



FIBER OPTICS

Sensors and Sensing systems

# SPW-01 (TS900) User Manual



## Sensors and Sensing systems

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## Sensors and Sensing systems

### 1 Basic characteristics and warnings

The SPW-01 (TS900) unit is a high-performance Capacity Discharge Welding machine – “CDW” used for spot welding and stud welding. The unit is capable and used for spot-weldable sensors such as the SWA-00 in the field or laboratory conditions. The SPW-01 can generate a maximum discharge of about 300J at the output of the unit which should be enough to penetrate most of the market's available spot-weldable sensors making the unit universal spot-welding equipment.

This document aims to provide the user with the basic guidelines on how to use the unit, provide basic safety information and address the maintenance and welding tips that are required for a successful operation.

 CAUTION



 CAUTION

- During use, avoid direct contact with uninsulated parts of the unit like cables or connectors, or welded surfaces.
- High currents are generated during use and care should be taken while the unit is used in any electrical sensitive environments.
- During the use of the unit, personal protective wear is mandatory to protect the eyes and skin from direct contact with the discharge pules. Additional protective wear is recommended.
- Storage capacitors will remain charged for an extended time interval after the unit is turned off. Discharging the unit after use is advised.
- Use the SPW-01 in well-ventilated areas.

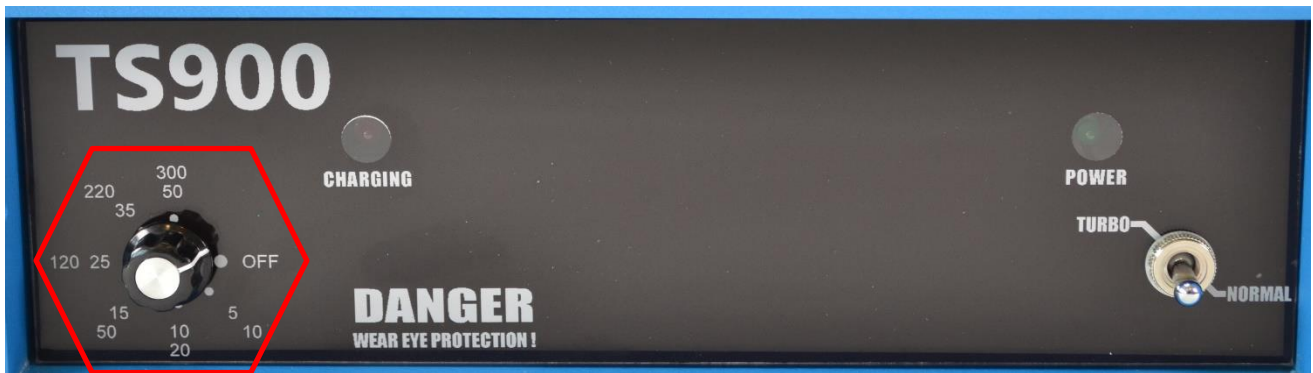
*Qualified personnel operating the unit needs to be aware of the above and the welding machine operating characteristics before using the SPW-01.*



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### 2 Functional parts of the unit

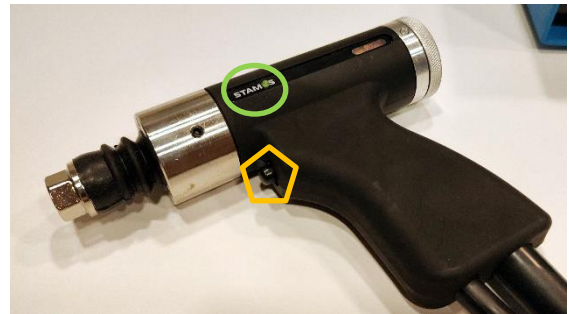
The SPW-01 is powered directly from the power grid with the specification of 220-240V/50Hz – other configurations are possible on request. The unit is connected to the input power grid using a power line cable provided by the unit that connects to a plug at the back side of the unit. The back side of the unit (back plate) provides all necessary connections I/O and the front panel all necessary controls for the unit like energy level. The maximum power output of the SPW-01 is approximately 300 Joules.



#### 2.1.1 Front panel and welding gun

The power level and ON/OFF switch are set by the position of the front panel control knob. 

The power operation, NORMAL (low) and TURBO (high) are selected by a two-position toggle switch.



#### CAUTION

- Decreasing the power level will not immediately reduce the value of discharge since the unit is already charged on the previous settings. A discharge and charge are necessary to set the unit to the desired charge after the settings have been changed.


