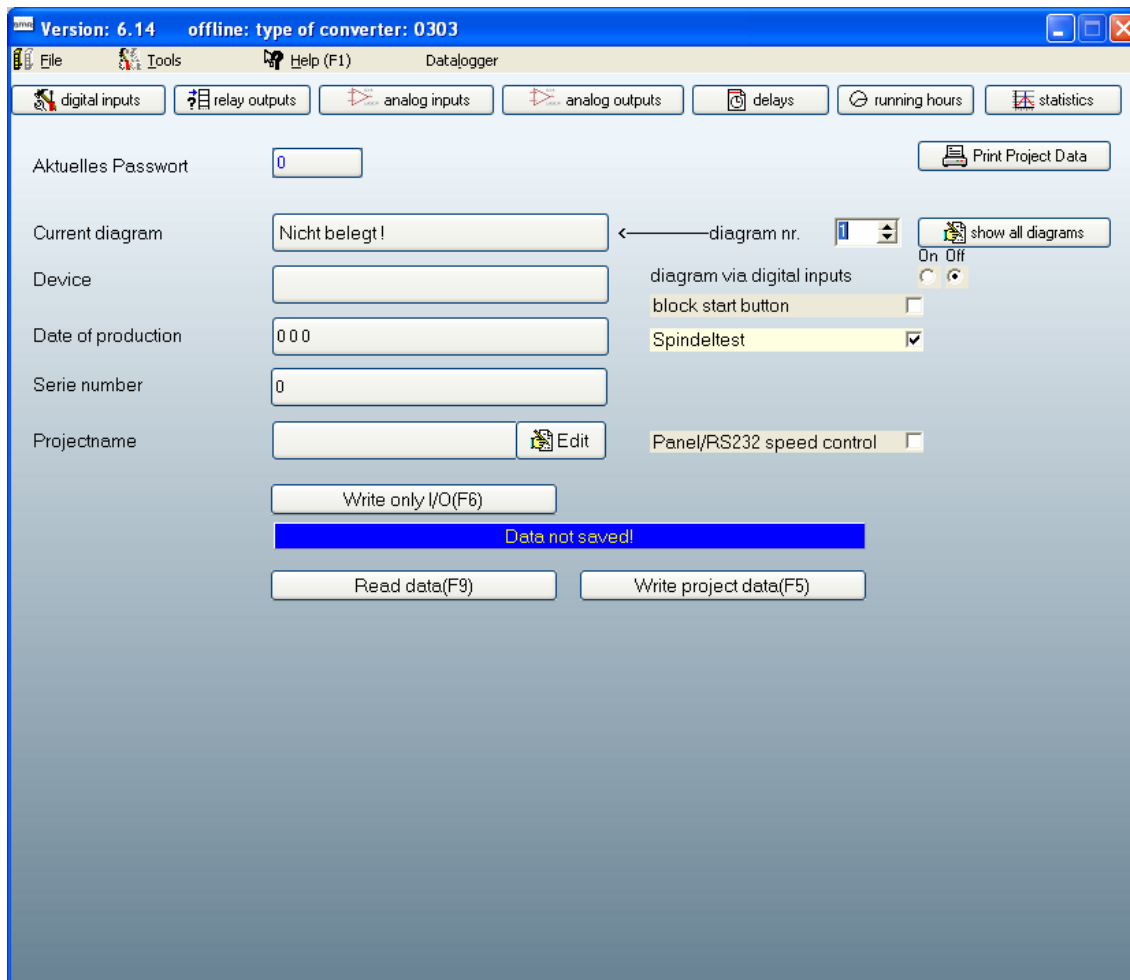


Picture 19

More information in Help

10. Automatic Spindle Tuning and Calibration (Autotuning)

If a motor without having a spindle characteristic has to be operated with SFU0303, it can be created very simple with the help of this tool in SFU-Terminal. The spindle is connected with the converter and the converter is connected with a PC and in the menu "Tools" the tool "Automatic Diagram" is started.

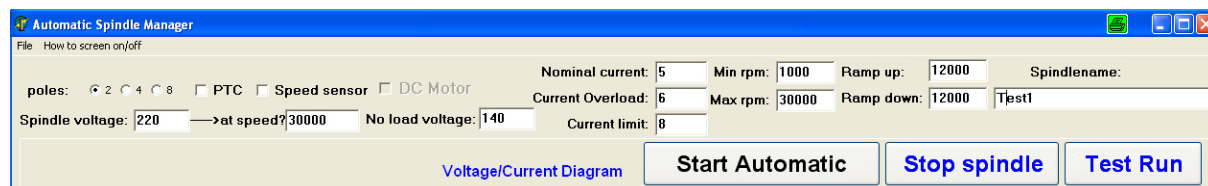


Picture 20

Simply the basic data of the spindle have to be input. Important is to mention the nominal voltage according to the proper speed value. The reason for this is, that AC-motors can be operated in a weakened field mode, also, which makes possible a higher rotational speed but with reduced power.

