Product Information

Servo-drive applications
High current applications

MFDC Weld Timer
*Servo***SPATZ+** *M400 / M600 / M900*

Weld Cabinets
SPATZ+ *CL-TS / CL-RS*

Accessory Parts

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Content

Preamble

In this product information the following **SPATZ+** MFDC weld timers are introduced:

- **SPATZ+***M400L/M600L/M900L*: air cooled MFDC inverter and weld timer
- **SPATZ+***M400W/M600W/M900W*: water cooled MFDC inverter and weld timer

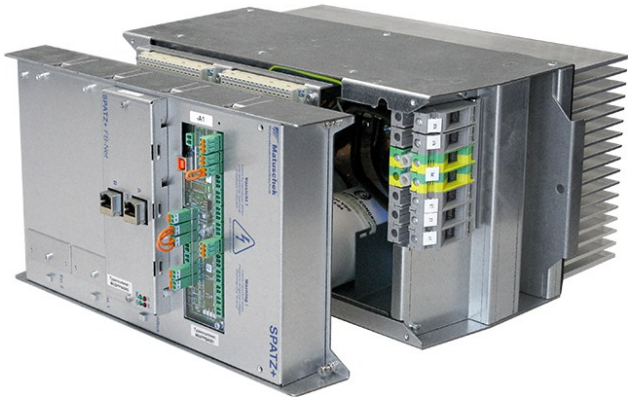
The different weld timers will only be treated separately, if there are differences between the versions (e.g. cooling). Only in these cases the specific name of the corresponding version (version *L* or W) will be used. In all common parts of the documentation the common name **SPATZ+** will be used.

If the weld timer and the weld cabinet are equipped with components for the control of electrical servo axes inside a welding gun or welding machine, the standard **SPATZ+** is called *Servo***SPATZ+**.

A General Information about the SPATZ+ Welding Equipment

A.1 Weld timer SPATZ+ *M400 / M600 / M900*

The 1,000 Hz Medium Frequency Inverter Power Source **SPATZ+** is specially designed for applications in the automotive industry. This weld timer provides extended data recording and online monitoring possibilities and an USB interface.



Extension boards with different field buses (e.g. Profibus-DP, Interbus-S with LWL or Cu conductor, PROFINET or ETHERNET IP with RJ45 connector) are available for connections of the **SPATZ+** to a robot controller or a line PLC.

The weld timer has a modular setup and can be configured for different purposes. It can be upgraded with up to 2 servo-drive extension boards for operations of welding guns with one or two servo-electrical axis.

In combination with an external MFDC transformer the **SPATZ+** is a cost efficient power supply for a welding current range of 3 kA to 18 kA. The weld timer and middle frequency inverter is housed in a compact IP20-protected housing for switch cabinet mounting.

With the **SPATZ+** weld timer each welding operation is feedback controlled during the weld procedure. The control process has short reaction time, which is based on the 1 kHz inverter frequency. Actual values are compared with target values every 0.5 ms. The output power is adapted during the welding process if targets are not being met.

Constant current control (KSR), constant power control (CPC), constant voltage control (CVC), constant trigger angle Control (CTC) and the adaptive **MASTER** control process can all be used. Using the **MASTER** control mode there is only one reference weld schedule for each sheet combination necessary. In total up to 1024 reference weld schedules can be stored. If the spot number related weld schedule selection is activated and the timer is running in **MASTER** control mode then for each individual weld spot number a fine adjustment can be done.

As a standard the **SPATZ+** includes signal inputs for welding current and electrode voltage and one proportional valve output. The internal welding data recorder keeps a detailed data set of the last 100,000 welds and a curve sets for the last 100 welds. For each weld it records details of the welding parameters, such as welding current, electrode voltage, energy, resistance and current time. Each data set gets a time stamp with time and date. In addition it also stores weld expulsions, counter reset, changing of target values, changing of the control parameters, details of fault status and instances where limits were exceeded. A customer specific extension of the data set is possible within bigger projects.

The whole tip dresser management (First tip dress, normal tip dress) and tip dresser supervision, duty cycle supervision, tip dress result supervision, **NUGGET***Index*) can be done with the **SPATZ+**. In addition 16 digital inputs and 10 digital outputs for 24 V DC signals as well as a specific fan output are available as a standard.

For communications between the **SPATZ+** and a line PC, an ETHERNET connection has been implemented, using the **SPATZ***StudioNET* software. Communication with a local PC is possible via the USB interface, using the **SPATZ***Studio* software.

The features of the **SPATZ+** *M400 / M600 / M900* weld controllers are:

- Adaptive **MASTER** control
- Generation of **MASTER** reference curves on a standard welding gun and transfer of this curves to any other gun even in different plants via **MASTER** database
- 32 Bit (max. 4 294 967 296 spots) weld spot number selectable via field bus
- 1024 **MASTER** reference weld schedules, can be related to the individual spot numbers
- 128 service schedules (scale force, scale current, change cap, first tip dress, tip dress, tip polishing, sensor test ...) complete the **MASTER** reference weld schedules
- Different weld schedules easy to configure, e.g.
  several squeeze and hold times, several current times - different in length and amplitude -, slope up and down, several pause times, force schedules
- Constant trigger angle Control
  Constant Current Control **KSR**
  Constant Power Control **CPC**
  Constant Voltage Control **CVC**
- Signal inputs for current and voltage, optionally 2 further signal inputs for force and penetration
- 0 - 10 V or 4 - 20 mA analog output, e.g. for proportional valve
- Weld parameter limit supervision for all weld parameters like weld current, electrode voltage, current time, total energy, final resistance, trigger angle...
- Extended QA data (e.g.: R_{Min}, R_{Max}, I_{Min}, I_{Max}, F_{Start}, F_{End} …)
- Extended QA documentation
- For quality assurance internal welding data recorder for the data sets of the last 100,000 and the curve sets for the last 100 welds
- Error memory for the last 100 error messages including waveforms (weld current, electrode voltage, control value) for error analysis
- Force schedules and check of minimum and maximum force before start of current time
- Sensor fault detection for electrode voltage and weld current sensor
- Input for WeldStop within 0.5 ms
- 8 independent counters for tip life, tip dresser cycle, dresser blade and gun life
- Tip dresser management and control
- Tip dresser supervision via **ELK-Check** and **NUGGET***Index*
- Interface for weld gun identification system **MASDAT** via extension board for manual gun applications
- Battery buffered real time clock and counter values
- Parallel I/O interface, 16 digital inputs, 10 digital outputs, 24 V DC
- Fan output, 24 V DC
- 24 V DC for digital outputs and peripherals via external power supply, e.g. robot
- Field bus slot, field bus almost freely selectable
- Slots for quasi parallel operation of two manual guns at a single weld controller with extension for I/O, proportional valve and gun identification system **MASDAT**
- Two slots for servodrive extension boards to drive servo-electric welding guns (e.g. stroke and equalizer)
- USB interface for local PC
- Firmware update via PC / Internet
- Water-cooled or Air-cooled

The significant technical data of the **SPATZ+** *M400 / M600 / M900* weld controllers are:

- Mains voltage: 3 ~ 400 V - 500 V, 50/60 Hz
- Output voltage $U_{2N:}$ 500 V / 1,000 Hz at 400 V
- Type of protection: IP 20 for switch cabinet mounting
- Nominal output current: $I2_{nominal}$ = 400 A / 600 A / 900 A
- Max. output current: $I2_{max}$ = 450 A / 650 A / 950 A
- Nominal power at 400 V: 140 kVA at 20 % duty cycle, 90 kVA at 50 % duty cycle
- Dimensions (W x H x D): 390 x 200 x 345 mm
- Weight: 20 kg

A.2 SPATZ+ *M900 Slave* for high current applications

For applications with high welding currents, e.g. aluminium welding, the additional slave inverter powers sources **SPATZ+** *M900 Slave* is available. One standard **SPATZ+** *M900* working as master is equipped with all necessary extension boards and is executing the complete process control. Up to 5 **SPATZ+** *M900 Slave* inverters can be controlled by one master **SPATZ+** *M900*. Already with two **SPATZ+** *M900* in master-slave connection welding currents up to 75 kA are possible.

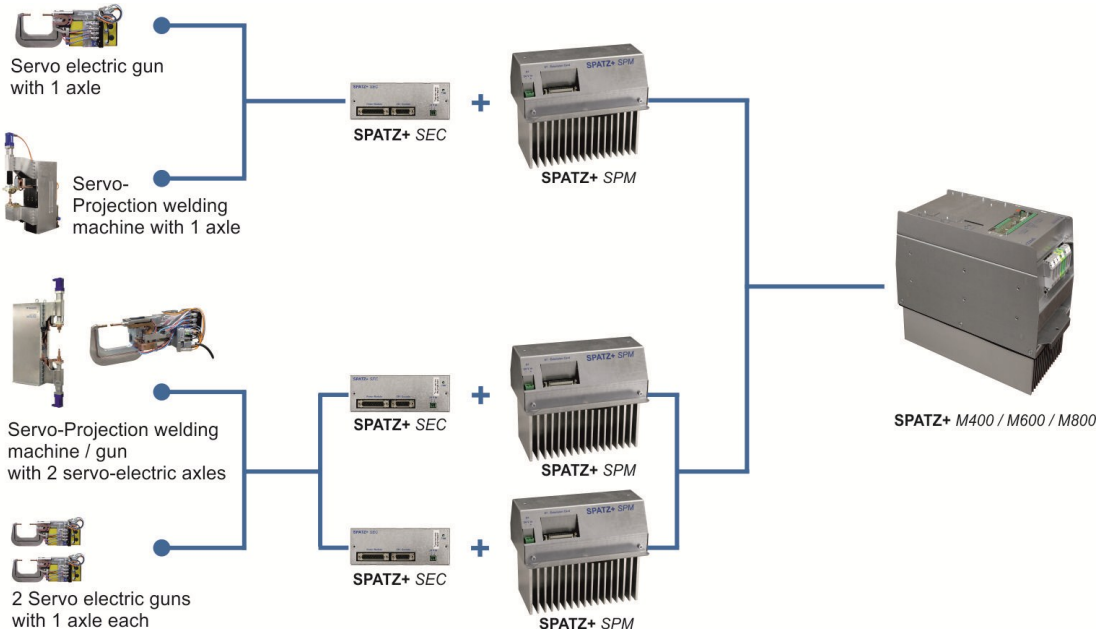
The power section of the **SPATZ+** *M900 Slave* remains unchanged, just the mainboard is reduced to the slave task. The master **SPATZ+** *M900* must be equipped with a special fieldbus board including the interface for the master/slave connection cable.

A.3 SPATZ+ *SEC* and SPATZ+ *SPM* – Control components for servo-drives

The extension board **SPATZ+** *SEC* and the motor power module **SPATZ+** *SPM* are used if the weld timer shall control up to two electrical servo axes inside a welding gun or welding machine. Applied with these components the standard **SPATZ+** is upgraded and called *Servo***SPATZ+**

The integration of the drives into the welding control is advantageous. It also facilitates the process sequence-determined control of electrode force, electrode displacement and equalization force. Moreover, the force and displacement measurements allow the optimization of gun closing time and force build-up speeds.

Data processing of all signals for the movement and force control of the servo axes, e.g. the encoder signal of the servo motor, is done at the **SPATZ+** *SEC* extension board of the weld timer. The control process of the servo drives is regulated at 8 kHz clock frequency. If the set parameters are not met, the power is adjusted during the running welding process.



The servo motor is connected at the **SPATZ+** *SPM* motor power module, the power output stages of both drive axles possess - at an inter-mediate circuit voltage of 560 V - a peak current of 32 A for e.g. the electrode force drive and for welding gun equalization. The module is mounted like the weld timer at the back wall of a cabinet, the heat sink of the module is cooled by the fans of the weld timer cooling too. The air cooling channel of the SPATZ+ weld inverter is just extended by appropriate cover plates, no additional fan unit is necessary.

A.3.1 Gun Module SPATZ+ *GM1* and *GM2* for one or two servo-drives

The **SPATZ+** *GM* gun modules can be used to minimize the high number of signal lines which is required especially by servo drives and to reduce the risk of line disturbances. It is mounted on the welding gun or the welding machine. This gun module pre processes the sensor signals for the welding current, the electrode voltage and, if necessary, for the electrode force and the electrode displacement. Encoder signals of the servo motors are, moreover, processed and, together with the sensor signals, transmitted via our high speed 2-wire Bus to the **SPATZ+** *SEC* extension board at the **SPATZ+** weld timer.

All welding program data, **MASTER** reference curves, motor parameters, geometry data and other maintenance and machine information data which are required for the operation of a specific welding gun are thus stored in the **SPATZ+***GM* gun module. Every time the system is switched on or every time the welding gun is changed, the data are automatically transferred to the high-tech controller. All servo guns or machines which are equipped with the gun identification system can be operated with any high-tech controller and without repeated pre-operational work. The welding guns can be programmed “offline” by the gun manufacturer or by the maintenance staff, thus weld parameter determination in the line is no longer necessary.

A.4 Fieldbus Boards

A.4.1 PROFIBUS Fieldbus board SPATZ+ *FB-Pro, FB-Pro2, FB-Pro4,*

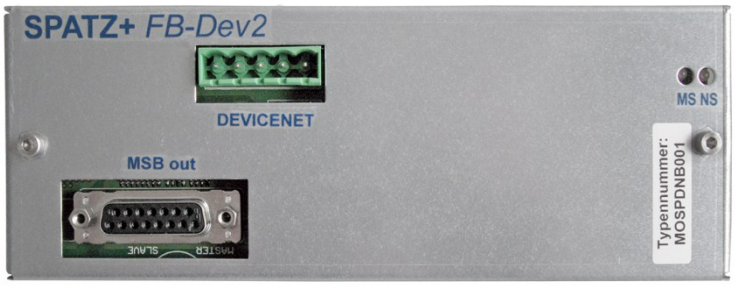
For the connection to a robot controller or a line PLC the **SPATZ+***FB-Pro* field bus extension board with PROFIBUS is available. The physical connection is done via a 9-pole D-Sub plug.

The **SPATZ+***FB-Pro2* board contains an additional MSB interface for a Master/Slave system for high current applications. The **SPATZ+***FB-Pro4* board contains a RS232 interface for sending data telegrams with QA data, a MSB interface for a Master/Slave system and an interface for the **MASDAT** IP chip.

A.4.1.1 DeviceNet Fieldbus board SPATZ+ *FB-Dev, FB-Dev2*

For the connection to a robot controller or a line PLC the **SPATZ+***FB-Dev* field bus extension board with DeviceNet is available. The physical connection is done via a pluggable connector.

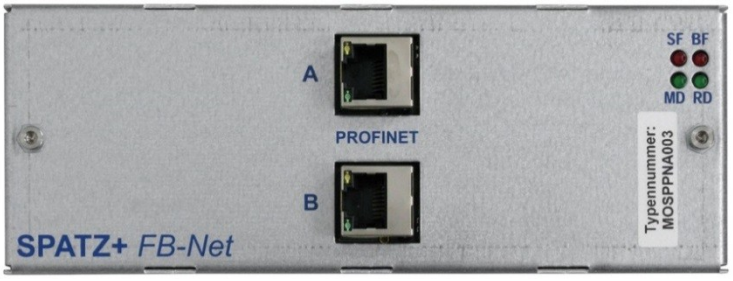
The **SPATZ+***FB-Dev2* board contains an additional Master-Slave-Bus interface for a output power increase via slave inverter systems.



A.4.2 PROFINET Field Bus Board SPATZ+ *FB-Net, FB-Net2*

The **SPATZ+** *FB-Net* field bus board connects the **SPATZ+** weld timer via PROFINET to a robot controller or a line PLC.

The PROFINET communication contains up to 320 bytes for input and output, depending to the implemented firmware version. The GSDML file for the PROFINET protocol is available on request. The PROFINET interface is connected via a 2 wire switch with 8-pole RJ45 plugs.



Furthermore the **SPATZ+** *FB-Net* could be used as an Ethernet switch in order to integrate several **SPATZ+** weld timers in a local network without using any company network. A description how to assign an IP address to it is shown in the documentation of the software **SPATZ***Studio*. While using the **SPATZ+** *FB-Net* bus board the local Ethernet interface on the **SPATZ+** mainboard is deactivated.

The **SPATZ+***FB-Net2* board contains an additional MSB interface for a Master/Slave system.

A.5 Switch Cabinets

A.5.1 Switch Cabinet SPATZ+ *CL-T2S* for aluminium applications and electrical servo-drives

The **SPATZ+***CL-TS* cabinet is designed for aluminium welding applications with a servo-electrical robot weld gun controlled by the **SPATZ+** weld timer and for weld transformers up to 320 kVA. The compact switch cabinet offers a carrier for two **SPATZ+** weld timers and for up to two **SPATZ+** *SPM* power modules for the servo motors, e.g. for the electrode force and for the gun equalizing. The main switch with earth fault detection (type B) has a handle in the cabinet door, the entry for all necessary cable like mains, gun transformer, servo actuators, sensory and control cables is done via cable glands and 8-fold data cable entry.

Equipped with two **SPATZ+***M900L* 1,000 Hz medium-frequency inverter power sources (up to 1800A) in master-slave connection and up to two **SPATZ+** *SPM* servo drive controllers for operation of up to two drive axes (e.g. electrode force, equalizing) the cabinet provides a closed system for aluminium resistance welding with two servo driven motors. Constant current control, constant power control, constant voltage control, percentage of heat control and, above all, the adaptive **AluMASTER** control modes is applicable.

The **SPATZ+***M900L* master controls all connected modules (e.g. servo extension boards, fieldbus, *CapClean*), the **SPATZ+***M900L Slave* provides additional current capacities needed for aluminium welding. Depending on the transformer at the welding gun welds up to 65 kA are possible.

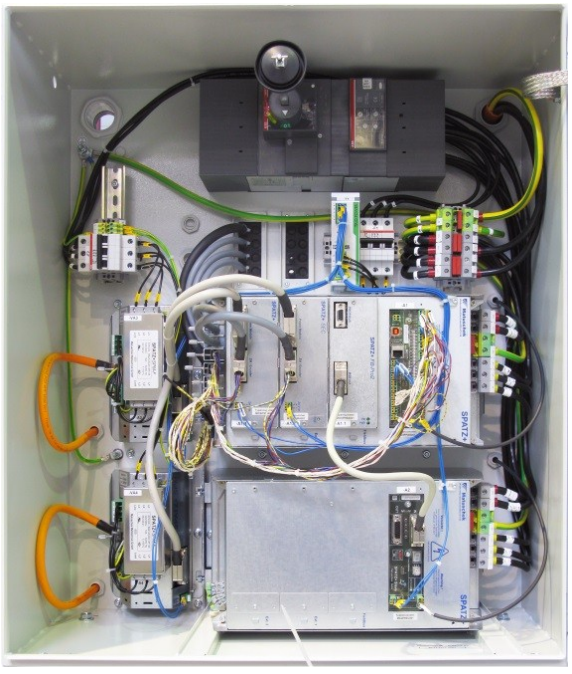
As a standard the cabinet comes with fan air-cooling for the **SPATZ+**. The fans are inside two cover plates on the backside of the cabinet. The air inlet is from rear side, air outlet is sideways. The air channel is hermetically sealed from the inner of the cabinet.

The cabinet is prepared for direct mounting on top of a KUKA Krc2 robot cabinet, for other brands different connection sockets are available.

The features of the **SPATZ+***CL-TS* switch cabinet are:

- Cabinet dimensions W x H x D: 700 x 800 x 350 mm (27.6 x 31.6 x 13.8 in)
- Circuit breaker with earth fault detection, handle in the door
- 24 V DC power supply inbuilt
- Safety relay
- Double fan cooling, block proved
- 24 V I/O coupling with CapClean
- Cable entry via cable glands in the rear panel of cabinet:
  - 1 x M50 for mains and 1-2 x M40 for transformer
  - 2 x M20 for power cables for 2 servodrives
  - 2 x M16 for air cooling fans
  - 2 x 8-fold data cable entry for:
    - sensory and 24 V I/O hybrid cable
    - 2 encoder leads for the servo actuators
    - 24 V I/O coupling with ***CapClean***

Options:
- Cabinet stand
- Adapter sockets for different robot cabinets

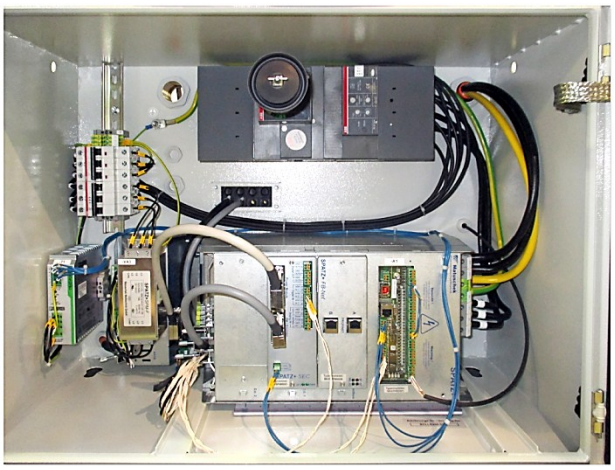


View inside weld cabinet including:
- **SPATZ+***M900* weld timer as master
- **SPATZ+***M900 Slave* Weld timer as slave
- **SPATZ+***FB-NET* PROFINET fieldbus board
- 24 V DC power supply
- Connecting cables
- 2 **SPATZ+** *SEC* and **SPATZ+** *SPM* for:
  - main electrode force
  - weld gun equalization

A.5.2 Switch Cabinet SPATZ+ *CL-RS* for applications with one servo-drive

The **SPATZ+** *CL-RS* cabinet is designed for welding applications with one servo-electrical axis controlled by the **SPATZ+** weld timer. The compact switch cabinet offers a carrier for the **SPATZ+** weld timer and for a **SPATZ+** *SPM* power modules for the servo motor, e.g. for the electrode force. The main switch with earth fault detection (type B) has a handle in the cabinet door, the entry for all necessary cable like mains, gun transformer, servo actuators, sensory and control cables is done via cable glands and 8-fold data cable entry.

The cabinet can be equipped with one **SPATZ+** *M400L, M600L or M900L* medium-frequency inverter power source. As a standard the cabinet comes with fan air-cooling for the **SPATZ+**. The fans are inside two cover plates on the backside of the cabinet. The air inlet is from rear side, air outlet is sideways. The air channel is hermetically sealed from the inner of the cabinet. The cabinet is prepared for direct mounting on top of a KUKA Krc2 robot cabinet, for other brands different connection sockets are available.



View inside weld cabinet including:

- **SPATZ+***M900* weld timer
- **SPATZ+** *FB-NET* PROFINET field bus board
- **SPATZ+** *SEC* and **SPATZ+** *SPM* for electrode force
- 24 V DC power supply
- Fuses for power supply and servo drive
- Cables from the outside

The features of the **SPATZ+***CL-RS* cabinet are:

- Cabinet dimensions W x H x D: 700 x 500 x 530 mm (including overlap)
- Main switch 100 A 4-pole with integrated 30 mA RCD, Type B, handle in the door
- Safety relay
- Cable entry via cable glands in the rear panel of cabinet:
  - 2 x M40 for mains and transformer
  - 1 x M20 for power cable of servo actuator
  - 1 x M16 for air cooling fans
  - 1 x 8-fold data cable entry for bus, sensory and 24 V I/O hybrid cable, encoder of servo motor
- Double fan cooling, block proved

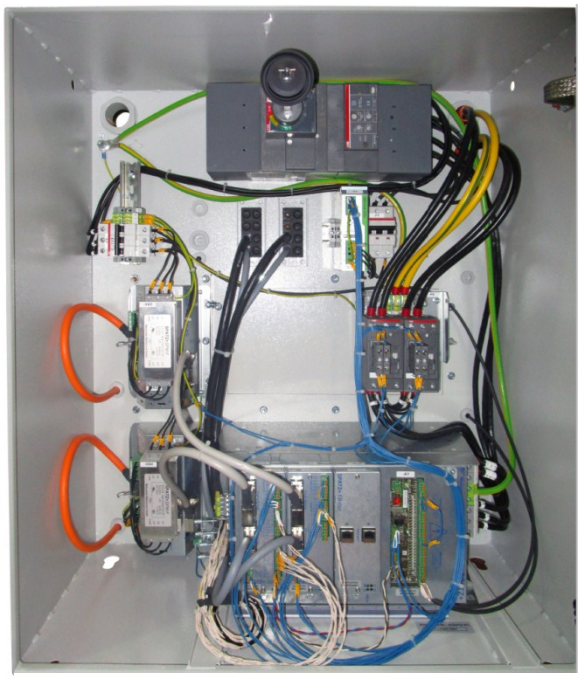
Options:

- Internal 24 V DC power supply
- Mains supply for tip dresser and robot with 3-pole line circuit breaker, including cable glands
- Adapter sockets for different robot cabinets
- Cabinet stand

A.5.3 Switch Cabinet SPATZ+ *CL-R2S* for applications with two servo-drives

The **SPATZ+** *CL-R2S* cabinet is designed for welding applications with two servo-electrical axis controlled by the **SPATZ+** weld timer. There ar two versions available: The 1st one is for applications with one welding machine or gun with two servo drives e.g. for electrode force and equalizing or a double-head welding machine. The 2nd one is for applications with two servo drives but in two different welding machines connected to one **SPATZ+** weld timer. The compact switch cabinet offers a carrier for the **SPATZ+** weld timer and for two **SPATZ+** *SPM* power modules for the servo motors. The main switch with earth fault detection (type B) has a handle in the cabinet door, the entry for all necessary cable like mains, gun transformer, servo actuators, sensory and control cables is done via cable glands and 8-fold data cable entry.

The cabinet can be equipped with one **SPATZ+** *M400L, M600L or M900L* medium-frequency inverter power source. As a standard the cabinet comes with fan air-cooling for the **SPATZ+**. The fans are inside two cover plates on the backside of the cabinet. The air inlet is from rear side, air outlet is sideways. The air channel is hermetically sealed from the inner of the cabinet. The cabinet is prepared for direct mounting on top of a KUKA Krc2 robot cabinet, for other brands different connection sockets are available.



View inside weld cabinet including:

- **SPATZ+***M900* weld timer
- **SPATZ+** *FB-NET* PROFINET field bus board
- Connecting cables
- 2 **SPATZ+** *SEC* and **SPATZ+** *SPM* for e.g. two servo drives in two welding machines
- 24 V DC power supply
- Fuses for power supply and servo drives
- Cables from the outside

The features of the **SPATZ+***CL-RS* cabinet are:

- Cabinet dimensions W x H x D: 700 x 500 x 530 mm (including overlap)
- Main switch 100 A 4-pole with integrated 30 mA RCD, Type B, handle in the door
- Safety relay
- Cable entry via cable glands in the rear panel of cabinet:
  - 2 x M40 for mains and transformer
  - 1 x M20 for power cable of servo actuator
  - 1 x M16 for air cooling fans
  - 1 x 8-fold data cable entry for bus, sensory and 24 V I/O hybrid cable, encoder of servo motor
- Double fan cooling, block proved

Options:

- Internal 24 V DC power supply
- Mains supply for tip dresser and robot with 3-pole line circuit breaker, including cable glands
- Adapter sockets for different robot cabinets
- Cabinet stand

A.5.4 Connection Sockets and Stand for Weld Control Cabinet

A.5.4.1 Connection socket for SPATZ+ *CL* and ABB robot cabinet

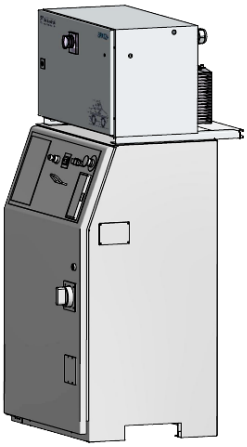
For setting up the weld cabinet on top of the ABB robot cabinet a specially designed adapter socket is available. This socket adjusts the hole pattern of the weld cabinet to the hole pattern of the ABB robot cabinet. The socket is equipped with fixing threads for mounting the socket on top of the robot cabinet and screw threads for mounting the cabinet on the socket. The height of the socket is 27 mm. The two lateral rails are mounted instead of the ABB crane lifting rails. The frontal dust cover rail of the robot cabinet can stay mounted.

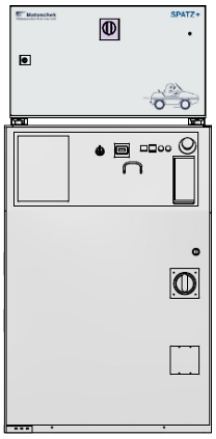
A.5.4.2 Connection socket for SPATZ+ *CL* and KUKA robot cabinet

For setting up the weld cabinet on top of the KUKA Krc4 robot cabinet a specially designed adapter socket is also available. This socket adjusts the hole pattern of the weld cabinet to the hole pattern of the KUKA robot cabinet. The socket is equipped with fixing holes for mounting the socket on top of the robot cabinet and screw threads for mounting the weld cabinet on the socket. The height of the socket is 21 mm. The two lateral rails are mounted instead of the KUKA crane lifting rails.

A.5.4.3 Connection socket for SPATZ+ *CL* and FANUC robot cabinet

For setting up the weld cabinet on top of the FANUC robot cabinet a specially designed adapter socket is also available. This socket adjusts the hole pattern of the weld cabinet to the hole pattern of the FANUC robot cabinet. The socket is equipped with fixing holes for mounting the socket on top of the robot cabinet and screw threads for mounting the weld cabinet on the socket. The height of the socket is 27 mm. The two lateral rails are mounted instead of the FANUC crane lifting ring-screws.





A.5.4.4 Connection socket for SPATZ+ *CL* and other robot cabinets

Adapter sockets for unlisted robot cabinet versions must be discussed in detail and are available on request.

A.5.4.5 Stand for SPATZ+ *CL* Weld Control Cabinets

As an option there is a stand available for setting up the **SPATZ+** *CL* cabinets independent from a robot cabinet. The stand is consisting of 2 side frames joined together by a supporting frame, which can be mounted in 4 different heights, and thus can be used as a 115, 210, 305 or 400 mm high socket. Furthermore it is possible to place 2 or 3 cabinets on top of each other by fixing the according number of stands together. The cable clamp rail for fixing the cable to the back of the supporting frame and the screw for mounting also belongs to the scope of delivery.

In addition, a rolling base for mounting underneath the stand is available.

- Size W x H x D: 810 x 470 x 471 mm
- Colour: RAL 7035, light grey

A.5.5 Media Panel SPATZ+*MPVL* for single welding gun

The **SPATZ+***MPVL* media panel provides the necessary cooling water and compressed air components to feed a single resistance welding gun or machine. It's a product of our Swedish sales and service partner company Svetsradet.

The panel is designed to fit to the side frame of the **SPATZ+** weld cabinet stand and can easily be mounted with brackets in different heights. For a **SPATZ+***CL-H2* weld cabinet for 2 guns the 2 panels can be mounted left and right at the cabinet stand on both sides of the cabinet. If the panel should be mounted separate from the weld cabinet a single side frame of the stand can be used or the panel can directly be mounted to a wall or to the steel structure.

The water "in" circuit of the cooling water starts with ½" female thread for the water supply line, followed by a water filter, a 24 V DC controlled 2 port solenoid valve and ends again with a ½" female thread as an outlet for the water hose to the gun. The water "out" circuit of the cooling water starts with ½" female thread for the water return hose of the gun, followed by a digital flow switch with water temperature switch and flow adjustment valve, a check valve and ends again with a ½" female thread as an outlet for the cooling water.

The compressed air circuit starts with ½" female thread, followed by a residual pressure exhaust 3 port valve, an air filter, a digital pressure switch for the line air pressure, a 0-10 V proportional valve with set pressure supervision and ends also with a ½" female thread as an outlet for the air hose to the gun.

All sensor and control cables are going to an electrical M12 sensor switch box, so only one M23 sensor cable is going to the weld cabinet. The 24 V water valve and the check valve can be used with the “water saving” function of the **SPATZ+** weld timer to save cooling water in non production times.

The water flow to the gun can easily be adjusted with the flow adjustment valve of the water flow switch. The flow rate is shown direct in l/min together with the water temperature on the display of the switch. Flow rate and temperature can be supervised with programmable limits, limit violation is clearly shown on the display with a different color and supervised by the **SPATZ+** weld timer too.

The residual pressure exhaust 3 port valve comes with a build silencer and can be used to block the compressed air to the gun and exhaust the air hoses to the gun together with the gun at the same time. The supply/exhaust status of the airflow is shown in an indicator window on the handle.

The air filter has a low pressure drop and a bowl with a transparent bowl guard. So the inside is visible from 360°. The line pressure sensor shows the actual line pressure in bar at the display, the minimum pressure can be supervised with programmable limits, limit violation is clearly shown on the display with a different color and supervised by the **SPATZ+** weld timer too.

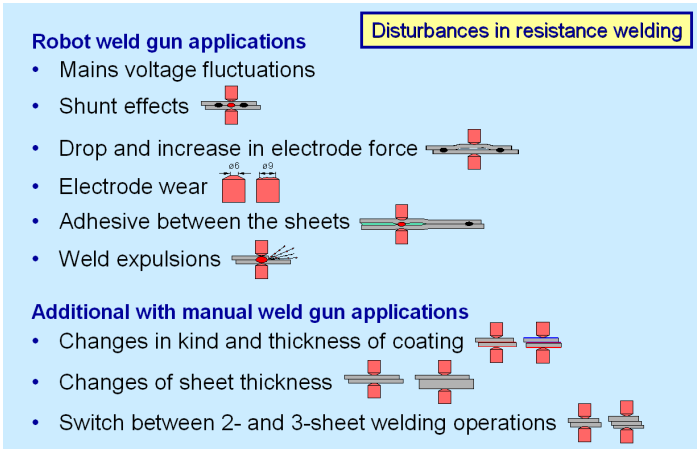
The proportional valve has a 0-10 V input and shows the set pressure value at the integrated display. The set value at the outlet of the valve can be supervised with programmable limits, limit violation is shown on the display and can also be supervised by the **SPATZ+** weld timer.

The features of the **SPATZ+** *MPVL* Media Panel are:

- Panel dimensions (W x H x D): approx. 325 x 370 x 130 mm
- Panel weight: 7,5 kg
- Supply voltage: 24 V DC
- Minimum pressure compressed air: 2.5 bar (0.25 MPa)
- Maximum pressure compressed air: 10 bar (1.0 MPa)
- Filter rate compressed air: 5 micron
- Minimum pressure cooling water: 2.5 bar (0.25 MPa)
- Maximum pressure cooling water: 10 bar (1.0 MPa)
- Measuring range flow meter: 2 – 16 l/min
- Filter rate cooling water: 45 micron
- Air pressure set: 0-10 V = 0-9 bar
- Set pressure supervision: switch output and display
- Line pressure supervision: switch output and display
- Cooling water flow supervision : switch output and display
- Cooling water temperature supervision : switch output and display
- Water shut down function: 24 V DC solenoid valve and check valve

A.6 The Adaptive MASTER Control Mode

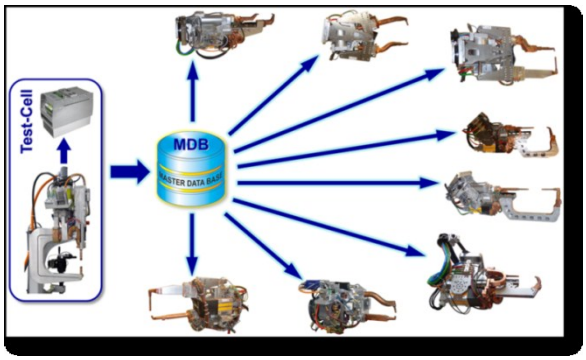
MASTER is an adaptive control mode for resistance welding and successfully in use in the automotive industry since 1994. It is based on the principle of a stored reference weld, which is carried out under defined conditions and without disturbances. During the set up weld -carried out for each sheet combination- the weld timer is running in constant current control (KSR); so for the worker it is operating in the usual way. The curves of the welding current and electrode voltage that are measured during this welding are stored as reference curves inside the weld timer. This "teaching" of the reference welds can be done with sheet metal strips or with the original components, but “teaching” with the sheet metal strips offers significant advantages:



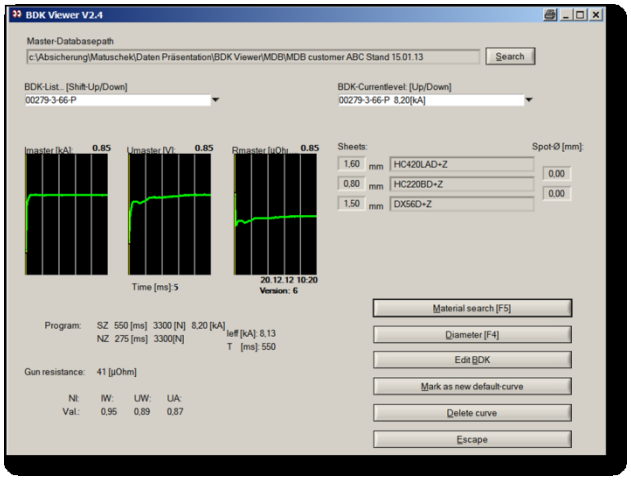
- “Teaching“ can be done before start-up of the production line, so right from the first component / vehicle an extremely high welding quality will be achieved.
- “Teaching” is independent of component fit up (especially for high-strength steel), adhesive and function of the gun equalizing.
- Vertical placement of the electrodes and sufficient flange width is assured.
- Sheet metal strips are easy to check with peel test.