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During the charging of the internal capacitors, the CHARGING indicator represented by a red LED is lit. The indicator with the label POWER on the front panel and indicator on the welding gun body (Letter “O” in the mark STAMOS) are indicating if the high-energy capacitors have been charged. Once the unit is fully charged, the CHARGING indicator will go dark. After each discharge (spot-weld) the charging cycle will repeat automatically. The time until the unit is after a discharge again operational is less than 10 seconds.

### CAUTION

- The SPW-01 can be damaged if operated in the mode which allows the charging circuit to operate continuously. After each discharge cycle, release the fire button on the welding gun.

### 2.1.2 Back panel

The Back panel includes all I/O for the unit including the welding gun connection, ground cable, AC input, etc.. The back panel features as well a resettable circuit breaker  , that protects against damage from internal circuit shorts.



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### 3 Operation of the unit

The SPW-01, the welding unit, together with all necessary accessories, is delivered in a convenient plastic case for easy transportation. The unit is provided with the below mentioned accessories packed separately in labeled plastic bags.

Item	QTY [pcs]	Details
Gun with cables	1	Universal welding gun with 1,5meter long cables
Ground cable	1	1,4meter long cable
Spot-welding tip adaptor	1	Accommodates Spot-welding Tips with 2 different thread dimensions: 1/4-20 UNC and M6x0.5-6H
Spot-welding tip	2	M6x0.5-6H threaded Tips for spot-welding.
Stud-welding adaptors	6	Set has adaptors for studs M3, M4, M5, M6, M10 and universal
Set of Stud-welding guiding spikes	2	For vertical positioning against the surface. 2 different lengths, each set contains 3 spikes
Grounding Clamp	1	For simple attaching the ground cable to non-magnetic surfaces
Grounding Magnet	1	For simple attaching the ground cable to magnetic surfaces
Set of tools	1	Allen key, stud adaptors fork wrench, 17mm socket (wrench)
Power cord	1	220V, EU socket
Eye Protection Goggles	1	Welding eye shielding (plastic, rimless)
Test plates	2	20x100x0,2mm, SS304 – 1.4301, with spots from outgoing inspection
Instructions Booklet	1	Datasheet, User Manual – under the white plastic foam of the top cover

#### CAUTION

- Before use, please verify that the unit is not damaged, the warranty seal is not broken, and the content of the package corresponds to the list above.



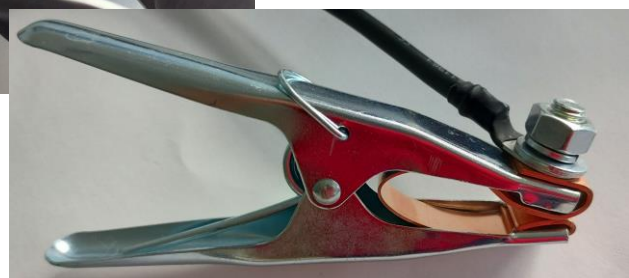
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### 3.1 Preparation of the unit

**⚠ CAUTION**

- Follow the guidance and operation instruction below to avoid unnecessary damage to the unit or health.

1. Verify that the front panel control knob is in the OFF position.
  - a. the control knob controls the power level and turns the unit OFF
  - b. turning the control knob CW and CCW to the origin position will generate a click sound in the OFF position.
2. Connect the Power cord to the SPW-01 back panel and the safe electrical outlet.
3. Connect Ground Cable to the SPW-01 back panel.
  - a. verify the physical integrity of the ground cable connector and connect the bayonet connector to the back panel
  - b. please choose the type of grounding for the welding surface/material:
    - i. Grounding Clamp
    - ii. Grounding Magnet
    - iii. Regardless of the choice of grounding method, properly tighten the screw connections on the eye of the grounding cable
4. Connect the Welding Gun to the SPW-01 back panel
  - a. verify the physical integrity of the welding gun electrode connector and connect the welding electrode with the bayonet connector
  - b. uncover the gun control cable connector on the cable and the unit and mate them together
  - c. check if the push button on the gun is free and if nothing is blocking it



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### 3.2 Spot-welding & Stud-welding

#### 3.2.1 Example No.1 for introduction to spot-welding process:

This example uses only default packaged accessories for preparing the spot-welding method.