Example 1, normal adjustment:

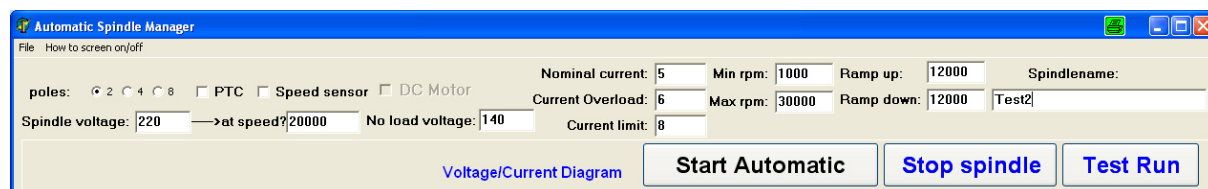
A 2-pole motor with a maximum rotational speed of 30.000rpm needs at this point a nominal voltage of 220V at a current of 5A .



Picture 21

Example 2, weakened field, field suppression:

A 2-pole motor with a maximum rotational speed of 30.000rpm needs at 20.000rpm a nominal voltage of 220V at a current of 5A . But the voltage cannot be raised further, so the desired speed can be achieved but with reduced power.



Picture 22

The current limit, in this case 8A, indicates the S6 mode, where it is 5A as the nominal current for the S1 mode.

The acceleration values (Ramp up/down) should be setup to be 12000rpm/sec. It has to be ensured that the shaft can rotate freely.

Start the automatic and save the characteristic after having finished the procedure. Download it into the converter.

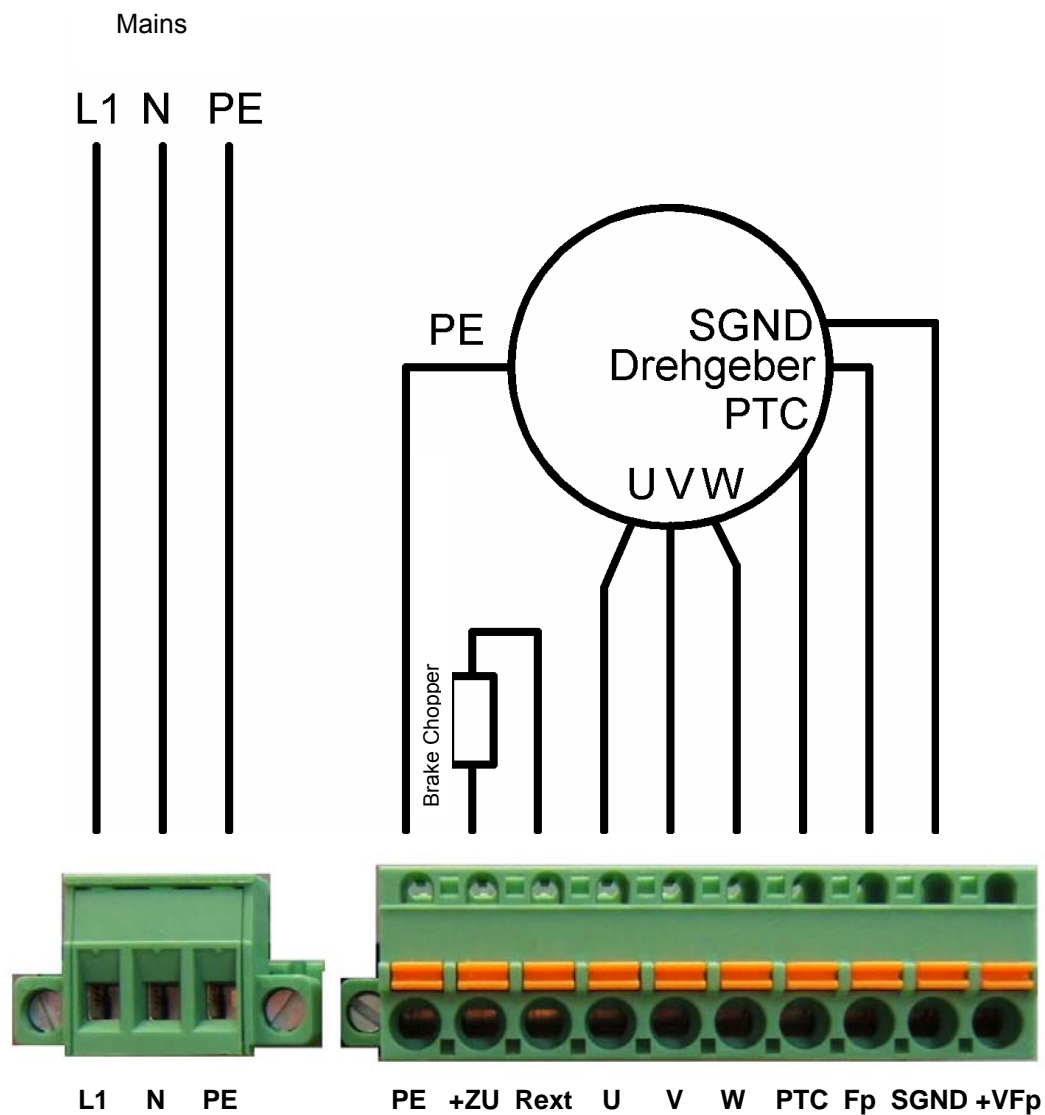


Caution:

If using this autotuning, damages at spindles or the converter are part of warranty, due to possible wrong input values.