After switching to **MASTER** control mode, all subsequent welding operations are controlled in accordance with the stored **MASTER** reference curves. Thus the need of individual adjustments of weld parameters for each weld can be omitted. All weld spots on a sheet combination (BDK, abbreviation of the German word: “Blech-Dicken-Kombination”) can be put together and allocated to one **MASTER** weld program and welded based on the same **MASTER** reference. Individual differences within the weld spots, like different distances to current shunts or different gap effects, are automatically and reliably compensated by the **MASTER** control by in-/decrease of weld current and/or weld time, whatever necessary is for achieving good weld quality despite the disturbance. A maximum prolongation of weld time can be set for each weld program. The optimum adjustment of weld parameters for each weld spot guarantees optimum weld quality in a wide range. The monitoring parameters for quality control **NUGGET***Index* can be determined already during the “teaching” procedure and so can be used directly together with the in the adaptive **MASTER** control.

A.7 MDB - MASTER Data Base

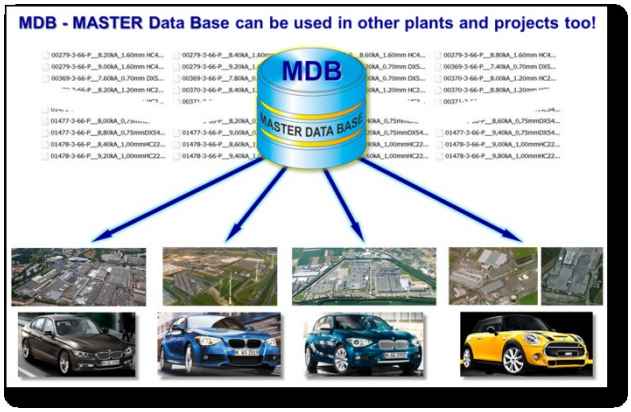


The **MASTER** Data Base (**MDB**) is Matuschek's recent but consistent advancement for the application of **MASTER** control mode in automatic production. Prior to this invention **MASTER** reference welds had to be executed for each weld gun separately, even when the same sheet combinations (BDK, abbreviation of the German word: "Blech-Dicken-Kombination") were welded on different weld guns. Using the **MDB** feature it is now possible to do the "training" of all **BDK**s of a project at any welding gun and store it in the **MDB**. Since "teaching" with production guns is no longer required, "teaching" of the MDB can be performed outside the production by trained professionals in the laboratory or in a test cell or as a service of Matuschek Messtechnik GmbH. The so-constructed **MDB** can be used throughout the company and different projects at all sites and thus becoming the group **MASTER** Data Base for resistance welding.



The welding parameters for the reference welding are usually given by the customer database. At a given time and electrode force then welds within the current range up to the spatter limit (e.g. in steps of 200 A) are done on sheet metal strips, the corresponding reference curves are stored automatically and the weld samples are subsequently tested destructively. The reference curve with the lowest current level stored in the MDB has already a sufficient spot diameter; the highest current level is close to the spatter limit. An intermediate reference curve is marked as the default curve. The visualization and administration of the MDB takes place with the **SPATZ***BDK-viewer* software.

Thus for each **BDK** are **MASTER** reference curves available at different current levels. Setting up a welding line can easily be performed with the Initial-Data-Import, which copies automatically the default curves to all weld timer of the line. The remaining reference curves of each **BDK** are available for future optimization of the production process and can be changed easily from the central **MDB**.

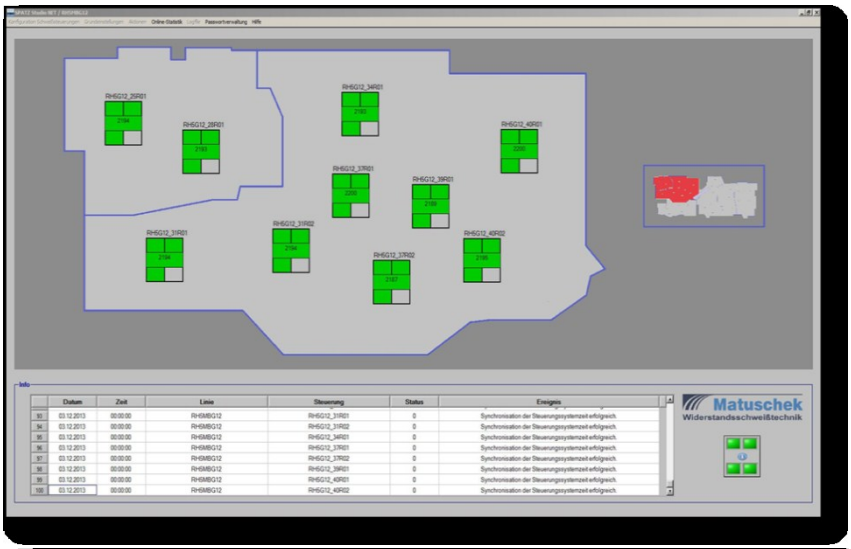


For the transfer of the reference curves of the **MASTER** Data Base to any gun in production only a quick set-up with the new gun has to be performed once, independent of the number of sheet combinations to be welded with this gun. So just a few minutes are needed for that. Then the weld timers of the production line are filled with the data from the **MDB** by the Initial-Data-Import without the necessity of individual welds on the production gun. Also the supervision data such as the **NUGGET***Index* will be transferred. Directly after this set-up the production can be started in adaptive **MASTER** control mode with active inline weld supervision.

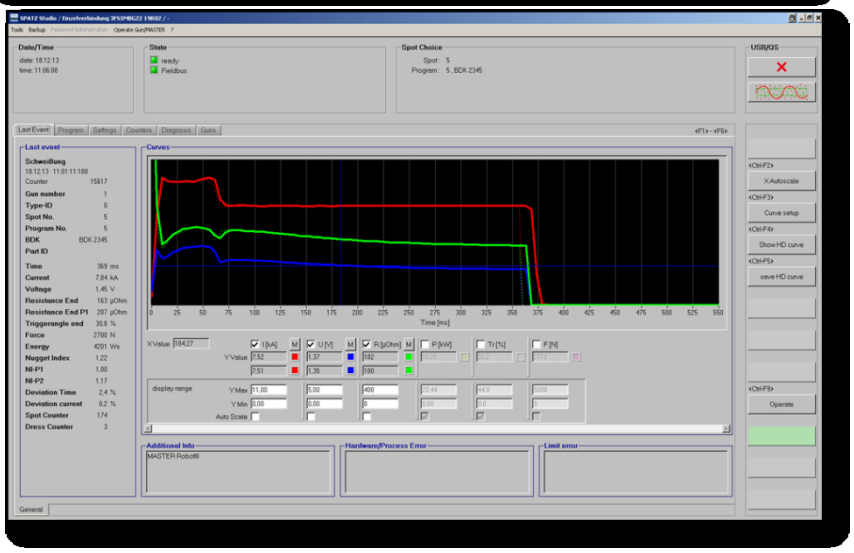
By applying the **MASTER Data Base**, time and cost for the initial setup can be greatly reduced whereas the transparency and comparability of weld data and weld programs will be increased immensely across the entire company. This is already proved in ongoing projects within the automotive industry.

A.8 PC Software SPATZ*Studio* and SPATZ*StudioNET*

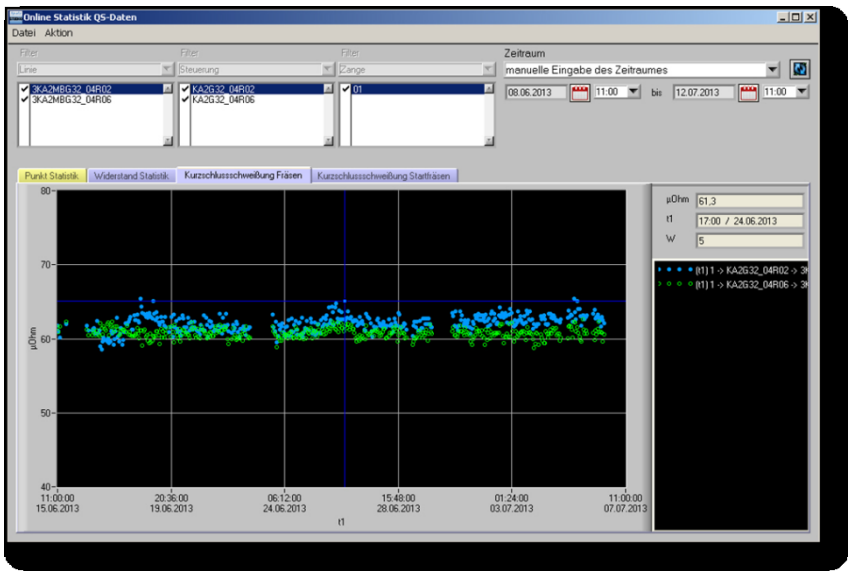
Online programming, online analysis and online diagnosis can be carried out with **SPATZ***StudioNET* PC-software. Communication with **SPATZ+** weld controllers is accomplished via USB interface (**SPATZ***Studio*) and Ethernet (**SPATZ***StudioNET*). The software is the interface between user and weld controller. All programs, settings, and other data are stored in the controller, which runs independent from PC software. In this case the local connected unit is always prior to the central line software.



SPATZ*StudioNET* line-PC-Software communicates with up to 100 weld controllers per installed instance and offers with additional administration tools more functions than **SPATZ***Studio* software. As the **SPATZ***Studio* Software the **SPATZ***StudioNET* allows full Online functionality. Display of electrode life and tip dress counters and spot errors and sequence errors for every connected **SPATZ+** controller are displayed. Weld programs, spot tables, limit- and counter and basic settings can be edited online. All data can be up and down loaded and saved. Weld schedules and **MASTER** programs can be up and downloaded from one weld controller to others. The **SPATZ***StudioNET* software offers additionally automatic storage and update of Backups, QA data, of error and change log files whenever settings and parameters are changed, errors happened or welds have been performed. Thus 100 % consistent backups of all data are given. In addition the firmware for all connected weld timers can be updated quickly, easily and simultaneously.



Modifications of fundamental parameters like weld current, weld time, expulsions, **NUGGET***Index* and tip dress monitoring are depicted quickly and clearly via the integrated online statistics, so that they are accessible to maintenance experts and process experts for line optimizations. Therefore the **SPATZ***Studio* software provides a clear visualization for whole welding lines and whole plants up to plant spanning presentations.



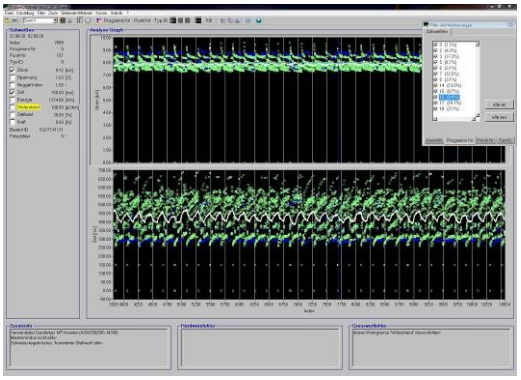
SPATZ*Studio* software offers the following performance characteristics:

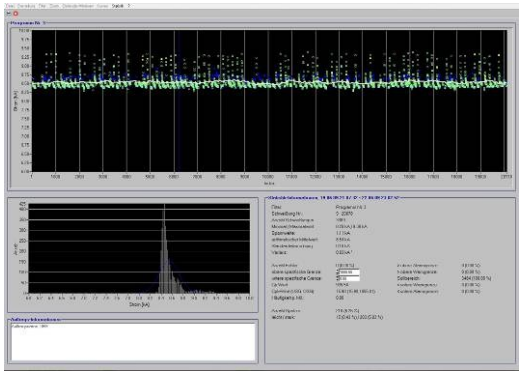
- Online programming of each connected weld controller via USB interface
- Entire online functionality
- QA analysis of the data sets of the last 100,000 welds and of the curve sets of the last 1000 welds
- Error protocol with display of weld parameter progression of weld current, -voltage and trigger angle for each error welding

SPATZ*StudioNET* software offers the following features:

- Administration and communication of up to 100 **SPATZ+** controllers via Ethernet
- **SPATZ***Studio* software completely integrated in **SPATZ***StudioNET s*oftware
- Therefore: Entire online functionality
- Firmware update of all connected weld controllers
- QA analysis of the data sets of the last 100,000 welds and of the curve sets of the last 1000 welds
- Consistent error and change log files
- Automatic Backup-function whenever settings and parameters are changed, including changes via **SPATZ***Studio s*oftware
- Weld spot, weld program or controller related Online statistic for 3 different time frames: short-, mid and long term displaying
  - relative occurrence of weld expulsions
  - percentage deviation from **MASTER** reference weld current
  - percentage deviation from **MASTER** reference weld time
  - relative frequency of **NUGGET***Index* errors
- Permanent storage of QA data of individually selected weld controllers
- Access to programming menus and functions can be programmed with individually set user administration. There is no limit to the number of different access levels. Login is accomplished via entering of password or USB stick identification
- Creation of **MASTER** DATA BASE and transfer of **MASTER** reference programs from **MDB** to **SPATZ+** weld controllers.
- First data import for FAST production line START UP. Extracted data files from customer data base are used for upload to destined weld controllers.

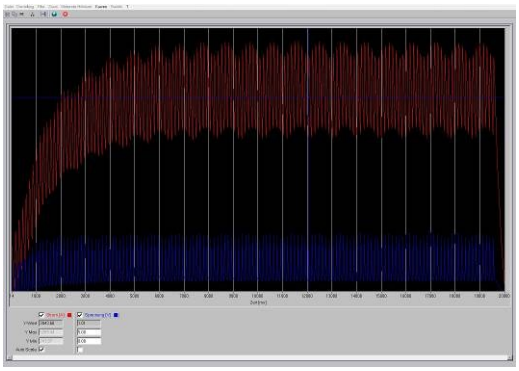
A.9 Analysis Software SPATZ*QS+*





The **SPATZ***QS***+** PC software for data analysis is a key element in quality assurance for high-quality resistance welded joints. Besides the task as a means of documentation of welding process data in running production, the **SPATZ***QS***+** PC software is a particularly efficient tool for achievement and examination of the required machine and process capability in connection with commissioning and process optimization measures.

The **SPATZ***QS***+** PC software which is installed at a PC allows the offline analysis of the weld process data which have been recorded by the **SPATZ+** weld controller (last 100,000 welds) or the **SPATZ***StudioNET* line PC software (arbitrary amount of data). The QA data contain the complete process parameters for each individual weld. The analysis of all data is made in selected intervals, either in accordance with delivery batches or production times. This means that it is possible to evaluate the welding process data in time intervals from a few seconds up to months or years, or, in terms of individual weld quantities, it means the evaluation of up to ten thousands of welds.



The scope of evaluation intervals allows the identification of

factors and correlations which have, so far, been disregarded. A print-out of the analyses for documentary reasons is possible. In addition to the analysis of the total population of weld data, it is also possible to carry out analyses, which refer to the weld gun, the weld program or the spot number. Independent analyses for each weld program can also be made. Quality control charts, necessary for the **S**tatistical **P**rocess **C**ontrol (SPC) for all welding process parameters can be generated.

SPATZ*QS***+** PC software features following characteristics:

- Analysis of weld data recorded via **SPATZ***Studio,* **SPATZ***StudioNET, Auto***SPATZ***AS-01, Auto***SPATZ***AS-32* Software, **SPATZ***BG-02* handhold operating device and **SPATZ***Multi04* weld data recorder
- Graphical representation of weld data as complete weld time, RMS values for weld current and voltage, energy, final resistance, final trigger angle, mean value of electrode force, electrode position after weld and indentation during weld, **NUGGET***Index*
- Weld program and spot number related presentation of weld parameters
- Graphical accentuation of program related weld limits (alarm and warning limits) and welds with limit violation for each weld parameter. Likewise but with different colors device errors and weld expulsions are highlighted graphically
- Presentation of all process data in tabular form
- Graphical presentations of moving average for each weld parameter. This allows detection and evaluation of equipment and operation specific particularities within the population of QA data
- Scaling of x-axis: time wise (time stamp of weld data) or weld spot index related
- Generation of quality control charts for above mentioned weld parameter
- Calculations of statistic parameters for all weld parameters:
    - Mean values
    - Standard deviation
    - Process capability values: Cp and Cpk
- Printout of all graphical presentations

B Notes on Safety

B.1 Intended Use

The **SPATZ+** power unit is intended for use as a weld timer with integrated 1 kHz MFDC inverter for resistance welding applications only. The **SPATZ+** power unit must not be used for any other purposes.

B.2 Safety instructions

- Only a qualified electrician may do the electrical installation of the **SPATZ+** power units, weld cabinets and accessory parts.
- The **SPATZ+** is equipped with internal capacitors which are charged to a dangerous voltage. The supply voltage must be switched off at least 10 minutes prior to opening or exchanging the **SPATZ+** power unit. This time allows the dangerous capacitor charge to be discharged via the internal discharge resistors. Prior to opening the device it must be ensured that it is completely de-energized. Refer to section 0 for further details.
- It is strictly forbidden to power up the system without mainboard.
- It is strictly forbidden to change extension boards or bus boards while the **SPATZ+** mainboard is under power.
- If any component of the **SPATZ+** *M400/M600/M900* power unit or its bus or extension boards will be opened and manipulated, the guarantee will expire immediately. Furthermore there is a high risk of injury!
- The **SPATZ+** *M400/M600/M900* power unit is designed to be built into a switch cabinet with a IP code

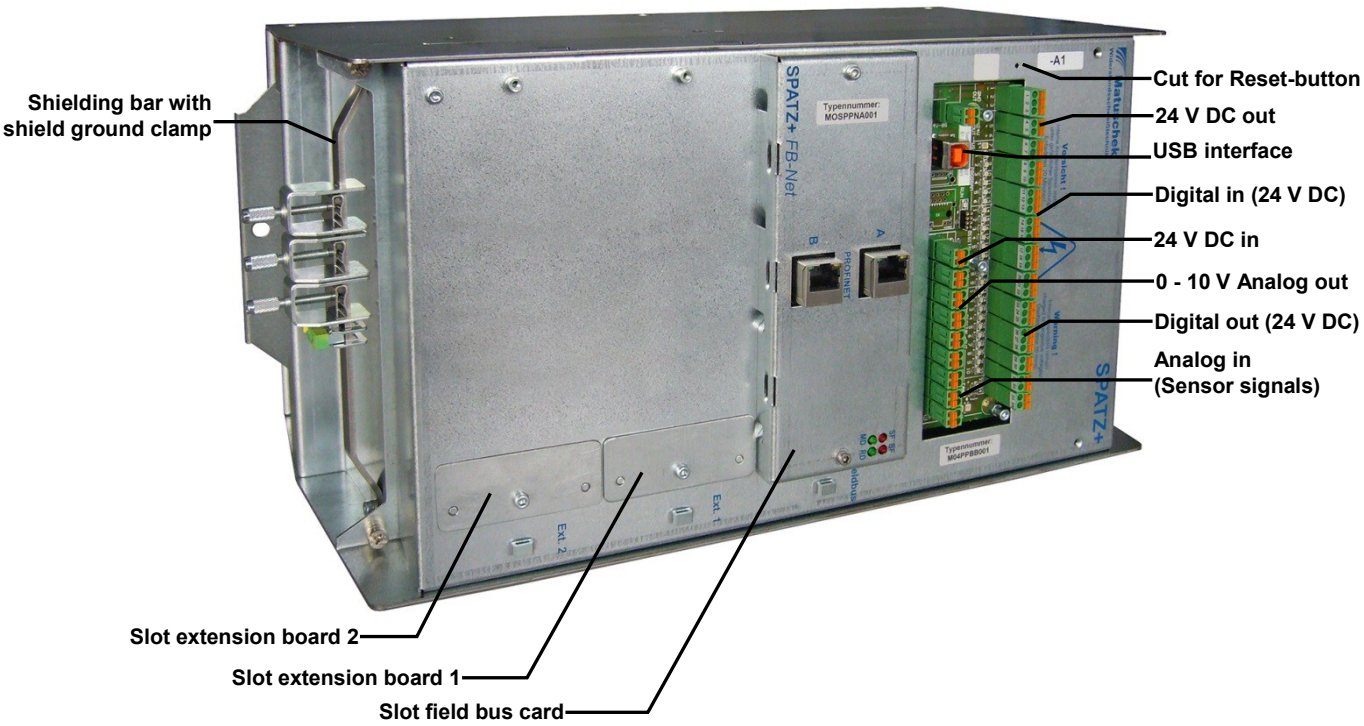
of at least IP 54 for solid particle and liquid ingress protection. If this switch cabinet is not in the scope of delivery of company Matuschek, the integrator is responsible for correct sizing of air / water cooling, cabling, fuses and breakers.

- Due to personal safety reasons it is highly recommended to connect the weld stop input of the **SPATZ+** power unit with safety circuits including devices like floor scanners, cell doors, robot motor stops etc.
- Weld cabinets for applications where the **SPATZ+** weld timer controls servo-electrical axes are equipped with a PHOENIX safety relay for the emergency stop function. For personal safety reasons it is highly recommended to connect the safety relay input and use safety devices like floor scanners, cell doors, robot motor stops etc.
- When using water cooled version of the **SPATZ+** weld timer the cooling water should be switched off after the welding with a certain time delay to avoid condensation of humidity inside the inverter. Such condensation may lead to lead to short circuit or earth leakage currents and may destroy the inverter hardware.
- Detailed information on the electrical calculation of the components of resistance welding devices can be found in the technical bulletin 2918 of the DVS (German Association for Welding and Related Processes). In addition the European standard DIN EN 62135-1 gives safety requirements for design, manufacture and installation of resistance welding equipment.
- Particular secondary circuits of resistance welding machines generate strong magnetic fields. Therefore, persons with cardiac pacemakers or other active implants must avoid the vicinity of resistance welding machines.

C General Technical Information about the SPATZ+

C.1 Position of Connectors and Terminals

Except of the mains connection, the transformer connection and the shield connection all other connections to the **SPATZ+** weld time are pluggable designed:



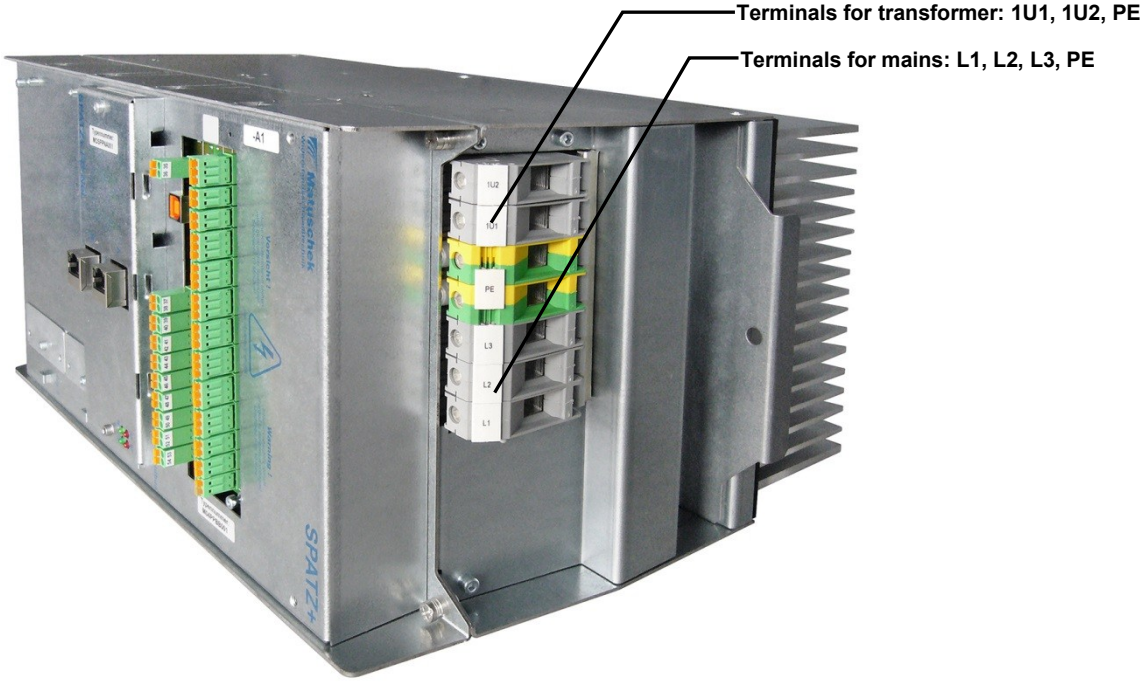


Figure 1: **Position of connectors and terminals of the SPATZ+** *M400L / M600L / M900L*

C.2 Pin Assignment SPATZ+

Contact number	Designation	Function	
1 - 3	GND OUT	0 Volt DC, Power supply of external devices like sensors, initiators	
4 - 6	24 V OUT	24 Volt DC, Power supply of external devices like sensors, initiators	
7	WS	Input WeldStop	
8 - 13	PROGRAM 1 - 6	Digital Inputs, program selection bit 1 - 6, 24 V DC	
14 - 22	DIGITAL IN 1 - 9	Digital inputs 1 - 9, 24 V DC	
23 - 32	DIGITAL OUT 1 - 10	Digital outputs 1 - 10, 24 V DC	
33, 34	FAN +, FAN -	24 Volt DC output for the fans of the air cooling at the cabinet	
35, 36	24 V BG +, -	24 Volt DC output, supply of external programming devices	
37	EXT +	24 Volt DC input, supply voltage for the inputs and outputs of the **SPATZ+** board	
38	EXT -		
39	INT +	24 Volt DC input, supply voltage for the **SPATZ+** board (without the inputs and outputs of the board)	
40	INT -		
41	24 V OUT +	24 Volt DC output, e.g. supply voltage for the inputs and outputs of the **SPATZ+** board	
42	24 V OUT -		
43, 44	24V OUT +, -	24 Volt DC output, e.g. supply of the proportional valve	
45, 46	A-OUT +, A-OUT -	Analog-output, 0 - 10 V respectively 4 - 20 mA, e.g. proportional valve	
47	I +	Weld current, signal in	
48	I -	Weld current, signal GND	
49	U +	Electrode voltage, signal in	
50	U -	Electrode voltage, signal GND	
51	S +	Electrode displacement, signal in	Only as option available for the **SPATZ+***M400L/M600L/M800L*
52	S -	Electrode displacement, signal GND	
53	F +	Electrode force, signal in	Only as option available for the **SPATZ+***M400L/M600L/M800L*
54	F -	Electrode force, signal GND	

Explanations to the function of the I/O of the **SPATZ+** weld timer will be given in section **Fehler! Verweisquelle konnte nicht gefunden werden.**.

C.3 Specification of the Connectors

All 24 V DC connectors, the digital 24 V DC inputs and outputs as well as the analog inputs and outputs are designed as 2- or 3-pole connectors with spring cage connection. Same connector type is used at the extension boards.

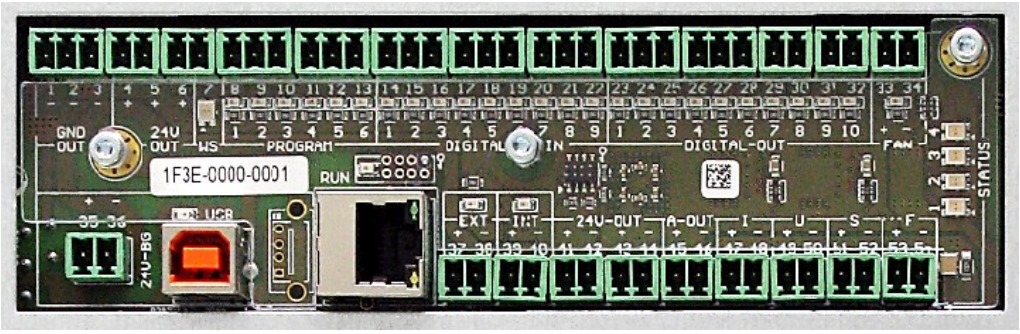


Figure 2: Connectors of the SPATZ+ *M400L / M600L / M800L*

Connector	2- or 3-pole connector
Conductor cross section (solid or stranded)	0.2 - 1,5 mm² / 24 - 16 AWG
Conductor cross section with ferrule without plastic sleeve	0.25 - 1,5 mm²
Conductor cross section with ferrule with plastic sleeve	0.25 - 0,75 mm²

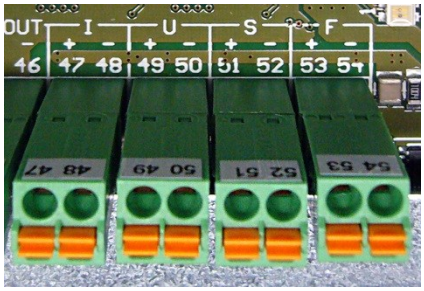
Stripping length, length of sleeve	**10 mm**

C.4 Analog Weld Process Signal Inputs and Analog 0 - 10 V Output

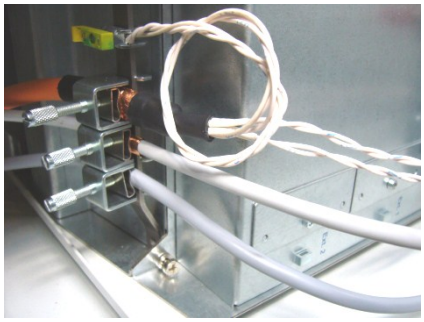
As a standard the **SPATZ+** weld timer is equipped with two analog signal inputs to measure the weld current and the electrode voltage. The **SPATZ+** weld timer can be ordered with two additional analog inputs as an option. With it the electrode force and the electrode displacement can be measured in addition.

Important Note:

When in adaptive **MASTER** control mode, disturbances in weld voltage feedback signal and weld current feedback signal may lead to bad welds. Therefore the maximum length of the sensory cable between gun and weld controller is recommended **not to exceed 15 m** (50 ft). In different situations please ask for further details.



All signal input cables to the **SPATZ+** must be twisted pair and each must have its own separate shielding and a separate pin for the shield of each signal input in every connector. It is not allowed to connect the shields or to connect the shields to Ground / PE in the connectors in between the gun and the timer. If there are several sensor cables in a multiple cable, each twisted pair to a sensor must have its own shielding.



The connections are designed as 2-pole connectors with spring cage connection; the technical details are listed in section C.3. The shield **must not** be connected at the gun or at the sensor; the shield has only to be connected to the shield bar of the **SPATZ+**.

For preparation of the cables for a good shield connection please refer to chapter 0.

C.4.1 Connection and Shielding of the Weld Current Signal

At the transformer the „signal ground“ and „signal“ must be connected to the current control sensor (toroidal coil, sensitivity 150 mV/kA, 50 Hz harmonic), at the gun side the shield is **not** connected, refer to Figure 3. At the **SPATZ+** the „signal“ will be connected to contact 47, the „signal ground“ to contact 48. The shield must be connected to the shield bar at the **SPATZ+**. Please refer to the technical data of the connectors, listed in section C.3.

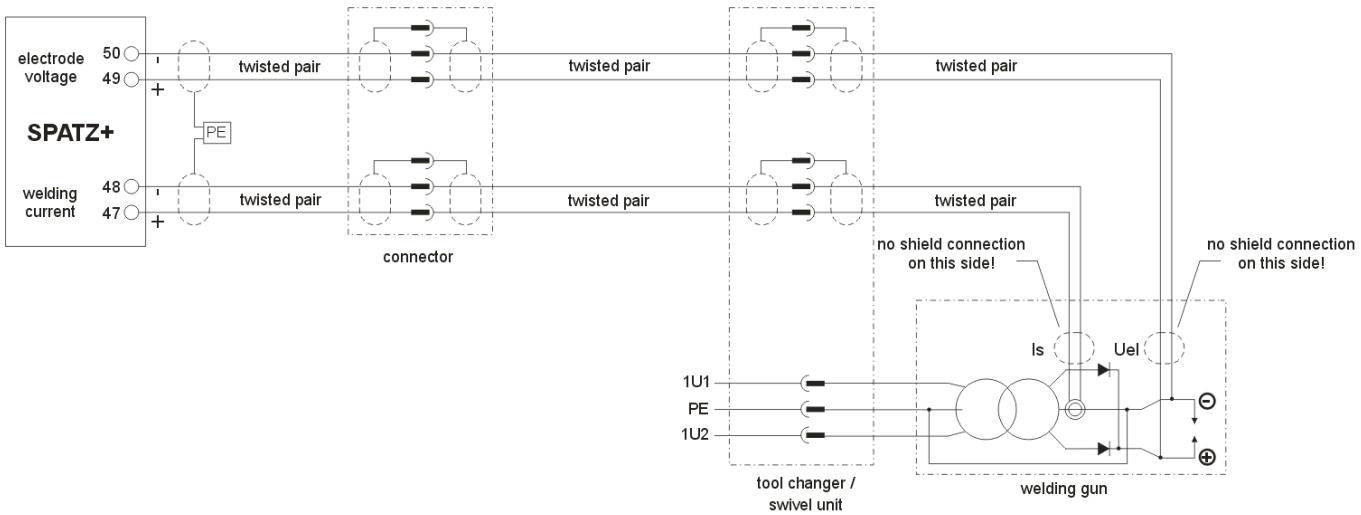
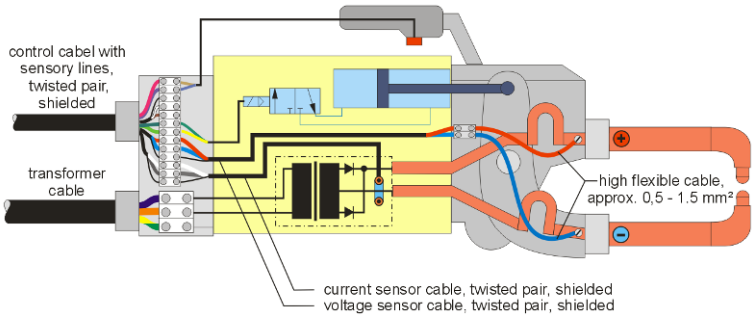


Figure 3: Schematic wiring diagram for shielding of weld current signal and electrode voltage signal

C.4.2 Connection and Shielding of the Electrode Voltage Signal

At the welding gun the **„signal ground" must be connected to the grounded (connected to PE) electrode arm, which is normally the "minus" of the secondary current circuit**, the „signal" must be connected to the "plus" of the secondary circuit. At the gun side the shield is **not** connected, refer to Figure 3. At the **SPATZ+** the „signal" will be connected to contact 49, the „signal ground" to contact 50. The shield must be connected to the shield bar at the **SPATZ+**. Please refer to the technical data of the connectors, listed in section C.3.

The two single ends of measuring cable shall be high flexible cable with a cross section of about 0.5 - 1.5 mm², recommended is the wire type LIFY. The electrode voltage single wires should be connected near to the electrodes. In a welding gun a good and safe position is at the fixing position of the electrode arms in the gun body, where is less risk of damage.



Coming from the transformer, the measuring point must be behind the flexible shunts of the welding gun, otherwise wear of the shunts or heating up of the shunts will be interpreted as a weld process effect and may lead to incorrect control responses.

C.4.3 Connection and Shielding of the Electrode Force Signal (Option)

The adaptive **MASTER** control mode requires the current and electrode voltage signals only. If the **SPATZ+** weld timer was ordered with two additional analog inputs (option), the electrode force signal can be used in addition to supervise the gun and/or the weld process.

At the force sensor the „signal" and the „signal ground" must be connected to the corresponding sensor terminals, the shield is **not** connected to the force sensor, refer to Figure 4. At the **SPATZ+** the „signal" of the force sensor will be connected to contact 53, the „signal ground" to contact 54. The shield must be connected to the shield bar at the **SPATZ+**.

The force sensor must have a floating output. In different situations please ask for further details. Please refer to the technical data of the connectors, listed in section C.3.