- used material is non-magnetic SS304 test plates and therefore only mechanical ground clamp will be used.
- attached test plates are already welded together by the energy around 75J on this supplied welding unit during the out-coming inspection, therefore an end user could compare his welding experience with Sylex's inspector.
  - a. 1<sup>st</sup> and 2<sup>nd</sup> spot with the maximum on NORMAL
  - b. 3<sup>rd</sup> to 5<sup>th</sup> at about 75J on TURBO power range




##### 3.2.1.1 Basic Spot-Welding Procedure:

- 1) Attach grounding clamp to grounding cable eye connector. Then clamp it to the bottom test plate.
  - a) on the ground clamp unscrew the nut, take out the spring washer and plain washer.
  - b) attach ground cable eye connector on copper surface and add plain washer, then spring washer and screw nut until spring washer is not pushed.
- 2) Screw the spot-welding tip into the spot-welding tip adaptor **"firmly"** for the best electric connection of this cooper parts.
  - a) attach the spot-welding tip adaptor into the welding gun and fix it with a 17mm socket.
    - i) spot welding tip must be at the far end inside the welding gun. The above pictures show correctly assembled parts.
    - ii) fixation must be tight, and the welding tip must be like one solid piece with a welding gun.
    - iii) please be careful and do not push the button switch accidentally if you are working with the device switched on or if you did not discharge capacitors.



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- b) try to push the gun with the welding tip opposite to the surface.
    - i) find the push range maximum and then try to maintain the push between the middle and maximum range. This is the optimum pushing force for the perfect weld spot.
    - ii) release the push force and always take care that you do not push the button switch accidentally.
    - iii) It is possible to adjust the push force by rotating knurled back of the welding gun.
  - c) if it is difficult to keep the tip perpendicular to the surface, then you can attach long guiding spikes to gun.
- 3) Clean the spot-welding area of the test plates
- a) we have the best experience with LOCTITE 7061 spray applicator, but also technical acetone, ISO propanol, or alcohol over 70% should be used.
  - b) wait until the cleaning agent evaporates (7061 evaporate in around 20seconds)
  - c) any dirt, grease, oxides, or particles on the surface or the tip can cause an electric arc over the surface of the materials to be joined
- 4) Check the power range toggle switch and put it into NORMAL.
- 5) By the power control knob switch ON the welding machine and set the level to in the middle between 50 and 120.
- a) When the welding machine is ready, the red led "CHARGING" die and the green led "POWER" are lit, together with the green led placed on the welding gun.
- 6) Place the TIP on the spot weld position.
- a) Push the welding gun with the push force between the middle and maximum.
  - b) The TIP and surface should be in a perpendicular position.
  - c) Still push the gun onto the surface and press the gun button switch.
  - d) After 1 second release the gun button switch and release the pushing force
  - e) With this small energy set of about 17 Joule (1 to 2,5 Joule on TIP) nearly nothing visible happened on the welding surface.
- 7) Change power range to TURBO.
- i) Now is the power set to about 85 Joule (5,5 to 14 Joule on TIP, see energy CROSS table)
- 8) Repeat point 6a to 6d.
- a) Now you can compare welding results.
    - i) This comparison is just visual and without previous experience or without tear-off test is not possible be sure if spot weld process is correct and fulfills requirements.

 **CAUTION**

- The most important parameters for best spot welding are:
  - TIP shape, cleanliness, PUSH force, nearest possible grounding place to spot place, and optimum energy level.
- Environmental conditions are also important, but first, the previous conditions must be fulfilled.

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### 3.2.2 Example No.2 Spot-welding process on construction material

The previous example was for general familiarization with welding equipment and the welding process. In this example, we will show how to realistically set spot welding for real construction.

Again, we will use the test plates to verify the right setting of the welding process. This time, however, we will not only evaluate the final joint visually but also functionally by Spot-welding Tear-off test in chapter 4.2. The main setting of the welding process is the same as in the first example. However, new unknowns will be added to us, namely:

- position of the grounding point
- the size of the used energy setting
- finding the best energy setting

#### 3.2.2.1 Position off the grounding point

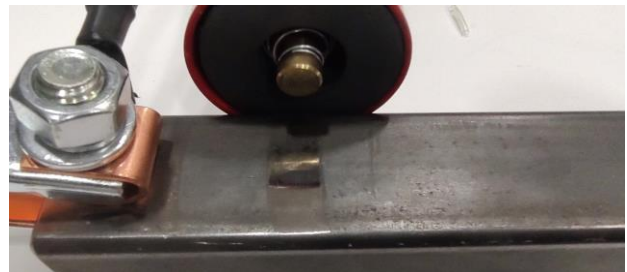
As the first decide the type of grounding. Most civil engineering constructions are made from construction steel and magnetic ground could be used. But sometimes due to non-magnetic material or hard-to-reach places, we need to use a mechanical clamp. In both cases, the grounding point must have a perfect electrical connection to the surface of the construction and the nearest possible place to spot welding point.

