MATELECT

Products for crack growth measurement and monitoring

Instruction & Operating Manual

SPW-1

Connections spot-welder

IMPORTANT

Thank you for your purchase of our SPW-1 spot welder. We hope you enjoy using it. Before proceeding with its use, please read these instructions carefully – especially before you embark on making any welds to your test specimens.

Please pay particular attention to the safety information in the Introduction, and elsewhere, especially that which deals with mains operation.

End-users are responsible for performing any appropriate and local risk assessment, associated with usage of the SPW-1 and spot welding in general, but you can use the information and advice contained in this manual to help assess the risks and plan appropriate mitigation.

Also, for your safety, and that of Matelect instrumentation, do not attempt to make connections to specimens, using this or any welding apparatus, with electronic instrumentation connected to the wiring/specimens. The input amplifiers of the both our AC and DC EPD instruments are protected against inappropriate inputs, but there are limits to this protection – and connecting a spot welder such as the SPW-1 to a sensitive scientific instrument such as a CGM-7 or DCM-2 will invariably result in permanent (and expensive) internal damage to the latter.

Introduction

SAFETY ISSUES – PLEASE READ FIRST!!!

The SPW-1 is a mains-operated instrument working from a mains input range of **85-260 V AC, 50/60Hz** and therefore it is important to treat it with respect and employ the appropriate safety precautions.

The SPW-1 must be connected to mains power using the supplied IEC lead, (or one terminated in a suitable locally compatible mains plug), which **must carry an Earth**. The SPW-1 IEC socket is fitted with a replaceable **2A** slow-blow (time-delay) 20mm fuse.

If the fuse needs to be replaced, disconnect the SPW-1 from the mains supply, and gently pry open the fuse tray integrated into the IEC socket, with the tip of a small screwdriver. Remove the old fuse and ensure that it is fitted with a fuse of the same rating as given above.

There are no user serviceable parts inside the SPW-1 and if it malfunctions or fails to operate correctly, please contact Matelect for advice on return and repair.

The SPW-1 is supplied in a discharged state and must be connected to a main supply in order to charge up its internal supercapacitors before use. Charging can take up to 30 seconds at 240V, but longer if the unit is used with at 110V sources, or below. Upon charging, the display of the SPW-1 will initially display “low batt”, then “ready” (when fully charged) after which the various parameters for welding can be set. The SPW-1 can then be optionally disconnected from the mains supply and will hold enough charge for a several welds.

The internal supercapacitor store of energy will gradually dissipate if the SPW-1 is disconnected from the mains, and it will return to its discharged state after about 30 mins of non-use, at which point the parameter display will first read “low-batt” and then dim and turn off.

When charged, the SPW-1 is capable of being triggered using the supplied welding accessories and leads – so care must be taken to avoid inadvertent and/or accidental triggering. End-users can elect to discharge the supercapacitor energy store by making dummy welds (or by waiting till the display reads “low batt”) at which point the SPW-1 will be incapable of accidental discharge.

The voltage supplied by the SPW-1 at its terminals is limited to 8.2 volts, and any induced voltage is clamped to 48 volts. Both these voltages are considered safe with regards to electric shock, but the current delivered is sufficiently high to melt metal.

Users should be aware that a lot of energy is dumped into the weld area and be cautious of touching it before the heat has fully dissipated, as skin burns can occur.

Sparks may also be generated at the specimen, if the weld is of poor quality, or at the terminals of the SPW-1 (if they are inadvertently shorted). These sparks can be intense enough to generate small amounts of UV radiation, localized heating, and skin burns, although the heat in a spark is usually minimal and therefore skin burns are unlikely.

Safety precautions when spot welding would normally call for light gloves for hand protection, and UV goggles to avoid eye damage – although local safety regulations may be less stringent. If in doubt always use protection.

Some organisations have strict codes associated with any form of welding, including spot (or resistance) welding, so please ensure you consult local safety regulations and your local safety officer.

A cautionary note on practical spot welding

Practical spot welding sometimes proceeds poorly, with very little bonding occurring, and this is often interpreted as a fault of the equipment – and its inability to provide sufficient energy to make a weld. The end user then invariably rases the energy output and attempt a second weld, and carries on doing this if unsuccessful – until a massive spark occurs and the contacting metals evaporate with a loud bang, and still no weld has formed.

The SPW-1's ability to control the energy does help to reduce welding issues, but in most cases, good spot welds can be achieved at surprisingly low energy levels – and the real issue is that surface contamination, insufficient pressure or a combination of these, has prevented the current from flowing into the workpieces, and hence no effective heating has occurred. The solution is therefore (normally) better cleanliness, by using abrasives to remove surface oxides and contamination, and consistently firm pressure to achieve the desired weld.