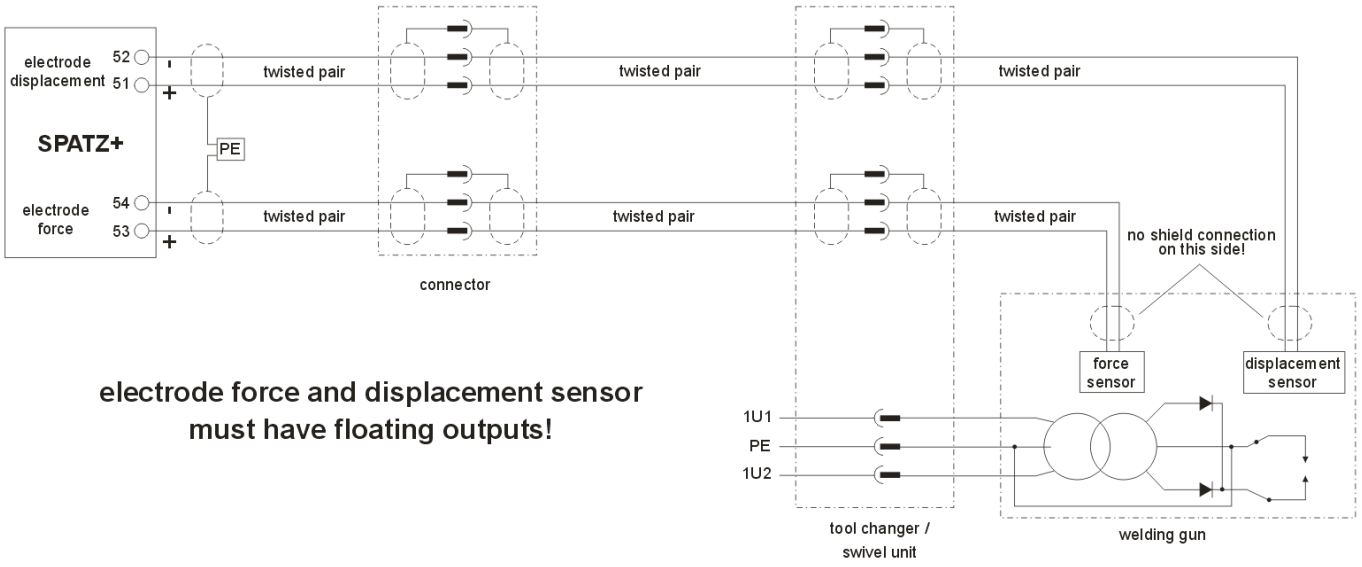


Figure 4: Schematic wiring diagram for shielding of electrode force signal and electrode displacement signal

C.4.4 Connection and Shielding of the Electrode Displacement Signal (Option)

The adaptive **MASTER** control mode requires the current and electrode voltage signals only. If the **SPATZ+** weld timer was ordered with two additional analog inputs (option), the electrode displacement signal can be used in addition to supervise the gun and/or the weld process.

At the displacement sensor the „signal“ and the „signal ground” must be connected to the corresponding sensor terminals. The shield is **not** connected to the displacement sensor, refer to Figure 4. At the **SPATZ+** the „signal“ of the displacement sensor will be connected to contact 51, the „signal ground“ to contact 52. The shield must be connected to the shield bar at the **SPATZ+**. Please refer to the technical data of the connectors, listed in section C.3.

The displacement sensor must have a floating output. In different situations please ask for further details.

C.4.5 Signal Inputs, Electrical Specification

Please refer to the technical data of the connectors, listed in section C.3.

	Weld current	Electrode voltage	Electrode displacement	Electrode force
Input integrator	yes	no	no	no
Input range	±80 kA*	±16 V	±10 V	±10 V
Sensor fault detection	selectable	selectable	selectable	selectable
Input impedance	1 kOhm	10 kOhm	10 kOhm	10 kOhm
Input signal bandwidth	80 kHz	80 kHz	80 kHz	80 kHz
Connector	2-pole	2-pole	2-pole	2-pole
Contact-No. / description Contact-No. / description	47 signal in 48 signal ground	49 signal in 50 signal ground	51 signal in 52 signal ground	53 signal in 54 signal ground
Connector data	refer to section C.3	refer to section C.3	refer to section C.3	refer to section C.3
Shield connection	shield bar	shield bar	shield bar	shield bar
Cable specification	twisted pair, shielded	twisted pair, shielded	twisted pair, shielded	twisted pair, shielded
Cable recommendation	LiYCY	LiYCY	depending on the	depending on the

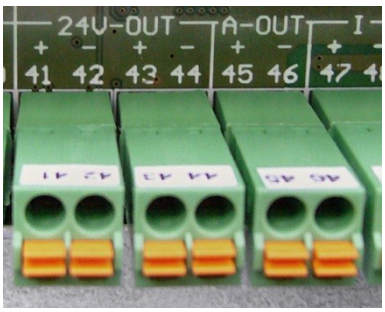
	2 x 0.5 mm² 2 x AWG 20	2 x 0.5 mm² 2 x AWG 20 Inside gun: Single wire LIFY, 0.5 - 1.5 mm²	sensor	sensor
Max. length of sensor cable	**15 m / 50 ft**	**15 m / 50 ft**	**15 m / 50 ft**	**15 m / 50 ft**

*Sensor type: External sensor, toroidal coil, 150 mV/kA, 50 Hz harmonic

C.4.6 Analog Output, Proportional Valve

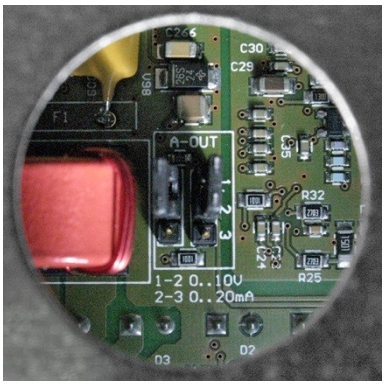
The analog output is provided to serve proportional/servo valves, servo-driven weld heads, etc. It can be used to control a proportional valve by setting a force value in each impulse of a weld schedule. To allow the connection of different types of proportional valves, a force calibration can be performed. By force calibration an adaption to different pneumatic cylinders can be carried out so the force can be programmed.

When using manual welding guns, the proportional valve is controlled via the **SPATZ+** *HAZ1* and **SPATZ+** *HAZ2* extension board, please refer to section **Fehler! Verweisquelle konnte nicht gefunden werden.**.



The connection cable for the programmed target value to the proportional valve must be twisted pair and must have its own separate shielding and a separate pin for this shield in every connector. It is not allowed to connect the shields of different signal input cables or to connect the shield to Ground / PE. If there are several twisted pair signal cables in a multiple cable, each twisted pair to a sensor and to the proportional valve must have its own shielding. The shield must be connected to the shield bar at the **SPATZ+**; at the proportional valve the shield is **not** connected.

At the **SPATZ+** the output signal to the proportional valve will be connected to contact 45, the signal ground to contact 46. **The 24 V DC supply voltage for the proportional valve must be fed via the SPATZ+. Therefore an output terminal is provided (contact 43 and 44).**



At the **SPATZ+** it is via plug-in jumpers selectable, if the analog output is set to 4…20 mA or to 0 - 10 V. The plug-in jumpers are at the lower side of the **SPATZ+** board. To change the settings, the board must be removed from the weld timer, refer to section 0.

The default setting of the analog output is 0 - 10 V, when supplied to the customer. That means, both jumpers are at position 1 - 2. To switch the output to 4 - 20 mA, remove the jumpers (long-nosed plier, forcipes) and put them to position 2 - 3. After checking correct position of the jumpers, the board must be inserted to the lower part of the **SPATZ+** and fixed.

C.4.6.1 Analog Output, Electrical Specification

Connector	2 x 2-pole connector
Contact-No. / description*	43 24 V DC output, supply voltage for valve
Contact-No. / description*	44 0 V DC output, supply voltage for valve
Contact-No. / description	45 analog signal out (0 - 10 V or 4...20 mA)
Contact-No. / description	46 analog signal ground
Connector data	refer to section C.3
Shield connection	Shield bar at the **SPATZ+**
Max. output current	2 A
Short circuit protection	yes

* The external 24 V DC supply for the proportional valve must be fed via the **SPATZ+**.

C.5 USB Interface

The **SPATZ+** weld timer is equipped with a USB interface, type B, to connect a laptop or PC in combination with the PC software **SPATZ***Studio*. The USB connection cable is in the scope of delivery of the **SPATZ***Studio* software. Depending on the USB specification, the maximum cable length is limited to 3 m (9.8 feet).

C.6 Ethernet Interface

The **SPATZ+** weld timer is equipped with an Ethernet interface, to connect a line PC in combination with the software **SPATZ***StudioNET*. Depending on the specification, the maximum cable length is limited to 100 m (330 feet).

Signal LED inside RJ45 connector

Link	(green LED)	
	On	Physical correct ETHERNET connection
	Off	No ETHERNET connection
RX/TX	(orange LED)	
	On	Data transfer via ETHERNET

Ethernet Interface, Electrical Specification

Connector	D-Sub, 9 pin, female, cable outlet 90 - 180°
Contact 1 Contact 2 Contact 3 Contact 4 Contact 5 Contact 6 Contact 7 Contact 8 Contact 9	signal shield not connected RXD/TXD+ not connected GND 5 V not connected RXD/TXD- not connected
Baud rate	max. 12 MBit/sec.
Max. cable length	100 m / 330 ft

C.7 Digital I/O

In addition to the field bus there are physical I/O-ports on the **SPATZ+**. 16 digital inputs and 10 digital outputs are provided for communications with a PLC, for connection of I/O devices respectively (e.g. switches, magnetic valves etc.) in manual gun systems or stationary welding machines. Furthermore there is an additional 24 V DC output to control the fans for the air cooling of an air cooled switch cabinet. Depending on the firmware version and depending if there is a bus connection there are different functions of the digital I/O implemented in the **SPATZ+**, see section **Fehler! Verweisquelle konnte nicht gefunden werden.** for details.

The status off all digital inputs and outputs is visualized with green LEDs on the board close to the corresponding terminal.

C.7.1 Digital Inputs, Electrical Specification

Connector	2- or 3-pole connector
Data of the connector	Refer to section C.3
Max. input voltage (EN 61131-2) for 0-signal	-3 to +5 V DC
Max. input voltage (EN 61131-2) for 1-signal	+11 to +30 V DC
Input current per input	typ. 5 mA
Delay at signal transition	typ. 0.5 ms
Status LED for each input	yes

C.7.2 Digital Outputs, Electrical Specification

Connector	2- or 3-pole connector
Data of the connector	Refer to section C.3
Max. output current per output	500 mA
Max. output current total	4 A
Short circuit protection	Yes
Status LED for each output	Yes

C.7.3 WeldStop

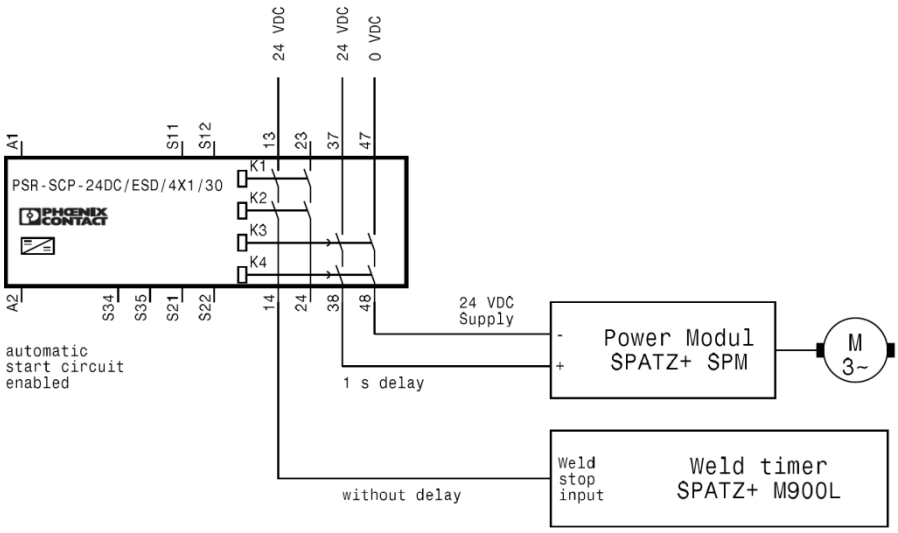
Due to personal safety reasons it is highly recommended to connect the weld stop input of the **SPATZ+** power unit with safety circuits including devices like floor scanners, cell doors, robot motor stops etc.

A running weld process may be interrupted via the special input WS (WeldStop). Its maximum reaction time is 0.5 ms only. See also the sections C.2, C.7.6 and **Fehler! Verweisquelle konnte nicht gefunden werden.**. This input is always working with high priority, independent of any field bus connection.

C.7.4 Emergency stop for systems with servo-drives controlled by the weld timer

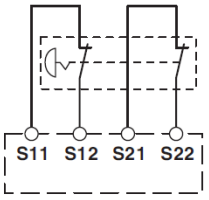
Weld cabinets for applications where the **SPATZ+** weld timer controls via the **SPATZ+** *SEC* extension board and the **SPATZ+** *SPM* power module servo-electrical axes are equipped with a PHOENIX safety relay for the emergency stop function. As a standard wiring in our cabinets the automatic start circuit of the safety relay is enabled: The enabling current paths close automatically when the power supply is switched on with closed emergency stop circuits.

If the relay is activated by the emergency stop circuit, first it activates the weld stop input of the weld timer (24 V DC off). If this 24V DC input is missing, no action can be performed, neither gun movement nor welding. When activating the emergency stop (removing the 24V signal) during gun movement or welding the movement or the welding will be stopped immediately, but in a controlled manner. In addition the safety relay will shut down the 24 V DC supply of the **SPATZ+** *SPM* power module after a short delay time of 1 second to have a 2nd safe shut off of the servo axis.

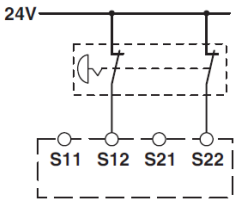


Depending on the safety category required for the whole manufacturing system there are different operation modes available for the emergency circuit:

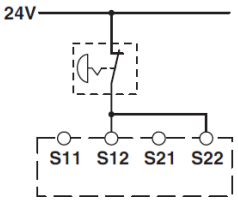
1) Two-channel with cross-circuit monitoring via clock outputs:
   If digital inputs S12 and S22 are controlled with the output signal of digital outputs S11 and S21, the emergency stop circuits are monitored for cross circuits by the safety relay.
   After the safety function has been triggered by the opening of an emergency stop circuit, both emergency stop circuits must be opened once at the same time before it is possible to reset the enabling current paths. If this condition is not met, the device signals an external error.



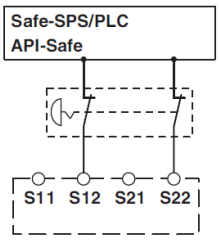
2) Two-channel without cross-circuit monitoring:
   As an option, the two digital inputs S12 and S22 can be activated with a static 24 V DC signal. However, cross-circuit monitoring will no longer be available.



3) Single-channel without cross-circuit monitoring
   Digital inputs S12 and S22 can be connected via a 24 V connection **This application is not "single-fault tolerant"**



4) Two-channel with cross-circuit monitoring via external clock signals:
   If digital inputs S12 and S22 are controlled with the output signals of a safe PLC or API safe, the emergency stop circuits are monitored for cross circuits by the external clock signals.
   Please refer to the documentation of the safety relay for the permitted signal forms of the external clock signals at inputs S12 and S22



Thus the relay will offer safety level up to SIL 3 or Cat.4, PL e according to EN ISO 13849, please refer to the documents of the safety relay attached in appendix A. In addition please refer to the wiring diagram of the cabinet.

Due to personal safety reasons it is highly recommended to connect the safety relay input and use safety devices like floor scanners, cell doors, robot motor stops etc.

C.7.5 Signal Diagrams of Digital I/O

C.7.5.1 Signal Diagram of Standard Welding

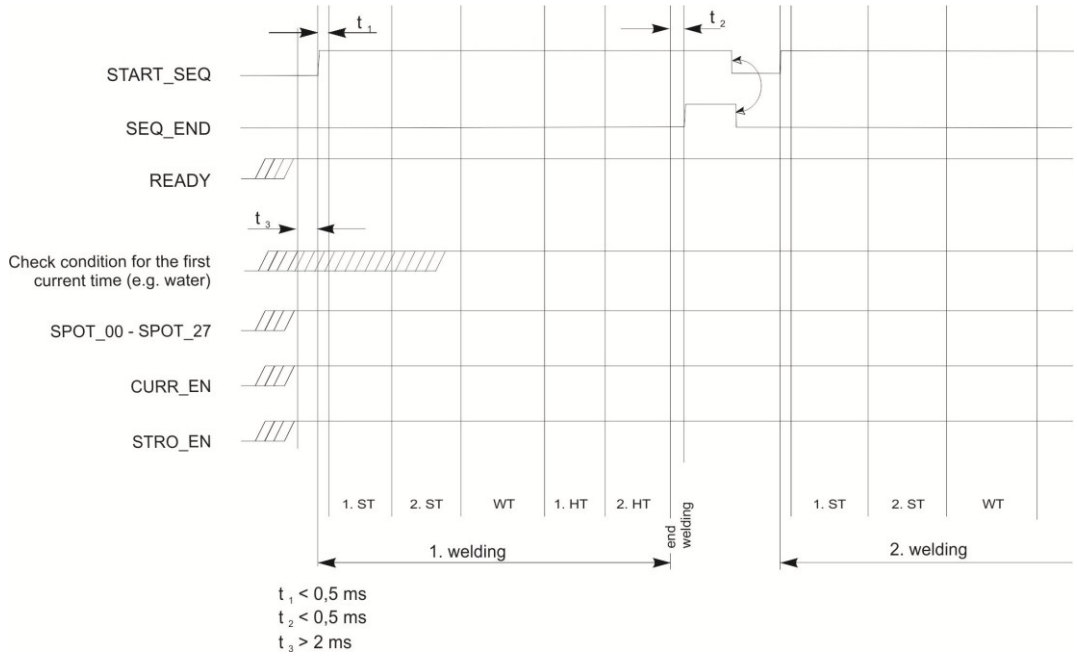


Figure 5: Signal diagram of a standard welding

C.7.6 Signal Diagram of Welding with WeldStop and Error Reset

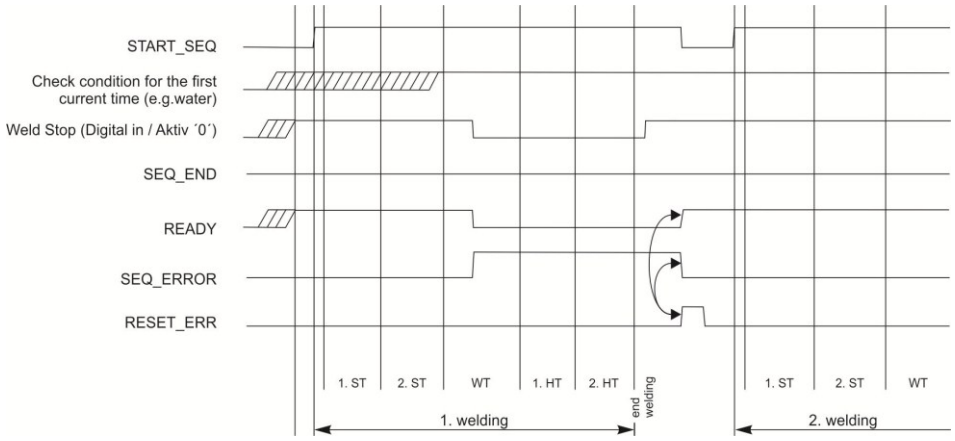


Figure 6: Signal diagram of welding with WeldStop and reset function

C.7.6.1 Signal Diagram of FAN output with delayed switch function

The “FAN” output with delayed switch function is switching on the air cooling or the cooling water via a solenoid at the beginning of a weld. The output is switched off after a programmable time T_v.

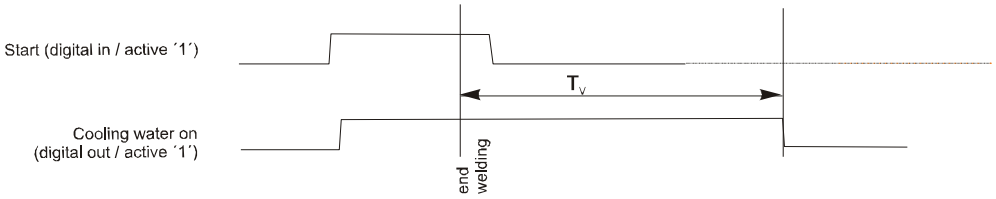


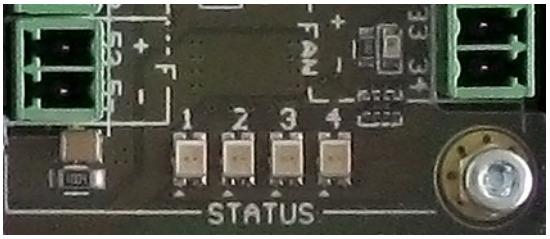
Figure 7: Signal diagram of the FAN output with delayed switch function

C.8 Status LEDs

Four status LEDs at the edge of the connector field give some information about the status of the **SPATZ+** weld timer.

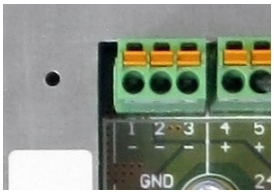
Status LED on board:

No.	Function
1	Without function
2	Blinking green every second during normal operation
3	Without function
4	Blinking green with high frequency during update



C.9 Reset Button

The RESET button is beneath the metal cover at the left narrow side of the connector field. Activate the RESET button with a thin part like the wire of a paper clip through the small hole in the sheet. During normal operation the weld timer will get a reset, similar to a new start when power up the weld timer.

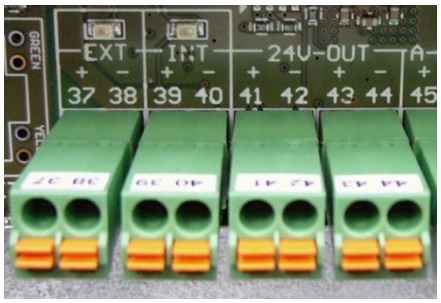


C.10 Power Supply 24 V DC

The **SPATZ+** weld timer is **not** equipped with an internal power supply. The 24 V DC power must be fed into the **SPATZ+** by an external power source, e.g. from the robot cabinet. The 24 V DC power supply of the inputs and outputs and the analog 0 - 10 V outputs are separated from the 24 V DC power supply for the processor board.

While starting the **SPATZ+** weld timer powers up in two steps without notable overshoots: 1st step: ca. 200 mA, 2nd step ca. 350 mA. This means in adjusted state the weld timer with fieldbus board uses ca. 350 mA (without fan or other loads connected to the digital or analogue outputs). The extension board **SPATZ+** *SUP3* needed for the operation of 2 - 3 weld guns spend additional 2 mA.

The overall starting current for both fans is about 700 mA decreasing within 1 second to 300 mA operating current for both fans.



The external power supply for the processor board device must be connected to terminal 37 and 38; the external power supply for the 24 V DC inputs/outputs and the proportional valve must be connected to terminal 39 and 40 of the **SPATZ+** weld timer.

If the external power supply for the board and for the I/O is all the same, supply of the I/O can be done by a bridge between terminal 39 and 41 and a bridge between terminal 40 and 42.

External devices (e.g. electrode displacement sensor, force sensor, proportional valve) can be supplied via terminal 1 - 6 and 41 - 44.

Important note:

- **The total current of all consumers (digital outputs, analog outputs, 24 V DC power supply outputs) must not exceed 6 A.**

C.10.1 24 V DC Power Supply, Electrical Specification

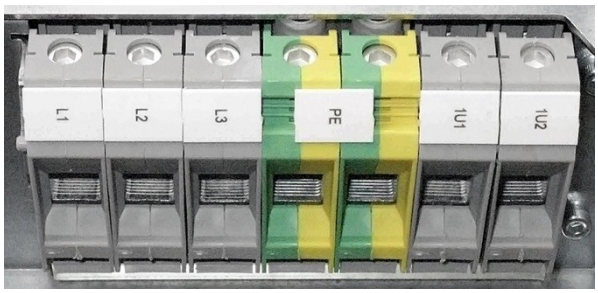
	24 V DC power supply of input and output functions	24 V DC power supply of the timer board
Connectors	2-pole connector	2-pole connector
Contact-No. / description Contact-No. / description	**37** 24 V DC **38** 0 V DC	**39** 24 V DC **40** 0 V DC
Data of the connectors	Refer to section C.3	Refer to section C.3
Max. current of **external** supply	For I/O only: 6 A	Controller boards only: 350 mA Boards and fans: 1 A Max. boards and I/O: 6 A
Protection against incorrect polarity	yes	yes

C.11 Terminals for Electrical Mains and Transformer

The three-phase line voltage is connected via terminals L1, L2, L3 and PE. The allowable line voltage range is 3~400 V to 3~500 V.

The welding transformer is connected to terminals 1U1, 1U2 and PE.

Designation	connection	Max. cross section
L1	400 - 500 V ~ mains	35 mm² / AWG 2
L2	400 - 500 V ~ mains	35 mm² / AWG 2
L3	400 - 500 V ~ mains	35 mm² / AWG 2
PE	Protective Earth / PE	35 mm² / AWG 2
PE	Protective Earth / PE	35 mm² / AWG 2
1U1	Transformer voltage	35 mm² / AWG 2
1U2	Transformer voltage	35 mm² / AWG 2



The required torque for connecting the power supply wire and the transformer wire is 3.2 - 3.7 Nm.

C.12 Cooling

C.12.1 Water Cooling of the SPATZ+

The **SPATZ+** *M400W / M600W / M900W* need cooling water. The aluminium cooling plate is equipped with a high-grade steel tube to avoid corrosion problems and to achieve a low pressure drop.

Important Note:

The cooling water should be switched off after the welding with a certain time delay to avoid condensation of humidity inside the inverter. Such condensation may lead to short circuit or earth leakage currents and may destroy the inverter hardware.

To avoid this, the FAN output (delayed switch function) can be used in most software versions to switch a solenoid valve in the water circuit, see chapter E.4 for more details.

The **SPATZ+** *M400W / M600W / M900W* is equipped with a 3/8" female thread for the water connectors.

	M400W	***M600W***	***M900W***
Water cooling	Cooling water flow at maximum load:	2 l / min at 20 °C - 25 °C, max. 10 bar 1 gal (US) / min at 68 °F - 77 °F, max. 145 PSI	
	Pressure drop:	< 150 mbar at 12 l/min < 2.2 PSI at 3.2 gal (US)/min	

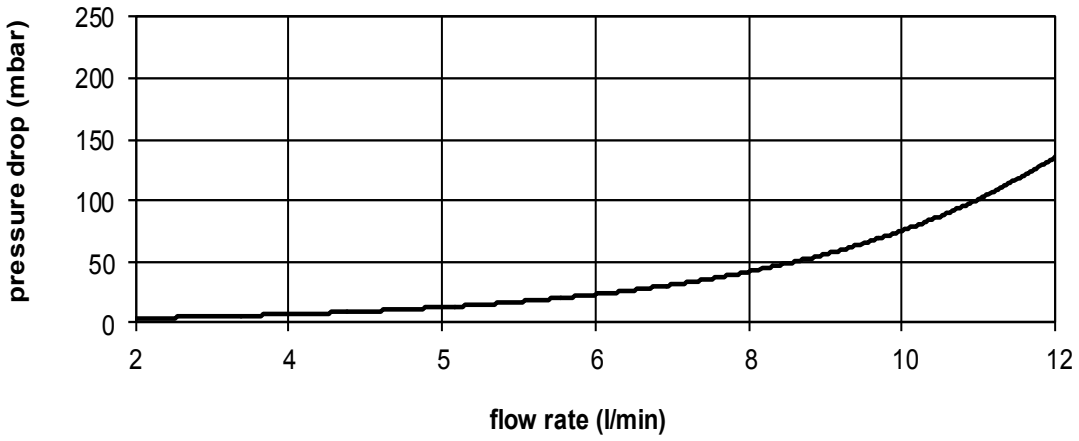
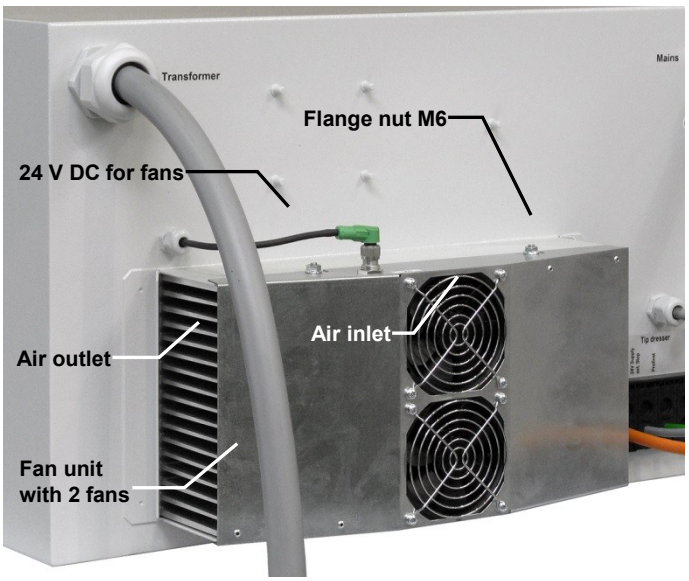


Figure 8: Cooling water, pressure drop of SPATZ+*M400W/M600W/M900W*

C.12.2 Air Cooling of the SPATZ+

The **SPATZ+** unit needs a fan driven air-cooling. The **SPATZ+** *CL-R* cabinet is equipped with the correct chosen fans and air channel dimension to achieve optimum air-cooling of the **SPATZ+** unit. The fans are inside a cover plate on the backside of the cabinet. The air inlet is from rear side, air outlet is sideways. The air channel is hermetically sealed from the inner of the cabinet.



C.13 Technical Data of the SPATZ+ *M400L / M600L / M900L*

	M400L	***M600L***	***M900L***
Mains voltage U_1	3 ~ 400 V - 500 V, 50/60 Hz		
Maximum power S_{max}	200 kVA with 400 V	300 kVA with 400 V	400 kVA with 400 V
Nominal power S_N	140 kVA with 20 % ED, 400 V 90 kVA with 50 % ED, 400 V	150 kVA with 20 % ED, 400 V 90 kVA with 50 % ED, 400 V	150 kVA with 20 % ED, 400 V 90 kVA with 50 % ED, 400 V
Nominal output current I_2	400 A	600 A	900 A
Maximal output current I_{2max}	450 A	650 A	950 A
Output voltage U_{2n}	500 V / 1 000 Hz		
Fan cooling	Ambient air temperature max. 50 °C / 122 °F		
Water cooling	Cooling water flow at maximum load: 2 l / min at 20 °C - 25 °C, max. 10 bar 1 gal (US) / min at 68 °F - 77 °F, max. 145 PSI Pressure drop: < 150 mbar at 12 l/min < 2.2 PSI at 3.2 gal (US)/min		
Type of protection	IP20		
Dimensions (HxWxD)	390 x 200 x 345 mm / 15.4 x 7.9 x 13.6 in		
Weight	20 kg	21 kg	22 kg

C.14 Load Diagrams of Input and Output Currents

The following diagram shows the input and output currents of the **SPATZ+** power unit depending on the welding current and the transformers ratio.

The input current is the current **in one phase** passing from the mains to the **SPATZ+** inverter power unit; the output current is the current passing from the **SPATZ+** power unit to the welding transformer. The value I_{max} must not be exceeded within the weld. To ensure this the **SPATZ+** inverter is equipped with over-current shutdown.

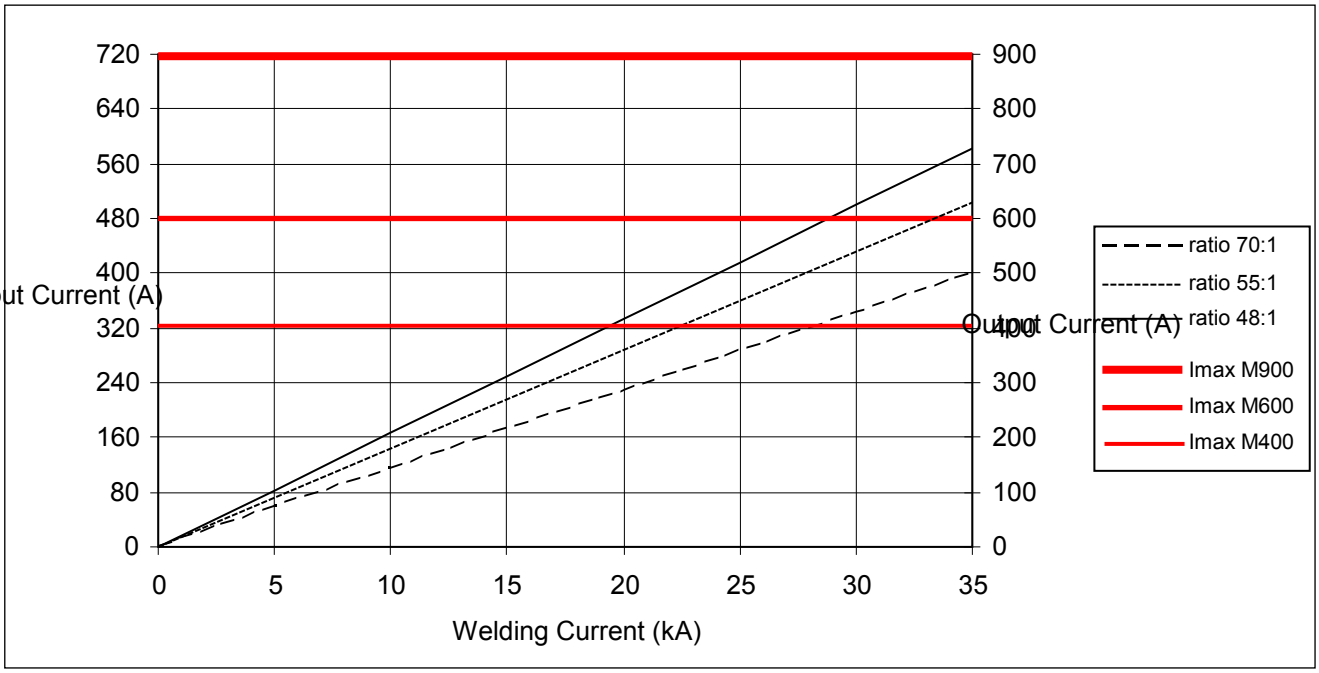


Figure 9: Input and Output current of the SPATZ+*M400L*, *M600L* and *M900L* as a function of the welding current

Next diagram shows the allowed output current of the **SPATZ+** power unit depending on the duty cycle. These values must not be exceeded during daily operation. The output current is the current passing from the **SPATZ+** power unit to the welding transformer.

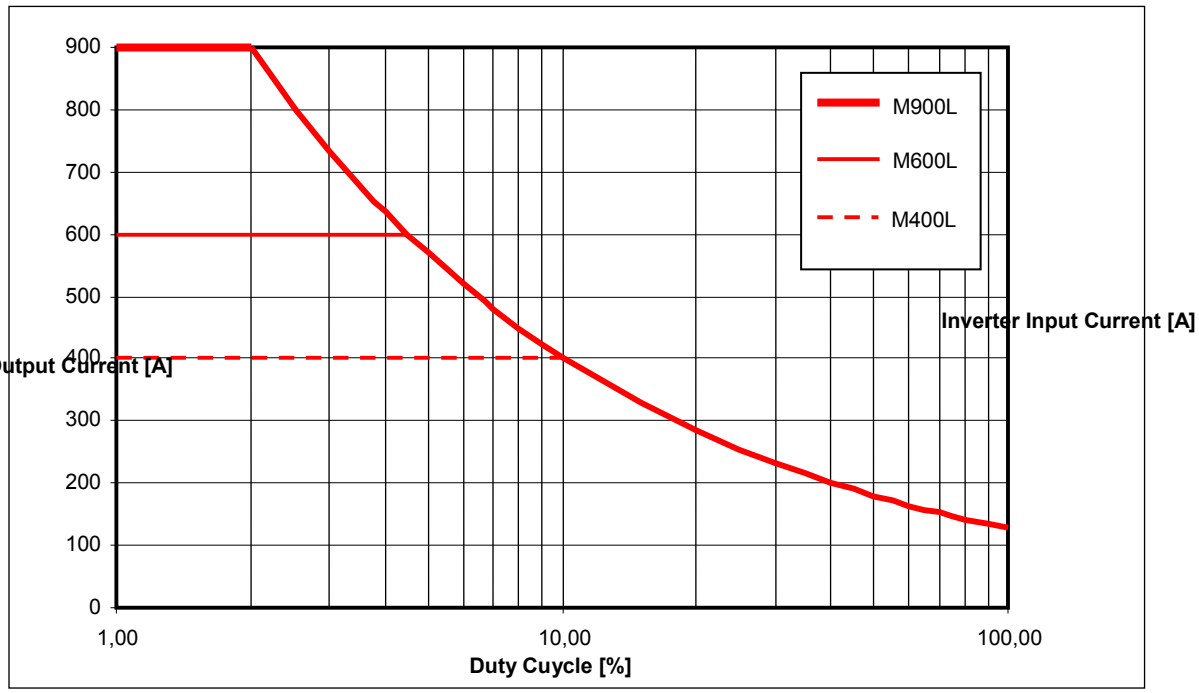


Figure 10: Duty cycle and inverter output current of the SPATZ+ *M400L, M600L* and *M900L*

The following diagrams show the thermal current of the **SPATZ+** weld inverter which depends on weld current, duty cycle and transmission ratio of the weld transformer. Wires and the appropriate fuses and switches must be dimensioned based on this thermal current. The value $I_{max\ therm}$ defines the maximum thermal current for the **SPATZ+**.

The value $I_{max\ therm}$ must not be exceeded.

The thermal input current is the rated current **in one phase** passing from the mains to the **SPATZ+** in-

verter power unit; the thermal output current is the rated current passing from the **SPATZ+** power unit to the welding transformer.