In the next pictures are shown examples of easy construction where both grounding methods are used and as construction is used square profile 40x40x2mm 0,4meter length from standard construction material S235 without any surface



protection.

For grounding is necessary to clean the surface following the instruction in section 4.5 Surface cleaning. And the same for the spot-welding area.



For the best possible position of the grounding point, see advice in 4.1 Correct grounding positioning. of course, it is not always possible to have the closest possible grounding to the welding point. That is why it is important to make trial welds before applying the final product.

#### 3.2.2.2 Position off the spot-welding area

The position of the spot-welding area is normally fixed and instructed in engineering drawings. It depends on spot welding applications, fixed sensor by spot weld, fixed covering/protection, or others. In this example, only individual spot welds on the test plates are made to find the best energy setting.



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When you arrange the exact position of the spot weld area, then is again necessary to clean the surface (see section 4.5 Surface cleaning).

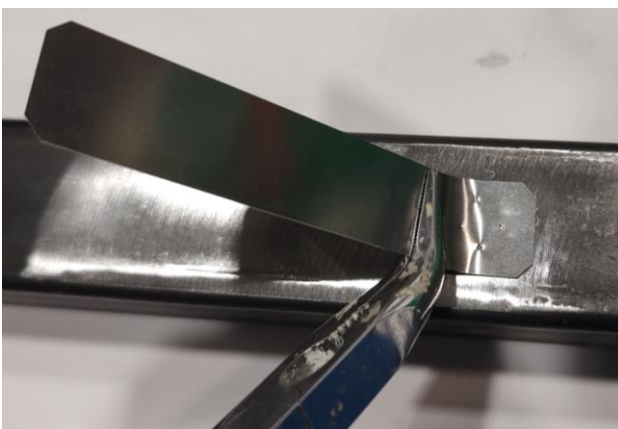


### 3.2.2.3 Finding the best energy setting

For simplifying this process, we found the following procedure where is not necessary to any measurement, calculations, or make a special study. For standard construction materials and ambient conditions, this procedure works and is sufficient to produce a quality weld joint.

### 3.2.2.4 Simplified Procedure for Setting “Quality Spot Weld Joint”

- 1) The minimum Spot-welding energy for the testing plate is 85J, like in Example No.1, therefore we start with this energy setting.
  - a) Make 1<sup>st</sup> spot weld (follow instructions from Example No.1)
- 2) Make Spot welding Tear-off test (follow 4.2 Spot-welding Tear-off test)
  - a) For construction like in this example this energy is not enough and therefore will be necessary to increase energy higher.
- 3) Set energy to the middle between 120 and 220J, about 170J.
  - a) Make another spot weld joint.
- 4) Make Spot welding Tear-off test.
  - a) For this example, is it the best energy setting like show pictures bellow.
    - i) Ambient condition (25°C, 40% RH, indoor)
    - ii) Equipment/accessories in new condition
    - iii) Operators follow instructions for spot welding preparation.
- 5) If you do not pass the Tear-Off test, try to increase, or decrease the energy and try again until you pass the test. Normally you will get satisfactory results after three tries.




Once you've passed mock tests and are confident about repeatability, you can move on to real product applications.

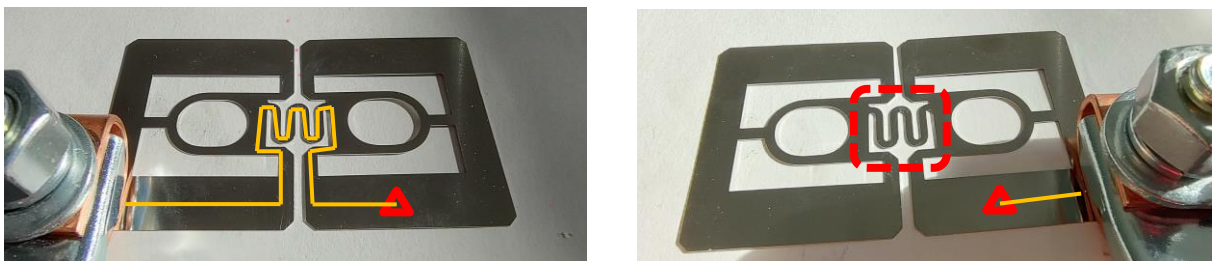
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### 4 Practical advice, experiences, maintenance

#### 4.1 Correct grounding positioning

Before the actual work, consider the best position of the grounding point and the welding point. The current flows between these points (electrodes), and a longer distance will result in less current in the welding point.