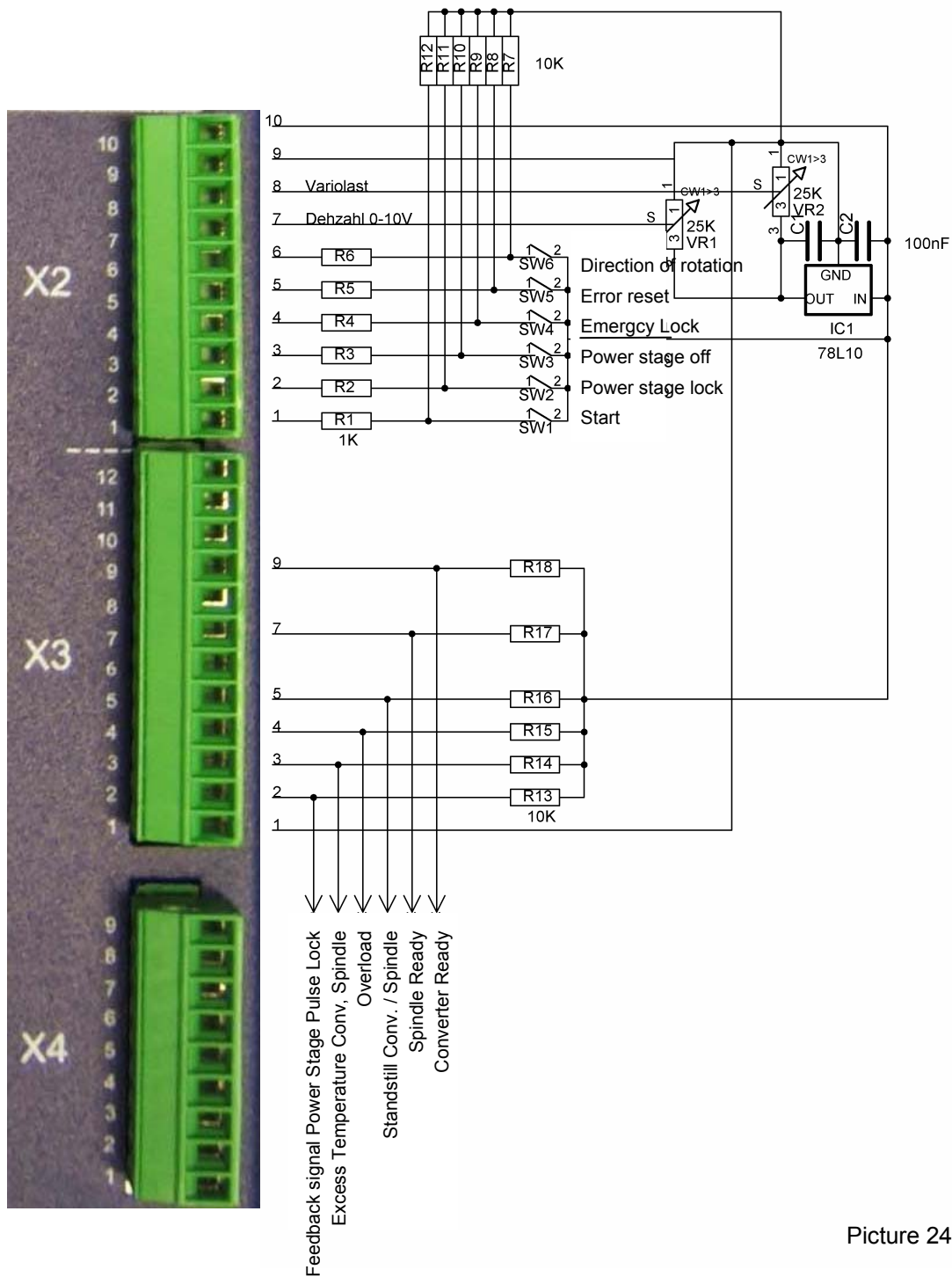
11. Examples of Connection

11.1 Mains and Spindle connection



Picture 23

11.2 Example for Logic and Wiring for Safety Circuit



Picture 24

The spindle interface X4 isn't wired, because the use is depending strongly on the configuration of the spindle and the according its specific characteristic.

This interface in combination with an automatic spindle detection should be used only after consultation with BMR.

By assigning the four address lines the spindle characteristic can be selected by an PLC or external switches, in case it has been enabled

The digital wiring can even be achieved with outputs of logic circuits, with a High Out level > 20V. The picture shows a configuration with passive switches in combination with the auxiliary voltage of the converter.

For stabilizing the reference analogue voltage for the duty speed a voltage regulator 7810 is used. In combination with a PLC generally a D/A-converter with 10V output level is used

The outputs are executed in such a way that the logic levels 0V and +24V are generated by the galvanically separated relays. For any other arrangement, the relay contacts can be wired and used freely. In the arrangement shown above, the logic level is assigned to the GND of the converter. The outputs shown in the diagram can be used directly as feed into a PLC.