The green area shows the valid weld current where the value I_{max} of the **SPATZ+** is not exceeded while welding (dotted line) respectively where the rated current $I_{max\ therm}$ is not exceeded within a weld cycle (red margin line).

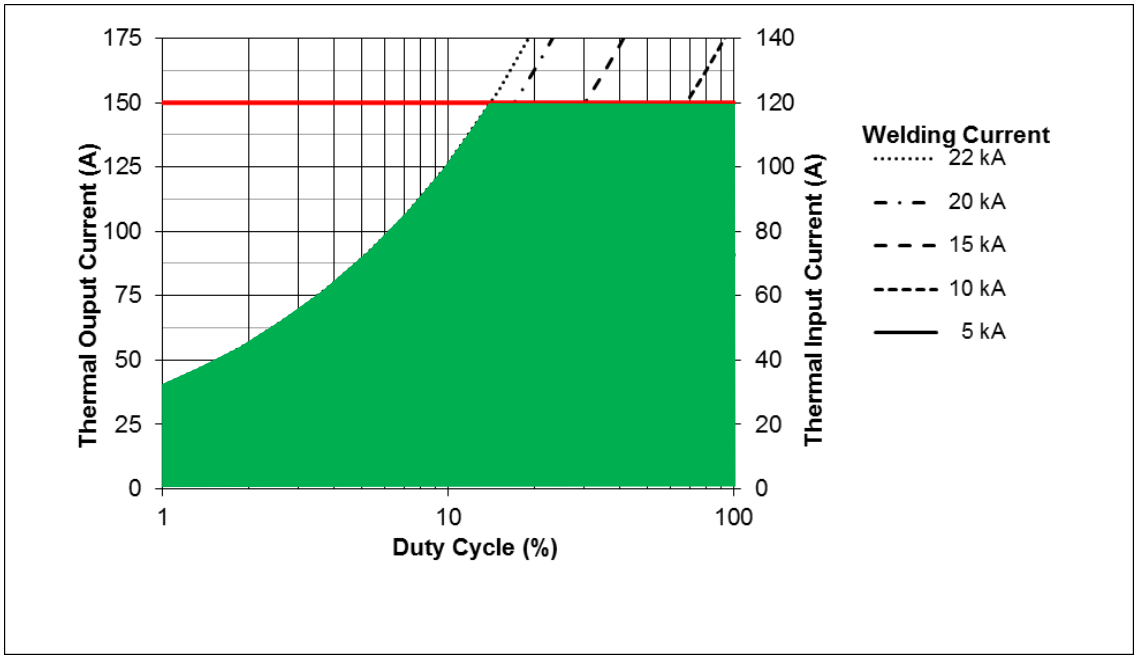


Figure 11: Rated operational (thermal) input and output current of the SPATZ+ *M400L* with transformer ratio 48:1

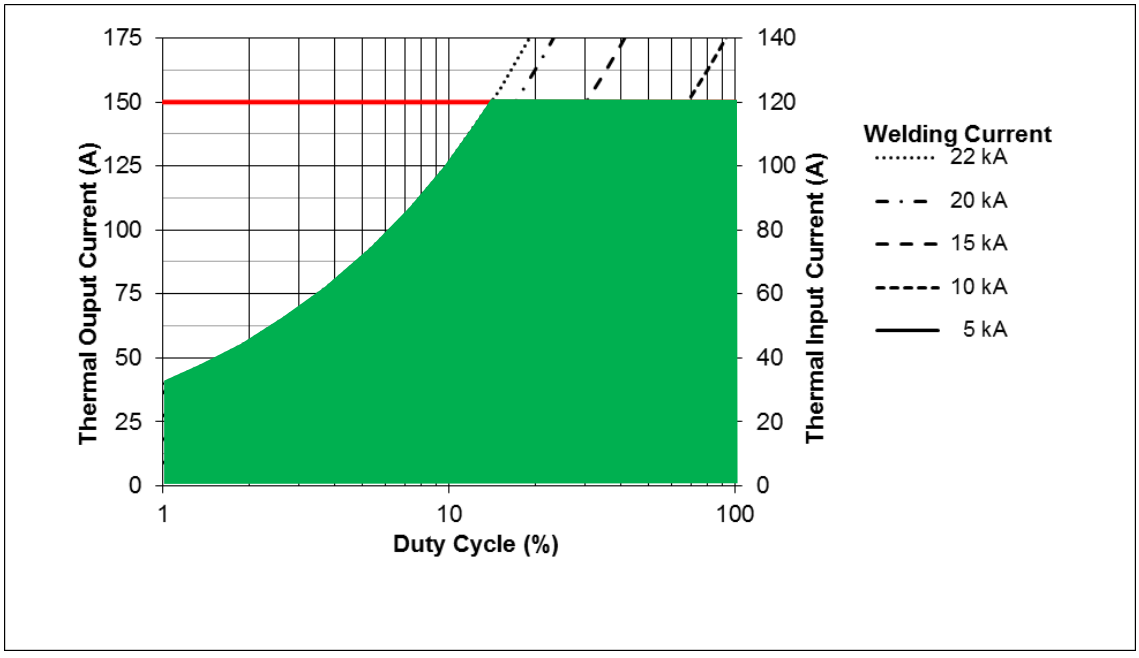


Figure 12: Rated operational (thermal) input and output current of the SPATZ+ *M400L* with transformer ratio 55:1

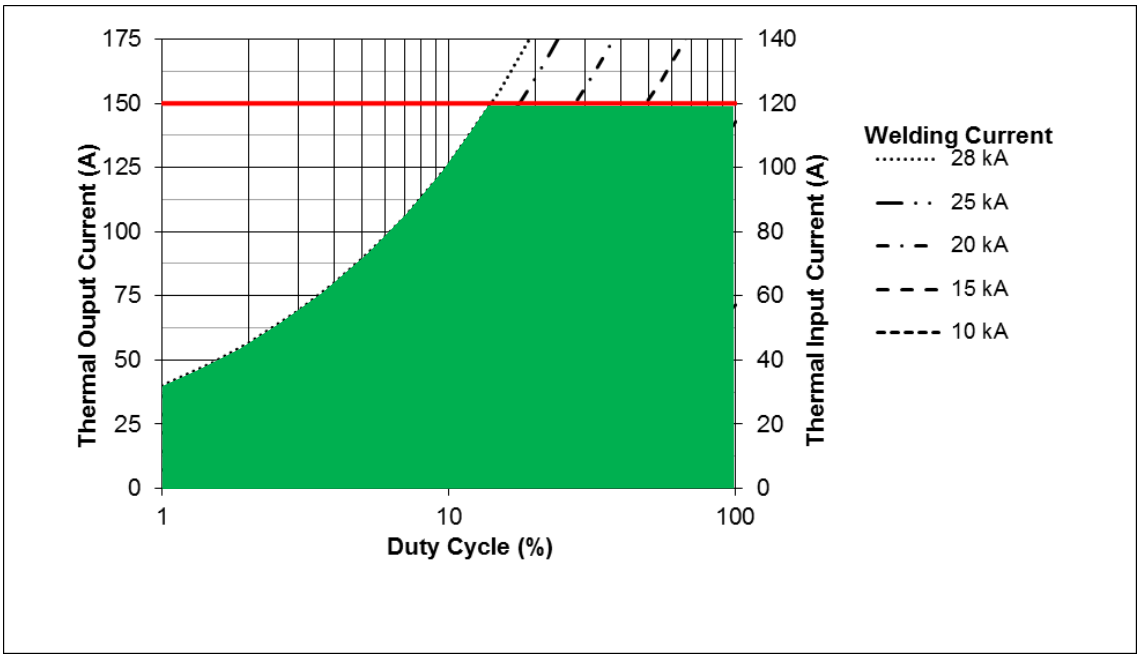
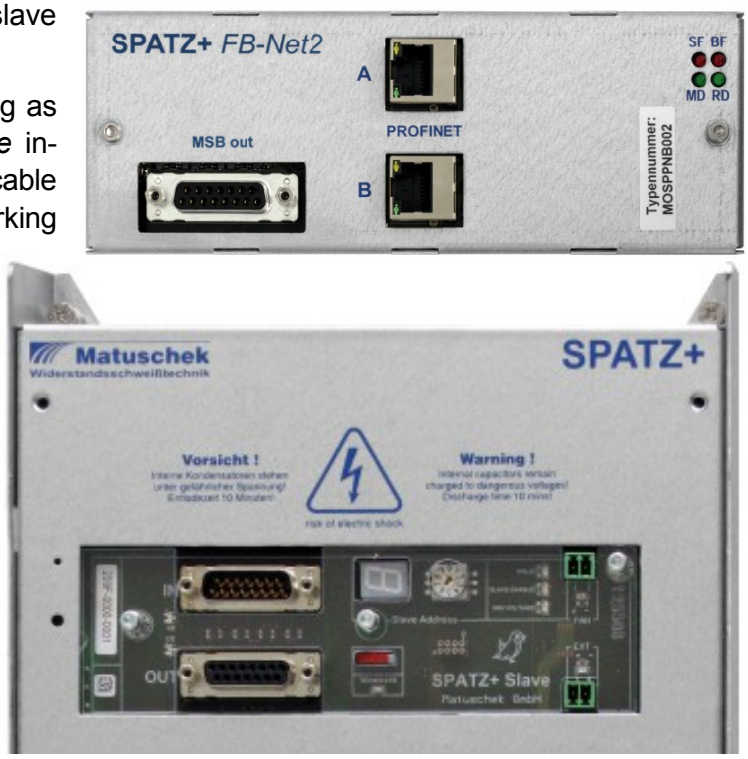


Figure 13: Rated operational (thermal) input and output current of the SPATZ+ *M400L* with transformer ratio 70:1

D High current and / or servo-drive applications

D.1 Master-Slave connection for high current applications

For applications with high welding currents, e.g. aluminium welding, the slave inverter power source **SPATZ+** *M900 Slave* is available. One standard **SPATZ+** *M900* working as master, is equipped with all necessary extension boards and is doing the complete process control. Up to 3 **SPATZ+** *M900 Slave* inverters can be controlled with one master slave **SPATZ+** *M900*.

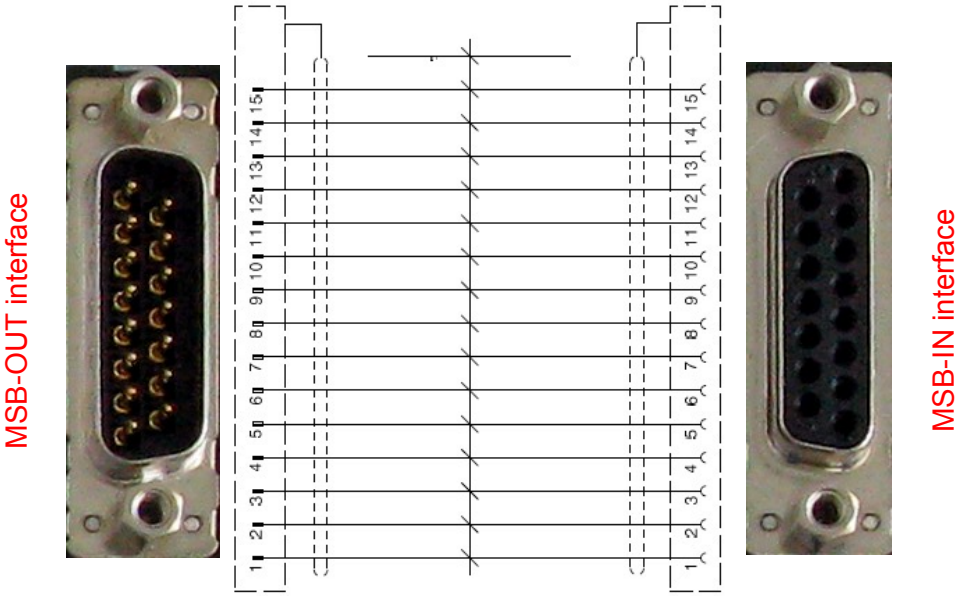


The connection from the **SPATZ+** *M900* working as master to one or several **SPATZ+** *M900 Slave* inverters is done via a master-slave connection cable (included in delivery). At the **SPATZ+** *M900* working as master the respective interface for the Master-Slave-Bus (MSB Out) is located at the corresponding bus extension board, e.g. **SPATZ+** *FB-Net2.* At the **SPATZ+** *M900 Slave* the MSB interface (MSB in) is located at the slave mainboard.

If there are more then one **SPATZ+** *M900 Slave* inverter, the 2nd and following connection cables will connect the MSB out interface of the slave mainboard with the MSB in interface of the next slave. The slave address for the first slave is "1" and must be set at the slave mainboard. The address is increased for every following slave. In addition the last slave must be terminated.

D.1.1 Connection cable SPATZ+ to SPATZ+ *Slave*

The connection cable comes as a ready to plug cable in a fixed length of 450 mm for our standard cabinets.



D.1.2 Setting the Slave Adress

The slave address for the first slave is "1" and set with the rotary dip switch at the **SPATZ+** *M900* Slave. It must be increased for every following slave.

D.1.3 Setting the Termination

The termination must be turned on at the last **SPATZ+** *M900* Slave. It is illuminated when active.

D.1.4 Slave Error Codes (7 Segment Display)

If the slave detects a hardware errors, an error code will be shown at the 7 segment display in the following order:

A (adress) → adress slave → E (error) → error code.

Several errors can be shown successively

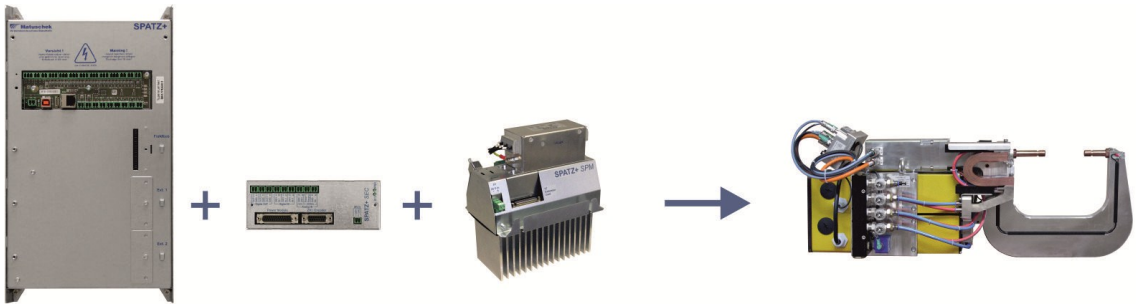
order	Code	Description
1st	A	Address: Next displayed code will be the Slave address
2nd	1 - 3	Slave address 1, 2 or 3
3rd	E	Address: Next displayed code will be the Error code
4th	1 - 9	1: 24 V supply too low (<16,2 V)
		2: Phase error at 400 V supply
		3: All 3 phases missing at 400 V supply
		4: IGBT error
		5: Overtemperature inverter
		6: Overcurrent during weld
		7: Master/Slave communication error
		8: Short circuit at Fan output
		9: Slave address error

D.2 Components for applications with servo-electrical drives

The **SPATZ+** weld timer is modular and can be configured with **SPATZ+** *SEC* servo extension boards at the **SPATZ+** weld timer and **SPATZ+** *SPM* servo power modules inside the switch cabinet for up to two servo electrical axes, each axis needs its own **SPATZ+** *SPM* module and **SPATZ+** *SEC* board. There are 3 different combinations possible:

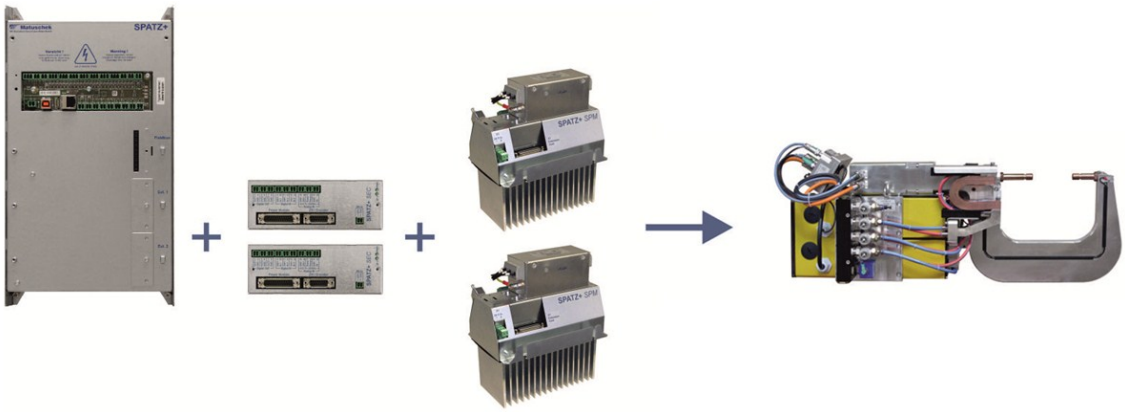
D.2.1 Control of one servo-electrical axis in a welding gun

With this configuration the **SPATZ+** weld timer can control the axis for the electrode force in a servo-electrical gun. The **SPATZ+** weld timer must be equipped with one **SPATZ+** *SEC* board and the weld cabinet with one **SPATZ+** *SPM* module.



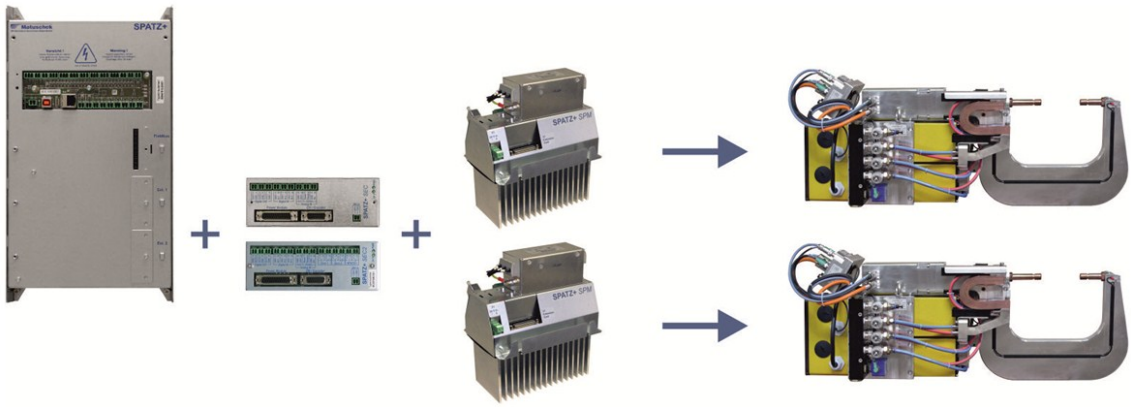
D.2.2 Control of two servo-electrical axes in one welding gun

With this configuration the **SPATZ+** weld timer can control the axis for the electrode force and the one for the gun equalizing in a servo-electrical gun. The **SPATZ+** weld timer must be equipped with two **SPATZ+** *SEC* boards and the weld cabinet with two **SPATZ+** *SPM* modules.



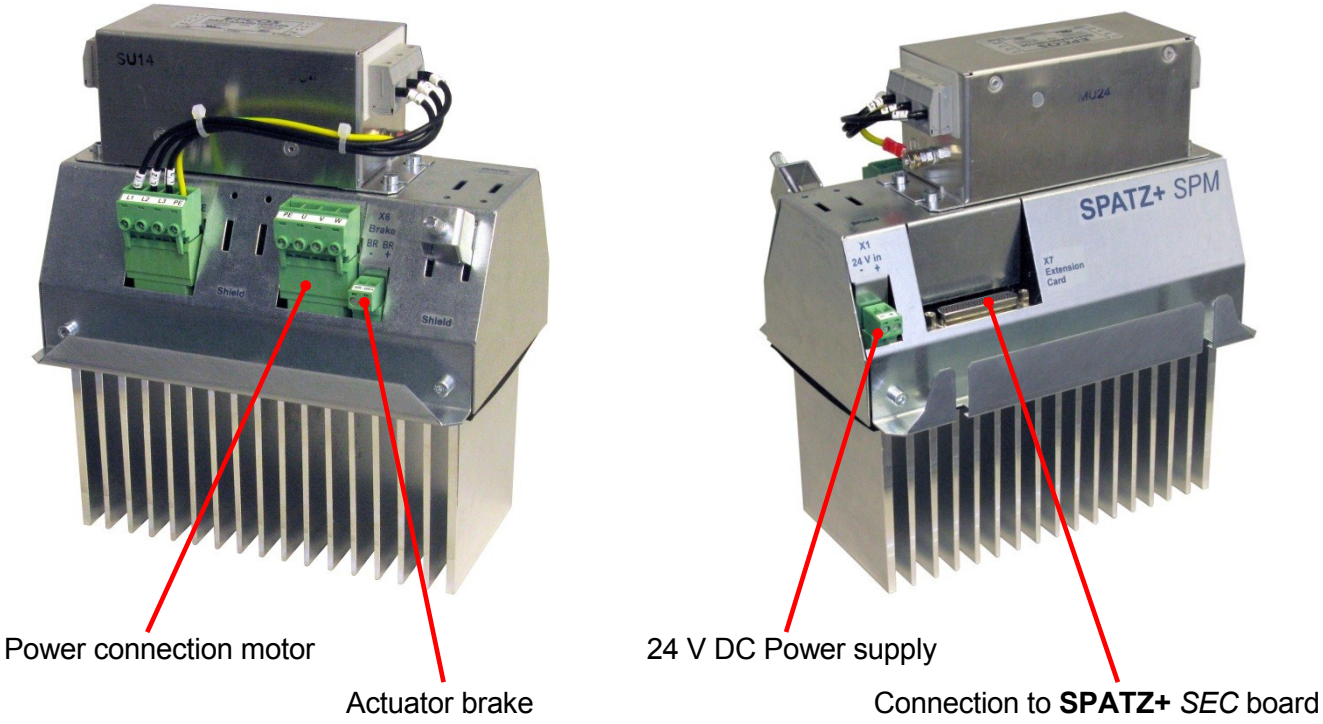
D.2.3 Control of two times 1 servo-electrical axis in two welding guns

With this configuration the **SPATZ+** weld timer can control the axis for the electrode force in two different servo-electrical guns. The **SPATZ+** weld timer must be equipped with one standard **SPATZ+** *SEC* board and the special **SPATZ+** *SEC2* board with an integrated sensory switch. The weld cabinet must be equipped with two **SPATZ+** *SPM* modules.



D.3 Servo Power Module SPATZ+*SPM*

The **SPATZ+** *SPM* servo power module is controlled by the **SPATZ+** *SEC* extension board. Up two 2 axes can be controlled by the **SPATZ+** weld timer, each axis needs its own **SPATZ+** *SPM* module and **SPATZ+** *SEC* board. The **SPATZ+** *SPM* module is mounted like the weld timer at the back wall of a cabinet, the heat sink of the module is cooled by the fans of the weld timer cooling too. The cooling channel of the cabinet is just extended by appropriate cover plates, no additional fan unit is necessary.



D.3.1 Pin assignment for the SPATZ+ *SPM* Servo Power Module terminals and connectors

PIN assignment mains terminals (at the filter on top of the SPATZ+ *SPM*)				
Pin	Name	Description	Max. Cross section	Torque
L1	Line L1	Phase L1	4 mm² / AWG11	0.6-0.8 Nm
L2	Line L2	Phase L2		
L3	Line L3	Phase L3		
PE	PE	Protective Earth / Ground	PE bolt M4 x 19 mm	-

PIN assignment mains input connector (X5)				
Pin	Name	Description	Conductor Cross section	Torque
L1	L1	Phase L1' from filter	ferrule without plastic sleeve:	≤ 4 mm²: 0.5-0.6 Nm

L2	L2	Phase L2' from filter	0.25 – 6 mm² / AWG24 - AWG10 ferrule with plastic sleeve: 0.25 – 4 mm² / AWG24 - AWG11	>4 mm²: 0.7-0.8 Nm
L3	L3	Phase L3' from filter		
PE	PE	Protective Earth / Ground		

PIN assignment motor power connector (X4)				
Pin	Name	Description	Conductor Cross section	Torque
PE	PE	Protective Earth / Ground	ferrule without plastic sleeve: 0.25 – 6 mm² / AWG24 - AWG10 ferrule with plastic sleeve: 0.25 – 4 mm² / AWG24 - AWG11	≤ 4 mm²: 0.5-0.6 Nm >4 mm²: 0.7-0.8 Nm
L1	U	Phase U		
L2	V	Phase V		
L3	W	Phase W		
Shield	Shield	Shield clamp SK14 at housing		

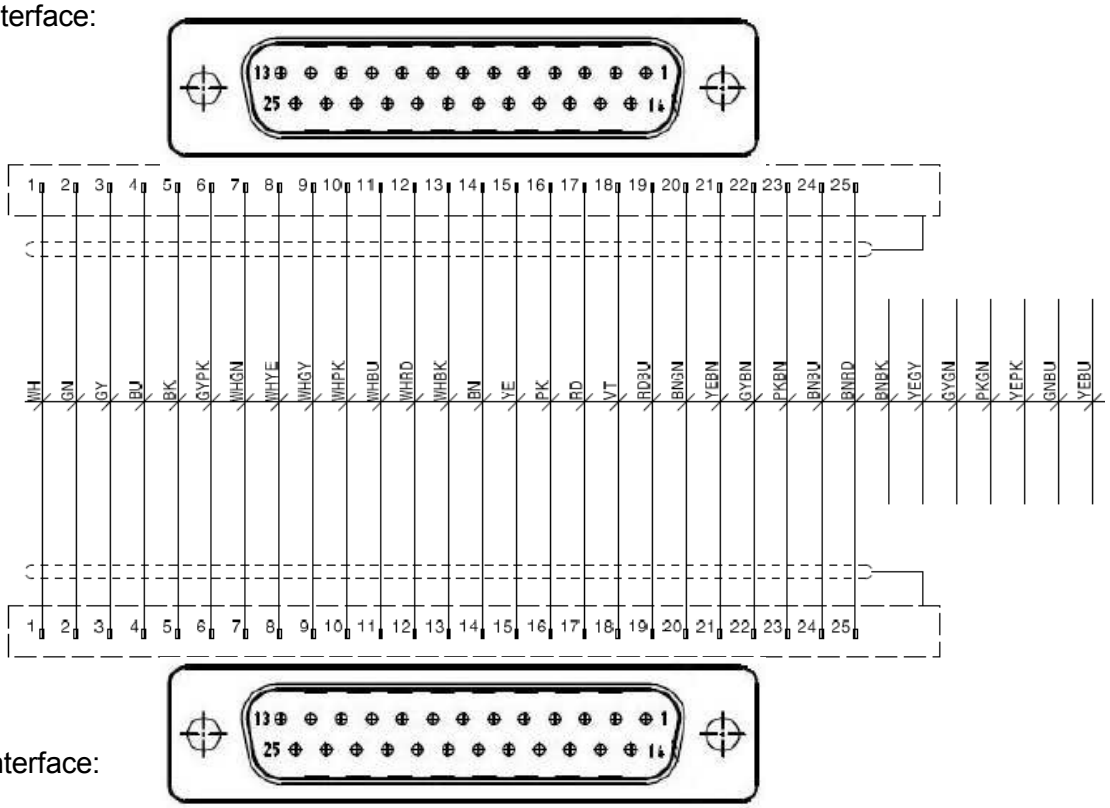
PIN assignment motor brake connector (X6)				
Pin	Name	Description	Conductor Cross section	Torque
BR -	BR -	Brake -	0.25 – 2.5 mm² AWG24 - AWG12	0.5-0.6 Nm
BR +	BR +	Brake +		

PIN assignment 24 V DC power supply connector (X1)				
Pin	Name	Description	Conductor Cross section	Torque
1	BR -	Brake -	0.25 – 2.5 mm² AWG24 - AWG12	0.5-0.6 Nm
2	BR +	Brake +		

D.3.2 Connection cable SPATZ+ *SEC* extension board to SPATZ+ *SPM* power module

The connection cable comes as a ready to plug cable in a fixed length of 550 – 750 mm depending on the different positioning of the **SPATZ+** *SPM* power modules inside the cabinet.

SPATZ+ *SEC* interface:



SPATZ+ *SPM* interface:

D.4 SPATZ+ *SEC* Servo Extension Board

The **SPATZ+** *SEC* extension board controls the **SPATZ+** *SPM* servo power module. Up two 2 axes can be controlled by the **SPATZ+** weld timer, each axis needs its own **SPATZ+** *SEC* board and **SPATZ+** *SPM* module. The **SPATZ+** *SEC* extension board is mounted at the extension slot of the **SPATZ+** weld timer, please refer to chapter 0 for detailed information of installation and detailed technical data.

Two different types of the **SPATZ+** *SEC* board are available:

- **SPATZ+** *SEC* extension board
- **SPATZ+** *SEC2* extension board with integrated sensor switch

D.5 SPATZ+ *GM* Gun module (optional)

The **SPATZ+** high-tech controller can be connected via 2-wire Bus with the **SPATZ+** *GM* gun module which is mounted on the welding gun or the welding machine. This gun module pre-processes the sensor signals for the welding current, the electrode voltage and, if necessary, for the electrode force and the electrode displacement. Encoder signals of the servo motors are, moreover, processed and, together with the sensor signals, transmitted via the 2-wire Bus to the **SPATZ+** controller.

All welding program data, **MASTER** reference curves, motor parameters, geometry data and other maintenance and machine information data which are required for the operation of a specific welding gun are thus stored in the **SPATZ+** *GM* gun module. Every time the system is switched on or every time the welding gun is changed, the data are automatically transferred to the high-tech controller. All servo guns or machines which are equipped with the gun identification system can be operated with any high-tech controller and without repeated preoperational work. The welding guns can be programmed “offline” by the gun manufacturer or by the maintenance staff, thus weld parameter determination in the line is no longer necessary.

D.5.1 SPATZ+ *GM* Status LED

There are 5 status LED at the upper left corner of the **SPATZ+** *GM* gun module.
They signal the following status information:

LED	Name	Colour	Meaning
1	PWR	**green**	Internal 24V OK
2	Proc	**green**	Internal CPU voltage OK
3	Ready	**green**	Gun Module Software initiated
4	Bus	**green**	Gun Module Bus communication established
5	Error	**red**	Error (red LED) Refer to **SPATZ***Studio* documentation for details

D.5.2 ServoSPATZ+ *GM1*

The **SPATZ+** *GM1* gun module is designed for servo-electrical welding guns were just the axis for the electrode force is controlled by the **SPATZ+** weld timer. It comes in a rigid aluminium housing for fix mounting with M5 screws at the welding gun and needs external 24 V DC power supply. It is connected via a high speed bus to **SPATZ+** *SEC* extension board of the **SPATZ+** weld timer, the bus is dockable.

The features of the **SPATZ+** *GM1* gun module are:

- 1 encoder input
- 3 digital inputs (24 V DC)
- 3 digital outputs (24 V DC), max. 500 mA each
- 3 signal inputs for electrode voltage,
  welding current, electrode displacement or electrode force
- integrated welding gun identification system **MASDAT**

All electrical connections are done with M12 male and female connectors:

Connector	Type	Specification
XG1	female	24 V DC power supply
XG2	male	High speed bus to **SPATZ+** *SEC* extension board of the **SPATZ+** weld timer
XG3	male	3 digital inputs and 3 digital outputs, 24 V DC
XG5	female	Encoder 1 for actuator 1 (main actuator, electrode force)
XG7	male	Force sensor for actuator 1 (main actuator, electrode force)
XG8	male	Electrode voltage
XG9	female	Welding current sensor and transformer temperature

D.5.3 ServoSPATZ+ *GM2*

The **SPATZ+** *GM2* gun module is designed for servo-electrical welding guns were the axis for the electrode force and the axis for equalizing of the gun are controlled by the **SPATZ+** weld timer. It comes in a rigid aluminium housing for fix mounting with M5 screws at the welding gun and needs external 24 V DC power supply. It is connected via a high speed bus to **SPATZ+** *SEC* extension board of the **SPATZ+** weld timer, the bus is dockable.

The features of the **SPATZ+** *GM2* gun module are:

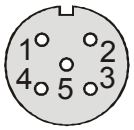
- 2 encoder input
- 3 digital inputs (24 V DC)
- 3 digital outputs (24 V DC), max. 500 mA each
- 4 signal inputs for electrode voltage, welding current, electrode displacement and electrode force
- integrated welding gun identification system **MASDAT**

All electrical connections are done with M12 male and female connectors:

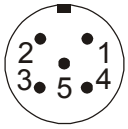
Connector	Type	Specification
XG1	female	24 V DC power supply
XG2	male	High speed bus to **SPATZ+** *SEC* extension board of the **SPATZ+** weld timer
XG3	male	3 digital inputs and 3 digital outputs, 24 V DC
XG4	female	Encoder 2 for actuator 2 (equalizing)
XG5	female	Encoder 1 for actuator 1 (main actuator, electrode force)
XG6	male	Force sensor for actuator 2 (equalizing)
XG7	male	Force sensor for actuator 1 (main actuator, electrode force)
XG8	male	Electrode voltage
XG9	female	Welding current sensor and transformer temperature

D.5.4 Connector specification of the SPATZ+ *GM1* and *GM2* gun modules

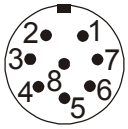
D.5.4.1 Connector XG1 - Voltage Supply

Connector XG1	Female receptacle M12, 5-pole		
Contacts: Female  View: Connection Side	**Pin**	**Name**	**Specification**
	1	GM P24	Pos. Supply Gun Module (+24 V)
	2	GM M24	Neg. Supply Gun Module (0 V)
	3	--	do not connect
	4	--	do not connect
	5	GM PE	PE / Ground Gun Module Supply

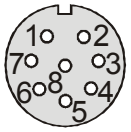
D.5.4.2 Connector XG2 - GM-BUS

Connector XG2	Male receptacle M12, 5-pole		
Contacts: Male  View: Connection Side	**Pin**	**Name**	**Specification**
	1	GM P24	Pos. Supply Gun Module (+24 V)
	2	GM M24	Neg. Supply Gun Module (0 V)
	3	G BH	Data + GM-BUS
	4	G BL	Data - GM-BUS
	5	PE	PE

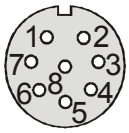
D.5.4.3 Connector XG3 - Digital I/O

Connector XG3	Male receptacle M12, 8-pole		
Contacts: Male  View: Connection Side	**Pin**	**Name**	**Specification**
	1	P24 IO	Pos. Supply Gun Module (+24 V)
	2	D I3	Digital Input 3
	3	D I2	Digital Input 2
	4	D I1	Digital Input 1
	5	D O1	Digital Output 1, max. 500 mA
	6	D O2	Digital Output 2, max. 500 mA
	7	D O3	Digital Output 3, max. 500 mA
	8	M24 IO	Neg. Supply Gun Module (0 V)

D.5.4.4 Connector XG4 - Encoder 2 (Equalizer actuator)

Connector XG4	Female receptacle M12, 8-pole		
Contacts: Female  View: Connection Side	**Pin**	**Name**	**Specification**
	1	NTC EN2	Encoder 2 input motor temperature
	2	GND EN2	Encoder 2 neg. Supply Voltage (0 V)
	3	Data A+ EN2	Encoder 2 Bus signal A+
	4	Data A- EN2	Encoder 2 Bus signal A-
	5	GND EN2	Encoder 2 Neg. Supply Voltage (0 V)
	6	Clock+ EN2	Encoder 2 Bus signal Clk+
	7	Clock- EN2	Encoder 2 Bus signal Clk-
	8	VCC5 EN2	Encoder 2 pos. Supply Voltage (+5 V)

D.5.4.5 Connector XG5 - Encoder 1 (Main actuator, electrode force)

Connector XG5	Female receptacle M12, 8-pole		
Contacts: Female  View: Connection Side	**Pin**	**Name**	**Specification**
	1	NTC EN1	Encoder 1 input motor temperature
	2	GND EN1	Encoder 1 neg. Supply Voltage (0 V)
	3	Data A+ EN1	Encoder 1 Bus signal A+
	4	Data A- EN1	Encoder 1 Bus signal A-
	5	GND EN1	Encoder 1 Neg. Supply Voltage (0 V)
	6	Clock+ EN1	Encoder 1 Bus signal Clk+
	7	Clock- EN1	Encoder 1 Bus signal Clk-
	8	VCC5 EN1	Encoder 1 pos. Supply Voltage (+5 V)

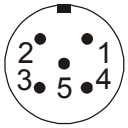
D.5.4.6 Connector XG6 - Electrode Force Actuator 2 (Equalizing)

Connector XG6	Male receptacle M12, 8-pole		
Contacts: Male  View: Connection Side	**Pin**	**Name**	**Specification**
	1	M24 SEN	Neg. Supply Voltage (0 V)
	2	F2 Range	Output Range 2
	3	F2 Reset	Output Reset 2
	4	M24 SEN	Neg. Supply Voltage (0 V)
	5	F2 IN+	Force Signal In 2 +
	6	M24 SEN	Neg. Supply Voltage (0 V)
	7	F2A GND	Force Signal In 2 -
	8	P24 SEN	Pos. Supply Voltage (+24 V)

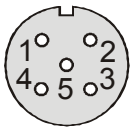
D.5.4.7 Connector XG7 - Electrode Force Actuator 1 (Electrode force)

Connector XG7	Male receptacle M12, 8-pole		
Contacts: Male  View: Connection Side	**Pin**	**Name**	**Specification**
	1	M24 SEN	Neg. Supply Voltage (0 V)
	2	F1 Range	Output Range 1
	3	F1 Reset	Output Reset 1
	4	M24 SEN	Neg. Supply Voltage (0 V)
	5	F1 IN+	Force Signal In 2 +
	6	M24 SEN	Neg. Supply Voltage (0 V)
	7	F2A GND	Force Signal In 1 -
	8	P24 SEN	Pos. Supply Voltage (+24 V)

D.5.4.8 Connector XG8 - Electrode Voltage

Connector XG8	Male receptacle M12, 5-pole		
Contacts: Male  View: Connection Side	**Pin**	**Name**	**Specification**
	1	--	do not connect
	2	--	do not connect
	3	U IN+	Electrode Voltage Signal +
	4	U IN-	Electrode Voltage Signal -
	5	--	do not connect

D.5.4.9 Connector XG9 - Voltage Supply

Connector XG9	Female receptacle M12, 5-pole		
Contacts: Female  View: Connection Side	**Pin**	**Name**	**Specification**
	1	P24 SEN	Output Mon. Transformer Temp. (U_{SEN} = +24 V)
	2	TRT IN	Input Monitoring Transformer Temperature
	3	I IN+	Toroidal Coil Signal +
	4	I IN-	Toroidal Coil Signal -
	5	--	do not connect

Temperature monitoring contacts are connected in series between pin 1 and 2.

