Calibration/Validation Guidance
For Miller Welding Equipment
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SECTION 1 – INTRODUCTION

⚠️ Read and follow all labels and the Owner’s Manual carefully before installing, operating, or servicing units. Only qualified persons should install, operate, maintain or repair units; or perform calibration, validation, or certification activities.

The transition from analog meters to digital displays brought a new level of accuracy to weld parameter control and indication in welding equipment made by Miller Electric Mfg. LLC (Miller). This evolution in technology also prompted changes in procedures for weld meter testing and calibration. In February of 2002, Miller released a document entitled *Welding Equipment Meter Calibration*. This was a collection of articles from Miller’s *Techline* newsletters that provided definitions, guidelines, and resources to help service technicians support their customers’ calibration needs.

Much has changed since that time. Developments in technology, products and regulatory standards have required the technical staff at Miller to revisit the topic of weld meter calibration. The result is the document you are now reading. It replaces the 2002 document and its purpose is to provide information aligned with current technology and industry standards. It defines the terminology of welding variables, test procedures and requirements. It also discusses documentation related to equipment manufacturing and servicing. The intention is to help machine owners and service technicians understand the requirements for periodic testing and documentation of welding equipment, and to understand the options for compliance.

SECTION 2 – INDUSTRY STANDARDS

The standards which apply to welding equipment design and calibration are primarily developed by the International Electrotechnical Commission (IEC). The IEC assesses international standards and conformity processes for all fields of electrotechnology. Safety and performance requirements for the manufacture, testing, and documentation of welding equipment are defined in publication IEC 60974-1Arc Welding Equipment. This standard and its subparts have been incorporated by many countries and agencies as the basis for referral. Information related to accuracy testing for industrial arc welding equipment is presented in IEC 60974-14 Calibration, Validation and Consistency Testing.

![Figure 2-1. The International Electrotechnical Commission Define Global Standards For Equipment Performance And Safety](image-url)
Miller's guidance for testing of electric welding equipment is based on information presented in IEC 60974-14. All of the welding equipment manufacturers who are members of the IEC have authored and voted to approve this Standard. An Internet search will yield many other documents that pertain to testing and documentation of welding equipment. The challenge is to determine which requirements apply to a given piece of equipment or a specific area of industry within each geographical region. These interpretations must be made by an employer’s regulatory compliance office or by the machine owner. For assistance, Miller recommends consultation with the agencies listed in Section 5 of this document.

2-1. Definitions

A Standard is a document that defines technical or procedural requirements to be met by welding equipment or by the owner of the welding equipment. Standards may originate from the United States, from countries other than the United States, or be hybrids that incorporate standards from multiple sources. Applicable standards may vary from country to country. Standards can be placed in one of two general categories: Manufacturing Standards or Operating Standards.

Manufacturing Standards define welding equipment requirements and operational parameters which must be met by the equipment manufacturers. These standards define the tolerance for accuracy of variable settings (control markings) versus actual output values, and tolerance of variable indicating and recording devices (data storage systems, meters and displays) vs actual output values.

Operating Standards define requirements that apply to welding equipment after entry into use. These standards include requirements for maintaining the accuracy of weld control and indicating/recording devices.

Conformity or Conformance

The condition of satisfying the design and performance requirements as specified in a manufacturing standard.

Certificate Of Conformity

Document ME−0860, Certificate of Conformity and Origin, is available from Miller Electric Mfg. LLC to declare and establish the initial validation of welding equipment. ME−0860 is serial number−specific to identify the date and place of manufacture and represent the condition of Miller products as delivered from the factory.

Certification

The process of performing calibration and/or validation tests per applicable Standards and formally documenting the results. (These tests must be performed by a qualified agency as defined per ISO/IEC 17025. Miller does not provide testing services.)

Displayed Value

The value of an output produced by a machine, as measured by permanent internal devices and displayed on the machine. In welding equipment, this will typically refer to levels of voltage, current, arc length, or wire feed speed.

Set Value

A value chosen and set by the operator or by an automatic system.

Reference Value

The value indicated by measurement with a precision instrument (the test instrument) for comparison to a displayed value or set value.

Expert

A person who is qualified through professional training, knowledge, and experience to safely perform and assess tests required for verification and certification.

Verification

Operations, tests, or measurements performed to demonstrate that the welding equipment or system conforms to its specified operating parameters. This includes procedures for calibration and validation.

Calibration

Operations, tests, or measurements performed under a specified set of conditions to define the relationship between a Displayed Value and a Reference Value.
In practice, calibration is the process of comparing indicated weld outputs (typically voltage and amperage) on a piece of welding equipment to indications of a certified test instrument. The comparison is made to determine whether the equipment indications are within the tolerances defined in the applicable standard. If so, the test yields a “Pass” result. If not, a “Fail” result is recorded. Simply stated, the calibration test answers the question, “Does the meter acceptably indicate the actual output?”