In the following example, the grounding cable was incorrectly placed, and the current flow was routed through a thin metal area in the middle – as shown below, resulting in burning down this area 



- the red triangle shows the spot-weld location
- the yellow trace shows the current flow

#### 4.2 Spot-welding Tear-off test

One of the uncomplicated ways for checking correct result of spot-welding process is tear-off test. It is destructive test therefore use test plates or dummy samples. And just one more accessory is necessary: pliers.

After the spot-welding process remove the testing place from the surface using pliers. And then visually check if there is a **“hole” in the testing plate** with a smaller diameter than tip diameter.



If you do not see a hole, then spot weld energy is too low.

If you see some burnouts, then probably spot weld energy is too high or you omit some basic spot-welding rules explained previously.

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### 4.3 Stud-welding Tear-off / Bending test

This device is primarily intended for spot welding of optical fiber sensors, but due to its universality and the supplied accessories, it can also be used for welding studs. In packaging are stud weld adaptors for M3, M4, M5, M6, M10, and UNIVERSAL. These are general standard accessories for the welding gun. With SPW-01 energy range is possible provide successfully M3 and M4 stud welds. In the pictures below are test samples of 3x M6, 1x M4, and 1x M3 stud welds. In these samples, only M3 passes the test. Why only M3? Because the integrity of the weld joint withstood the test and there was no separation of the stud from the surface.

How to make the test? Push to stud from one side (RED arrow) until the stud bend or detach from the surface. Force should be applied in various ways: by the welding gun, by pliers, or by a hammer.

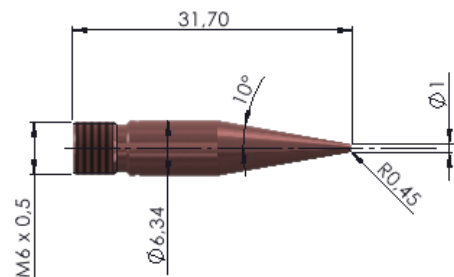


### 4.4 Spot-welding tips shape



The service life of the tip during spot-welding without the need for maintenance is approximately 20 spot welds. After that, it is advisable to clean the tip of burnt parts or grind the tip. The most important parameter that must be kept in the tip diameter of 1 mm and the removal of sharp edges.

The tip angle does not have to be exactly 10° (respectively 20°), but it should not look like the bottom tip in the picture on the left. Here, you will no longer be able to create a tip with a diameter of 1 mm.