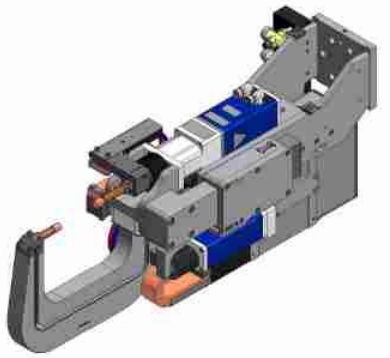
Current coil (150 mV/kA at 50 Hz, 180 mV/kA at 60 Hz) connected between pin 3 and 4.

D.6 CapClean

The **SPATZ+** *Tandem* may be equipped with a *CapClean* electrode cleaning unit which is connected to the **SPATZ+** Master via the 24V Digital I/O.

For detailed information about the *CapClean* please refer to the *CapClean* Product Information.

D.7 Weld Gun



The **SPATZ+** *Tandem* may be equipped with a **SPATZ** welding gun.

For detailed information please refer to the corresponding Product Information of the welding gun.

E Calculation of Cross Section and Fuse Requirements

Detailed information on the calculation of the components of resistance welding devices can be found in the technical bulletin 2918 of the DVS (German Association for Welding and Related Processes). A simple calculation example is given below:

Nominal current from **SPATZ+** inverter power unit to transformer: $I_{Trans\ max}$ = 400 A

Duty Cycle: $$D.C. = \frac{t_{current}}{t_{cycle}}$$

Cable resistance: $$R_{Cable} = R_{CableSpec} * l$$

Current from **SPATZ+** inverter to transformer during welding: $$I_{Trans} \geq \frac{I_{weld}}{n}$$

Thermal current from inverter power unit to transformer: $$I_{therm.Trans} \leq I_{Trans} * \sqrt{D.C.}$$

Current in one phase from mains to inverter power unit: $$I_{Phase} = 0.82 * I_{Trans}$$

Thermal current in one phase from mains to inverter power unit: $$I_{therm.Phase} \leq I_{Phase} * \sqrt{D.C.}$$

Voltage drop in a cable: $$U_{Drop} = I * R_{Cable}$$

Voltage drop in the cable for one phase in %: $$\Delta U_1 = \frac{U_{Drop\,1}}{\frac{U_{Phase}}{\sqrt{3}}} * 100$$

Voltage peak to the transformer: $$\hat{U}_{Trans} = U_{Phase} * \sqrt{2}$$

Voltage drop in the cable to transformer in %: $$\Delta U_2 = \frac{U_{Drop2}}{\hat{U}_{Trans}} * 100$$

Turn ratio	n		
Welding Current	I_{Weld}	[A]	secondary current at the transformer
Specific Cable Resistance	$R_{CableSpec}$	[Ohm]	see table below
Phase Voltage	U_{Phase}	[V]	voltage between two phases
Cable length	l_1	[m]	cable length power supply - power unit (way there)
	l_2	[m]	cable length power unit - transformer respectively mains (way there, way back)
Weld time	t_{Weld}	[s]	sum of all current times within one weld
Cycle time	t_{Cycle}	[s]	time from one weld to another weld

Cable resistance (extracts from VDE 0295 and IEC 60 228 respectively).

Wire size	$R_{CableSpec}$ at 20 °C (68 °F), untined wires	
[mm²]	Class 2 *, [Ω / m]	Class 5+6 *, [Ω / m]
16	0.001150	0.001210
25	0.000727	0.000780
35	0.000524	0.000554
50	0.000387	0.000386
70	0.000268	0.000272
95	0.000193	0.000206

***** Class 2: more than one wire; Class 5: flexible cable core; Class 6: high flexible cable core

Influence of temperature:
Resistance increase for Cu because of temperature increase: about 0.4 % per °C
Example: For a wire temperature of 50 °C instead of 20 °C the resistance increases about 12 %

E.1 Example Calculations

Determination of the voltage drop for the cable between transformer and inverter power unit

Cable 1, mains: 4 x 25 mm² (AWG 4), flexible (class 5), length: l = 35 m (115 ft),
Cable 2, transformer: 3 x 35 mm² (AWG 2), flexible (class 5), length: l = 15 m (49 ft),
Transformer: n = 1:70
Welding: I_{Weld} = 10 kA, t_{Weld} = 600 ms, t_{Cycle} = 2 s
Mains: 3 ~ 400 V, 50 Hz

$$D.C. = \frac{t_{current}}{t_{cycle}} = \frac{600ms}{2000ms} = 0.3 = 30\ \%$$

$$R_{Cable\,1} = R_{CableSpec} * l = 0.78\ \frac{\Omega}{km} * 35\ m = 0.0273\ \Omega = 27.3\ m\Omega$$

$$R_{Cable\,2} = R_{CableSpec} * l = 0.554\ \frac{\Omega}{km} * 15\ m = 0.0083\ \Omega = 8.3\ m\Omega$$

$$I_{Trans} = \frac{I_{weld}}{n} = \frac{10kA}{70} = 143A$$

$$I_{therm.Trans} = I_{Trans} * \sqrt{D.C.} = 143A * \sqrt{0.3} = 78A$$

$$I_{Phase} = 0.82 * I_{Trans} = 0.82 * 143A = 117A$$

$$I_{therm.Phase} = I_{Phase} * \sqrt{D.C.} = 117A * \sqrt{0.3} = 64A$$

$$U_{Drop1} = I_{Phase} * R_{Cable1} = 117A * 0.0273\Omega = 3.2V$$

$$\Delta U_1 = \frac{U_{Drop1}}{\frac{U_{Phase}}{\sqrt{3}}} * 100 = \frac{3.2\ V}{\frac{400\ V}{\sqrt{3}}} * 100 = 1.4\ \%$$

$$U_{Drop2} = I_{Trans} * 2R_{Cable2} = 143A * 2 * 0.0083\Omega = 2.4V$$

$$\hat{U}_{Trans} = U_{Phase} * \sqrt{2} = 400\ V * \sqrt{2} = 566\ V$$

$$\Delta U_2 = \frac{U_{Drop2}}{\hat{U}_{Trans}} * 100 = \frac{2.4\ V}{566\ V} * 100 = 0.4\ \%$$

Result:

- D.C. (duty cycle): 30 %
- Voltage drop, mains: 1.4 % < 4 %
- Voltage drop, transformer: 0.4 % < 4 %
- Fuse mains: 80 A

F Dimensions

F.1 Dimensions SPATZ+ M400W / M600W / M900W and SPATZ+ M900LSlave

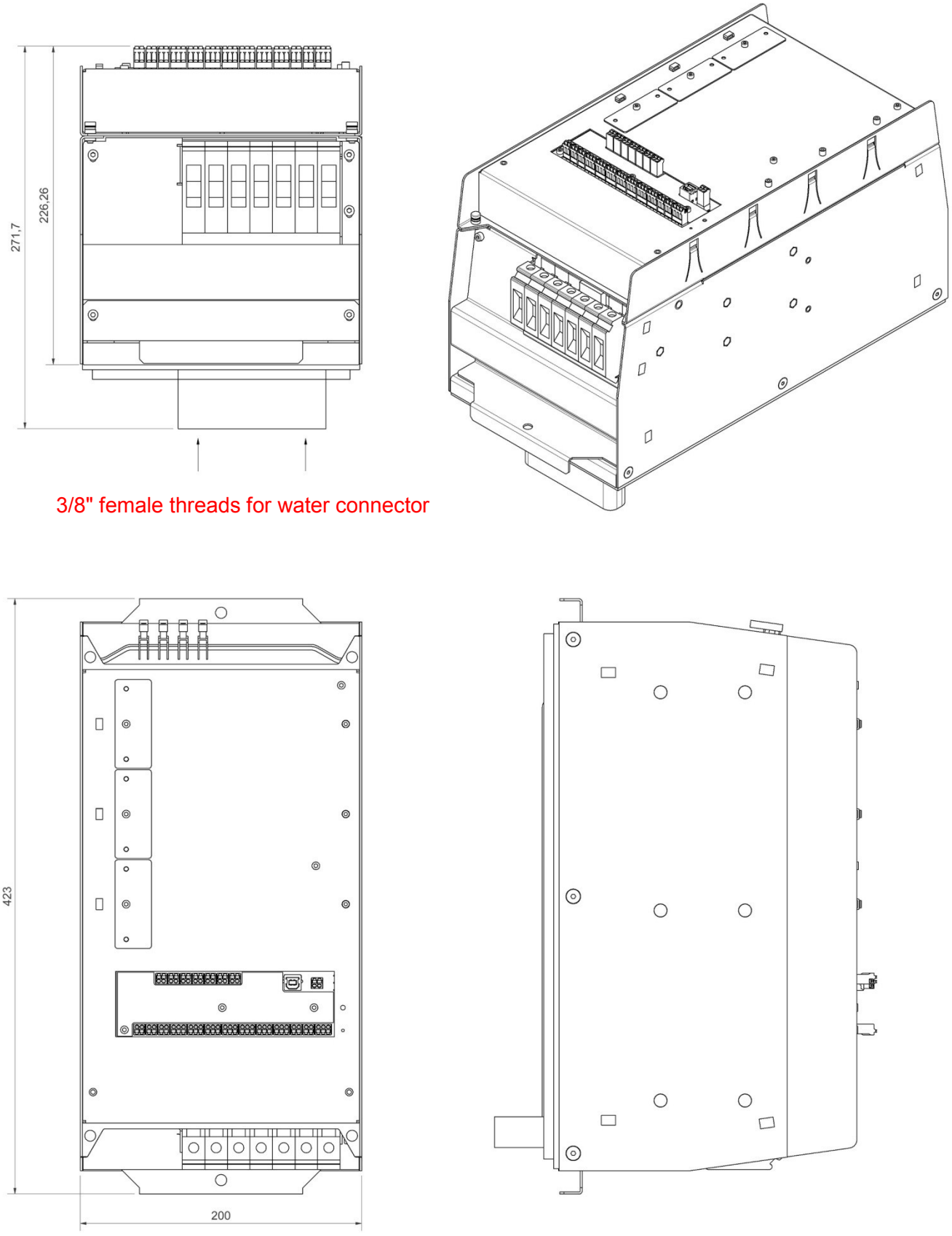


Figure 14: **Dimensions of the water cooled SPATZ+** *M400W* / *M600W* / *M900W* and *M900 Slave* in mm

F.2 Dimensions SPATZ+ M400L / M600L / M900L and SPATZ+ M900LSlave

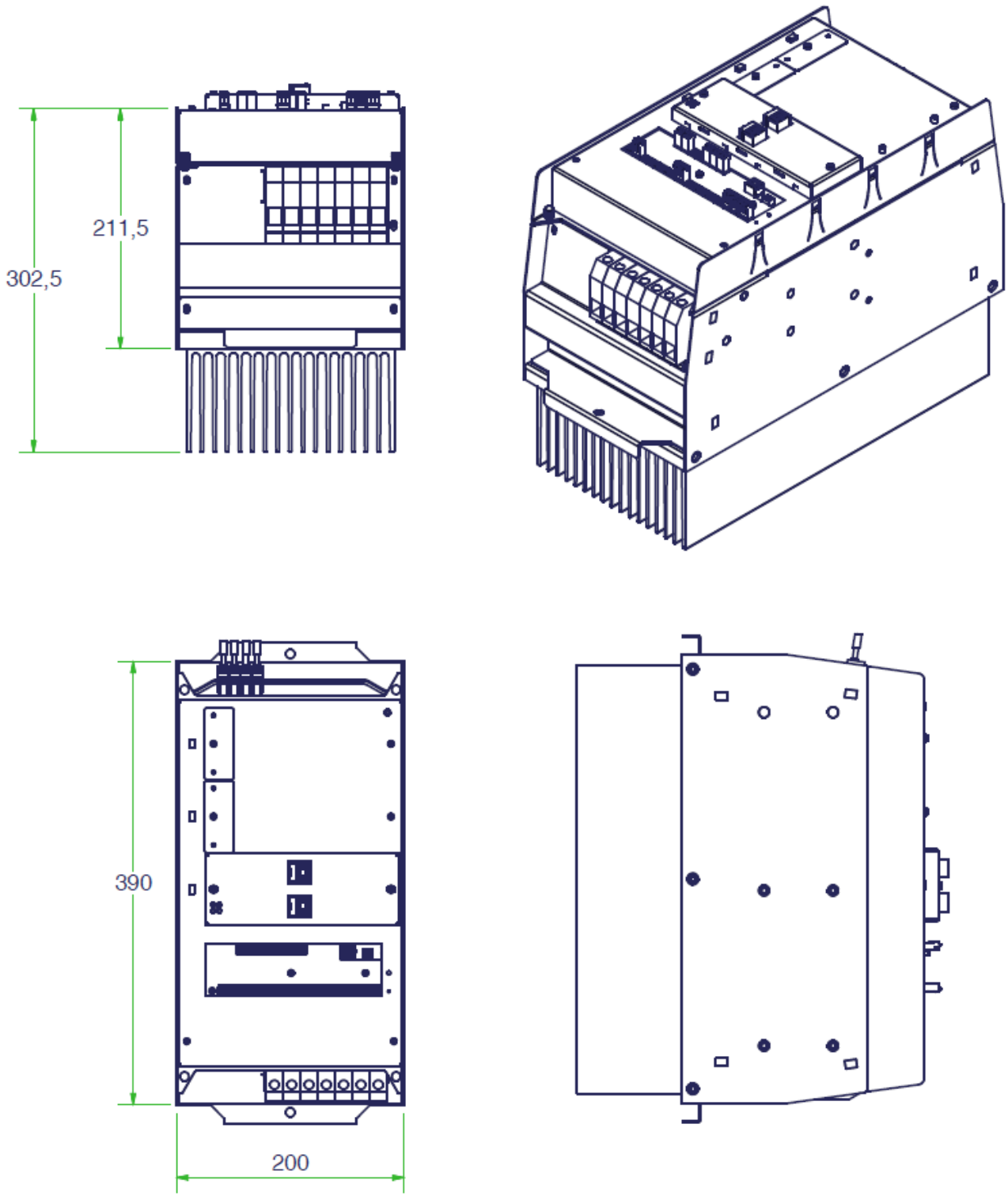


Figure 15: Dimensions of the air cooled SPATZ+ *M400L / M600L / M900W* **and** *M900 Slave* **in mm**

F.3 Dimensions of SPATZ+ cabinets and accessories

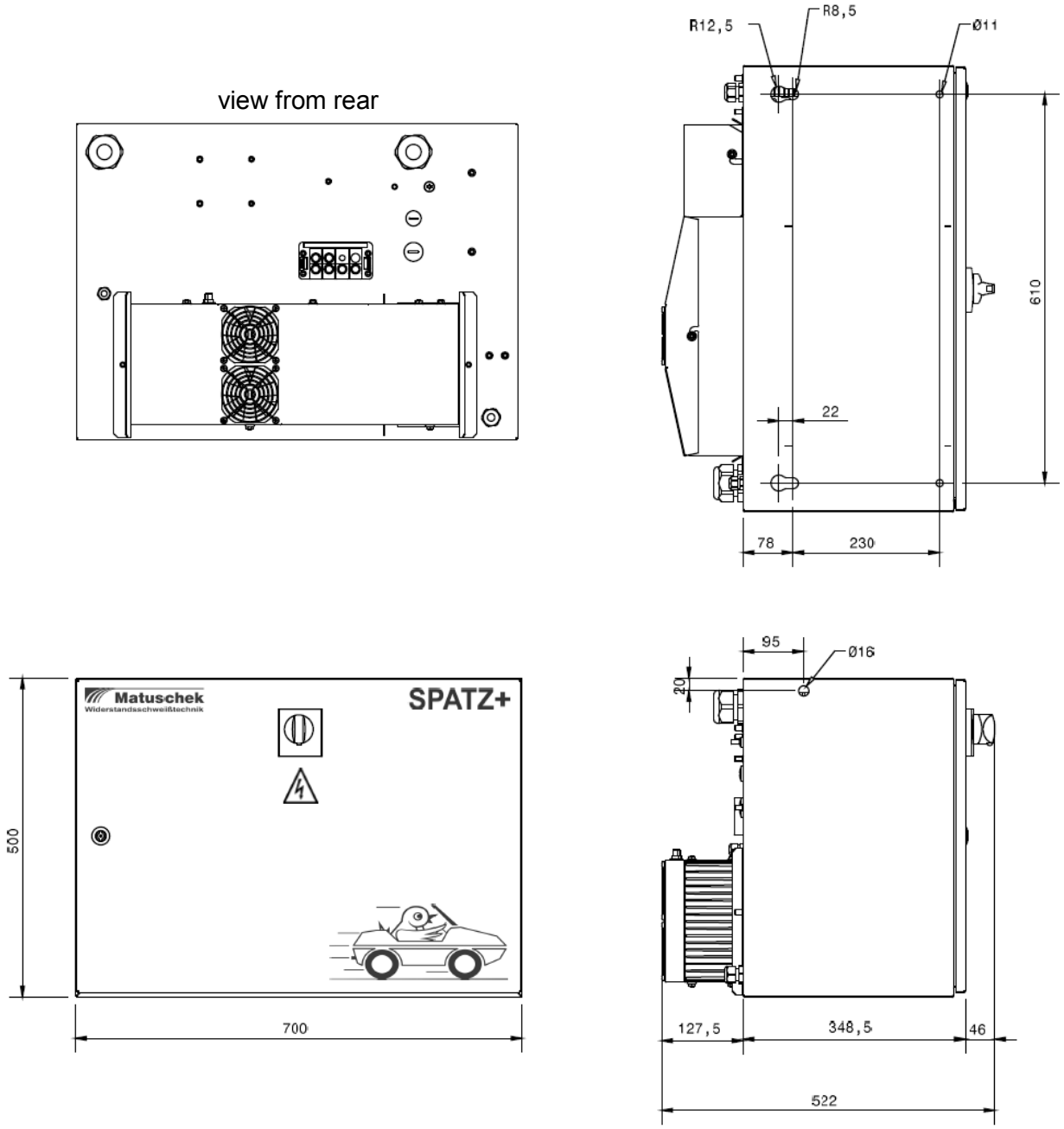


Figure 16: Dimensions in mm of the SPATZ+ *CL-RS* cabinet for one SPATZ+ weld timer and components for one servo drive

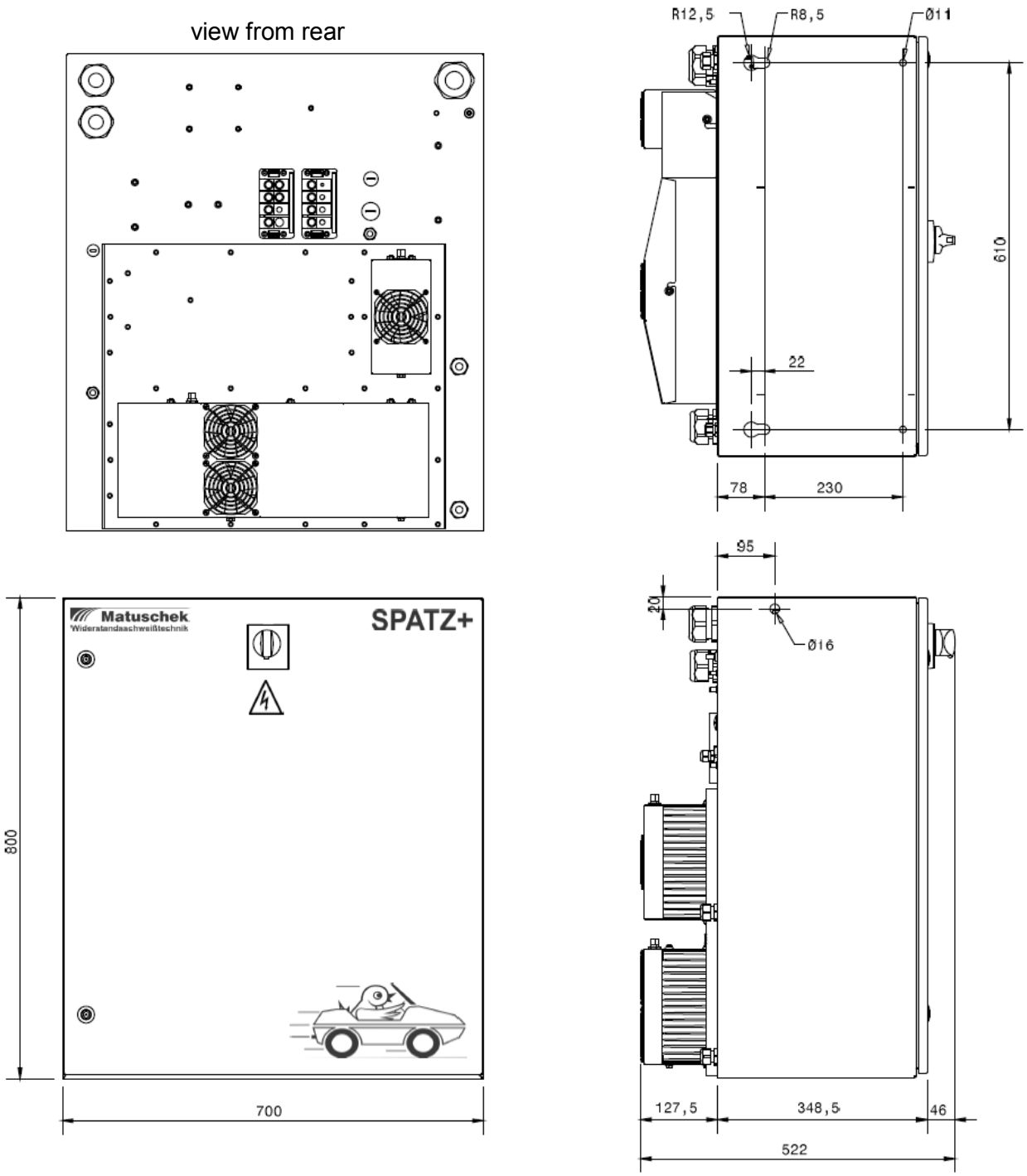


Figure 17: **Dimensions in mm of the SPATZ+ *CL-RS* cabinet for one SPATZ+ weld timer and components for two servo drives**

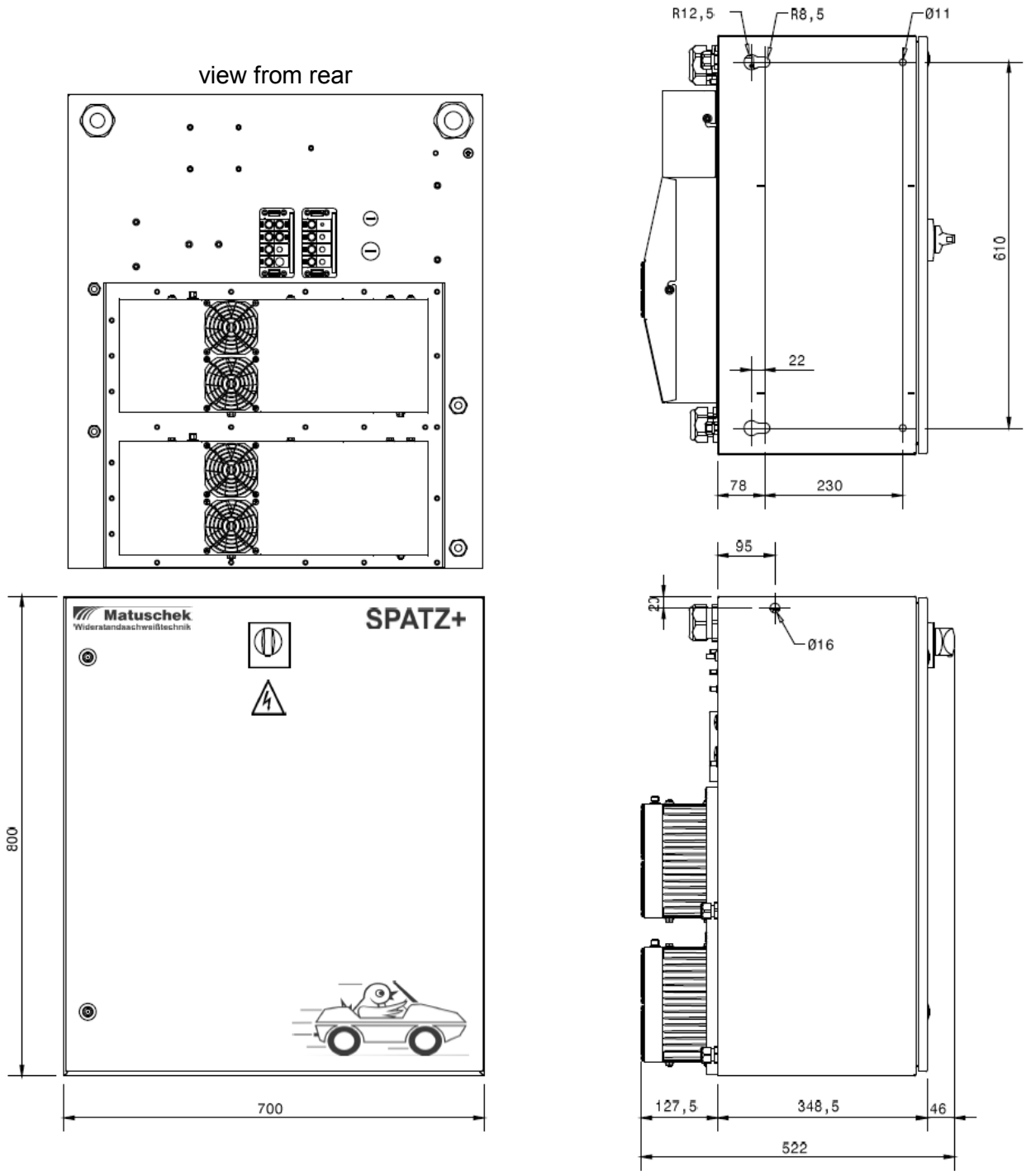


Figure 18: Dimensions in mm of the SPATZ+ *CL-TS* cabinet for two SPATZ+ weld timer and components for two servo drives

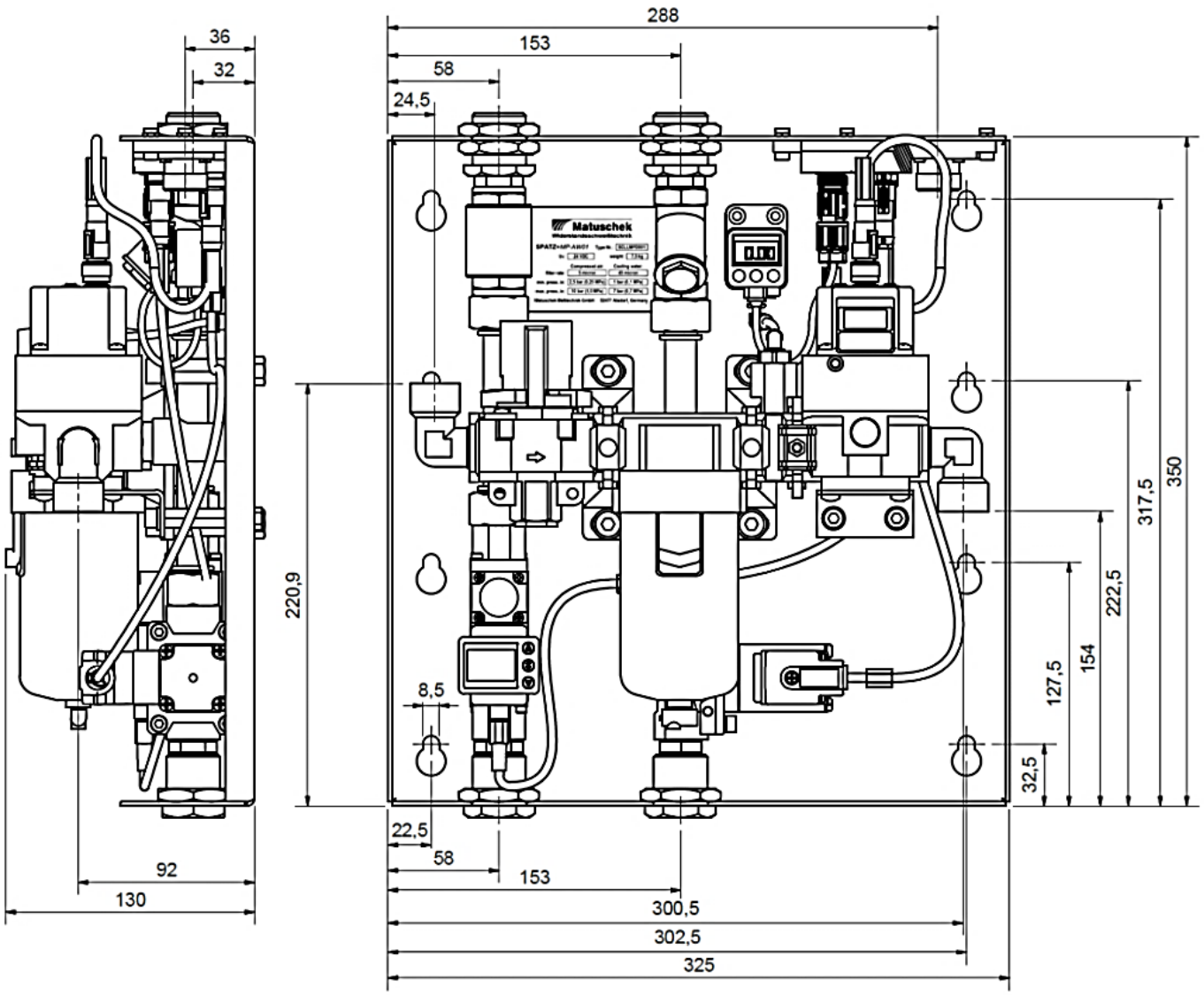


Figure 19: **Dimensions of the SPATZ+ *MP-AW* Media panel for one gun in mm**

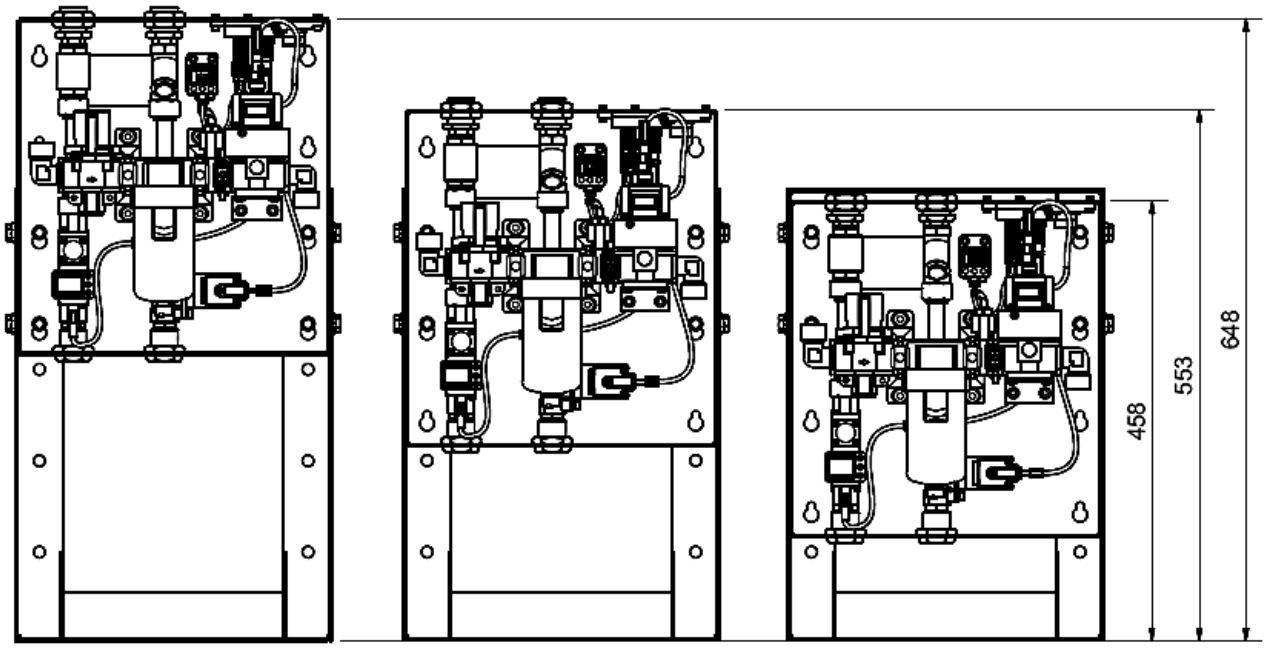


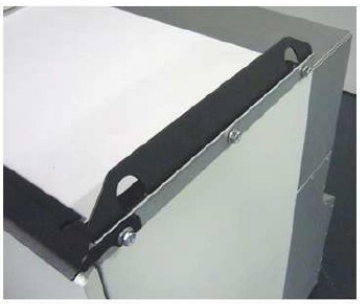
Figure 20: **Different mounting positions of the Media Panel at the cabinet stand or at its own stand**

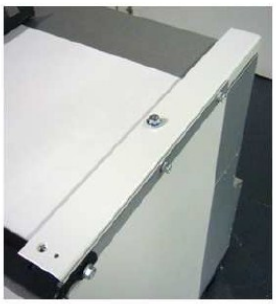
G Installation, exchange and maintenance of the SPATZ+ equipment

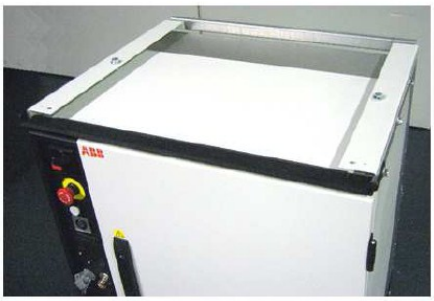
G.1 Mounting of the SPATZ+ weld cabinets

G.1.1 Mounting of the SPATZ+ weld cabinet with connection socket at the ABB Robot cabinet

- Please also refer to the pictures below for the mounting of the cabinet.
- Remove the black lifting bars on top of the ABB robot cabinet. The three M8 bolts on each side are used to fix the **SPATZ+** mounting bars. Once the left and right mounting bars are installed, mount the cable clamp rail at the end of the bars with two M6 bolts, delivered with the mounting bars.
- The **SPATZ+** cabinet is fixed with four M10 bolts to the mounting bars. The two rear ones are already mounted with a washer for the correct distance (arched side upwards). The two in the front are delivered together with the cabinet. They are in a small plastic bag inside the cabinet.
- The weight of the cabinet is approx. 49 kg. There are two holes in the side walls of the cabinet, covered with plastic caps. Remove the plastic caps and use a crane with slings and standard S-hooks to lift the **SPATZ+** cabinet, refer to section **G.1.4**.
- Put the **SPATZ+** cabinet on top of the mounting bars, so that the installed rear M10 bolts fit to the big hole in the cabinet floor. Move the cabinet backwards until the two front holes fit to the M10 thread in the mounting bar. Fix the cabinet with the two front M10 bolts.
- Remove the S-hooks and seal the holes again with the plastic caps.