Validation

Operations, tests, or measurements performed to demonstrate that a Set Value produces the Reference Value within specified limits.

In practice, validation is the process of taking measurements to determine if the output of a welding power source with controls marked by graduated scales is within the tolerances of the applicable standard. A graduated scale is a range of settings between reference points. The set points might be specific values of volts or amps, but they might also be identified with markings that represent 0 to 100%. Again, the comparison is made to measurements taken with a certified instrument. This measurement can also be referred to as verification of conformity. The validation test answers the question, “Does the control setting give an output that corresponds to the set point marking of the control?”

Consistency Test

Operations, tests, or measurements performed to demonstrate the repeatability of the output over a period of time.

Standard Grade

Equipment verified to meet the accuracy for Displayed Values required by IEC 60974–1 or IEC 60974–5.

Precision Grade

Equipment verified to a higher level of accuracy for Displayed Values than is required by IEC 60974–1 or IEC 60974–5.

SECTION 3 – VALIDATION OR CALIBRATION?

While the terms “calibration” and “validation” have different meanings, they are often thought to mean the same thing. The difference between these terms can be simply explained as follows: **Calibration** is performed on equipment fitted with meters, whether analog or digital, to verify that the indicated values are within the required tolerances when compared to a reference value. **Validation** is performed on equipment with output controls that are marked with graduated scales, to demonstrate that the resultant outputs are within tolerance per the set points on the controls.

There is a common belief that the process of calibration involves adjustment of electrical components to bring indication accuracy within specified limits. Some Miller welding products are designed with an internal function to electronically align the meter indications with voltage and current outputs. Miller Owner’s and Technical Manuals refer to this process as “Calibration.” By itself, however, this process does not satisfy the requirements for welding equipment verification.
When the welding equipment does not pass the calibration or validation tests, further evaluation by a qualified technician will be needed to determine the source of the error. In most cases, one or more faulty components will be the cause. Replacement of these components will be required to restore operation within acceptable limits.

### 3-1. When Is Validation Or Calibration Required?

IEC 60974–14 recommends a verification interval of 12 months or at more frequent intervals as may be stated by the equipment manufacturer or the end user. Verification is also recommended if there are indications that equipment performance has deteriorated. The standard specifies that verification shall be performed after any repair that might impact the accuracy of values displayed by the equipment.

Miller does not specify a verification interval. This determination must be made by the equipment owner after researching the pertinent standards.

Note that verification is different than periodic inspection and performance of electrical safety tests. IEC 60974–4 Periodic Inspection and Testing defines test procedures and parameters to ensure electrical safety of industrial arc welding equipment. This standard advises equipment owners to follow the manufacturer’s maintenance schedule for periodic testing. Miller products must be inspected and maintained per the schedules in the product Owner’s and Technical Manuals.

Note that IEC 60974–4 requires the defined tests to be performed after repair of arc welding equipment. Equipment owners must review and understand IEC 60974–4 to ensure this requirement is satisfied.

Miller does not specify a periodic or annual requirement for electrical safety tests. Equipment owners are advised to define a test interval that complies with regional or local safety regulations while considering the impact of the working environment on equipment electrical safety.

### 3-2. What Are The Tolerances For Calibration and Validation Accuracy?

The 2018 revision of IEC 60974–14 provides separate tables for calibration and validation tolerances for welding equipment designed per IEC 60974–1, the standard to which Miller equipment is built. The tables are reproduced here for reference and discussion purposes only. The entire standard must be reviewed for a complete understanding of which tests must be performed and which data applies.

Miller welding equipment is designed to Standard Grade specifications.

**Table 1. Tolerances for Calibration of Display Variables**

<table>
<thead>
<tr>
<th>Variable Type</th>
<th>Signal Type</th>
<th>Standard Grade</th>
<th>Precision Grade</th>
<th>Qualification Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage</td>
<td>Analog</td>
<td>±2.5%</td>
<td>±1%</td>
<td>From upper range value of instrument</td>
</tr>
<tr>
<td></td>
<td>Digital</td>
<td>±1.5V or ±2.5%</td>
<td>±0.5 V or ±1%</td>
<td>Preferred method or Of rated no-load voltage (U₀) or according to manufacturer’s specifications</td>
</tr>
<tr>
<td>Amperage</td>
<td>Analog</td>
<td>±2.5%</td>
<td>±1%</td>
<td>From upper range value of instrument</td>
</tr>
<tr>
<td></td>
<td>Digital</td>
<td>±2.5%</td>
<td>±1%</td>
<td>Of highest rated value for welding amperage according to rating label</td>
</tr>
<tr>
<td>Wire Feed Speed</td>
<td>Analog or Digital</td>
<td>±2.5%</td>
<td>Of maximum setting below 25% of maximum setting</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Digital</td>
<td>±10%</td>
<td>Of reference value between 25% and 100% of maximum setting</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Analog or Digital</td>
<td>±2.5%</td>
<td>Of maximum setting below 40% of maximum setting</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Digital</td>
<td>±6.25%</td>
<td>Of reference value between 40% and 100% of maximum setting</td>
<td></td>
</tr>
</tbody>
</table>
Table 2. Tolerances for Validation of Control Set Points

