



CALIBRATING MODERN WELDING POWER SOURCES – NECESSITY OR NECESSARY EVIL?

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INTRODUCTION

When we refuel our cars, we all rely on the fact that the 50 litres shown on the pump display is the actual amount we get in the tank – rather than, say, only 48 litres – although everyone knows and accepts that the mechanical components such as pumps, electric motors and valves are subject to a certain degree of variability due to manufacturing tolerances and general wear. In the case of a petrol pump, however, periodical calibration of the fuel delivery system, identifiable by the presence of a testing inspectorate sticker, ensures that we actually get what it says on the display.

But how is that question dealt with when it comes to welding and welding power sources? The “fuel” for welding is the welding current and voltage provided by the power source. Since the current and voltage, along with the welding speed, have a fundamental influence on the welding process as well as on the properties of the weld seam, they are also defined as quality-related parameters in the welding procedure specification (WPS), and compliance with them is an essential requirement for weld quality.

On modern welding machines, which consist of highly complex electronic components including integrated measuring instruments, the current and voltage levels can simply be read from the display. But is the information displayed correct and/or does the accuracy of the readings and the figures displayed alter over time?

This article briefly explains the causes in electrical engineering terms for possible variations in the readings, elucidates the requirements of the applicable standards, and discusses the technical necessity and the “calibration” of the power source.

A BRIEF EXCURSION INTO THE WORLD OF TECHNICAL STANDARDS

In welding, ensuring compliance with precise measurement and display tolerances is not only essential for obtaining optimum welding results but also largely governed by technical standards. EN1090, for example, demands internal production control at

the factory and, therefore, monitoring of compliance with the specified welding parameters as well. If one works according to that standard, regular calibration of the welding power sources is a fundamental requirement for quality control in order to be certain that the figures displayed on the machine match the actual levels in play.

Therefore, the “calibration” of welding power sources is an important quality-related aspect that should be taken into account in any welding shop. For metalworking businesses certified to the EN ISO 9000 series of standards, it is even compulsory. Another important aspect is the possible economic implications, such as in connection with product liability issues.

But just as important as regular calibration is the technical safety inspection of the power sources. Practice shows that the obligatory safety inspection of welding power sources leads to the “disqualification” of welding power sources much more frequently than calibration does. In roughly 40% of the safety inspections carried out, the machines reveal serious defects such as damaged plugs or cables, damaged sockets or burnt earth connections. Although such defects are essentially unrelated to the results of a calibration, they should nevertheless always be rectified first before any calibration process is started.

For that reason, it makes sense to always have an electrical safety inspection by authorised persons carried out immediately before calibrating the equipment. Accordingly, it is also important to be familiar with the currently applicable welding equipment standards that relate to electrical safety. We offer a brief overview below.

STANDARDS THAT DEFINE ELECTRICAL SAFETY AND THE CALIBRATION OF POWER SOURCES

Welding power sources operate with high electrical currents and voltages and, therefore, pose a high level of potential electrical danger. Accordingly, manufacturers must comply with the strict electrical engineering standards when developing such products and guarantee that in practical use the welding power source poses no danger to the welder during normal use when in proper working order. That is a fundamental reason that argues for the use of high-quality power sources designed for industrial/commercial use even by private individuals.

Figure 1 provides an overview of the essential standards for welding power sources. The full versions of the standards can be obtained from the national standards institutions.

STANDARD DESIGNATION	BRIEF DESCRIPTION
EN IEC 60974:2018 Arc welding equipment	<ul style="list-style-type: none"> » A European standard implemented in the various countries with corresponding prefix (e.g. DIN, OVE, etc.) » Subdivided according to subsystems (e.g. power sources, liquid cooling systems, etc.) » Individual parts are identified by a dash followed by part number
EN IEC 60974-1:2018 Arc welding equipment – Part 1: Welding power sources	<ul style="list-style-type: none"> » Applies to welding power sources for arc welding and related processes for commercial use that have a power supply voltage up to 1000V, are battery-operated or mechanically driven. » Deals with safety and performance requirements for the construction of welding power sources and during regular maintenance or repair
OVE EN IEC 60974-1:2019 Arc welding equipment – Part 1: Welding power sources	<ul style="list-style-type: none"> » Current edition of Austrian version of relevant standard EN IEC 60974-1
DIN EN IEC 60974-1:2018; VDE 0544-1:2018 Arc welding equipment Part 1: Wel- ding power sources	<ul style="list-style-type: none"> » Current edition of German version of relevant standard EN IEC 60974-1 » Corresponds to VDE 0544-1:2018
DIN EN IEC 60974-14:2019; VDE 0544-1:2019 Arc welding equipment Part 14: Ca- libration, validation and consistency testing	<ul style="list-style-type: none"> » Applies to checking the performance of arc welding equipment built according to the safety requirements of IEC 60974-1 » Currently applicable and replaces DIN EN 50504:2009; VDE 0544-50:2009 » All national standards that conflict with this standard must be withdrawn by 23/11/2021
DIN EN 50504:2009; VDE 0544-50:2009 Validation of arc welding equipment	<ul style="list-style-type: none"> » This (old) standard laid down validation procedures for arc welding equipment. » This standard has been withdrawn and replaced by DIN EN IEC 90974-14:2019; VDE 0544-14:2019

Figure 1: Overview of essential standards for welding power sources (source: own presentation)

MEANING AND DEFINITION OF CALIBRATION

The standard “OVE EN IEC 60974-14 Arc welding equipment – Part 14: Calibration, validation and consistency testing” defines not only “calibration” but also “validation”.