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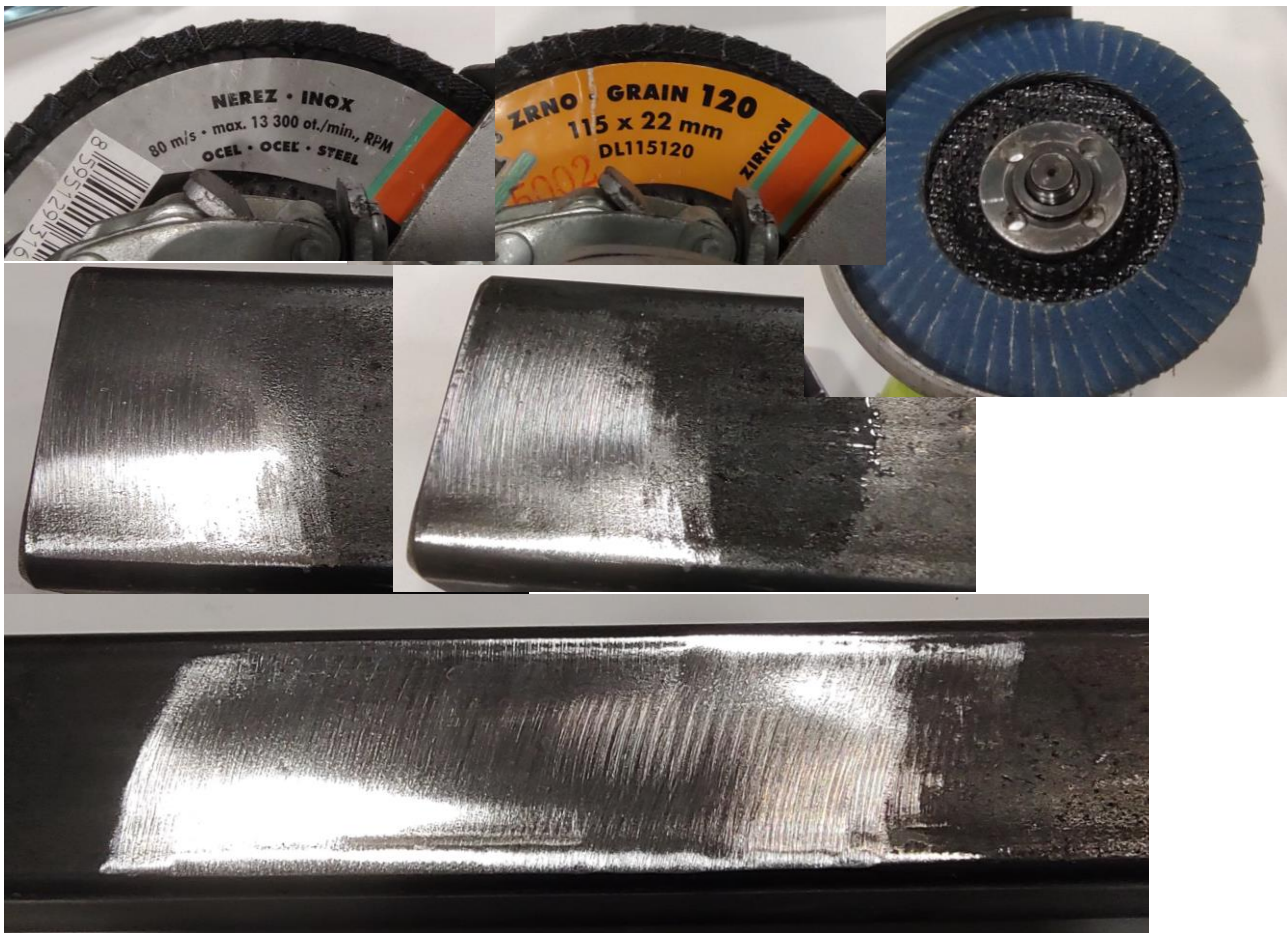
### 4.5 Surface cleaning

Cleanliness of the surface, or of all contact parts in this welding method, is one of the most important parameters that must be observed.

Any imperfection, impurity, or particles in the electrical circuit between the electrode of the welding tip and the electrode of the grounding point will cause an electric arc not to occur at the point where the tip is pressed, but precisely in the places that disrupt this electrical connection.

All oxidation, protective coatings, and surface irregularities must be removed. The following procedure proved to be the best for this.

- 1) Using a 120-grit sanding wheel
- 2) Cleaning by spraying Loctite 7061 cleaner
- 3) Wipe with a lint-free paper towel.
- 4) Re-application of Loctite 7061 cleaner and let it evaporate freely from the surface.
- 5) In this way, the surface is ready for spot or stud welding.



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### 5 To be considered

- ▲ Nominal and real (welding tip) energy differences are attributable to welding gun connection cables, ambient and surface conditions of the welded materials.
- ▲ Welding tip requires frequent checks and sharpening (with sandpaper for example), a general rule of thumb for a new tip is a slight sharpening after every 10 welds.
- ▲ Always evaluate your welding energy using a dummy metal plate of the same thickness and composition as your sensors.
- ▲ Recommended weld tip energy for our SWS-02 or SWA-01 sensors is 200 Joules nominal (see table below) or 24 Joules real (average) - measured laboratory conditions.
- ▲ Before using the device, it is recommended that the user familiarize himself at least with the user manual, where, in addition to basic control, practical tips are also given. Of course, the best option is training from an experienced user.

#### Nominal versus real weld energy cross table

Set energy – Nominal on the knob	(J)	Real Energy Range (J)	
		Min.	Max.
NORMAL	35	2,3	5,8
NORMAL	50	3,3	8,3
NORMAL max	55	3,6	9,1
TURBO	85	5,5	14,0
TURBO	120	7,8	19,8
TURBO	300	19,5	49,5
TURBO max	350	22,8	57,8

For more information contact our sales team at [sales@sylex.sk](mailto:sales@sylex.sk)

\* Specifications are subject to change without notice