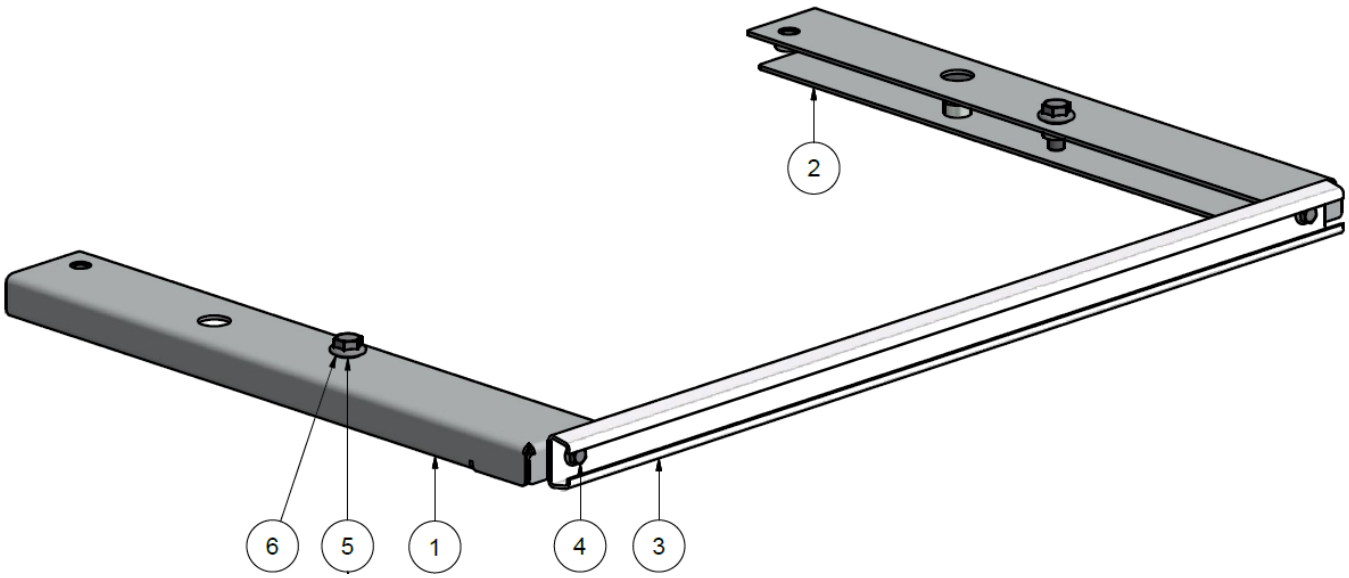






G.1.2 Mounting of the SPATZ+ weld cabinet with FANUC connection socket at the FANUC Robot cabinet

- Dismantle the crane eyelets at the FANUC robot cabinet.
- Loosely fasten the left and right mounting bars ① ② at the FANUC cabinet with hexagonal M10 bolts each (inside delivery). Do not yet fasten the bolts from the FANUCS cabinets inside. The M10 bolts have plenty lash inside the FANUC cabinet for the compensation of tolerances but the bolts cover the 12mm hole completely without any washer.
- Loosely fasten the cable clamp rail ③ with the two delivered M6 bolts ④ at the back of the mounting bars. Do not yet fasten the bolts!
- The **SPATZ+** cabinet is fixed with four M10 bolts to the mounting bars. The two rear ones ⑥ are already mounted with a washer ⑤ for the correct distance (arched side upwards). The two in the front are delivered together with the cabinet. They are in a small plastic bag inside the cabinet.
- The weight of the cabinet is approx. 49 kg. There are two holes in the side walls of the cabinet, covered with plastic caps. Remove the plastic caps and use a crane with slings and standard S-hooks to lift the **SPATZ+** cabinet, refer to section **G.1.4**
- Put the **SPATZ+** cabinet on top of the mounting bars, so that the installed rear M10 bolts fit to the big hole in the cabinet floor. Move the cabinet backwards until the two front holes fit to the M10 thread in the mounting bar. Fix the cabinet with the two front M10 bolts.
- Remove the S-hooks and seal the holes again with the plastic caps.
- Adjust the weld cabinet at the FANUC robot cabinet and fasten the mounting bar bolts inside the FANUC robot cabinet.
- Finally fasten the cable clamp rail bolts!



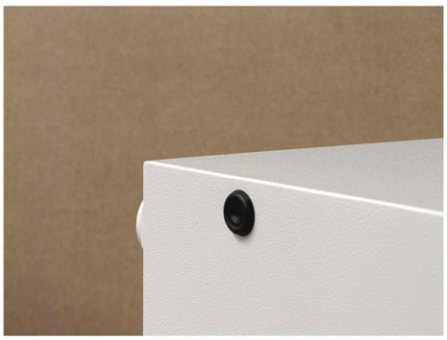
G.1.3 Mounting of the SPATZ+ weld cabinet at the stand

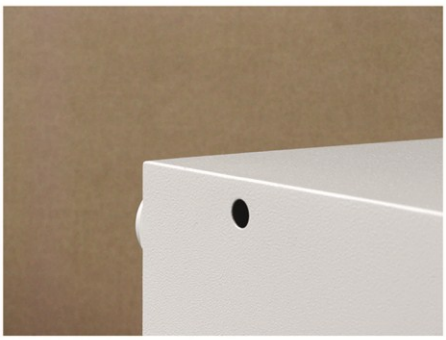
- Please mount the stand according to its installation manual. All necessary screws are in an extra plastic bag together with the installation manual.
- **Important note:** The stand must be secured with suitable fastening submit to the floor before mounting the weld cabinet.
- The **SPATZ+** cabinet is fixed with four M10 bolts to the plate of the stand. Mount the two rear one with the hinge hook ring (**with its bow to the top**) for the correct distance. This 2 screws only “guide” the cabinet, the 2 in front will fix the cabinet.
- The weight of the cabinet is approx. 49 kg for the **SPATZ+** *R* and the **SPATZ+** *H1* cabinet and 53 kg for the **SPATZ+** *H2* cabinet. There are two holes in the side walls of the cabinet, covered with plastic caps. Remove the plastic caps and use a crane with slings and standard S-hooks to lift the **SPATZ+** cabinet, refer to section **G.1.4** or to the corresponding page of the cabinet circuit diagram.
- Put the **SPATZ+** cabinet on the stand, so that the installed rear M10 bolts fit to the big hole in the cabinet floor. Move the cabinet backwards until the two front holes fit to the M10 thread in the mounting plate. Fix the cabinet with the two front M10 bolts.
- Remove the S-hooks and seal the holes again with the plastic caps.

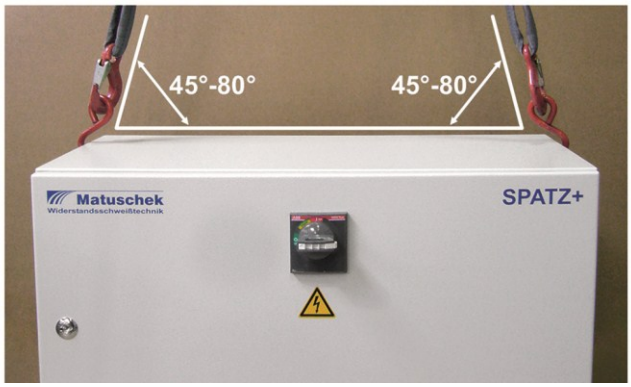
G.1.4 Lifting of the SPATZ+ weld control cabinet

The weight of the weld control cabinet is 49 kg, including the build in **SPATZ+** Inverter. There are two holes in the side walls of the cabinet for the usage of lifting equipment, covered with plastic caps. Remove the plastic caps and use a crane with slings and standard S-hooks to lift the **SPATZ+** cabinet.

The maximum total lifting load for two S-hooks is 70 kg, lifting with a single S-hook is forbidden. Keep attention to the allowed lifting angle (45° to 80°), please refer to the last picture below!





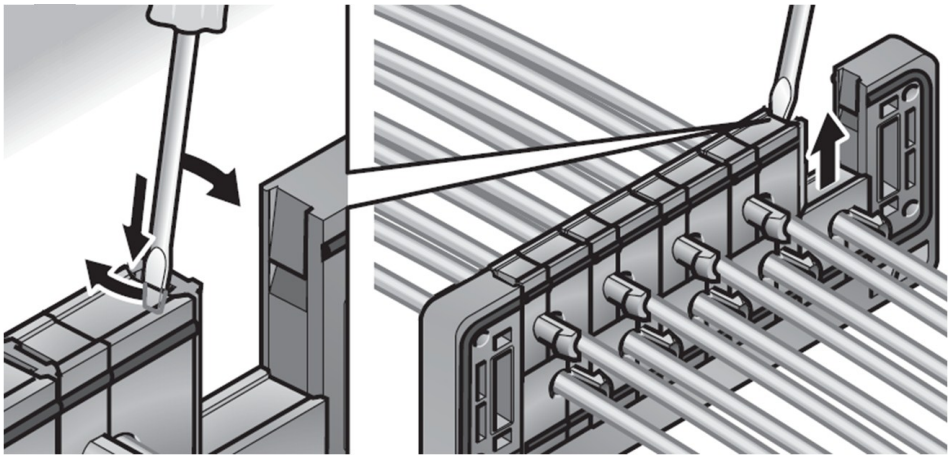


G.1.5 Assembly and disassembly of the 8-fold data cable entry

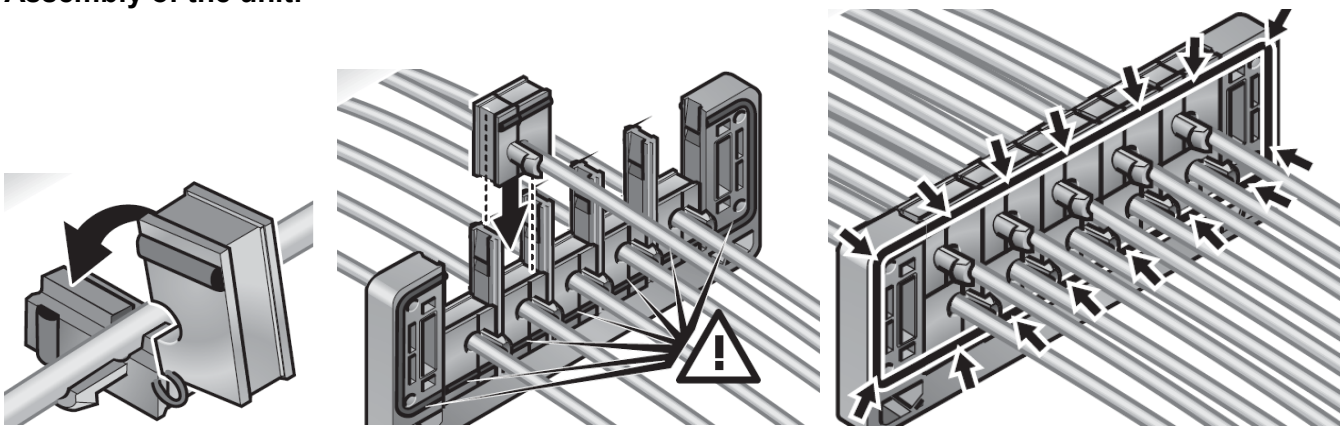
The KDL/E 8-fold data cable entry unit provides the entry and lead through of pre-assembled cables. It offers an easy and quick installation in the switch cabinet for up to 8 preassembled cables with a very high packing density. To install a cable please unscrew the plate from the cabinet and remove the corresponding cable grommet from the unit. Put the cable with the connector through the cabinet opening and fold the cable grommet around the cable. Push the grommet back into the unit and fasten the unit back to the cabinet. The torque of the 4 fastening screws should be: **0.5-0.8 Nm.**

Important note: Please check after assembly, that there is a continuous sealing ring at the backside of the unit!

Disassembly of the unit.



Assembly of the unit:



Depending on the cable diameter there are different cable grommets available on request:

Type	Part No.	clamping Ø (mm)
KDT/ZE 03	87121210	3-4
KDT/ZE 04	87121212	4-5
KDT/ZE 05	87121214	5-6
KDT/ZE 06	87121216	6-7
KDT/ZE 07	87121218	7-8
KDT/ZE 08	87121220	8-9
KDT/ZE 09	87121222	9-10
KDT/ZE 10	87121224	10-11
KDT/ZE 11	87121226	11-12
KDT/ZE 12	87121228	12-13
KDT/ZE 13	87121230	13-14
KDT/ZE 14	87121232	14-15
KDT/ZE 15	87121234	15-16

Type	Part No.	clamping Ø (mm)
KDT/ZE 2x4	87121284	2x 4
KDT/ZE 2x5	87121286	2x 5
KDT/ZE 2x6	87121288	2x 6
KDT/ZE 2x7	87121290	2x 7
KDT/ZE 2x8	87121291	2x 8
KDT/ZE 4x2	87121292	4x 2
KDT/ZE 4x3	87121293	4x 3
KDT/ZE 4x4	87121294	4x 4
KDT/ZE 4x5	87121295	4x 5
KDT/ZE 4x6	87121296	4x 6
BTK/E	87121266	dummy
KDT/VE 3-7	87121272	3-7
KDT/VE 7-10	87121274	7-10

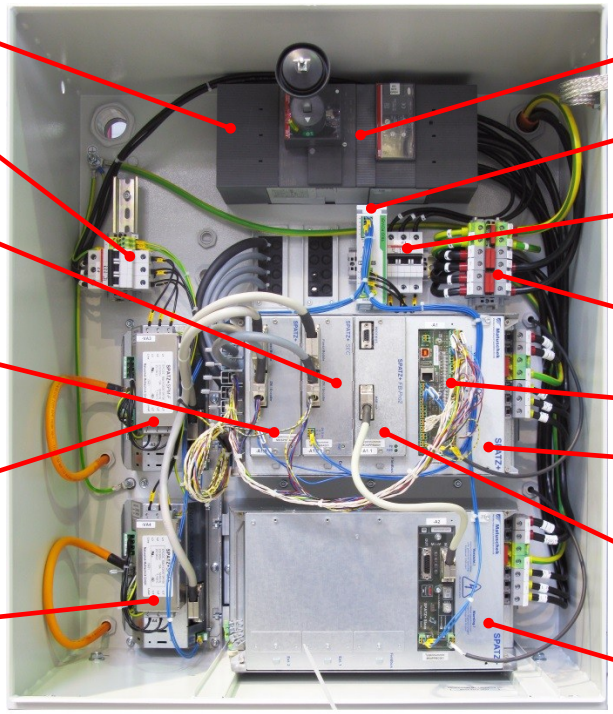
G.2 Electrical installation of the SPATZ+ weld cabinets

Important Note: Only a qualified electrician may do the electrical installation of the **SPATZ+** cabinets.

G.2.1 Overview about the setup of the different welding cabinets

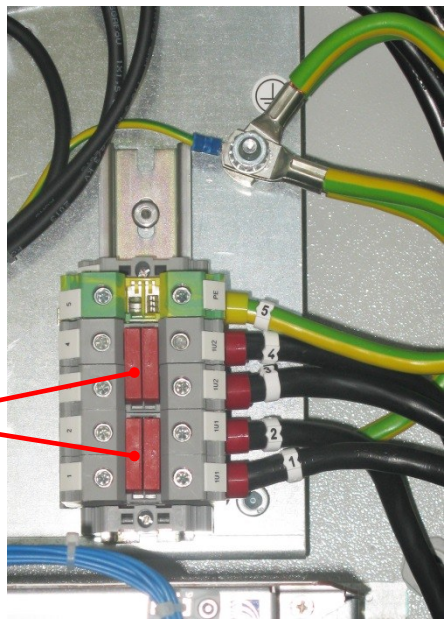
G.2.1.1 Switch Cabinet SPATZ+ *CL-T2S* for aluminium applications and electrical servo-drives

The *Servo***SPATZ+** *CL-T2S* cabinet contains two parallelized **SPATZ+***M900L* 1,000 Hz medium-frequency inverter power sources (with a total primary transformer current up to 1800 A) with two servo drive controllers for operation of up to two drive axis. The controller provides a closed system for aluminium resistance welding with two servo driven motors.



Connecting bridges for inverters, in case of a transformer with single connector.

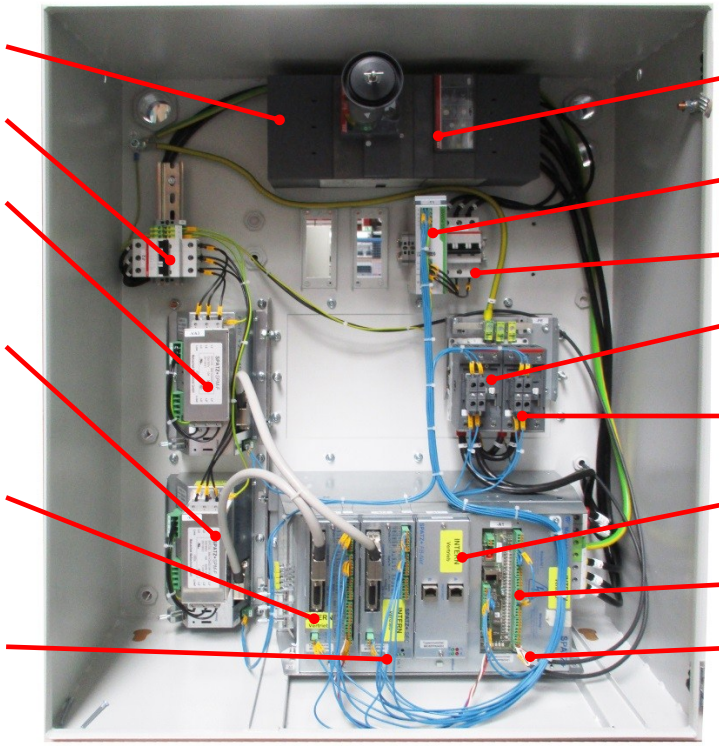
In case of a double transformer with two connectors, the bridge is omitted.



24 V DC power supply for slave

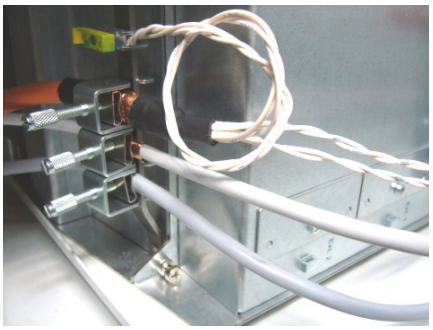
G.2.1.2 Switch Cabinet SPATZ+ *CL-R2S* for applications with two servo-drives

The **SPATZ+** *CL-R2S* cabinet is designed for welding applications with two servo-electrical axis controlled by the **SPATZ+** *M400/M600/M800* weld timer. There are two versions available: The 1st one is for applications with one welding machine or gun with two servo drives e.g. for electrode force and equalizing or a double-head welding machine. The 2nd one in the figure below is for applications with two servo drives but in two different welding machines connected to one **SPATZ+** weld timer.



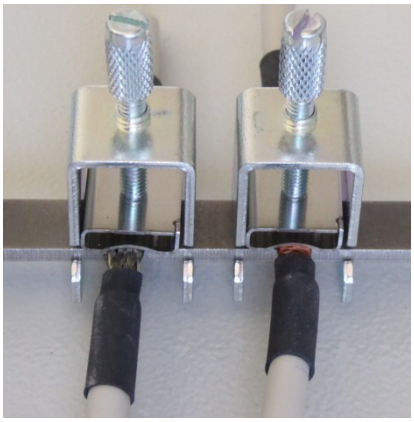
G.2.2 Shield connection to the shield bar at the SPATZ+ weld control.

All signal input cables to the **SPATZ+** must be twisted pair and each must have its own separate shielding and a separate pin for the shield of each signal input in every connector. It is not allowed to connect different shields to Ground / PE in the connectors in between the gun and the timer. If there are several sensor cables in a multiple cable, each twisted pair to a sensor must have its own shielding. The shield **must not** be connected at the gun or at the sensor; the shield has only to be connected with a shield clamp to the shield bar at the left side of the **SPATZ+** inverter (torque shield clamp SK14: 0.8 Nm).



For a safe and long term connection the shield of a cable can be prepared as shown in the following pictures: Dismantle the cable to the shield for a length of approx. 36 mm. Fasten the shield with two pieces of heat shrinking hoses at each side of the dismantled section. If the shield is not woven, it can be secured with a copper foil with an electrically conducting adhesive before using the shrinking hose. This cooper foil can be offered on request:

ZEL0 0004-33: Copper foil, 0.035 x 35 mm, electrically conducting adhesive, coil with 33 m, 1 piece
ZEL0 0004-0.6: Copper foil, 0.035 x 35 mm, electrically conducting adhesive, 6 cm, bag with 25 pieces



G.2.3 Electrical installation of the SPATZ+ *CL-R* weld control cabinet for robot applications

Important Note: Before an insulation test for the installation of the **SPATZ+** cabinet can be performed, the residual current (RC) unit of the ABB main switch must be deactivated. Remove the “Do not open” label from the clear plastic cover and lift the cover. Switch the “Insulation test” switch to position “TEST”, the red button will pop out. After the test push the red button in to switch back to “ON” position. Close the plastic cover and seal it with a new “Do not open” label, part no. 8160 0025.

Do not change the setting of the RC unit! (IΔn = 0.03 A; Δt = 0 s; f = 1,000 Hz; Insulation Test = ON)

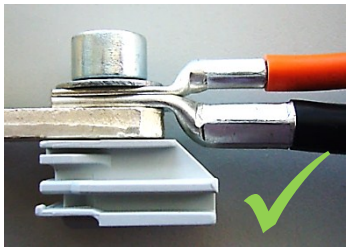
Tightening torques of electric terminals:

ABB switch, mains input:	8 Nm	PE star point inside (bolt M8):	10 Nm
ABB switch, output to inverter:	8 Nm	PE connector outside (bolt M8):	10 Nm
35² mm terminals **SPATZ+** inverter:	3.2 - 3.7 Nm	PE terminal robot:	1.5 - 1.8 Nm
Shield clamp SK14 at shield bar:	0.8 Nm	PE terminal tip dresser:	0.6 - 0.8 Nm

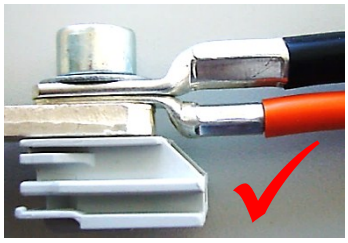
Mains: Use the “Mains” cable gland, M40 (M50), cable Ø 22 - 32 mm (32 - 38 mm). Crimp M8 cable lugs to the mains cable. Connect the three phase cables to the main switch (torque 8 Nm), the PE to the PE bolt (torque 10 Nm).

Please refer to the following pictures for the correct orientation of the cable lugs at the mains input of the ABB main switch:

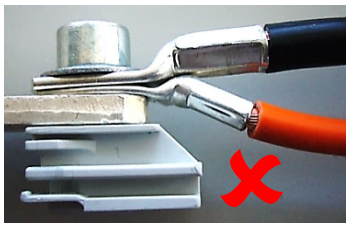
Right:



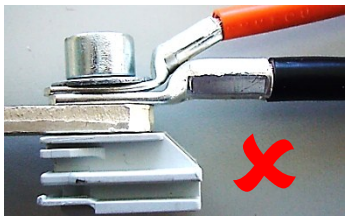
Acceptable:



Wrong:



Wrong:



Transformer: Use the “Transformer” cable gland(s), M40, cable Ø 22 - 32 mm. Crimp cable ferrules to the transformer cable. Connect the two phase cables and the PE to the 35²mm terminals of the **SPATZ+** inverter (torque 3.2 - 3.7 Nm).

Fieldbus: Use the “BUS” or spare inlet of the 8-Way data cable entry. Fix a connector to the Fieldbus cable and insert the connector into the corresponding socket on the **SPATZ+** field bus board. The shield of the bus cable **must** be connected with the shield clamp to the shield bar at the left side of the **SPATZ+** inverter (torque 0.8 Nm).

24 V: When an external 24 V DC power supply is used, please use the “24 V supply” inlet (KDT/ZE06, cable Ø 6 - 7 mm) of the 8-Way data cable entry. Use a shield clamp to fix the cable at the shield bar at the left side of the **SPATZ+** inverter. Connect the 24 V to the corresponding terminals of the **SPATZ+**; refer to the circuit diagram of the cabinet.

Important Note: If possible, connect the wires without ferrules; the stripping length should be 10 mm. When using ferrules the length of ferrule must be 10 mm!

Sensor Use the corresponding inlets or spare inlets of the 8-Way data cable entry. The sensor line for the current and the voltage sensor must be each twisted pair and each with its own shield. The shields are connected with a shield clamp to the shield bar at the left side of the **SPATZ+** inverter (torque shield clamp SK14: 0.8 Nm). Connect the current and voltage sensors to the corresponding terminals of the **SPATZ+**; refer to the circuit diagram of the cabinet.

Important Note: Between shield bar and the terminals of the SPATZ+ the two wires of each sensor must be twisted!

Important Note: If possible, connect the wires without ferrules; the stripping length should be 10 mm. When using ferrules the length of ferrule must be 10 mm!

CapClean, Emergency stop: Use the corresponding inlets or spare inlets of the 8-Way data cable entry. Shields are connected with a shield clamp to the shield bar at the left side of the **SPATZ+** inverter (torque shield clamp SK14: 0.8 Nm). Connect the wires to the corresponding terminals of the **SPATZ+**; refer to the circuit diagram of the cabinet.

Important Note: If possible, connect the wires without ferrules; the stripping length should be 10 mm. When using ferrules the length of ferrule must be 10 mm!

Encoder Use the corresponding inlets or spare inlets of the 8-Way data cable entry. Shields are connected with a shield clamp to the shield bar at the left side of the **SPATZ+** *SPM* module (torque shield clamp SK14: 0.8 Nm). Connect the wires to the corresponding terminals of the **SPATZ+** *SPM,* please refer to the circuit diagram of the cabinet. (torque xx Nm).

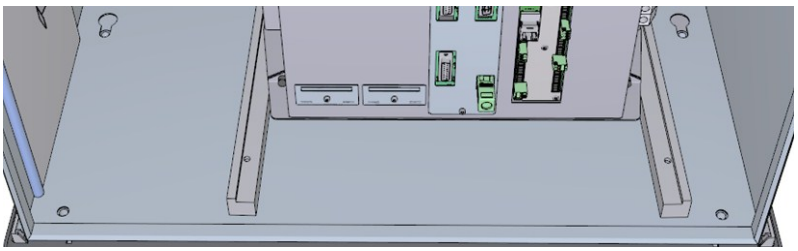
Servomotor Use the “Motor” cable gland(s), M20, cable Ø 11 - 14 mm. Crimp cable ferrules to the motor cable. Connect the three phase cables and the PE to the 2.5² mm terminals of the **SPATZ+** inverter (torque 3.2 - 3.7 Nm).Use the corresponding M20 cable gland inlets or spare inlets of the 8-Way data cable entry. Shields are connected with a shield clamp to the shield bar at the left side of the **SPATZ+** *SPM* module (torque shield clamp SK14: 0.8 Nm). Connect the wires to the corresponding terminals of the **SPATZ+** *SPM,* please refer to the circuit diagram of the cabinet. (torque xx Nm)

Please refer in addition to the corresponding sections of this product information and to the wiring diagram of the cabinet.

G.3 Installation of the SPATZ+ weld timer and SPATZ+ *Slave* timer

Important Note: Only a qualified electrician may install the **SPATZ+** power units.

The **SPATZ+** unit needs a fan driven air-cooling. The **SPATZ+** *CL* cabinets are equipped with the correct chosen fans and air channel dimension to achieve optimum air-cooling of the **SPATZ+** unit. The fans are inside a cover plate on the backside of the cabinet. The air inlet is from rear side, air outlet is sideways. The air channel is hermetically sealed from the inner of the cabinet, refer to section C.12.2.



In addition there is a special fixture implemented into these cabinets to fasten the **SPATZ+** unit. To mount the **SPATZ+** unit into the cabinet the unit can be deposited onto the mounting rails with the heat sink directed to the back. Then unit must be pushed with the heat sink through the opening in the back plane until the unit comes to a stop. During this the M6 bolts must slide through the holes of the fastening brackets of the **SPATZ+** unit. Then the **SPATZ+** unit must be fixed with the two M6 flange nuts.

Important Note:

The **SPATZ+** *M400/M600/M900* power unit is designed to be built into a switch cabinet with a IP code of at least IP 54 for solid particle and liquid ingress protection. If this switch cabinet is not in the scope of delivery of company Matuschek, the integrator is responsible for correct sizing of air / water cooling, cabling, fuses and breakers.

Important Note:

The SPATZ+ is equipped with internal capacitors that are charged to a dangerous voltage. Prior to opening or exchanging the SPATZ+ unit discharging of the capacitors must eliminate this dangerous voltage.

To fulfil this demand the units are equipped with a discharge circuit: After the mains voltage has been switched off, the capacitors will be discharged through intern discharging resistors in less than one second to such a level as to render it harmless. The complete discharging will take up to 10 minutes.

The supply mains voltage (3~400 V to 3~500 V) is connected via terminals L1, L2, L3 and protective earth (PE). The neutral conductor has not to be connected.

The welding transformer is connected to the terminals 1U1 and 1U2.

Terminal	Connection at 3~400 V to 3~500 V	Max. Cross Section	Tightening torque
L1	400 - 500 V ~ power supply	35 mm² / AWG 2	3.2 - 3.7 Nm
L2	400 - 500 V ~ power supply	35 mm² / AWG 2	
L3	400 - 500 V ~ power supply	35 mm² / AWG 2	
PE	Protective earth / Ground	35 mm² / AWG 2	
PE	Protective earth / Ground	35 mm² / AWG 2	
1U1	Transformer voltage	35 mm² / AWG 2	
1U2	Transformer voltage	35 mm² / AWG 2	

Next the field bus, the sensory, the 24 V DC supply and the required inputs and outputs must be connected, refer to section C.4 to C.10. Please consider all instructions how to connect the shield.

Important Note:

It is strictly forbidden to power up the system without electronic board set.

G.4 Maintenance of the SPATZ+ weld timer

The **SPATZ+** needs nearly no preventive or continuous maintenance. The fans, the cooling channel and the heat sink must be cleaned from dust regularly. The cleaning intervals should depend on the amount of dust and dirt in the ambient air.

The 24 V DC supply of the fans has to be interrupted by disconnecting the M12 pin connector. Then the fan unit can be taken off and cleaned after the removal of the two M6 flange nuts, refer to section C.12.2. Thereby the ribbed aluminium heat sink can be cleaned too.

On the board is a battery for the internal real time clock. Its life time is more than 10 years.

G.5 Replacement of the SPATZ+ weld timer

Important Note: Only a qualified electrician may replace the **SPATZ+** weld timer.

The replacement must only be done with switched off mains voltage and disconnected 24 V DC supply voltage.

Important Note:

The SPATZ+ is equipped with internal capacitors that are charged to a dangerous voltage. Prior to opening or exchanging the SPATZ+ unit discharging of the capacitors must eliminate this dangerous voltage. To fulfil this demand the units are equipped with a discharge circuit: After the mains voltage has been switched off, the capacitors will be discharged through intern discharging resistors in less than one second to such a level as to render it harmless. The complete discharging will take up to 10 minutes.

To replace the complete **SPATZ+** weld timer disconnect all connectors, the wires for mains and transformer and the shielding bar. The **SPATZ+** unit is fastened to the back wall of the cabinet with two M6 flange nuts. Unscrew both nuts, pull the **SPATZ+** unit over the mounting rails to the front of the cabinet and lift the **SPATZ+** weld timer out of the cabinet.

G.5.1 Replacement of the SPATZ+ mainboard

Important Note: Only a qualified electrician may replace the **SPATZ+** mainboard

The replacement must only be done with switched off mains voltage and disconnected 24 V DC supply voltage.

Important Note:

The SPATZ+ is equipped with internal capacitors that are charged to a dangerous voltage. Prior to opening or exchanging the SPATZ+ unit discharging of the capacitors must eliminate this dangerous voltage. To fulfil this demand the units are equipped with a discharge circuit: After the mains voltage has been switched off, the capacitors will be discharged through intern discharging resistors in less than one second to such a level as to render it harmless. The complete discharging will take up to 10 minutes.

To replace the **SPATZ+** mainboard disconnect all connectors, the wires for mains and transformer and the shielding bar must **not** be disconnected.

To replace the mainboard of the **SPATZ+** the four screws in the edges of the housing of the mainboard must be unscrewed. After that the Board Set can be pulled out of the weld timer.

Figure 21: Position of fastening screws for exchanging the board set of the SPATZ+

First the correct position of all contact pins on the two connection plug boards at the rear panel of the circuit board shall be checked. After that put the board block on top of the power unit and press the block carefully into the plugs. Then the fastening screws in the corner of the housing of the mainboard must be tightened (maximum torque 2.5 Nm).

Important Note:

It is strictly forbidden to power up the system without mainboard.

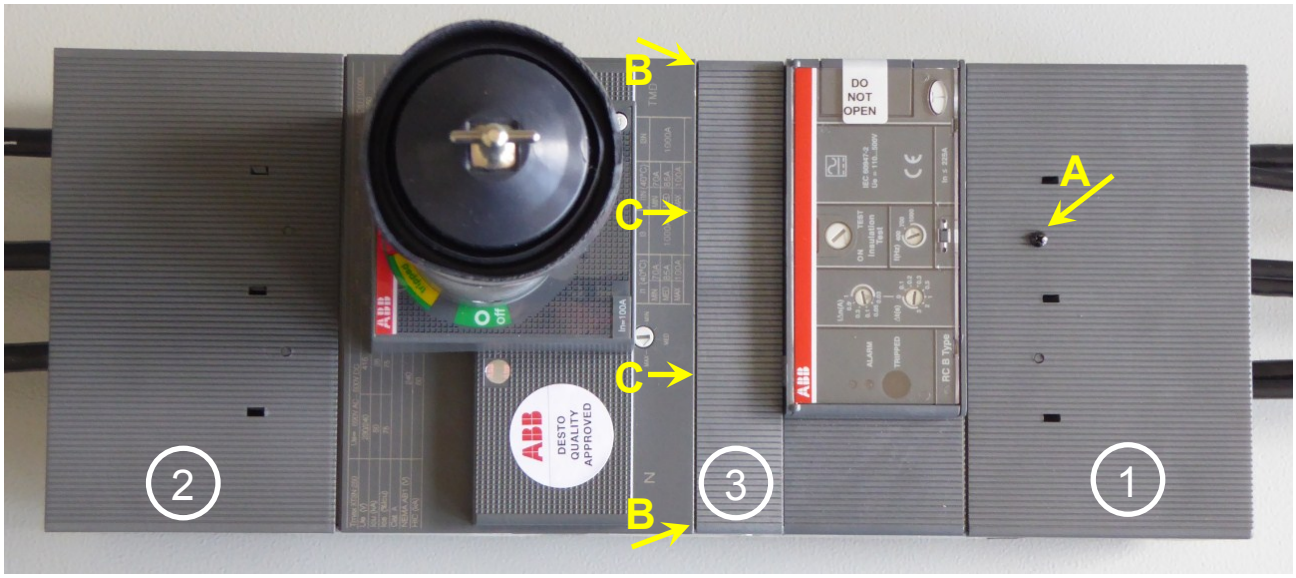
G.5.2 Replacement of the ABB main switch

In case of a broken ABB main switch please use the following instruction to replace this unit.

Important Note: The replacement must only be done by a qualified electrician with switched off mains voltage cable!

Mains voltage to the cabinet must be switched of and secured against switching on. Remove the 3 covers of the main switch:

- Cover 1: Unscrew the screw A (Phillips Size 1) and lift up the cover toward you.
- Cover 2: Lift up the cover towards you.
- Cover 3: Lift up the cover first at positions B, than at positions C and remove it.



SPATZ+ *CL-Hx* cabinet: Disconnect the mains connection cables and the cables to the **SPATZ+** inverter and the 24 V power supply (hex-wrench 6 mm).

SPATZ+ *CL-R* cabinet: Disconnect the mains connection cables, the cables to the fuses and the cables to the **SPATZ+** inverter (hex-wrench 6 mm).

Unscrew the 3 screws D (M4x110, Phillips Size 2) and the 2 screws E (M5x85, Phillips Size 2). **Do <u>not</u> open the screws F**; they are fixing the rotating unit on top of the switch:

Make sure that you don't lose the distance rolls of 5 mm thickness for the screws; they must be reused for the new switch! Without using the rolls, the screws are too long and the thread in the

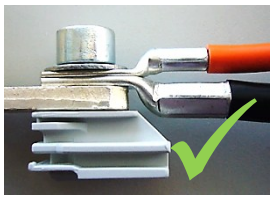
backpanel of the of the cabinet or the screws will be damaged.

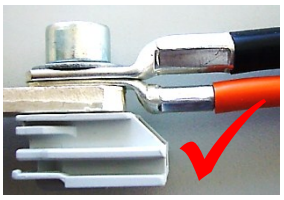
Exchange the switch to a new spare part. Tighten the 5 fastening screws with the right torque. Make sure that the distance rolls for the 5 screws are in place on top of the switch:

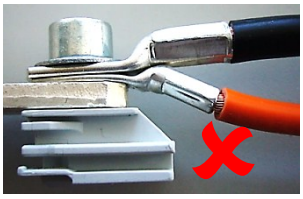
- Screws D: 3 pieces, M4x110, Phillips Size 2, torque: 1.1 Nm, distance roll 5 mm.
- Screws E: 2 pieces, M5x85, Phillips Size 2, torque: 2.0 Nm, distance roll 5 mm.