Calibration:

“Activities for determining the relationship existing between a DISPLAYED VALUE and a REFERENCE VALUE under defined conditions”

Validation:

“Activities for the purpose of verifying that a SET VALUE matches the REFERENCE VALUE (within defined limits)”

In practice, that means that in the case of welding power sources without an integrated measuring instrument and display, i.e. “old” systems, the procedure carried out is validation, which means basically checking whether welding parameters can still be correctly set. In the case of “modern” power sources with integrated measuring instruments and displays, on the other hand, the procedure carried out is calibration. In such cases, calibration means comparing the readings displayed with the actual reference values. Since most power sources now have digital displays, calibration is the most frequently used verification procedure in practice. In many cases, however, both calibration and validation are carried out, which although allowed according to the standard, is not necessary for power sources with a digital display. Since the two processes are very similar, the two terms are also frequently confused and incorrectly used.

NECESSITY AND BENEFITS OF CALIBRATION

Modern power sources are now highly complex electronic components (Fig. 2) and are essentially supplied in calibrated condition. The calibration interval specified by the manufacturer and/or in the standards (usually one year) should always be complied with. Due to a variety of environmental effects and natural ageing processes of various electronic components such as capacitors (there are large differences according to design in this area) and, to a lesser extent, resistors and coils (oxidation, diffusion, etc.), parameters may begin to drift from the set values.

When a welding power source starts to drift noticeably and, especially, by how much depends on the ambient conditions (temperature fluctuations, humidity, dust exposure, etc.), partly on the load on the machine (frequent use in the upper power range, frequent changing of the settings, etc.), but most particularly on the quality of the electronic components fitted.

Experience shows that, overall, roughly 3-5% of older-generation welding power sources (without digital control systems) that are tested in the course of standard annual calibration procedures return values outside the specified limits and, therefore, should not continue to be used for welding processes that are subject to a technical standard. In such cases, the machines should be readjusted or repaired by qualified persons or directly by the manufacturer. In the case of modern inverter power sources, unacceptable drift levels occur only in isolated exceptional cases (<0.5%), even after many years of use.



Figure 2: Design of a modern welding power source (source: voestalpine Böhler Welding)

Nevertheless, it is advisable to perform regular checks even on modern power sources, especially to ensure the equipment complies with the specifications of the WPS and the standard. Machines should in any case always be calibrated after any major servicing or repairs.

PERMISSIBLE TOLERANCES FOR CALIBRATION

The maximum permissible tolerances for current, voltage and wire feed rate are specified in each case in OVE EN IEC 60974-14, with a distinction being made between “standard class” and “precision class” with reference to EN IEC 60974-1. Thus, the tolerance for current for standard-class welding equipment with digital measurement and display units is +/- 2.5% of the maximum rating for the welding current specified on the rating plate.

In the case of a 500A system, that

would be +/- 12.5 A. By comparison, the permissible tolerance for precision-class equipment is +/- 1%, i.e. as little as +/- 5 A. With lower-power systems the permissible tolerances are accordingly smaller.

For special applications, it may also be necessary to calibrate other components of a welding system where specified by the WPS or the power source manufacturer.

NECESSARY CAPABILITIES OF THE CALIBRATORS

As a fundamental principle, calibration and validation of power sources should only be carried out by an expert. According to OVE EN IEC 60974 -14, that is a person who “can show proof of suitable qualifications, appropriate experience and adequate training in relation to welding and measurement technology, and knowledge regarding possible electrical hazards and the necessary safety measures”.

METHODS FOR CALIBRATING WELDING POWER SOURCES

In general, all common types of power source for arc welding (GMAW, SAW, SMAW, FCAW, GTAW) are calibrated/validated. The calibration/validation process is basically defined by the standard. Since modern power sources generally have integrated calibration software (usually accessible via the Service menu) and professional service and maintenance technicians almost exclusively use purpose-designed calibration equipment and software in practice, calibration is almost always done in that way today.

Calibration in direct current mode is sufficient in many cases. The specifications of the standard in each case are summarised in Figure 3.