The need for connections

Electrical potential drop (EPD, or just PD) is a four-point measurement methodology. This means that PD requires four connections per measurement location – and all those connections need to be ohmic and of low value resistance. For ACPD studies, these connections are a way of measuring the specimen's impedance (which will hopefully alter as the specimen cracks, or in the presence of a crack) whereas in DCPD, it is the electrical resistance that is being measured. Resistance and impedance cannot be measured directly – they need a current to be passed, and a voltage drop (hence PD) to be measured. In the simplest case of DCPD, the resistance is then calculable by using Ohm's law. Of the four connections, two pass the current, to and from the specimen, and the second pair (normally located inboard of the current wires) measure the resultant potential drop.

A comprehensive primer on the methods available to end-users to make these connections, is available from Matelect, but spot welding is probably the most effective and robust methodology – and the SPW-1 is well suited to make both the voltage and current connections to most commonly encountered test specimens. For heavy duty spot welding of thicker current conductors (for example for use with DCPD instrumentation, where excitation currents of up to 50A are often employed) a larger, more powerful stud-welder is available from Matelect.

Background

A spot welder is a form of welder for metals that employs the specimen's surface (or contact) resistance to generate enough heat to melt the contacting surfaces. A large current is supplied by the welder for a short duration, and this current, in combination with the contact resistance, generates a pulse of thermal energy sufficient to melt metals. Unlike most spot welders, that require you to set a pulse length (usually by trial and error) to set the weld energy, the SPW-1 simply requires the user to enter the energy needed for their connection. The system takes care of the rest, calculating the pulse duration automatically, and then applying the requisite pulse.

Like most spot welders, the SPW-1 stores the energy required in a bank of capacitors (supercapacitors in the case of the SPW-1). In addition to permitting the setting of a far more precise and hence reproducible energy pulse, the SPW-1 keeps the amount of energy dumped into the weld constant between subsequent welds, adjusting the pulse length automatically in real time, during the welding process - to achieve the overall set weld intensity. It does this by monitoring the current (and hence energy) delivered into the weld. This methodology recognises the fact that factors such as the resistance of the specimen, corrosion, and mechanical force applied, all affect the quality of the weld in a conventional spot welder, because they impact the energy delivered.

Monitoring the current makes it easier to achieve consistent welds and reduces the chance of generating defects at the weld location in the process. A further benefit of this "active" current monitoring is that it is then an easy step for the SPW-1 to check the integrity of the weld that it makes – and this guide explains how this works in practice.

Basic operation

Operating the SPW-1 is straightforward and most of the variables can be set from simple menu options accessible via the small front panel display.

The SPW-1 offers control of weld energy (in Joules) as well as providing audible and numerical indication of weld quality – all via the display. The options visible in the display are navigated using the adjacent control knob.

The unit offers a calibration mode (**see below**) which helps with its determination of weld quality. Calibration involves the SPW-1 measuring and storing the electrical resistance of itself (i.e. including wiring and connections) such that it is able to subtract this from the total resistance of the system (which it measures after a weld has been made) thereby allowing calculation of the weld resistance (and hence quality).

Once calibrated and in normal operation, re-calibration is not required. Any change to the welding wires or clamping method will require re-calibration. See below for instructions on how this can be achieved using the menu system.

Initial switch on:

- Place the SPW-1 on a flat and stable surface. The handle can be re-positioned by depressing both of the side buttons integral with the handle, and gently rotating the hand grip. Do not force the handle to rotate.

- On the front-panel of the SPW-1, connect the high current cables (from the welding-head and to the specimen), as shown in Figure 1 below.

  At the specimen, two forms of connection are supported (see below). Ensure the high current connectors are firmly pushed together (to minimise on-resistance).

  The trigger jack-socket needs to be mated with either the footswitch trigger jack-plug (as shown below) or the jack-plug that is connected to the welding-head (the welding-head has an integral trigger button fitted – see Figure 3).