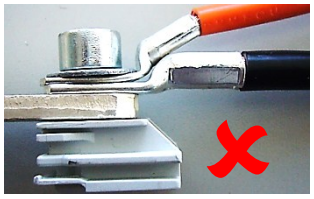
Connect the electrical cables back to the main switch, the tightening torque of the M8 screws (hex 6 mm) for the electrical connection on both sides of the switch is 8 Nm. Connect the M8 cable lugs of the mains connection cables at the left side of the main switch (and optional the cables to the fuses); and the M8 cable lugs of the cables to the **SPATZ+** inverter (and optional to the 24 V power supply) at the right side of the main switch.

Please refer to the following pictures for the correct orientation of the cable lugs at the ABB main switch in cases where more than one cable lug per terminal is used:

Right: 

Acceptable: 

Wrong: 

Wrong: 

Check the right settings of the ABB main switch:

IΔn = 0.03 A

Δt = 0 s

f = 1000 Hz

Insulation Test = ON

Close the clear plastic cover of the RCD unit and seal it with a new “Do not open” label. New labels can be offered on request part no. 8160 0025.

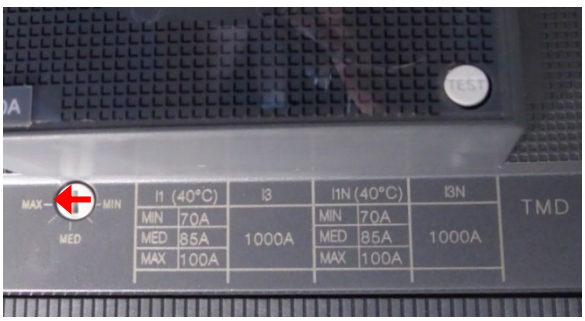
After the weld cabinet is powered up again, a test with the internal test button of the unit should be performed.

Press the oval button with the “T” at the right side of the RCD unit of the main switch. The main switch must switch off.

This test should be performed once a year.

The thermal and short circuit supervision (TMD) of the 100 A breaker can be set to the following values:

Setting	thermal	Short circuit
MIN	70 A	6 x I_n
MED	85 A	9 x I_n
MAX	100 A	12 x I_n



Standard setting when delivered is “MAX”.

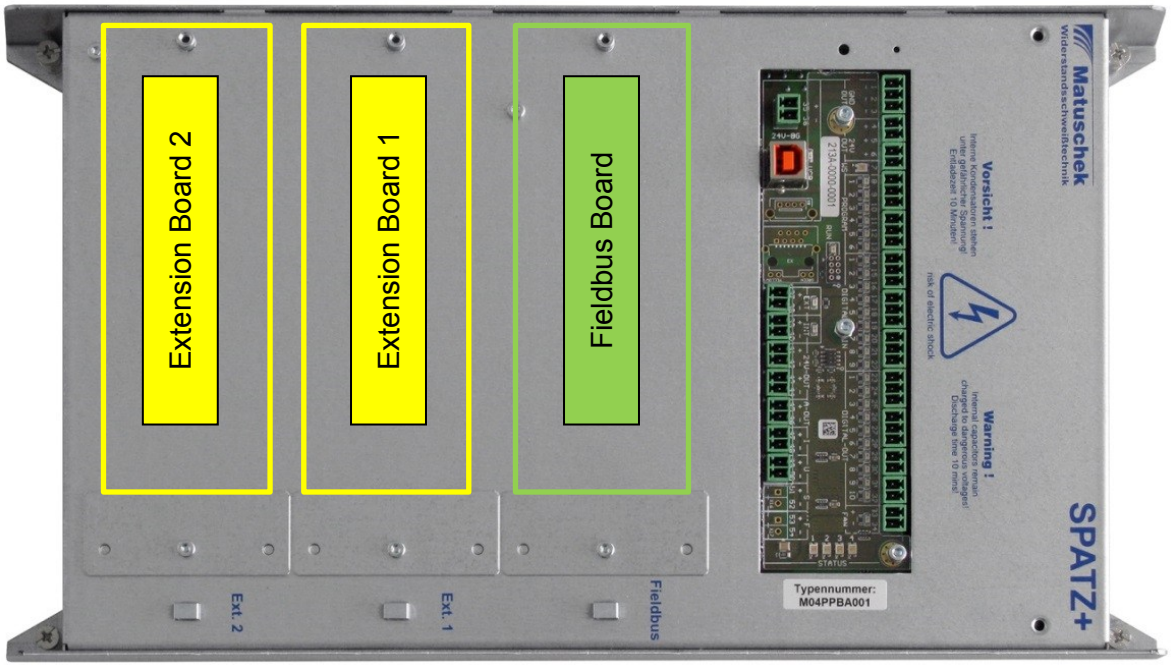
G.6 Installation and exchange of SPATZ+ extension boards

G.6.1 Arrangement of the slots for extension boards

The mainboard of the **SPATZ+** weld timer has two slots for extension boards and one slot for the fieldbus board. The slots are indicated with small labels at the housing.

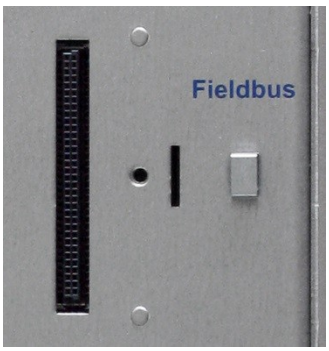
Important Note: It is strictly forbidden to change extension boards or bus boards while the SPATZ+ mainboard is under power.

Note:
The extension boards and the bus card are mechanically coded, fitting for the respective slot only.



G.6.2 Fieldbus Interface

Extension boards with different field buses (e.g. Profibus-DP, Interbus-S with LWL or Cu conductor, PROFINET or ETHERNET IP with RJ45 connector) are available for the connection of the **SPATZ+** to a robot controller or a line PLC.



The power for the electronic boards of the SPATZ+ weld timer is fed via external 24 V DC. If this external 24 V DC supply is shut off, the weld timer will not run and will not exist on the bus.

To begin with the installation of a field bus board, the 24 V DC supply voltage of the **SPATZ+** weld timer must be switched off. Afterwards the rectangular sheet metal cover beside the marking *„Field bus“* must be removed (release M3 screws). Insert the field bus board to the connector and fix it with the two M3 screws.

G.6.2.1 PROFIBUS Fieldbus board SPATZ+*FB-Pro*, *FB-Pro2* and *FB-Pro4*,

For the connection to a robot controller or a line PLC a field bus extension card with PROFIBUS is available.

The **SPATZ+***FB-Pro* board contains just the PROFIBUS connection. It is physical done via a 9-pole D-Sub plug.

The **SPATZ+***FB-Pro2* board contains an additional MSB interface for a Master/Slave system. It is physical done via a 15-pole D-Sub plug.

The **SPATZ+***FB-Pro4* board contains an RS232 interface (15-pole D-Sub connector) for sending data telegrams with QA data, a MSB interface (15-pole D-Sub plug) for a Master/Slave system and an interface for the **MASDAT** IP chip (4-fold terminal plug).

G.6.2.1.1 PROFIBUS Interface, Electrical Specification

Connector	D-Sub, 9 pin, female, cable outlet 90 - 180°
Contact 1 Contact 2 Contact 3 Contact 4 Contact 5 Contact 6 Contact 7 Contact 8 Contact 9	signal shield not connected RXD/TXD+ not connected GND 5 V not connected RXD/TXD- not connected
Baud rate	max. 12 MBit/sec.
Max. cable length	100 m / 330 ft

G.6.2.1.2 RS232 Interface, Electrical Specification

Connector	D-Sub, 9 pin, male, cable outlet 90 - 180°
Contact 1 Contact 2 Contact 3 Contact 4 Contact 5 Contact 6 Contact 7 Contact 8 Contact 9	n.c. RXD TXD n.c. Signal ground n.c. RTS CTS RI
Baud rate	4.8 - 115 kBit/sec.
Max. cable length	3 m
Transfer format	8 Databit, no parity, 1 Stopbit
Telegram length	40 Byte
Data format	LWORD: 32 Bit unsigned WORD: 16 Bit unsigned INT: 16 Bit signed BYTE: 8 Bit

G.6.2.1.3 Structure of the RS232 Data Telegram

	Starting byte	Byte	Date	Weld number	Limit value-fault	Device fault	Program number
Number of bytes	1 byte	=0	4 byte	LWORD	LWORD	LWORD	WORD
Meaning:	Always 0x0FF (255)	H6000	Refer to format date	Counter level global counter	Refer to format limit value fault	Refer to format device fault	0-62

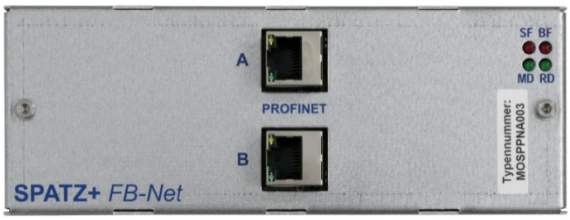
	Current	Voltage	Penetration	Time	Energy	Resistance
Number of bytes	WORD	WORD	INT	WORD	WORD	WORD
Meaning:	Root-mean-square current [kA]	Root-mean-square voltage [V]	Electrode penetration [µm]	Welding time [ms]	Welding energy [Ws]	Final resistance [µOhm]
Factor*	1	100	1	10	10	100

	Trigger angle [%]	Force [N]	Internal used	Penetration		
Number of bytes	WORD	WORD	WORD	INT/Word		
Meaning:	Final trigger angle	Mean force	-	Penetration before Welding [µm]		
Factor*	10	10				

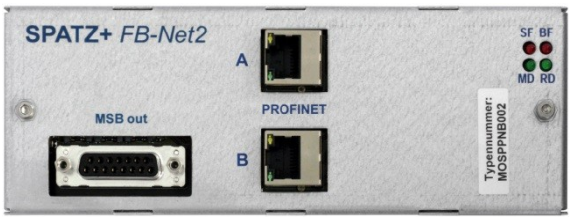
*Factor example: WORD-value of voltage = 123, factor = 100 ➔ voltage = 1,23 Volt

G.6.2.2 PROFINET Field bus board SPATZ+ *FB-Net* and *FB-Net2*

The PROFINET communication contains up to 320 bytes for input and output, depending on the implemented firmware version, refer to section G.6 for details. The GSDML file for the PROFINET protocol is available on request. The bus assignment depends on the firmware version, see section **Fehler! Verweisquelle konnte nicht gefunden werden.**.



The PROFINET interface is connected via a 2 wire switch with 8-pole RJ45 plugs. The status of the PROFINET is reported via status LEDs on the **SPATZ+** *FB-Net* board and in the RJ45 connectors.



The **SPATZ+***FB-Net2* board contains an additional MSB interface for a Master/Slave system. It is physical done via a 15-pole D-Sub plug.

Furthermore the **SPATZ+** *FB-Net* could be used as an Ethernet switch in order to integrate several **SPATZ+** weld timers in a local network without using any company network. A description how to assign an IP adress to it is shown in the documentation of the software **SPATZ***Studio*.

Important note:
While using the **SPATZ+** *FB-Net* the local Ethernet interface on the PCB is deactivated. Due to that the Ethernet RJ-45 connector at the SPATZ* mainboard should be covered with a blind-cap, which belongs to the scope of delivery of the **SPATZ+** *FB-Net* fieldbus board.

Signal LED on the board

RD	(green LED)	Ready
	On	PROFINET connection active
	Off	No connection
	Blinking	Built up connection
MD	(green LED)	Without function
BF	(red LED)	Bus error
	On	No PROFINET E/A communication.
	Off	Connection for E/A communication to the controller
SF	(red LED)	System error
	On	Error

Signal LED inside RJ45 connector

Link	(green LED)	
	On	Physical correct ETHERNET connection
	Off	No ETHERNET connection
RX/TX	(orange LED)	
	On	Data transfer via ETHERNET

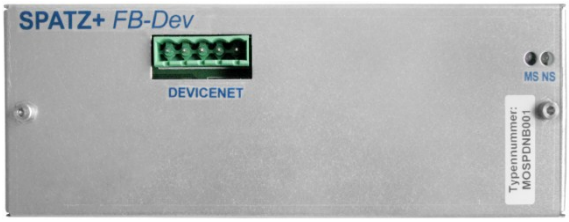
G.6.2.2.1 PROFINET Interface, Electrical Specification

Connector	RJ45, 8-pole, contactor socket
Contact 1 Contact 2 Contact 3 Contact 4 Contact 5 Contact 6 Contact 7 Contact 8	TXD+ TXD- RXD+ Not connected Not connected RXD- Not connected Not connected
Baud rate	10/100 MBit/Sec.
Max. cable length	100 m

G.6.2.3 DeviceNet Fieldbus board SPATZ+*FB-Dev* and *FB-Dev2*

For the connection to a robot controller or a line PLC a field bus extension card with DeviceNet is available. The physical connection is done via a 5-fold 5.08 mm terminal plug.

The status of the DeviceNet is reported via status LEDs.



The **SPATZ+***FB-Dev2* board contains an additional MSB interface for a Master/Slave system. It is physical done via a 15-pole D-Sub plug.

G.6.2.3.1 DeviceNet Interface, Electrical Specification

PIN	Signal	Description
Contact 1 (right)	V-	Negative supply voltage (24 V)
Contact 2	CAN-L	CAN_L bus line
Contact 3	SHIELD	Cable shield
Contact 4	CAN-H	CAN_H bus line
Contact 5 (left)	V+	Positive supply voltage (24 V)

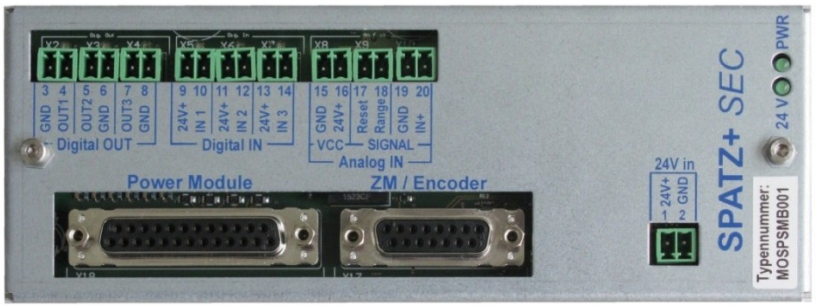
G.7 SPATZ+*SEC* and SPATZ+*SEC2* Servo Extension Boards

To begin with the installation of a field bus board, the 24 V DC supply voltage of the **SPATZ+** weld timer must be switched off. Afterwards the rectangular sheet metal cover beside the marking *„Field bus“* must be removed (release M3 screws). Insert the extension board to the connector and fix it with the two M3 screws. The signal LED **Power** indicates the internal CPU voltage and that the board is ready without errors. The LED **24 V** Ready indicates the 24 V operating voltage.

Two different types of the **SPATZ+** *SEC* board are available: **SPATZ+** *SEC* extension board and **SPATZ+** *SEC2* extension board with integrated sensor switch.

Important Note: If possible, connect the wires without ferrules; the stripping length should be 10 mm. When using ferrules the length of ferrule must be 10 mm!

G.7.1 SPATZ+*SEC* extension board



The **SPATZ+** *SEC* extension board is used to connect a servo axis in a weld gun or welding machine via the **SPATZ+** *SPM* to the **SPATZ+** weld controller. For the operation of a second axis an additional **SPATZ+** *SEC* board is required.

Beside the connections to the **SPATZ+**SPM module the board offers 3 additional 24 V DC digital inputs and 3 additional 24 V DC digital outputs. In addition it comes with an analogue input for a force sensor. The board must be supplied with 24 V DC.

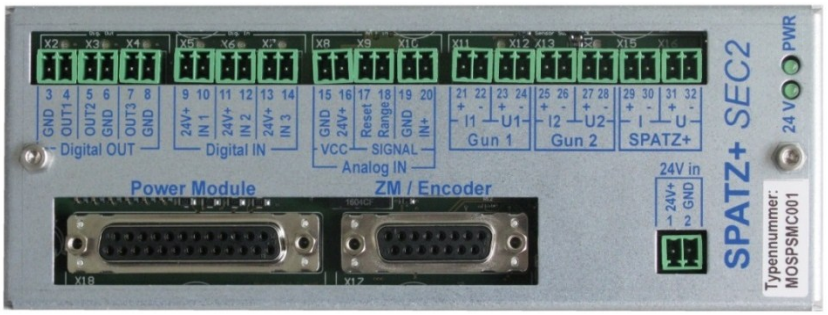
- The signal LED **PWR** shows power on.
- The **24 V**-LED shows if the board is powered with additional 24 V DC.
- The LEDs above the connectors X2 – X3 indicate which digital output is set.
- The LEDs above the connectors X4 – X7 indicate which digital output is set.

Examples of use:

G.7.1.1 Servoelectric driven weld gun with pneumatic equalization

In case a servo weld gun with integrated pneumatic driven weight equalization is applied, the pneumatic valve for the equalization shall be controlled by the ServoSPATZ+ controller. Therefor the Digital Output1 (Pin 3=Ground and Pin 4=24V) has to be wired to the pneumatic valve on the weld gun via 2-wire cable. The SPATZ controller gives a 24V voltage out via Pin 4 as soon as a SEQ START signal is received for activation of the pneumatic valve and resets the 24 V for deactivation after the complete sequence is finished (SEQ END or in case of error a SEQ ERR or SPOT ERR).

G.7.2 SPATZ+*SEC2* extension board with sensor switch



The **SPATZ+** *SEC2* extension board is used as a 2nd extension board when 2 guns with one servo electrical axis each are connected to one **SPATZ+** weld controller. In addition two **SPATZ+** *SPM* power modules are needed.

The board offers 3 additional 24 V DC digital inputs and 3 additional 24 V DC digital outputs. In addition it comes with an analogue input for an force sensor. The board must be supplied with 24 V DC.

Compared with the **SPATZ+** *SEC2* board the **SPATZ+** *SEC2* board comes with an additional sensory switch for 2 guns, 2 sensors each (weld current, electrode voltage).

- The signal LED **PWR** shows power on.
- The **24 V**-LED shows if the board is powered with additional 24 V DC.
- The LEDs above the connectors X2 – X3 indicate which digital output is set.
- The LEDs above the connectors X4 – X7 indicate which digital output is set.
- The LEDs above the connectors X12 and X14 indicate which gun is switched to the weld timer.

G.7.3 Pin Assignment of the SPATZ+*SEC* and SPATZ+*SEC2* Servo Extension Boards, X1-X16:

Contact	Designation	Function		Connector
1	24 V +	+24 V DC, supply of digital I/O		X1
2	GND	0 V DC, supply of digital I/O		
3	GND	Digital output 1 with related 0 V DC supply		X2
4	OUT 1			
5	GND	Digital output 2 with related 0 V DC supply		X3
6	OUT 2			
7	GND	Digital output 3 with related 0 V DC supply		X4
8	OUT 3			
9	24 V +	Digital input 1 with related +24 V DC supply		X5
10	IN 1			
11	24 V +	Digital input 2 with related +24 V DC supply		X6
12	IN 2			
13	24 V +	Digital input 3 with related +24 V DC supply		X7
14	IN 3			
15	GND	Supply voltage for the external force sensor	External force sensor	X8
16	24 V +			
17	Reset	Reset output for the external force sensor		X9
18	Range	Range output for the external force sensor		
19	GND	Feedback Signal (0-10 V) of the external force sensor		X10
20	IN +			

The setup of the input and output signals is often related to a customer related project. The corresponding setup of the in and outs is always given in the wiring diagram of the cabinet.

The **SPATZ+** *SEC2* board is equipped with the following additional terminals (sensor switch):

Contact	Designation	Function		Connector
21	+I1 Gun 1	signal in	Welding current signal, Gun 1	X11
22	-I1 Gun 1	signal GND		
23	+U1 Gun 1	signal in	Electrode voltage signal, Gun 1	X12
24	-U1 Gun 1	signal GND		
25	+I2 Gun 2	signal in	Welding current signal, Gun 2	X13
26	-I2 Gun 2	signal GND		
27	+U2 Gun 2	signal in	Electrode voltage signal, Gun 2	X14
28	-U2 Gun 2	signal GND		
29	+I SPATZ+	bridge (brown) to weld timer, contact 47, I +	Welding current signal to **SPATZ+** timer	X15
30	-I SPATZ+	bridge (white) to weld timer, contact 48, I -		
31	+U SPATZ+	bridge (red) to weld timer, contact 49, U +	Electrode voltage signal to	X16

32	-U SPATZ+	bridge (blue) to weld timer, contact 50, U -	**SPATZ+** timer	

The sensor signals of weld current and of electrode voltage from the two guns will be connected to the sensor switch at the **SPATZ+** *SEC2* board, contact 21 - 28. LEDs on the board beside the connectors 51/52 and 55/56 indicate, which gun is switched to the weld timer. Notes on cable layout and shielding are listed in sections C.4, C.4.1 and C.4.2. The twisted pair bridge cables (in the scope of delivery of the **SPATZ+** *SEC2*) must be inserted at contact 29 - 32) of the **SPATZ+** board and connected with the corresponding inputs of the **SPATZ+** weld timer.

Important Note: If possible, connect the wires without ferrules; the stripping length should be 10 mm. When using ferrules the length of ferrule must be 10 mm!

G.7.3.1 Digital Inputs SPATZ+ *SEC* and SPATZ+ *SEC2*, Electrical Specification

Connector	2-pole connector, X2 – X4
Data of the connector	Refer to chapter C.3
Max. input voltage (EN 61131-2) for 0-signal	-3 to +5 V DC
Max. input voltage (EN 61131-2) for 1-signal	+11 to +30 V DC
Input current per input	typ. 5 mA
Delay at signal transition	typ. 0.5 ms
Status LED for each input	yes

G.7.3.2 Digital Outputs SPATZ+ *SEC* and SPATZ+ *SEC2*, Electrical Specification

Connector	2-pole connector, X5 – X7
Data of the connector	Refer to chapter C.3
Max. output current per output	500 mA
Max. output current total	1.5 A
Short circuit protection	Yes
Status LED for each output	Yes

G.7.3.3 Analog Input SPATZ+ *SEC* and SPATZ+ *SEC2*, Electrical Specification

Connector	3 x 2-pole connector, X8 – X10
Contact-No. / description Contact-No. / description	15 0 V DC output, supply voltage for force sensor 16 24 V DC output, supply voltage for force sensor
Contact-No. / description Contact-No. / description	17 Reset signal for force sensor 18 Range signal for force sensor
Contact-No. / description Contact-No. / description	19 signal ground of force sensor 20 signal in of force senor (0 - 10 V)
Connector data	refer to chapter C.3
Shield connection	Shield bar at the **SPATZ+**
Short circuit protection	yes

G.7.3.4 24 V DC Power Supply SPATZ+ *SEC* and SPATZ+ *SEC2*, Electrical Specification

The external 24 V DC power supply voltage of the **SPATZ+** *SEC* and **SPATZ+** *SEC2* board must be connected to terminal 1 and 2.

Connector	2-pole connector, X1
Contact-No. / description Contact-No. / description	**1** 24 V DC **2** 0 V DC
Connector data	refer to chapter C.3
Max. current of **external** supply	1.5 A
Protection against incorrect polarity	yes

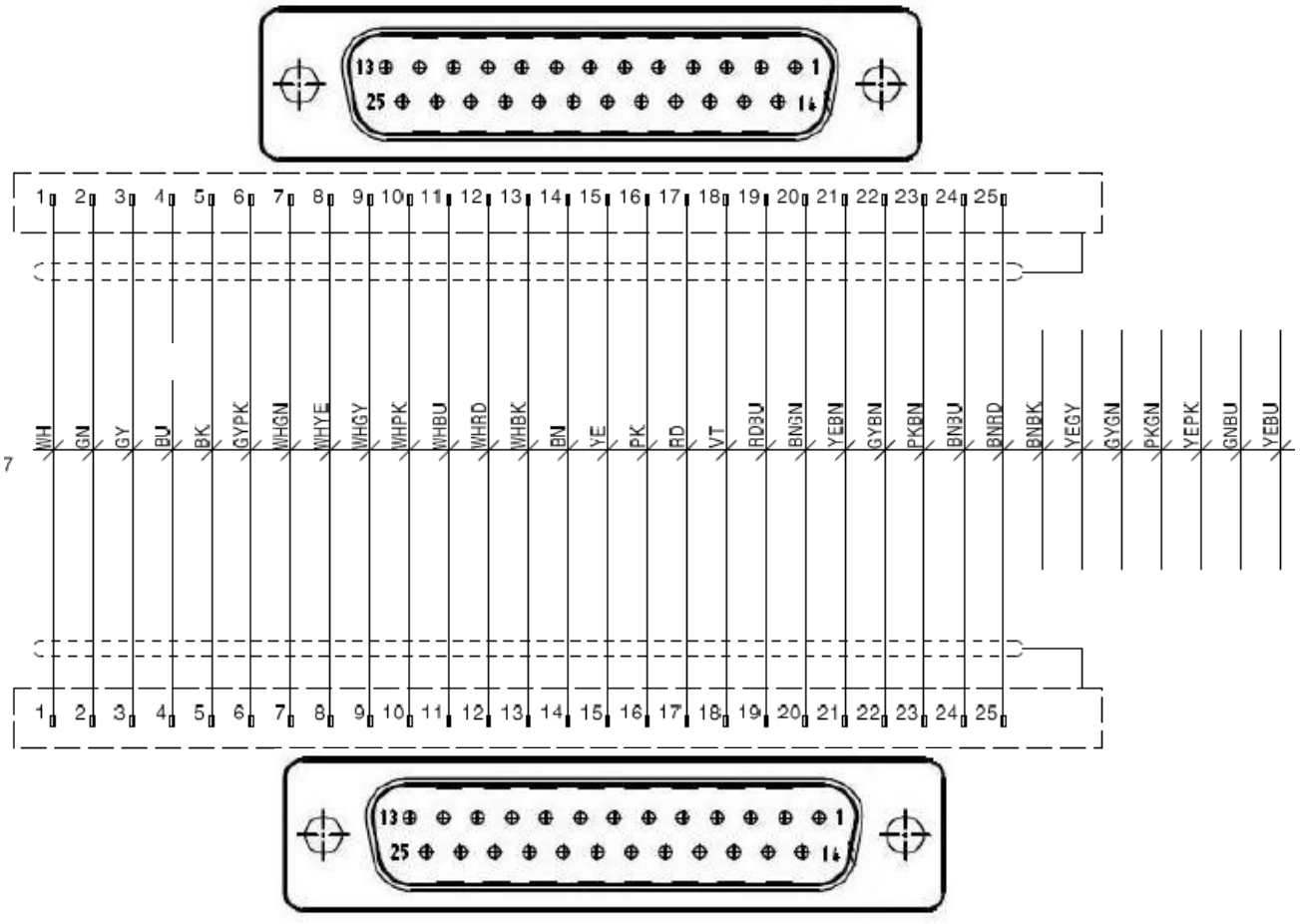
Important note:

The total current of all consumers (digital outputs, 24 V DC power supply of force sensor) must not exceed 1.5 A.

G.7.3.5 Connection cable SPATZ+ *SEC* extension board to SPATZ+ *SPM* power module

The connection cable comes as a ready to plug cable in a fixed length of 550 – 750 mm depending on the different positioning of the **SPATZ+** *SPM* power modules inside the cabinet. The connection cable is a one to one connection of the two Sub-D plugs.

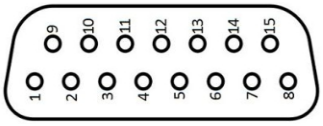
SPATZ+ *SEC* interface (X18):



SPATZ+ *SPM* interface (X7):

G.7.3.6 SPATZ+ *SEC* interface for Encoder or SPATZ+ *GM* Gun module, X17

The interface X17 “ZM / Encoder” can be used either for the gun module or for the encoder signal of a servo drive. At the SPATZ+ ***SEC*** it comes as an 15-pol sub-D female connector.



G.7.3.6.1 SPATZ+ *SEC* interface for Encoder, X17

Important Note: The cables for data channels **A** and **B** should be twisted pair.

Contact	Designation	Interface for servo drive with Encoder	Channel
1	24 V +	Not in use	
9	0 V		
2	GND GM	Not in use	
10	GND	GND Encoder	
3	Clock -	Encoder Clock signal	**A**
11	Clock +		
4	+ 5 V Supply	Encoder	
12	+ 5 V Supply	Sensor Motor temperature	
5	Data -	Encoder Data signal	**B**
13	Data +		
6	PE		
14	GND		
7	Signal Temperature	Motor Temperature	
8	Data -	Not in use	
15	Data +		
Shield	Shield	Connected to connector housing	

G.7.3.6.2 SPATZ+ *SEC* interface for SPATZ+ *GM* Gun module, X17

Important Note: The cables for data channel **C** should be twisted pair.

Contact	Designation	Interface for **SPATZ+** *GM* Gun module	Channel
1	24 V +	+24 V DC, supply of Gun module	
9	0 V		
2	GND	Not in use	
10	GND		
3	Clock -	Not in use	
11	Clock +		
4	+ 5 V Supply	Not in use	
12	+ 5 V Supply		
5	Data -	Not in use	
13	Data +		
6	PE		
14	GND	Not in use	
7	Signal Temperature	Not in use	
8	Data -	Gun module data signal Gun-Bus	**C**
15	Data +		
Shield	Shield	Connected to connector housing	

H Specific Documentation of Different SPATZ+ Firmware Versions

There are different firmware versions for different applications of the **SPATZ+** available. The actual installed firmware versions of the **SPATZ+** can be shown via the **SPATZ***Studio* PC software. See documentation of this product for more details.

H.1 Field BUS

H.1.1 List of available Protocols

The following list shows the different available Field Bus Protocols. This list will be continuously improved:

	Bus Protocol with 8 Byte Input and 8 Byte Output for aluminium welding applications. The I/O configuration of the **SPATZ+** weld timer is given in section Fehler! Verweisquelle konnte nicht gefunden werden.**.**
	Bus Protocol with 8 Byte Input and 64 Byte Output for miniature part welding. The I/O configuration of the **SPATZ+** weld timer is given in section Fehler! Verweisquelle konnte nicht gefunden werden.**.**

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H.1.2 Field BUS protocol for aluminium welding (high current, servo drive, CapClean)

This protocol has 8 Byte for Input and 8 Byte for Output signals.

Databit	Input signal	Symbol	Output signal	Symbol
1.0	Start sequence	START_SEQ	Sequence finished	SEQ_END
1.1	Weld current On	CURR_EN	Weld timer ready	READY
1.2	Weld stroke ON	STRO_EN	Sequence error	SEQ_ERROR
1.3	Reset error	RESET_ERR	Spot error	SPOT_ERROR
1.4				
1.5				
1.6				
1.7	CapClean brush on	BRUSH_ON		
2.0			Request Tipdress / Buff	DRESS_REQ
2.1	Confirm new wheel	WHEEL_CONF	Request new tips	TIP_REQ
2.2	Save Teach-Position M1	TCH_SAV1	Request new wheel	WHEEL_REQ
2.3	Save Teach-Position M2	TCH_SAV2		
2.4	Teach Plus Motor 1	TCH_PLU1		
2.5	Teach Minus Motor 1	TCH_MIN1		
2.6	Teach Plus Motor 2	TCH_PLU2		
2.7	Teach Minus Motor 2	TCH_MIN2		
3.0	Part ID Bit 0	PID_00	Gun referenced	GUN_REF
3.1	Part ID Bit 1	PID_01	CapClean referenced	CC_REF
3.2	Part ID Bit 2	PID_02		
3.3	Part ID Bit 3	PID_03		
3.4	Part ID Bit 4	PID_04		
3.5	Part ID Bit 5	PID_05		
3.6	Part ID Bit 6	PID_06		
3.7	Part ID Bit 7	PID_07		

Databit	Input signal	Symbol	Output signal	Symbol
4.0	Part ID Bit 8	PID_08		
4.1	Part ID Bit 9	PID_09		
4.2	Part ID Bit 10	PID_10		
4.3	Part ID Bit 11	PID_11		
4.4	Part ID Bit 12	PID_12		
4.5	Part ID Bit 13	PID_13		
4.6	Part ID Bit 14	PID_14		
4.7	Part ID Bit 15	PID_15		
5.0	Spot selection Bit 0	SPOT_00	Status Bit 0	STATUS_00
5.1	Spot selection Bit 1	SPOT _01	Status Bit 1	STATUS_01
5.2	Spot selection Bit 2	SPOT _02	Status Bit 2	STATUS_02
5.3	Spot selection Bit 3	SPOT _03	Status Bit 3	STATUS_03
5.4	Spot selection Bit 4	SPOT _04	Status Bit 4	STATUS_04
5.5	Spot selection Bit 5	SPOT _05	Status Bit 5	STATUS_05
5.6	Spot selection Bit 6	SPOT _06	Status Bit 6	STATUS_06
5.7	Spot selection Bit 7	SPOT _07	Status Bit 7	STATUS_07
6.0	Spot selection Bit 8	SPOT _08	Status Bit 8	STATUS_08
6.1	Spot selection Bit 9	SPOT _09	Status Bit 9	STATUS_09
6.2	Spot selection Bit 10	SPOT _10	Status Bit 10	STATUS_10
6.3	Spot selection Bit 11	SPOT _11	Status Bit 11	STATUS_11
6.4	Spot selection Bit 12	SPOT _12	Status Bit 12	STATUS_12
6.5	Spot selection Bit 13	SPOT _13	Status Bit 13	STATUS_13
6.6	Spot selection Bit 14	SPOT _14	Status Bit 14	STATUS_14
6.7	Spot selection Bit 15	SPOT _15	Status Bit 15	STATUS_15
7.0	Spot selection Bit 16	SPOT _16		
7.1	Spot selection Bit 17	SPOT _17		
7.2	Spot selection Bit 18	SPOT _18		
7.3	Spot selection Bit 19	SPOT _19		
7.4	Spot selection Bit 20	SPOT _20		
7.5	Spot selection Bit 21	SPOT _21		
7.6	Spot selection Bit 22	SPOT _22		
7.7	Spot selection Bit 23	SPOT _23		
8.0	Spot selection Bit 24	SPOT _24		
8.1	Spot selection Bit 25	SPOT _25		
8.2	Spot selection Bit 26	SPOT _26		
8.3	Spot selection Bit 27	SPOT _27		
8.4	Typ ID Bit 0	TYP_0		
8.5	Typ ID Bit 1	TYP_1		
8.6	Typ ID Bit 2	TYP_2		
8.7	Typ ID Bit 3	TYP_3		

H.1.3 Field BUS protocol for Microweld QS (8 Byte In / 64 Byte Out)

This protocol has 8 Byte for Input and 64 Bytes for Output signals.