Description of the behaviour during Start with released analogue input: Scaling:0-10V/MinMax

Enabling via input "digital start" – the spindle starts as soon as the level at the analogue input "duty speed" is higher than the minimum rotational speed limit being setup in spindle characteristic. It will stop, as soon as either "digital start" is low or the level at analogue input "duty speed" is below the minimum rotational speed limit.

In case of applying 10V to "analogue input "duty speed" and 16V to "digital start", the spindle will accelerate up to maximum speed.

12. EMC

This device was developed for use in industrial environments. For trouble-free operation and to reduce emitted interference, the following should be observed during wiring of the equipment:

- The EMC of a machine or device is affected by all connected components (motor spindle, length and type of cables, wiring, etc..). Under certain circumstances the use of additional filters may be necessary to maintain the current laws.
- The earth and shield connections of all those devices used in interconnection with the frequency converter should be as short as possible and have as large a cross-section as possible.
- Control units (PLC, CNC, IPC, ...) used in interconnection with the frequency converter should be connected to a common earth terminal bar.
- For mechanical installation, use serrated lock washers to guarantee good electrical contact with the housing.
- All connections both to and from the frequency converter should be via shielded cable. Earth shield should be connected on both sides.
- The shield must be completely connected to PE (protective earth).
- Power lines, motor lines and control lines should be laid separately and have to be isolated from each other. Where crossings cannot be avoided, it should be executed at 90° to each other.
- The control cable should be laid as far away as possible from the power cables.

13. Troubleshooting

| Error Description | Cause | Fixing |
|--|--|--|
| After power on the converter indicates Not Ready and Error | Input "Emergency Stop" is not properly or not wired at all. | +24V Signal at this input |
| | The converter is at excess temperature | <ul style="list-style-type: none"> > Let the converter cool down > Check, if the fan is working properly or maintain that air flow around the heatsink is sufficient > Slow down the tooling process |
| | Pulse inhibitor circuit is engaged, at devices with such a circuit (SFU0303) | <ul style="list-style-type: none"> > For disengaging wire +24V to the appropriate Pin > Wire a bridge between X2.1 - X2.10 (SFU0303) |
| | A spindle diagram which is not valid is selected | Change spindle characteristic with the help of the front panel keys or with <i>SFU-Terminal</i> |
| | Short circuit detection of the out put has tripped | <ul style="list-style-type: none"> > Check, if the spindle is blocked > Check, if there is a short circuit within the spindle > Check, if there is a Ground fault (at least one prong of the spindle cable is connected with PE) > Check, if there is a short circuit within the spindle cable |
| Error Description | Cause | Fixing |
| After power on the converter indicates Not Ready and Error and the evaluation of the temperature sensor is activated in the spindle characteristic | No spindle connected | Connect spindle |
| | No temperature sensor present within the spindle | Disable in spindle characteristic menu in <i>SFU-Terminal</i> the Temperature Sensor button |
| | Temperature sensor of the spindle defective | <ul style="list-style-type: none"> > Change spindle > Disable in spindle characteristic menu in <i>SFU-Terminal</i> the Temperature Sensor button |

| Error Description | Cause | Fixing |
|---|--|---|
| In case of connecting the converter with a PC or after launching the SW <i>SFU-Terminal</i> the Converter is not detected and not recognized | Incorrect connection cable or wiring fault | <ul style="list-style-type: none"> > Check cable for proper Pinout. > Verify at USB cables that it's length is not longer than 2m > Try to use original BMR cables, only. |
| | In case of using RS232 | <ul style="list-style-type: none"> > Use the USB-Interface at the PC together with a USB-RS232 converter. > For use with SFU 0303 a specific RS232 cable is required |
| | In case of using a USB-RS232 converter the USB-driver is not installed correctly. | install driver |
| | unsure | Restart <i>SFU-Terminal</i> |
| Start with push buttons not possible | Start button deactivated | Enable Start button by un-checking the checkbox "Block Start Button" |
| Spindle does not start , in spite of a valid signal for Start | <p>An input is assigned with the function Emergency Stop and configured as "Low Active".</p> <p>> This is default state on delivery</p> | <ul style="list-style-type: none"> > For unlocking, a signal of "HI" / +24V is required at this input > Deactivate this function or setup as "High Active" |
| | <p>The evaluation of the temperature sensor is activated in the spindle characteristic, but it is not connected or a sensor isn't implemented within the spindle</p> <p>-> in this case Error is indicated, additionally</p> | <ul style="list-style-type: none"> > Connect the temp sensor wires with the SFU . > un-check the button "Temp Sensor" in the spindle characteristic in <i>SFU-Terminal</i> |
| | The spindle test is engaged | <ul style="list-style-type: none"> > Check cable and connections for proper wiring or short circuit > Check spindle |