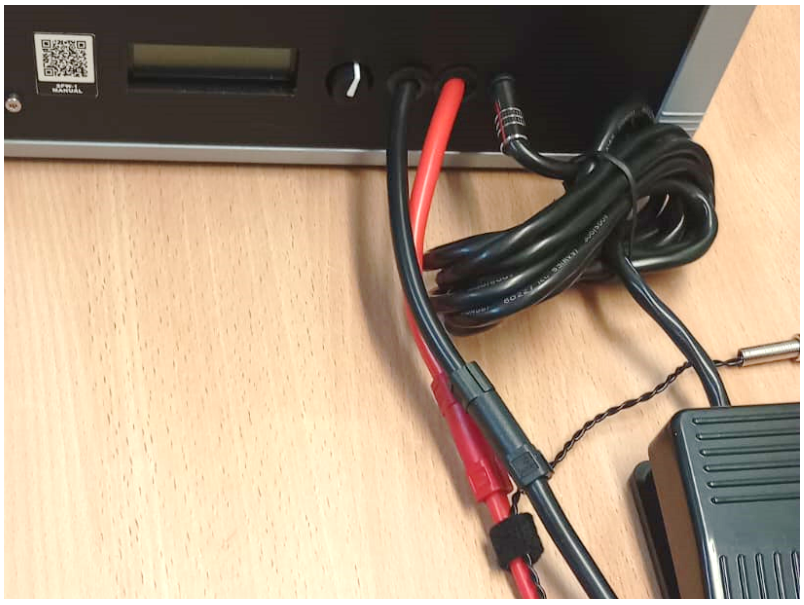


Figure 1. Connections to the front of the SPW-1

- Plug the SPW-1 into a wall outlet and switch it on using the red button by the IEC inlet on the rear. It should illuminate.
- The following should happen after switching on.
    1. If the unit has been switched off for a prolonged period, you should hear faint clicking sounds for approximately 30 seconds (for 240V AC mains supplies, but longer for 110V). The front panel screen will be off during this period.
    2. The front screen should eventually illuminate and show a “low batt” message.
    3. After another 15 seconds, the “low batt” message should disappear and “E=XX.XJ” should appear. This is the default energy setting from the factory.
- The unit is now ready to be used.

Choosing an energy setting:

Simply rotate the dial to the desired energy setting, displayed in joules. The energy setting is set to 10 Joules by default after switching the unit on. A different default can be set in the menu system (Figure 2).

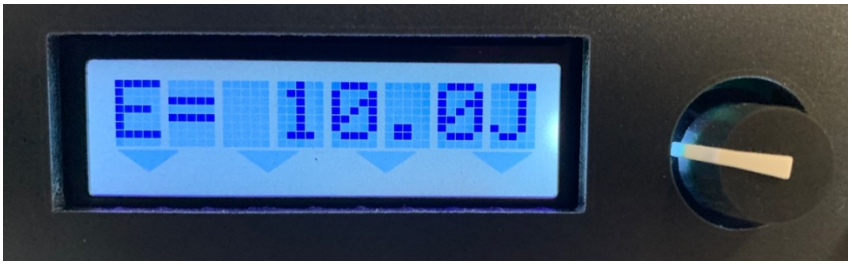


Figure 2. Front panel display of the SPW-1, with control knob to right

Preparing the specimen:

As mentioned above, for any successful spot weld, a clean surface is paramount. Clean the area to be spot welded and the area that shall have the negative cable attached to it. Corrosion, dirt or any coatings will negatively impact the spot weld quality.

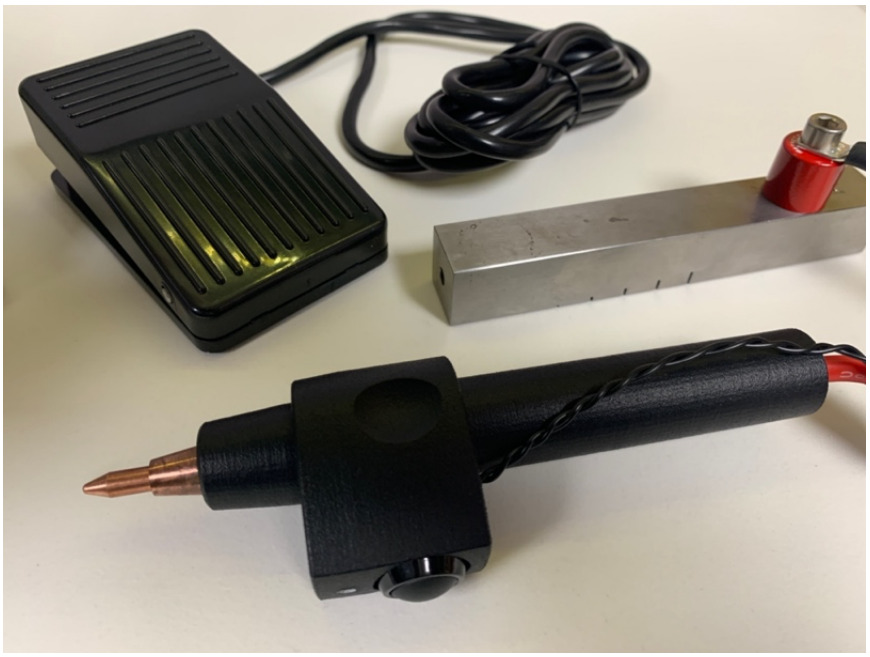


Figure 3. The SPW-1 welding-head and trigger switches

Connecting to the specimen:

To spot weld, for example, a nickel wire to a mild steel specimen, the negative cable must be connected to the specimen and the nickel wire trapped beneath the electrode of the spring-loaded pen WP-1, which will spot weld the wire to the specimen.

There are two principal methods provided to connect the negative cable to a specimen:

- Magnet - The preferred and pre-installed method is to place the magnet on your specimen relatively close to your desired spot weld location. Of course, this requires that the specimen be magnetic.
- Crocodile clip – If your specimen is not magnetic, we have included a crocodile clip in the kit of parts. The user should swap this with the magnet, and again, it should be clipped onto the specimen close to the spot weld location.
- Alternatively, the magnet can be simply held tightly against the specimen using a suitable clamp.

Note: It is essential to keep the base of the magnet **clean** at all times. Otherwise, sparking can occur at the magnet/specimen interface and minor marks may appear on the specimen directly beneath the magnet, when spot welding. In extreme cases, the magnet may be spot-welded to the specimen. For this reason, we strongly advise that the metal “keeper” plate be kept on the magnet when not in use and cleaned regularly.

Choosing a welding mode:

Once the negative cable has been attached, the spot weld can be made. There are three ways the SPW-1 can be triggered to make a weld:

- Pen switch – The pre-attached welding pen WP-1 has a switch on its case.
- Foot switch – If the user prefers, they may use the foot switch supplied in the kit of parts. Simply unplug the pen switch connector and attach the foot switch connector.

  Note: When removing or attaching the connector, a weld may be triggered. For this reason ensure the electrode is not touching anything.
- Auto mode – The SPW-1 can be set to automatically weld once the electrode is placed on the specimen after a pre-configured set time in the menu system. This can be useful if making many repeated connections, although we do not recommend it, as accidental weld triggers are more likely in this mode. To set the welder to auto-trigger, do the following:
  - Press the dial on the SPW-1 once.
  - Scroll left and right using the dial until “MODE” appears.
  - Press the dial once more.
  - You will now hear the spot welder beeping every second. This indicates it is in auto mode and ready to weld.
  - To return to manual mode, press the button again, select “MODE”, and press the dial button again. The system should stop beeping and display the energy setting for the next weld.

If using the pen switch or foot trigger, once ready to weld, simply trap the wire between the pen electrode and the specimen, push down firmly on the pen and press the pen switch or foot switch. One of two sounds will be made by the SPW-1.

- Short beep – a successful weld has been achieved.
- High tone followed by low tone – an unsuccessful weld has been made.

Note: If you press and hold the pen or foot switch when making welds, the SPW-1 spot welder will display several data values. This can help quantify the quality of the weld.

Cleaning the WP-1 electrode:

Over time, the electrode on the WP-1 can become corroded. Simply clean the electrode using wet and dry abrasive paper or other abrasive material. Eventually, the electrode may need to be replaced. Please contact Matelect for assistance in this matter.

Calibration:

The SPW-1 has been pre-calibrated for you and should not normally require further calibration unless accidentally triggered from the menu system or a new electrode has been attached to the WP-1 pen. The following should be done to calibrate the unit:

- Press the dial on the SPW-1 once.
- Scroll left and right using the dial until “CAL” appears.
- Press the dial once more.
- The system now shows “Open!” Make sure the electrodes are not touching, press the dial or WP-1 switch, and hold. The display will then show “Offs=70” or similar.
- Upon releasing the dial or WP-1 switch, the following will appear, “Short!”
- Firmly place the electrode of the WP-1 on to the tab of the negative connection (either the magnet base or the copper clamp – see Fig 4. below).
- While doing so, press and hold the dial or WP-1 switch; the display should show a resistance value (e.g. “R=3.91”). A reading of 4 or less should be expected. If this is not achievable, please check your connections or contact Matelect for further advice.