Databit	Input signal	Symbol
1.0	Start sequence	START_SEQ
1.1	Weld current ON	CURR_EN
1.2	Weld stroke ON	STRO_EN
1.3	Reset error	RESET_ERR
1.4		
1.5		
1.6		
1.7		
2.0		
2.1		
2.2		
2.3		
2.4	Teach Plus Motor 1	TCH_PLU1
2.5	Teach Minus Motor 1	TCH_MIN1
2.6	Teach Plus Motor 2	TCH_PLU2
2.7	Teach Minus Motor 2	TCH_MIN2
3.0	Part ID Bit 0	PID_00
3.1	Part ID Bit 1	PID_01
3.2	Part ID Bit 2	PID_02
3.3	Part ID Bit 3	PID_03
3.4	Part ID Bit 4	PID_04
3.5	Part ID Bit 5	PID_05
3.6	Part ID Bit 6	PID_06
3.7	Part ID Bit 7	PID_07
4.0	Part ID Bit 8	PID_08
4.1	Part ID Bit 9	PID_09
4.2	Part ID Bit 10	PID_10
4.3	Part ID Bit 11	PID_11
4.4	Part ID Bit 12	PID_12
4.5	Part ID Bit 13	PID_13
4.6	Part ID Bit 14	PID_14
4.7	Part ID Bit 15	PID_15
5.0	Spot selection Bit 0	SPOT_00
5.1	Spot selection Bit 1	SPOT _01
5.2	Spot selection Bit 2	SPOT _02
5.3	Spot selection Bit 3	SPOT _03
5.4	Spot selection Bit 4	SPOT _04
5.5	Spot selection Bit 5	SPOT _05
5.6	Spot selection Bit 6	SPOT _06
5.7	Spot selection Bit 7	SPOT _07

Output signal	Symbol
Sequence ready	SEQ_END
Timer ready	READY
Sequence error	SEQ_ERROR
Limit value error	SPOT_ERROR
Request Tipdress / Buff	DRESS_REQ
Request new tips	TIP_REQ
Gun 1 referenced	GUN_REF
Gun 2 referenced	CC_REF
QA Data Valid	QA_VALID
Status Bit 0	STATUS_00
Status Bit 1	STATUS_01
Status Bit 2	STATUS_02
Status Bit 3	STATUS_03
Status Bit 4	STATUS_04
Status Bit 5	STATUS_05
Status Bit 6	STATUS_06
Status Bit 7	STATUS_07

Databit	Input signal	Symbol
6.0	Spot selection Bit 8	SPOT _08
6.1	Spot selection Bit 9	SPOT _09
6.2	Spot selection Bit 10	SPOT _10
6.3	Spot selection Bit 11	SPOT _11
6.4	Spot selection Bit 12	SPOT _12
6.5	Spot selection Bit 13	SPOT _13
6.6	Spot selection Bit 14	SPOT _14
6.7	Spot selection Bit 15	SPOT _15
7.0	Spot selection Bit 16	SPOT _16
7.1	Spot selection Bit 17	SPOT _17
7.2	Spot selection Bit 18	SPOT _18
7.3	Spot selection Bit 19	SPOT _19
7.4	Spot selection Bit 20	SPOT _20
7.5	Spot selection Bit 21	SPOT _21
7.6	Spot selection Bit 22	SPOT _22
7.7	Spot selection Bit 23	SPOT _23
8.0	Spot selection Bit 24	SPOT _24
8.1	Spot selection Bit 25	SPOT _25
8.2	Spot selection Bit 26	SPOT _26
8.3	Spot selection Bit 27	SPOT _27
8.4		
8.5		
8.6		
8.7		

Output signal	Symbol
Status Bit 8	STATUS_08
Status Bit 9	STATUS_09
Status Bit 10	STATUS_10
Status Bit 11	STATUS_11
Status Bit 12	STATUS_12
Status Bit 13	STATUS_13
Status Bit 14	STATUS_14
Status Bit 15	STATUS_15

Output data byte 9-64:

Data byte	Bit	Output bits	Output signal	Comment
9-10	0-15	O64-79	Time 1/1000 sec	
11	Bit 0-7	O80-87	Time Second	
12	Bit 0-7	O88-95	Time minute	
13	Bit 0-7	O 96-103	Time hour	
14	Bit 0-7	O104-111	Date day	
15	Bit 0-7	O112-119	Date month	
16	Bit 0-7	O120-127	Date year	(Offset to 1980)
17-20	Bit 0-31	O128-159	Program number	
21-24	Bit 0-31	O160-191	Weld time (ms)	
25-28	Bit 0-31	O192-223	Ieff (A)	
29-32	Bit 0-31	O224-255	Uaverage (V*100)	Two decimal places
33-36	Bit 0-31	O256-287	Raverage (µOhm)	
37-40	Bit 0-31	O288-319	Energy (Ws*100)	Two decimal places
41-44	Bit 0-31	O320-351	Trigger angle end (%*10)	One decimal place
45-48	Bit 0-31	O352-383	Force start (N)	
49-52	Bit 0-31	O384-415	Penetration (µm)	
53-56	Bit 0-31	O416-447	Temperature (°C*10)	One decimal place
57-60	Bit 0-31	O448-479	Reserve	
61-64	Bit 0-31	O480-511	Reserve	

H.1.4 Field BUS: Timer Status Codes

The following list shows the status codes, sent out by the weld timer in case of a weld error via field bus. These codes might differ from the presented code in the **SPATZ***Studio* or **SPATZ***StudioNet* software.

Timer status	Error message in weld timer	Suggestion for error messages at PLC or robot controller
E1	WeldStop circuit open	Welding terminated
E3	Over-current switch off	Inverter output over current
E4-7	IGBT fault	Power Inverter fault
E8	Under-voltage primary circuit	Supply voltage fault
E9	Phase error mains	error supply voltage mains
E11	Undervoltage 24 V DC for I/O	error supply voltage 24 V
E15	Current sensor fault	Current sensor fault
E16	Voltage sensor fault	Voltage sensor fault
E17	External Stop Robot	Robot signal missing
E18	Overheating of weld inverter	Power inverter overheated
E19	Invalid weld spot selection	Invalid weld spot is selected Check selection or spot table
E20	Lower alarm limit of Welding time violated	Short welding time - Check spot
E21	Upper alarm limit of Welding time violated	Long welding time - Check spot
E22	Lower alarm limit of Current violated	Low current - Check spot
E23	Upper alarm limit of Current violated	High current - Check spot
E24	Lower alarm limit of Electrode voltage violated	Low electrode voltage - Check spot
E25	Upper alarm limit of Electrode voltage violated	High electrode voltage - Check spot
E26	Lower alarm limit of Resistance violated	Low weld resistance - Check spot
E27	Upper alarm limit of Resistance violated	High weld resistance - Check spot
E30	Lower alarm limit of Trigger angle violated	Small trigger angle - Check spot
E31	Upper alarm limit of Trigger angle violated	Large trigger angle - Check spot
E32	Lower alarm limit of Energy violated	Small weld energy - Check spot
E33	Upper alarm limit of Energy violated	Large weld energy - Check spot
E34	Lower alarm limit **NUGGET***Index* violated	NI - Check spot
E35	Upper alarm limit **NUGGET***Index* violated	NI - Check spot
E40	Spot Counter Alarm	Tip dressing
E41	Lower alarm limit of short circuit resistance First Tip dress	Low short circuit resistance after first tip dress - Check tip and tip dresser
E42	Upper alarm limit of short circuit resistance First Tip dress	Large short circuit resistance after first tip dress - Check tip and tip dresser
E43	Lower alarm limit of trigger angle First Tip dress	Low trigger angle after first tip dress - Check tip and tip dresser
E44	Upper alarm limit of trigger angle First Tip dress	Large trigger angle after first tip dress - Check tip and tip dresser
E45	Lower alarm limit of short circuit resistance Tip dress	Low short circuit resistance after tip dress - Check tip and tip dresser
E46	Upper alarm limit of short circuit resistance Tip dress	Large short circuit resistance after tip dress - Check tip and tip dresser
E47	Lower alarm limit of trigger angle Tip dress	Low trigger angle after tip dress - Check tip and tip dresser
E48	Upper alarm limit of trigger angle Tip dress	Large trigger angle after tip dress - Check tip and tip dresser

Timer status	Error message in weld timer	Suggestion for error messages at PLC or robot controller
E49	Lower alarm limit of weld time deviation	
E50	Upper alarm limit of weld time deviation	**Weld time uncommonly long!** Check sheet combination, large gap, electrode surface, gun resistance, weld current calibration, max. trigger angle
E51	Lower alarm limit of weld current deviation	**Weld current too low!** Check sheet combination, large gap, electrode surface, gun resistance, weld current calibration, max. trigger angle
E52	Upper alarm limit of weld current deviation	**Weld current too high!** Check shunts, sheet combination, spot position, gun resistance, weld current calibration
E53	Lower alarm limit of Electrode force violated	Low electrode force - Check spot
E54	Upper alarm limit of Electrode force violated	High electrode force - Check spot
E125	Max. weld time extension exceeded	Max. weld time exceeded - Check spot
E131	START input while **SPATZ** not ready	**START input set while SPATZ control not ready.** Eliminate causes for NOT-READY of the **SPATZ** control and reset error
E132	Missing sheet detected	**Overall sheet thickness too low!** Check sheet combination and number of sheets. Edge welding?
E133	Weld gun resistance not determined	**Determinate gun resistance!** Check if gun resistance value is available. Execute service program 121 with dressed electrode tips.
E135	Spot check ticked in spottable	**Check gun and spot position for actual spot.** If position okay, deactivate the spot check for this spot and confirm error with “Reset Repeat”.
*	Gun pressure not reached. Welding stopped!	Gun pressure fault
*	Overload digital output driver	Output driver overloaded
500	IGBT error (motor power module 1)	
501	IGBT overheating (motor power module 1)	
502	Undervoltage (motor power module 1)	
503	Overvoltage (motor power module 1)	
504	Error break resistance (motor power module 1)	
505	Mechanical break not connected (motor power module 1)	
506	Short circuit mechanical break (motor power module 1)	
507	Overcurrent motorphase (motor power module 1)	
508	Intermediate circuit not loaded (motor power module 1)	
509	Motor power module not connected (motor power module 1)	
510	No force calibration	
511	Maximum Tip Wear reached	
512	Wrong sheet thickness detected	
513	Invalid position motor 1	
514	Invalid position motor 2	
520	Timeout during motion task	

Timer status	Error message in weld timer	Suggestion for error messages at PLC or robot controller
521	'Motion Controller' error	
522	Motor 1 not referenced	
524	*CapClean* error: referencing failed	
525	*CapClean* error: buffing failed	
526	*CapClean* error: *CapClean* not referenced	
527	Error encoder motor 1	
528	Error encoder motor 2	
529	Error 'Motion Controller' initialisation	
530	IGBT error (motor power module 2)	
531	IGBT overheating (motor power module 2)	
532	Undervoltage (motor power module 2)	
533	Overvoltage (motor power module 2)	
534	Error break resistance (motor power module 2)	
535	Mechanical break not connected (motor power module 2)	
536	Short circuit mechanical break (motor power module 2)	
537	Overcurrent motorphase (motor power module 2)	
538	Intermediate circuit not loaded (motor power module 2)	
539	Motor power module not connected (motor power module 2)	
540	No connection encoder motor 1	
541	No connection encoder motor 2	
542	Motor 2 not referenced	
543	Overheating motor 1	
544	Overheating motor 2	
600	Lower alarm limit '*Servo***NUGGET***Index*' violated	
601	Upper alarm limit '*Servo***NUGGET***Index*' violated	
602	Lower alarm limit ‚Position' violated	
603	Upper alarm limit ‚Position' violated	
604	Lower alarm limit ‚Position Abbrand' violated	
605	Upper alarm limit ‚Position Abbrand' violated	

*currently not in use

H.1.5 Field BUS: Error Handling Guide

The following list shows explanations for the error codes, sent after the weld in case via field bus to the robot. The code might differ from the presented code in the **SPATZ***Studio* software.

Error no.	Error message	Description	Possible reasons	Handling
E1	WeldStop circuit open	Stop-circuit open.	• An actuator has opened the WeldStop circuit • Cable defect	Check all items that are included in the WS-circuit.
E3	Over-current switch off	Power inverter fault The current on the primary side of the transformer was too high.	• The control value (e.g. the current in KSR^2 mode) is set too high. • Cable defect of sensor cable of current or electrode voltage • Short circuit welding in **MASTER** mode • Short circuit or cable break in transformer cable • Faulty diode in transformer rectifier	Check possible reasons. If more current is needed change to a more powerful version of the weld timer.
E4-7	IGBT fault	The current on the primary side of the transformer was too high.	• Faulty power semiconductor • Short circuit / cable break in transformer cable • Over-current circuit breaker, see error 1045 • Hardware error of main board or power unit • Max. trigger angle to high	Save weld programs of the defect timer, change timer and upload the weld programs, change cable …
E8	Under-voltage primary circuit	Supply voltage fault.	• One of the three mains phases is not properly connected • The fuse of one of the phases is destroyed • Cable defect of the mains connection	Check possible reasons.
E9	Phase error mains	error supply voltage mains.	• One of the three phases of the mains is missing. • One fuse of the mains is broken • Cable defect of the mains	Check for possible reasons!
E11	Undervoltage 24 V DC for I/O	error supply voltage 24 V.	• Supply voltage for the Inputs and outputs to low. • Cable defect	Check for possible reasons!
E15	Current sensor fault	Weld process fault. The current has not reached the programmed value within the programmed time.	• Isolation between the electrodes (e.g. adhesive on the tips, labels on the unit) • Defective or disconnected current sensor cable • Electrodes had no contact, as the gun had not been closed when the welding current started. • The programmed settings are impossible to reach.	Check possible reasons.
E16	Voltage sensor fault	Weld process fault. The electrode voltage has not reached the programmed value within the	• The programmed settings are impossible to reach. • Defect or disconnected voltage sensor cable. • In combination with 1053: power cable to transformer not connected	Check possible reasons.

		programmed time.		
E17	External Stop Robot	Robot signal missing.	• Signal of the robot is missing. • Cable defect	Check robot programming and electric circuit.
E18	Overheating of weld inverter	Power inverter fault.	• No cooling water or low cooling water flow rate. • Fan blocked/dirty • Dirty/Blocked heat sink • Duty cycle too high	Check possible reasons.
E19	Invalid weld spot selection	Invalid weld spot is selected.	• Selected spot is not in the spot table of the timer.	Check selection or spot table
E20	Lower alarm limit of Welding time violated	Short welding time Check spot.	• Weld fault • Programmed set point and/or limits are not appropriate.	Check spot and possible reasons.
E21	Upper alarm limit of Welding time violated	Long welding time Check spot.	• Weld fault • Programmed set point and/or limits are not appropriate.	Check spot and possible reasons.
E22	Lower alarm limit of Current violated	Low current Check spot.	• Weld fault • Programmed set point and/or limits are not appropriate.	Check spot and possible reasons.
E23	Upper alarm limit of Current violated	High current Check spot.	• Weld fault • Programmed set point and/or limits are not appropriate.	Check spot and possible reasons.
E24	Lower alarm limit of Electrode voltage violated	Low electrode voltage Check spot.	• Weld fault • Programmed set point and/or limits are not appropriate.	Check spot and possible reasons.
E25	Upper alarm limit of Electrode voltage violated	High electrode voltage Check spot.	• Weld fault • Programmed set point and/or limits are not appropriate.	Check spot and possible reasons.
E26	Lower alarm limit of Resistance violated	Low weld resistance Check spot.	• Weld fault • Programmed set point and/or limits are not appropriate.	Check spot and possible reasons.
E27	Upper alarm limit of Resistance violated	High weld resistance Check spot.	• Weld fault • Programmed set point and/or limits are not appropriate.	Check spot and possible reasons.
E30	Lower alarm limit of Trigger angle violated	Low trigger angle Check spot.	• Weld fault • Programmed set point and/or limits are not appropriate.	Check spot and possible reasons.
E31	Upper alarm limit of Trigger angle violated	Large trigger angle Check spot.	• Weld fault • Programmed set point and/or limits are not appropriate.	Check spot and possible reasons.
E32	Lower alarm limit of Energy violated	Low weld energy Check spot.	• Weld fault • Programmed set point and/or limits are not appropriate.	Check spot and possible reasons.
E33	Upper alarm limit of Energy violated	Large weld energy Check spot.	• Weld fault • Programmed set point and/or limits are not appropriate.	Check spot and possible reasons.
E34	Lower alarm limit **NUGGET***/index* violated	Lower Alarm limit of **NUGGET***/Index* violated. (Number of errors for stop	• Bad tip dressing. • Electrode wear too big to be compensated. • Shunt effects too big to be compensated. • Resistance of sheet stack up	Check the possible reasons, e.g. shunts, worn out caps, bad tip dresser, sensor lines, sheet material, coating.

		depending on specific filter settings)	much lower than during reference welding.	
E35	Upper alarm limit **NUGGET***Index* violated	Check spot.	• Weld fault • Programmed set point and/or limits are not appropriate.	Check spot and possible reasons.
E40	Spot Counter Alarm	No tip dress after counter prewarning.	• Tip dress request ignored • Wrong programming of PLC or robot	Check electrodes Tip dressing
E41	Lower alarm limit of short circuit resistance First Tip dress	Low short circuit resistance after first tip dress.	• Tip dress fault • Tip dresser fault • Programmed set point and/or limits are not appropriate.	Check tip! Check tip dresser and possible reasons!
E42	Upper alarm limit of short circuit resistance First Tip dress	Large short circuit resistance after first tip dress.	• Tip dress fault • Tip dresser fault • Programmed set point and/or limits are not appropriate.	Check tip! Check tip dresser and possible reasons!
E43	Lower alarm limit of trigger angle First Tip dress	Low trigger angle after first tip dress.	• Tip dress fault • Tip dresser fault • Programmed set point and/or limits are not appropriate.	Check tip! Check tip dresser and possible reasons!
E44	Upper alarm limit of trigger angle First Tip dress	Large trigger angle after first tip dress.	• Tip dress fault • Tip dresser fault • Programmed set point and/or limits are not appropriate.	Check tip! Check tip dresser and possible reasons!
E45	Lower alarm limit of short circuit resistance Tip dress	Low short circuit resistance after tip dress.	• Tip dress fault • Tip dresser fault • Programmed set point and/or limits are not appropriate.	Check tip! Check tip dresser and possible reasons!
E46	Upper alarm limit of short circuit resistance Tip dress	Large short circuit resistance after tip dress.	• Tip dress fault • Tip dresser fault • Programmed set point and/or limits are not appropriate.	Check tip! Check tip dresser and possible reasons!
E47	Lower alarm limit of trigger angle Tip dress	Large trigger angle after tip dress.	• Tip dress fault • Tip dresser fault • Programmed set point and/or limits are not appropriate.	Check tip! Check tip dresser and possible reasons!
E48	Upper alarm limit of trigger angle Tip dress	Large trigger angle after tip dress.	• Tip dress fault • Tip dresser fault • Programmed set point and/or limits are not appropriate.	Check tip! Check tip dresser and possible reasons!
E49	Lower alarm limit of weld time deviation	Weld time shorter than MASTER reference	• Weld welding in STANDARD MASTER mode: wrong settings • Welding in ServoMASTER mode: wrong stack, • Wrong weld program	• Weld welding in STANDARD MASTER mode: Check settings • Welding in ServoMASTER mode: check stack, Check weld program
E50	Upper alarm limit of weld time deviation		• Wrong stack • Wrong weld schedule • Bad tip dressing • Gaps between sheets • Too much adhesive between sheets • Too low weld force • Etc…	• Check stack • Check weld chedule • Check electrode condition • Check tip dresser • Check part fitting • Check adhesive • Check fixture • Check electrode force Execute new force calibra-

				tion
E51	Lower alarm limit of weld current deviation	Measured weld current too low	• Wrong stack • Wrong weld schedule • Bad tip dressing • Gaps between sheets • Too much adhesive between sheets • Too low weld force • Wrong current measurement (weld transformer or current coil changed?)	• Check stack • Check weld chedule • Check electrode condition • Check tip dresser • Check part fitting • Check adhesive • Check fixture • Check electrode force Execute new force calibration • Check current calibration (weld transformer changed?) • Execute new current calibration
E52	Upper alarm limit of weld current deviation	Measured weld current too high	• Wrong stack • Wrong weld schedule • Bad tip dressing • Weld expulsions • Too high weld force • Wrong current measurement (weld transformer or current coil changed?)	• Check stack • Check weld chedule • Check electrode condition • Check tip dresser • Check fixture • Check electrode force Execute new force calibration • Check current calibration (weld transformer changed?) Execute new current calibration
E53	Lower alarm limit of Electrode force violated	Low electrode force Check spot.	• Weld fault • Programmed set point and/or limits are not appropriate.	Check spot and possible reasons.
E54	Upper alarm limit of Electrode force violated	Large electrode force Check spot.	• Weld fault • Programmed set point and/or limits are not appropriate.	Check spot and possible reasons.
E125	Max. weld time extension exceeded	Welding could not be carried out within the preset max. welding time prolongation.	• Weld process trouble caused by large gap, wrong sheet combination, isolation on or in between the sheets.	Check spot! Check welding conditions and programming!
E131	START input while **SPATZ** not ready	START signal Input from robot or PLC not reset before weld	• START signal Input from robot or PLC not reset before weld.	Reset START signal Input from robot or PLC before weld!
E132	Missing sheet detected	Low resistance all over measured, indicating missing sheet.	• Sheet is missing in stack • Welding on edge •	Check stack Check weld position
E133	Weld gun resistance not determined	Weld gun resistance missing	• Weld gun resistance has never been determined • It has been was deleted • Wrong/old back has been imported	• Determine the weld gun resistance according to operation manual .
E135	Spot check ticked in spottable	Spot check function activated for actual spot	• Spot check function was manually activated via **SPATZ***Studio* software in spottable	Check gun and spot position for actual spot. If position okay, deactivate the spot check for this spot and confirm error with "Reset Repeat".

*	Gun pressure not reached. Welding stopped!	Gun pressure fault. Electrode force not big enough at the start of the weld, the proportional valve has not reached the programmed pressure. Weld was stopped	• Less air pressure • Defect of prop. valve. • Sensor cable defect between proportional valve and timer	Check possible reasons.
*	Overload digital output driver	Output driver fault. The driver for the 24 V DC line-outputs is overheated.	• Short circuit in the cable of a connected user. • Users of output need too much power. • Ventilator blocked	Check possible reasons.
500	IGBT error (motor power module 1)	IGBT error (motor power module 1)	• Faulty power semiconductor • Faulty control electronics for the IGBT. • Short circuit / cable break in motor cableHardware error of board	Check cabling visually and electrically for short Change cabling Change SPM module Change SEC board
501	IGBT overheating (motor power module 1)	SPM Power module fault.	• No cooling, fan blocked/dirty • Dirty/Blocked heat sink • Duty cycle and weld forces too high	Check air channel of SPM and fan Check cooling air circulation Check weld schedules for exceeding weld forces and duty cycles
502	Undervoltage (motor power module 1)	Undervoltage (motor power module 1)	• Unsufficient and fluctuating mains voltage	• Check mains voltage • Check DC BUS voltage via of weld inverter SPATZStudio/Daignosis
503	Overvoltage (motor power module 1)		• Mains voltage too high	• Check mains voltage • Check DC BUS voltage via of weld inverter SPATZStudio/Diagnosis
504	Error break resistance (motor power module 1)		• Break resistor defective	• Repeated error • Change SPM module motor 1
505	Mechanical break not connected (motor power module 1)		Defective cabling/connectors of motor 1 power cable	• Check cable for defects • Change cables
506	Short circuit mechanical break (motor power module 1)		• Short in cabling for Motor 1 power • Safety break in Motor 1 defective	• Check cable and connectors for power Motor 1 for defects. • Change motor cable • Change motor 1
507	Overcurrent motorphase (motor power module 1)		• Short in motor 1 cable • Short in motor 1 • Sudden slipping of the electrodes	• Check cable and connectors for power Motor 1 for defects. • Change motor cable • Change motor 1 • Check mechanics of weld gun
			•	
508	DC-BUS not loaded (motor power module 1)		• No 3~ mains connected to SPM	• Check connections inside cabinet to SPM

				• Check power cables to and inside cabinet • Change cables • Change SPM
509	Motor power module not connected (motor power module 1)		• No 24 V mains voltage at the SPM1 • Defect cabling • Defective Safety relay • Defect SPM device	• Check 24 V connections inside cabinet to SPM • Check cableing of Safety relay • Change SPM • Change Safety relay.
510	No force calibration		• No force calibration done • Wrong back up imported to controller	• Checkif correct backup backup • Execute force calibration
511	Maximum Tip Wear reached		• Maximum programmed Tip wear reached when measurement during reference drive after tip dress	• Change tips • Check weld gun and tips
512	Wrong sheet thickness detected		• At least on sheet is missing • Wrong stackup to program selection • Welding beside the stack • Welding in hole	• Check for missing sheet • Check for correct stack for called program • Check QS data for details • Check weld position • Check for missing electrodes
513	Invalid position motor 1		• Programmed position in the called task is outside of maximum travel distance for motor 1	• Check programmed positions by comparing with maximum motor stroke • Check opening stroke: must be greater than sheet thickess
514	Invalid position motor 2		• Programmed position in the called task is outside of maximum travel distance for motor 1	• Check programmed positions by comparing with maximum motor 1 stroke
520	Timeout during motion task		• Internal error	• Check error Diagnosis for further information
521	'Motion Controller' error		• Internal error	• Check error Diagnosis for further information
522	Motor 1 not referenced		• Actual position not stored • Abortion of Gun reference New Cap operation	• Change electrode caps and execute Gun reference New Cap • Check Encoder battery
524	*CapClean* error: referencing failed		• CapClean wheel blocked during operation • Weld gun ins CapClean • Loss of power during operation •	• Check CapClean wheel for blockade • Check for Error details via SPATZStudio connected to CapClean • Check mains power cabling to CapClean • Check 24 V power supply in CapClean
525	*CapClean* error: buffing failed		• CapClean wheel blocked during operation • Wrong positions in CapClean programmed	• Check CapClean wheel for blockade • Check positions • Check for Error details via SPATZStudio connected to CapClean •

526	*CapClean* error: *CapClean* not referenced		• Mains power cut • Bad wiring connection	• Check mains power 100 V – 240 V • Check CapClean wheel for blockade • Check CapClean and wheel for positions
527	Error encoder motor 1		• Encoder of Motor 1 not connected to SPATZ+ controller • Defective cabling • Defect Encoder	• Check Cabling and Connectors of Encoder 1 • Check Menu Error Diagnosis/Mocon in SPATZ Studio for detailed information.
528	Error encoder motor 2		• Encoder of Motor 2 not connected to SPATZ+ controller • Defective cabling • Defect Encoder	• Check Cabling and Connectors of Encoder 2 • Check Menu Error Diagnosis/Mocon in SPATZ Studio for detailed information.
529	Error 'Motion Controller' initialisation		• Wrong Motor data installed •	• Check for correct Backup installed in SPATZ controller
530	IGBT error (motor power module 2)	IGBT error (motor power module 2)	• Faulty power semiconductor • Faulty control electronics for the IGBT. • Short circuit / cable break in motor cableHardware error of board	• Check cabling visually and electrically for short • Change cabling • Change SPM module • Change SEC board
531	IGBT overheating (motor power module 2)	SPM Power module fault.	• No cooling, fan blocked/dirty • Dirty/Blocked heat sink • Duty cycle and weld forces too high	• Check air channel of SPM and fan • Check cooling air circulation • Check weld schedules for exceeding weld forces and duty cycles
532	Undervoltage (motor power module 2)	Undervoltage (motor power module 1)	• Unsufficient and fluctuating mains voltage	• Check mains voltage • Check DC BUS voltage via of weld inverter SPATZStudio/Daignosis
533	Overvoltage (motor power module 2)		• Mains voltage too high	• Check mains voltage Check DC BUS voltage via of weld inverter SPATZStudio/Diagnosis
534	Error break resistance (motor power module 2)		• Break resistor defective	• Repeated error • Change SPM motor 2
535	Mechanical break not connected (motor power module 2)		• Defective cabling/connectors of motor 1 power cable	• Check cable for defects Change cables
536	Short circuit mechanical break (motor power module 2)		• Short in cabling for Motor 2 power • Safety break in Motor 2 defective	• Check cable and connectors for power Motor 2 for defects. • Change motor cable Change motor 2
537	Overcurrent motorphase (motor power module 2)		• Short in motor 2 cable • Short in motor 2 • Sudden slipping of the electrodes	• Check cable and connectors for power Motor 2 for defects. • Change motor cable • Change motor 2 Check mechanics of weld gun
538	DC-BUS not loaded (motor power mod-		•	

	ule 2)			
539	Motor power module not connected (motor power module 2)		•	
540	No connection encoder motor 1		• Encoder Motor 1 not connected	• Check Cables and connector to Encoder Motor 1
541	No connection encoder motor 2		• Encoder Motor 2 not connected	• Check Cables and connector to Encoder Motor 2
542	Motor 2 not referenced		• Actual position not stored • Abortion of Gun reference New Cap operation	• Change electrode caps and execute Gun reference New Cap • Check Encoder battery
543	Overheating motor 1		• Flow of water cooling for motor1 not working • Cooling water temperature to high	• Check water cooling Unit, hoses, valves and temperature
544	Overheating motor 2		• Flow of water cooling for motor1 not working • Cooling water temperature to high	• Check water cooling Unit, hoses, valves and temperature
600	Lower alarm limit '*Servo***NUGGET-***Index*' violated		Indicates: Poor spot weld quality • Weld gun not okay • Weld position not okay • Fixture not okay • Worn / missing electrodes • Sheet combination not according to weld program • Part missing • Edge welds • Gaps in stack • Cooling water flow through electrodes not working • Limit settings wrong	• Check weld gun • Check fixture • Check electrodes • Check weld position • Check sheet combination • Check part • Check for edge welds • Check cooling water flow through electrodes • Check limit settings
601	Upper alarm limit '*Servo***NUGGET-***Index*' violated		• Sheet combination not according to weld program • Weld expulsion • Weld gun not okay • Weld position not okay • Fixture not okay • Limit settings wrong • Worn / missing electrodes	• Check weld gun • Check fixture • Check electrodes • Check weld position • Check sheet combination against weld schedule • Check part • Check limit settings
602	Lower alarm limit ‚Position' violated		• Sheet indentation after weld too hig • Limit settings wrong	• Check sheet indentation after weld • Check limit settings
603	Upper alarm limit ‚Position' violated		• Sheet thickness to big • Wrong sheet combination • Limit settings wrong	• Check sheet combination • Check limit settings
604	Lower alarm limit ‚Position Abbrand' violated		• CapClean wheel worn • Wrong CapClean settings • Wrong electrodes	• Check CapClean wheel • Check CapClean settings • Check electrodes
605	Upper alarm limit ‚Position Abbrand' violated		• Wrong CapClean settings • Wrong electrodes	• Check CapClean wheel • Check CapClean settings • Check electrodes • Check weld gun

[2]: KSR = Konstant-Strom-Regelung = Constant Current Regulation

H.2 Digital I/O of the SPATZ+ weld timer

H.2.1 Digital 24 V Inputs

No.	Terminal	Bus	Function	Description
WS	6: 24 V DC out 7: signal in *	with + without	WeldStop (WS) (active '0')	This input is provided to interrupt the weld process and motor motion in case of emergency. It should be integrated in the emergency circuit of the robot / PLC.
Prg. 1-3	8-10: signal in Bit 1 to 3	with	not available	
		without	program selection Bit 1-3 (active '1')	3 digital inputs are provided to select one of 8 weld programs.
Prg. 4	11	with + without		Overheating motor 1
Prg. 5	12	with + without		Overheating motor 2
Prg. 6	13	with + without		Overheating transformer
IN 1	14: signal in	with	not available	
		without	Start (active '1')	If the timer ready output is set, a weld will be initiated with the rising edge of this start input.
IN 2	15: signal in *	with	not available	
		without	weld current ON (active '1')	If this input is not set when a start is detected, the weld program will be executed without current. It is used for adjustment of the welding machine.
IN 3	16: signal in	with + without	reset error (active '1')	This input resets the error output of the **SPATZ+** and allows a new weld.
IN 4	17: signal in	with + without	CC_SEQ_END	***CapClean*** sequence finished
IN 5	18: signal in	with + without	CC_READY	***CapClean*** ready
IN 6	19: signal in	with + without	CC_SEQ_ERROR	***CapClean*** error
IN 7	20: signal in	with + without	CC_REFERENCED	***CapClean*** referenced
IN 8	21: signal in			Monitoring water sensor
IN 9				

***) Input must be connected to 24 V DC (active 1), if not in use.**

H.2.2 Digital 24 V Outputs

No.	Terminal	Bus	Function	Description
Out 1	23: signal out	with + without	Weld complete WC[1] (active '1')	This output is set at the end of the weld if the hardware error output is not active and if input IN 1 is still high at the end of the welding and no interpulse time is programmed. It is reset with the ´1´/´0´ - transition of the start input signal.
Out 2	24: signal out	with + without	Control of contactor (active '1')	This output is set at the beginning of the weld. It is reset after 10 s without further weld or in case of an error.
Out 3	25: signal out	with + without	DRESSER_ON	Controls tip dresser
Out 4	26: signal out	with + without	CC_START_BUFF	***CapClean*** buffing
Out 5	27: signal out	with + without	CC_START_BRUSH	***CapClean*** brushing
Out 6	28: signal out	with + without	CC_START_REF	***CapClean*** reference run
Out 7	29: signal out	with + without	CC_RESET_ERROR	***CapClean*** error reset
Out 8	30: signal out	with + without	CC_START_BUFF_NEW	***CapClean*** buffing after cap change
Out 9	31: signal out	with + without	RESET_F	Force sensor reset
Out 10	32: signal out	with + without	WATER	Cooling water
FAN	33: signal out 34: signal ground	with + without	Control of the fans for air cooling	Default: active 1. To save energy, this output can be used to switch off the fans during breaks in production. This function can be activated with the programming software **SPATZ***Studio*. After activation the output is set at weld start and reset with a delay time adjustable between 15 and 120 minutes.

H.3 Service Schedules and Counters

H.3.1 Definition of Service Schedules with ServoSPATZ+ controller in RSW of aluminium with CapClean electrode treatment device

List of service programs (SP)

1. Reference Run „New Caps“
   is a task that has to be executed after change of electrode caps. It is needed to determine the new Zero position of both electrodes.
   Usually it is assigned to spot number 0,100
2. Reference Run „after tip dress“
   Is a Reference Run of the weld gun that has to be carried out after Cap Cleaning operation.
   By this SP the Tip abrasion of the caps by the Cap Cleaning operation is identified and all following welding positions are adjusted by this amount.
   Usually it is assigned to spot number 0,101
3. Cap Clean Buff
   This service program is a part of the complete CapCeaning procedure
   It is called by the robot after traveling through the brush when positioning the weld gun at the Cleaning level in order to start the main Cap Clean operation.
   Usually it is assigned to spot number 0,102
4. Cap Clean Buff New Caps
   has to be called for the first Cap Cleaning operation only after cap change.
   Usually it is assigned to spot number 0,103
5. Cap Clean reference run
   must be initiated after each time the Cap Clean device is powered off.
   With every loss of power the CapClean is losing its Reference position. Please note:
   Never call this SP when the gun is positioned in the Cap Clean.
   Usually it is assigned to spot number 0,104
6. Positioning
   is a positioning task only, moving both electrodes to the via SPATZStudio software programmed positions.
   Usually it is assigned to spot number 0,105
7. Cap Clean Pos. Brush
   has to be performed during the Cap Clean procedure before the weld gun is placed right over the brush in order to position the electrodes properly for going through the brush.
   Usually it is assigned to spot number 0,106

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H.3.2 Definition of Service Schedules with ServoSPATZ+ controller in RSW of steel apps

8. Tip dress
   This SP is called by the robot for closing the weld gun in a tip dresser and applying force for the tip cut. Settings for force, time of cut iterations, blade thickness, opening strokes, etc. are programmed via SPATZStudio software and stored in the ServoSPATZ+ controller
   Usually it is assigned to spot number 0,107

H.3.3 Definitions of counters

H.3.3.1 Definitions of counters for standard applications with robot guns

The function of the counters depends whether tip dressing or tip grinding with CapClean of the electrodes is used or not. If not, a "tip life counter" is available, which counts the weld spots until the electrode must be changed. When tip dressing or tip grinding is used, a "spot counter", which counts the weld spots within a tip dress/grinding interval and a "tip dress counter", which counts the number of tip dressings/grindings are available. The selection if the "tip life counter" or the "spot counter" together with the "tip dress counter" is activated, is carried out via the **SPATZ***Studio* programming software.

Tip life counter	This counter is available only if no tip dressing is used. The tip life counter counts the welds since the last change of the electrodes and is incremented after each weld. Once the programmed tip life counter warning limit is reached, the output "tip life counter pre-warning" is set. This should mean that at the end of the component, the electrodes should be changed. If the alarm limit is reached, the output "tip life counter alarm" is set and the weld controller reports an error that needs to be reset. The counter will be reset after change of electrodes
Spot Counter	The spot counter is counting the spots within a dress interval. It will be increased after each spot. As soon as the pre-warning limit of the counter is reached, the output „Tip dress request“ is set. This should lead to a tip dress after the actual welding part is finished. An error is set if the alarm limit is reached without tip dress. This error must be reset to continue. The counter is reset after a tip dressing.
Tip Dress Counter/	The tip dress counter is counting the dresses operations. It will be increased after each tip dress. As soon as the tip dress counter and at the same time the spot counter have reached the pre-warning limit, the Field BUS output „Tip life pre-warning“ is set. This should lead to a call for tip change after the actual welded part is finished. If the pre-warning limit of the tip dress counter is exceeded and the alarm limit is reached, the output „Tip life end“ the *Servo*SPATZ+ controller stops and an error is set . This error must be reset first to continue. The counter is reset after a tip change.
CapClean Counter	The CapClean counter is counting the CapClean operations. It will be increased after each CapClean operation by one. As soon as the CapClean counter and at the same time the spot counter have reached the pre-warning limit, the Field BUS output „Tip life pre-warning“ is set. This should lead to a call for tip change after the actual welded part is finished. If the pre-warning limit of the tip dress counter is exceeded and the alarm limit is reached, the output „Tip life end“ the *Servo*SPATZ+ controller stops and an error is set . This error must be reset first to continue. The counter is reset after a tip change.
Dresser Blade Counter	The dresser blade counter is counting the dresses. It will be increased after each tip dressing. As soon as the pre-warning limit of the counter is reached, the output „Dresser blade end“ is set. This should lead to a dresser blade change. The output „Alarm Blade Counter“ is set if the alarm limit is reached without dresser blade change. The counter is reset after a dresser blade change.
CapClean Wheel Counter	The CapClean wheel counter is counting the dresses. It will be increased after each CapClean operation by one. As soon as the pre-warning limit of this counter is reached, the output „CapClean wheel change“ is set. This should initiate the change of a CapClean wheel. If the alarm limit is reached the Output „Alarm CapClean Wheel Counter“ is set, the *Servo*SPATZ+controller stops and an error is messaged. The counter is reset after a dresser blade change.

Maintenance Counter	The Maintenance Counter is counting all weld spots. It will be increased by one after each gun stroke. As soon as the pre-warning limit of the counter is reached, the output „Pre-warning Gun Counter“ is set. The pre waning limit should be according to maintenance interval of the weld gun specified by its manufacturer. Thus it can be used for regular check by maintenance: In case the „Alarm Gun Counter“ is reached the *Servo*SPATZ+ stops welding and an error meassage is sent to robot. The counter is reset after a gun change.