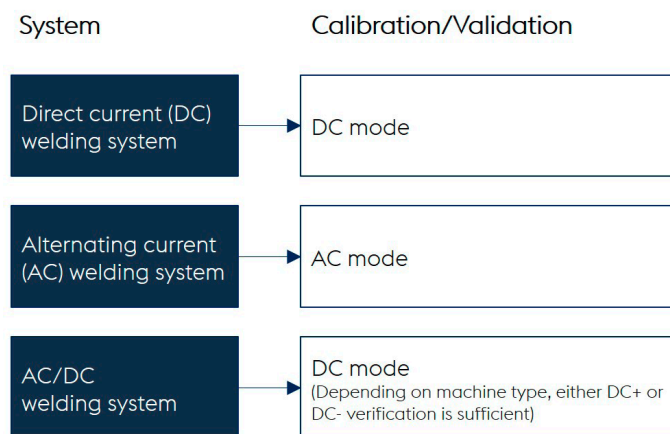
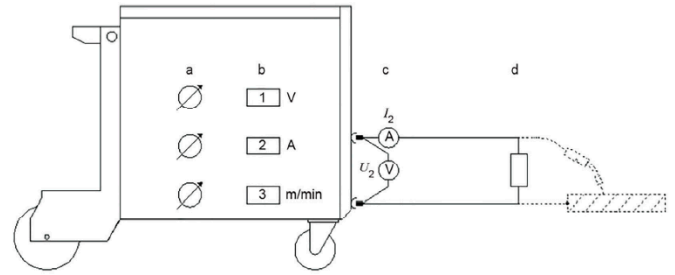


Figure 3: Operating modes for calibration (source: based on OVE EN IEC 60974-14)

A basic set-up for the calibration process is illustrated in Figure 4. Power source manufacturers may specify different test configurations for their products.



Key
a SET VALUE
b DISPLAYED VALUE
c REFERENCE VALUE
d Standard load or arc load
1 Voltage
2 Current
3 Wire feed rate

Figure 4: Example configuration for a calibration process (source: OVE EN IEC 60974-14)

The measurements must be performed using calibrated instruments that ensure sufficient resolution of the measured variable (at least two and a half times more precise than specified by the verification class concerned). In addition, the power sources must be placed under standardised loads (normal load) according to the process during the measurements. All relevant parameters and measurement results must be fully recorded and documented in a corresponding report.

If a standardised calibration device as offered by a number of reputable manufacturers is used, the calibration process can be performed relatively quickly and easily. In such cases, specialised software solutions simplify not only the generation of reports but also set the parameters specified in the standard, such as current, voltage and wire feed rate, along with the permissible tolerances in each case and the number of measurement points required. The loads required in each case can be implemented with the aid of the resistive loads integrated in the calibration device. Figure 5 shows a possible set-up for calibration.

A revolution counter is generally used to check the wire feed rates. In that case, the wire feed rate is mathematically calculated from the speed of rotation measured on the wire feeder. An alternative method would be a travel/time measurement using a stop-watch and tape measure followed by mathematical calculation of the feed rate.

Every measurement must be documented accordingly. If the measured values established in each case are acceptable according to the specifications of the standard, the fact is documented accordingly in the “calibration report” for the machine concerned. The machine is also provided with a sticker indicating the same.

It is essential that any defects that are identified in the course of the safety inspection that is usually carried out in conjunction with calibration are rectified immediately before the calibration process. Fundamentally, however, it should be in the interests of every single business, and especially the welders, to eliminate any such risks without delay as soon as they are discovered.



Figure 5: Calibration of a welding power source using a calibrator (source: Schweisstechnik Jantscher)

ECONOMIC ASPECTS

When procuring welding power sources one should in any case be aware of the safety and quality features and also consider from the outset what the associated service concept is to look like (what service is required, who can provide it, how often will a service be required, etc.). Furthermore, welding power source manufacturers can significantly influence the quality and safety of a system by various means such as the use of high-quality electronic components and comprehensive quality controls. That is why, at voestalpine Böhler Welding for example, every circuit board in a welding power source is manufactured on the in-house PCB production line in Cittadella, Italy, checked by a 3-stage quality assurance process and sensitive electronic components are protected by an extra coating of lacquer. What is more, every single power source is put through a static and dynamic end-of-line test before shipping.

For metalworking businesses that have several welding power sources, an economic efficiency analysis of calibration per se definitely makes sense. Depending on the welding machine and its condition, the work involved in the technical safety inspection and calibration/validation should be estimated at approx. one hour's labour for a service technician and assistant. But if one weighs those costs against the risks and quantifies the possible losses of production, quality deficiencies, product liability issues and health-and-safety aspects, it quite quickly becomes clear that such regular (usually annual) outlays are absolutely worth the expense.

SUMMARY

Welding power sources fundamentally pose a high potential electrical danger due to the high welding currents and voltages. Nevertheless, the risk is reduced to a minimum by compliance with current electrical engineering standards right from the development stage and the use of high-quality electrical components, especially in the case of systems intended for commercial use. Reputable power source manufacturers and professional service technicians can provide more detailed expert advice on the subject.

To ensure work is carried out in accordance with the applicable standards, regular calibration of welding power sources, generally once a year, is necessary, even though modern power sources very rarely show any unacceptable divergence from the specified values. In practice, however, it has been shown that annual inspections frequently reveal safety-related defects on the welding power sources that could certainly pose a danger to the welder. For that reason alone, it is an obvious step to have the inspections regularly performed and documented by qualified service technicians, even if it may not appear necessary for high-quality welding power sources at first sight. Only in that way is it possible to sustainably ensure that all health-and-safety and quality-related aspects are complied with, which in turn contributes to the safety of the welder, customer satisfaction and financial success.

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