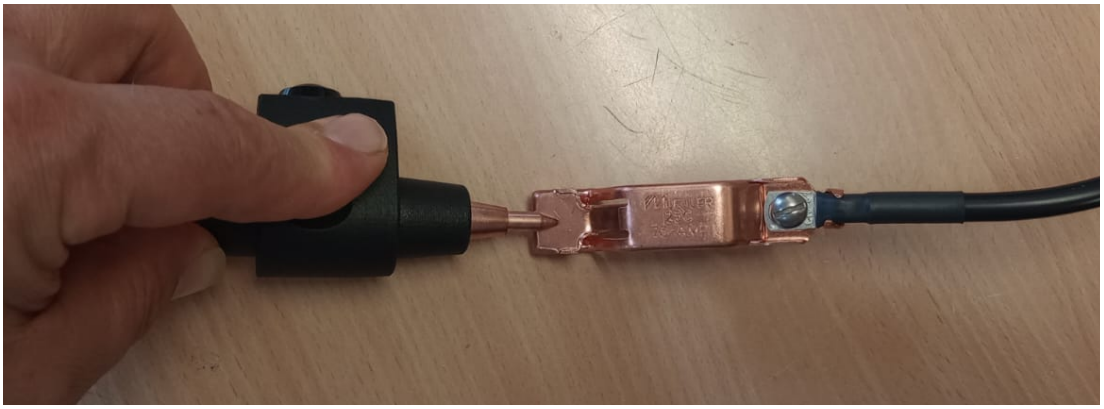


Figure 4. Calibrating the SPW-1 welding head and cabling

Switching off the unit.

To turn off the unit, switch it off using the red button by the IEC inlet on the rear. It should no longer illuminate. Note how the front display stays on - this is normal, and the display will remain on until the supercapacitors within the unit completely discharge.

During this time, the unit can still spot weld if the supercapacitors have enough charge left in them. This can be useful when making connections away from the bench – but this does mean that the SPW-1 is still capable of being discharged if the trigger switches are accidentally operated – so care needs to be taken!

The supercapacitor energy store can be deliberately discharged by making dummy welds (or by waiting till the display dims and turns off), at which point the SPW-1 will be incapable of accidental discharge.

WARRANTY, SERVICE & UPDATES

All our products carry a one-year warranty. Extensions beyond this period can be purchased at the time of order or subsequently if still within the warranty period. Please contact head office for more information, and prices. Technical support is free, for the life of our products.

Matelect also service and recalibrate instruments, although re-calibration is normally only needed when instruments are employed for quality testing or assurance monitoring. A standard fee structure for recalibration applies and is available by contacting Matelect.

All servicing and warranty repairs need to be conducted back at Matelect's UK base although a limited degree of local support can be provided by our agency network. On occasions where security issues do not permit shipment of an instrument back to the UK, Matelect engineers can carry out local servicing - please get in touch for a quotation.

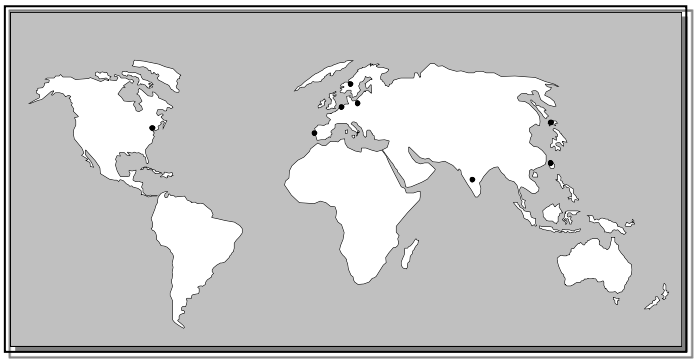
Occasionally firmware updates are issued and made freely available to our end-user database if the update addresses a specific design fault or unintended limitation.

TRAINING, EDUCATION & RESEARCH

Matelect offer training with the sale of new products and refresher training for those who join an organization where Matelect products are already employed. Please get in touch to discuss your needs and pricing.

LOCAL AGENTS

Matelect has a network of local agents that handle customers in various parts of the world. Some of the countries covered by agents are shown below.



In most locations, customers are free to deal either through their local agent or directly with Matelect. If you have obtained this Guide and product through your local agent, then it is best to deal via that agent. Further details are available from our head office. Our agents can usually assist with minor technical issues and repairs but are primarily local points of contact between the end-user and Matelect UK.

CONTACT DETAILS

Matelect Ltd
7 Park Place
Newdigate Road
Harefield
UB9 6EJ
United Kingdom

Tel: +44 (0)1895 823 334
Email: sales@matelect.com
Web: www.matelect.com

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