| Error Description | Cause | Fixing |
|--|---|--|
| Spindle does not start , in spite of a valid signal for Start | <p>Spindle cable and spindle are OK, and the spindle test is activated</p> <p>> Spindle cable is too long</p> <p>With activated spindle test, a test current is send via spindle cable to the spindle by applying a voltage at output lines. In case that this current is too low, or a wrong spindle characteristic selected, it does not match to the reference values and the spindle test fails.</p> | <p>> Select correct spindle characteristic</p> <p>> In the spindle characteristic the value of the start voltage has to be increased.</p> <p>-> contact BMR</p> |
| The error message Spindle not ready is indicated. | Spindle is at excess temperature | <p>Let it cool down</p> <p>> Check, if the characteristic matches with the spindle</p> |
| | PTC in the spindle is defective | change spindle |
| | The PTC-wires within the spindle cable are defective | exchange cable or fix the connection |
| Start via Digital Input is not possible | Start via Analogue input is activated. | <p>Deactivate Start via analogue input.</p> <p>-> Manual: "Analogue Inputs" and activate Digital Start</p> |
| | Set value for duty speed is too low | <p>Increase Analogue value for duty value.</p> <p>> A spindle start is carried out after reaching the required minimum voltage according to the scaling, only</p> |
| It is displayed Error Char xx or E xx | The selected spindle characteristic at memory place xx is wrong, invalid or corrupted. | <p>> Select matching characteristic with the help of the buttons at the front panel or with <i>SFU-Terminal</i></p> <p>> Contact BMR</p> |

| Error Description | Cause | Fixing |
|---|--|---|
| <p>With activated speed sensor:</p> <p>The spindle runs properly, but sometimes there appears the message Encoder Error.</p> | Loose connection in spindle, spindle cable or at the connectors | <ul style="list-style-type: none"> > Check spindle cable and exchange potentially > Check connectors |
| | <p>Disturbances on the signal or the signal amplitude is too low</p> <ul style="list-style-type: none"> > sensor wires in spindle cable are not shielded | <ul style="list-style-type: none"> > Exchange spindle cable > for verification test exchange spindle |
| <p>Error Without Spindle, Cable is displayed</p> | Spindle cable is defective | <ul style="list-style-type: none"> > Check the 3 spindle phase wires |
| | <p>Spindle cable too long</p> <p>With activated spindle test, a test current is send via spindle cable to the spindle by applying a voltage at output lines. In case that this current is too low, or a wrong spindle characteristic selected, it does not match to the reference values and the spindle test fails.</p> | <ul style="list-style-type: none"> > Check, if the proper characteristic is selected. > Increase value for start voltage in the spindle characteristic -> contact BMR > Deactivate function "Spindle test" |

14. General Hints

Our frequency converters are highly valuable precision devices. Please take care of them with the necessary attention, to preserve their high precision, high power ability, and long lifetime.

These devices leave our company only after a quality test and a full load check have been carried out. Before mounting and use, please read the attached manual carefully and pay attention to the points listed below.

- Before first activation of the device, verify, if it is in a faultless condition. If it was damaged during shipping and transportation it must not be switched on.
- During installation the safety regulations have to be observed.
- Before the device is turned on for the first time, it should be verified, that the connected parts cannot carry out uncontrolled movements.
- The frequency converter must not be operated close to heating devices or magnets or devices generating strong magnetic fields.
- The maximum permissible ambient temperature of this device is from +41 °F till +104 °F.
- Sufficient air circulation around the converter should be ensured
- Fluids should be prevented from intruding into the housing. If it seems to be happened, the converter has to be switched off immediately.
- The relative humidity must not exceed 90% (not condensed).
- The ambient air must not use aggressive, flammable or electrically conductive substances and should be as free of dust as possible.
- All repairs and maintenance on the converter and the relating accessories must be carried out by skilled personal and with powered off, only. To ensure this, the mains plug should be pulled out. In doing this, both the terms of regulations for preventing accidents and the general and national rules for mounting and safety have to be applied.
- The device must not be operated without properly connected PE connection and it has to be verified that the mains connector is fixed with screws, if detachable.

Our common hints can give only a rough guideline because it is not possible for **BMR GmbH** to cover all specific situations. The compliance with limits of EMC demanded by law is the responsibility of the manufacturer of the unit or the machine. By doing controls and tests in our laboratory or in delegated test-laboratories, BMR takes care, that our products comply with the corresponding standards, in case they are installed appropriately.

15. Warranty

With exclusion of additional claims we give a warranty on our Frequency Converters for 1 year on errors due to material, mounting and construction.

We commit to repair or replace the parts without any costs which seem to be defective by our estimation and which are not damaged by appropriate handling.

Warranty claims have to be sent to us in written form. The customer has to pay the costs to send the defective device back to BMR within the time of warranty. If this is not complied with or if we detect an external intrusion into our device, we feel free to withdraw our duty of warranty.

Our duty of warranty is limited to the repairing or replacing of the defective parts. We refuse claims of responsibility or warranty for direct or indirect consequential damages, caused by faults of our products.

Changes in construction may be carried out without any message or notification.
Our common terms of business conditions apply.

BMR GmbH is a dynamic and flexible company. We take into account specific requirements of our customers as well as demanding solutions in design. These are integrated according to qualitative and functional aspects maintaining of course our high quality standard.

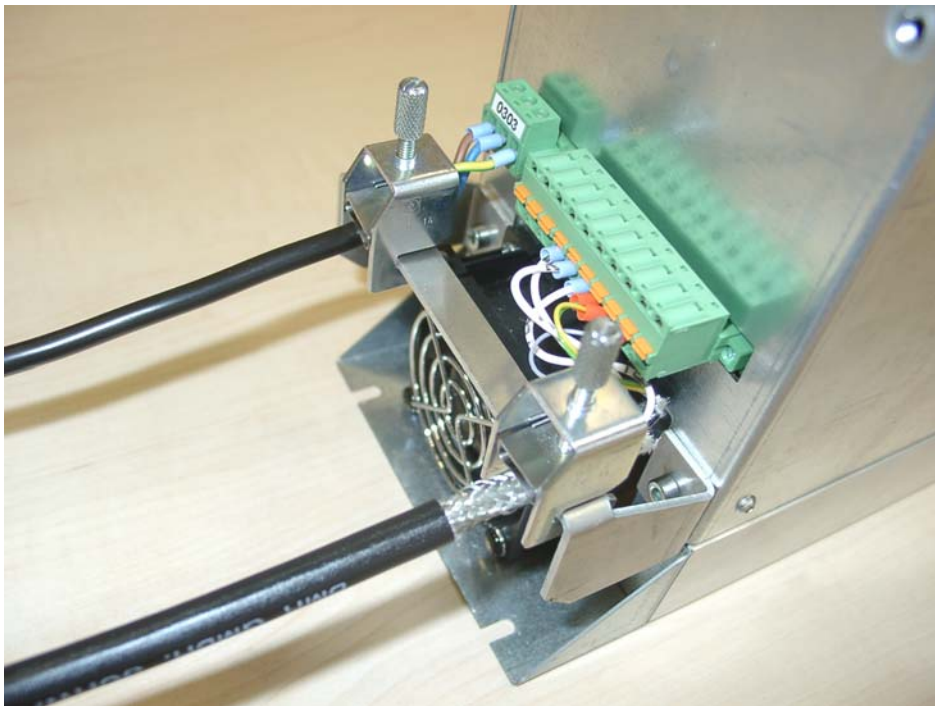
Our company is working according to the highest economical and ecological standards which are mirrored at **BMR GmbH** in all areas. Especially in manufacturing we try to improve steadily our ecological standard. It has been and is our constant purpose to comply with these demands.

16. Accessories

| | |
|----------------------------------|---------------|
| RS232 Cable | P 2001.100012 |
| USB Cable | P 2001.100013 |
| RS485 Cable | P 2001.100014 |
| LCD Operating Panel | P 1203.100003 |
| Mounting Bracket for the Housing | P 1700.504133 |

| | |
|---|---------------|
| Kit of pluggable Connection Clamps for X2,X3,X4, Mains and spindle connector | P 1001.100005 |
|---|---------------|

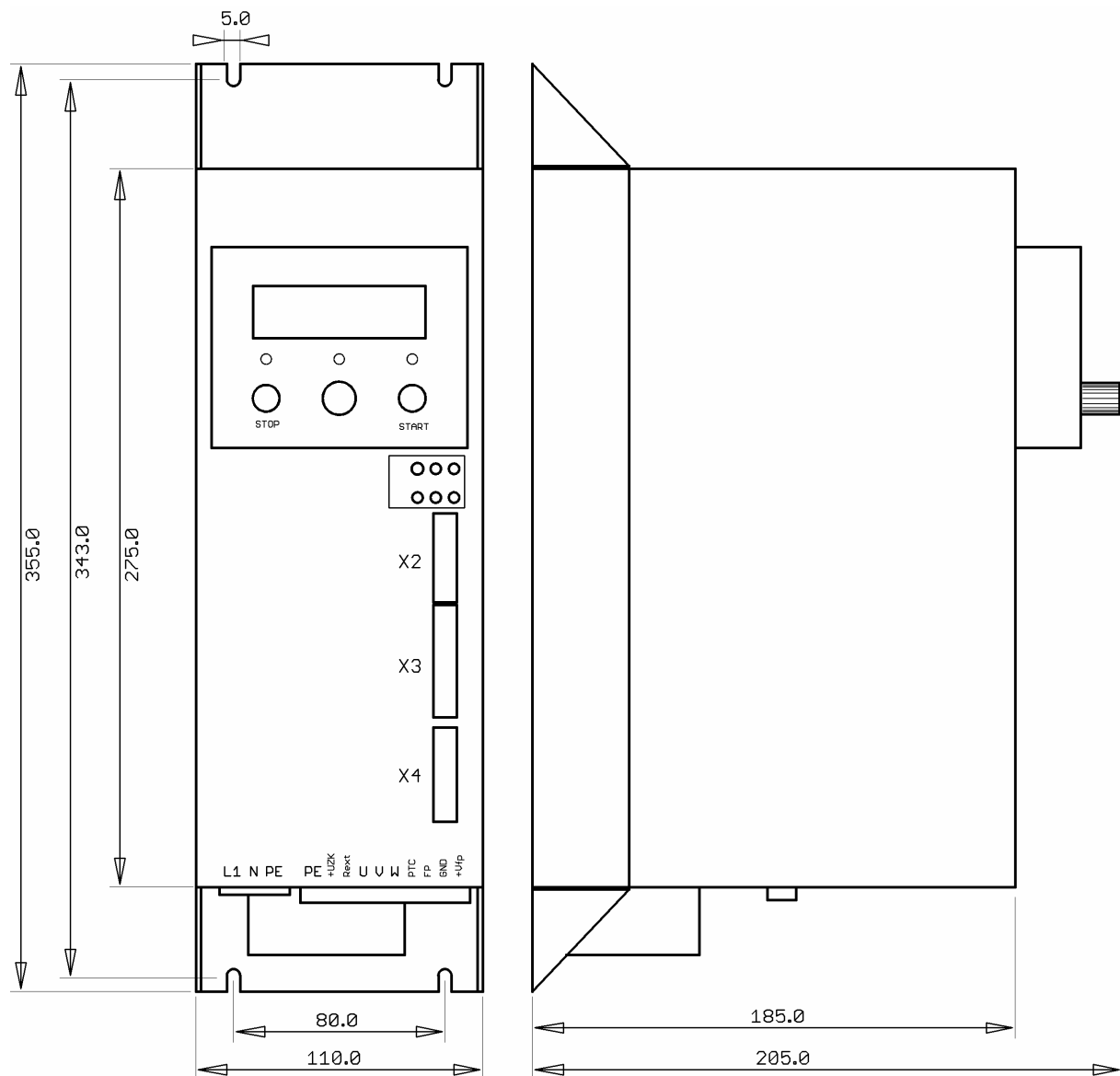
| | |
|---|---------------|
| Mounting Bracket and 2 Clamps for fixing the cables and for establishing the cable shielding | P 1001.100006 |
|---|---------------|

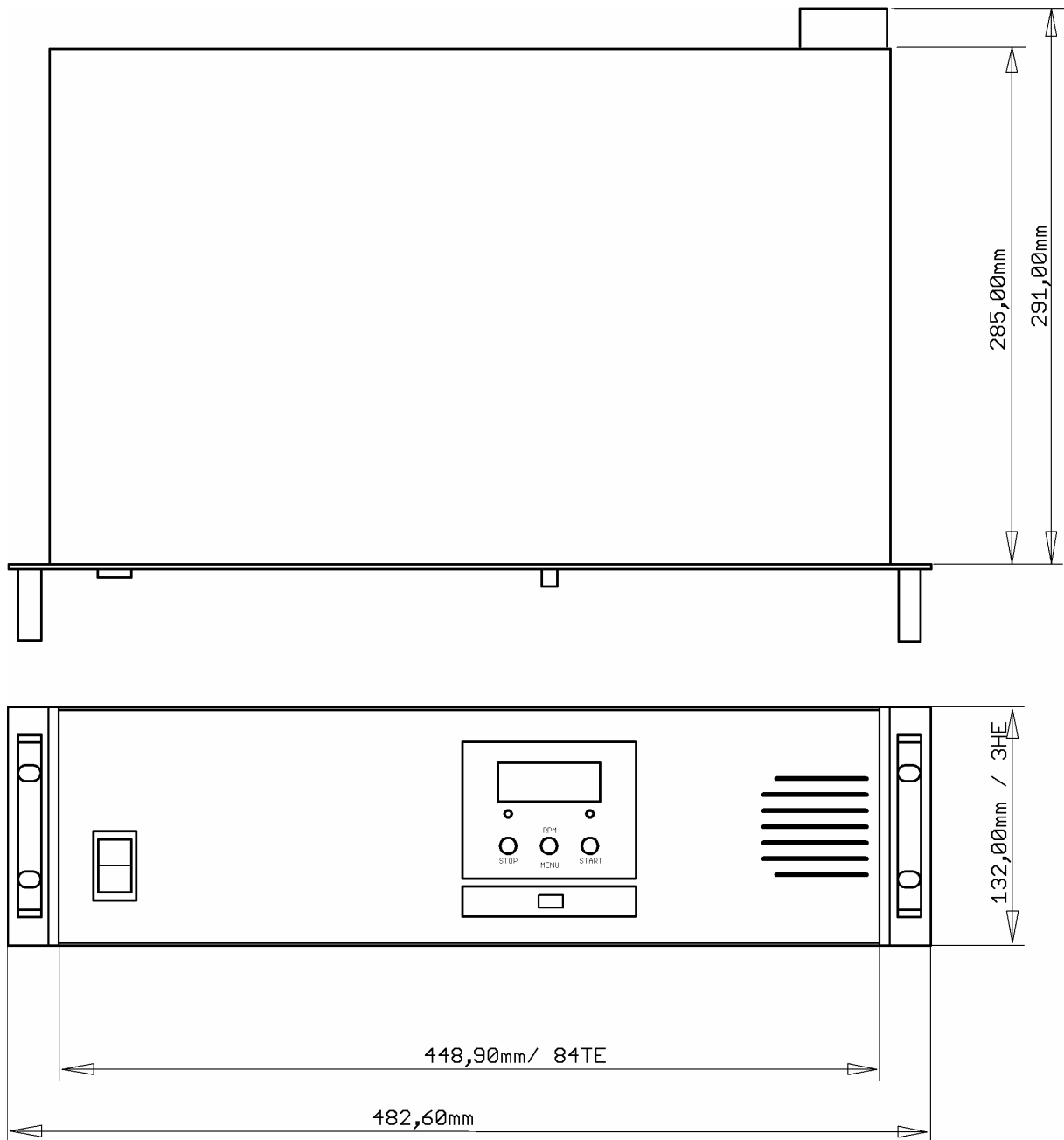


Mounting of cable clamps at the mounting brackets for mains and spindle cables
picture 25

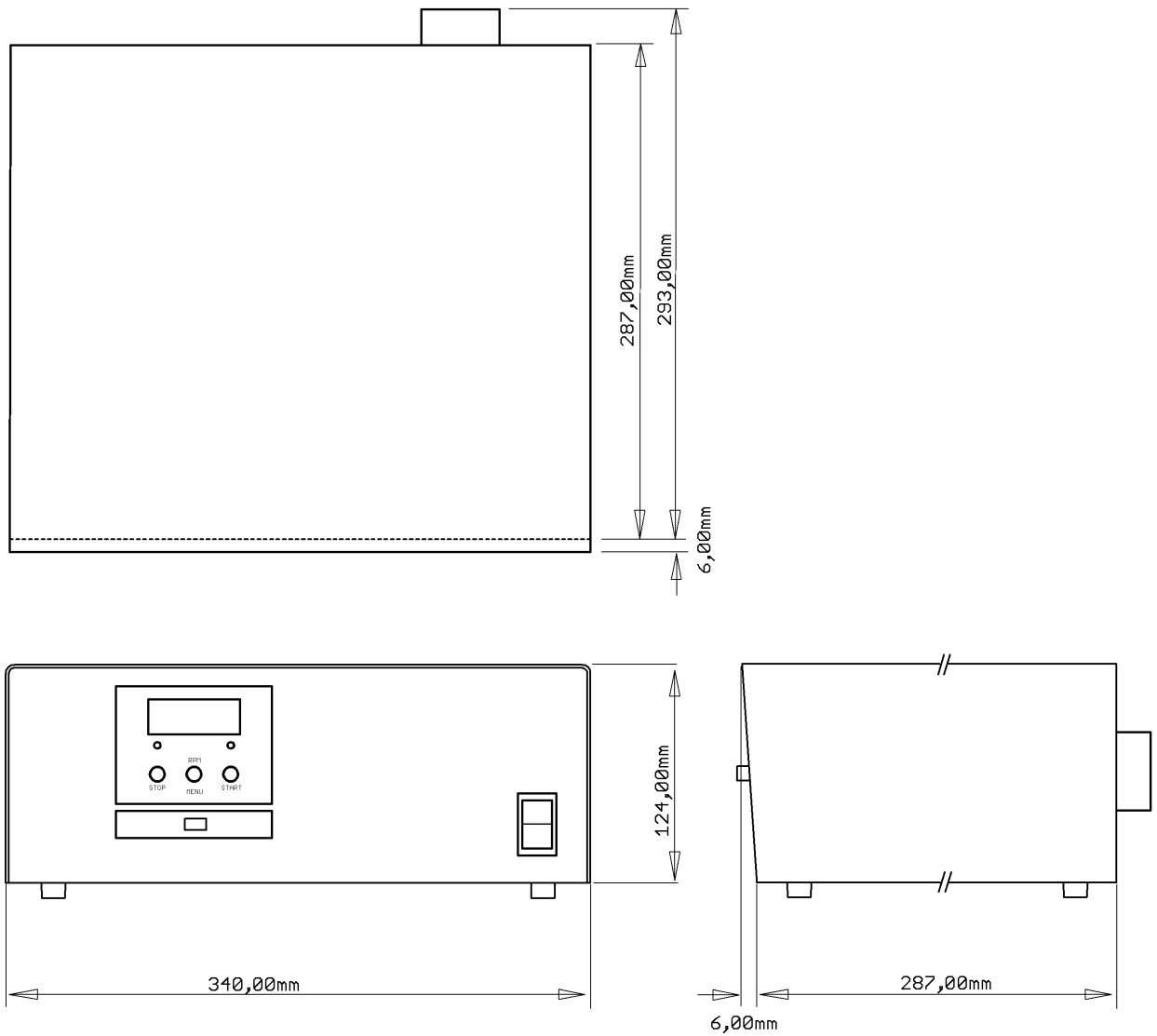
17. Mechanic, Views and Dimension

17.1 SSE Version for cabinet mounting



17.2 19" Version

17.3 Version Desktop



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