<table>
<thead>
<tr>
<th>Variable</th>
<th>Grade</th>
<th>Tolerance</th>
<th>Qualification Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage</td>
<td>Standard</td>
<td>±2.5%</td>
<td>Of highest set value below 25% of highest set value</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±10%</td>
<td>Of reference value 25% to 100% of highest set value</td>
</tr>
<tr>
<td>Precision</td>
<td></td>
<td>±2%</td>
<td>Of highest set value below 40% of highest set value</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±5%</td>
<td>Of reference value 40% to 100% of highest set value</td>
</tr>
<tr>
<td>Amperage</td>
<td>Standard</td>
<td>±2.5%</td>
<td>Of highest set value below 25% of highest set value</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±10%</td>
<td>Of reference value 25% to 100% of highest set value</td>
</tr>
<tr>
<td>Precision</td>
<td></td>
<td>±1%</td>
<td>Of highest set value below 40% of highest set value</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±2.5%</td>
<td>Of reference value 40% to 100% of highest set value</td>
</tr>
<tr>
<td>Wire Feed Speed</td>
<td>Standard</td>
<td>±2.5%</td>
<td>Of highest setting below 25% of highest setting</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±10%</td>
<td>Of reference value between 25% and 100% of highest setting</td>
</tr>
<tr>
<td>Precision</td>
<td></td>
<td>±2.5%</td>
<td>Of highest setting below 40% of highest setting</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±6.25%</td>
<td>Of reference value between 40% and 100% of highest setting</td>
</tr>
</tbody>
</table>

3-3. How Is A Wire Feeder Verified?

Miller wire feeders must be calibrated and validated. This includes indicators for voltage, amperage, and wire feed speed. For the voltage calibration, the indicated voltage must be within tolerance in comparison to the reference voltage measured across the electrode cable connection to the drive assembly and the work cable from the welding power source. The reference voltage measurement point might be at the workpiece for wire feeders that use a voltage-sensing lead to measure arc voltage. The indicated amperage under load must be within tolerance in comparison to the reference value indicated by the test instrument. The indicated wire feed speed must be within tolerance in comparison to the measured or calculated wire feed speed.

![Figure 3-1. Validating Wire Feed Speed](image)

Accuracy of the wire feed speed control settings must be validated. IEC 60974–14 defines three methods of measurement and calculation. A basic validation can be performed with a stopwatch, an RPM counter, and a mathematical formula across a range of speed settings. For validation, the measured RPM of the drive roll is multiplied by the nominal circumference of the drive roll. (An easy way to determine the circumference of a drive roll is to multiply the diameter of the drive roll by 3.14.) The wire feed speed (measured RPM x drive roll circumference) will be the length of wire that will be fed in sixty seconds at that given RPM. This value is then compared to the display value. On a properly adjusted wire feeder where no slippage occurs, this value will accurately represent the actual length of wire that would be fed at that speed. Note that the accuracy of the indication may vary as drive motor heat increases during operation.

3-4. When Should The Miller Load Bank Be Used?

The Miller load bank is primarily intended for diagnostic load testing and run-in of diesel engine-driven welding power sources. The voltage and amperage meters are for reference only but a limited range of adjustment is possible if desired. The Owner’s Manual for the Miller load bank provides meter adjustment instructions. Verification with certified instruments is recommended by Miller when adjustments are made.
It is important to understand that the Miller load bank might not provide the resistance needed by some Miller products to follow the IEC load curves at higher amperage levels. In these cases, a disparity in readings will be observed under high load conditions. Miller performs developmental measurements and testing of production units in certified test cells that have a load capacity greater than the Miller load bank. This allows the full range of loads and setpoints to be accurately tested per IEC requirements.

The meters on the Miller load bank are not intended for use in verification tests.

3-5. Verification Of Induction Heating Equipment

Induction heating equipment, such as Miller’s ProHeat 35 system, as used for preheating and post-weld heat treatment may require validation per Clause 15 of ISO 17662. The standard states that thermocouples themselves are “reasonably stable and accurate” but the supporting “electrical instruments” and “the entire set-up shall be validated.” Instructions for calibration of the temperature indication and recording components of the ProHeat 35 system are provided in the ProHeat 35 Owner’s Manual which can be downloaded from www.millerwelds.com. Submit the product serial number to obtain the correct manual.

3-6. Who Should Perform Validation And Calibration?

Verification must only be performed by an Expert or Competent Person as defined per IEC 60974-14 and other Standards. Individuals with knowledge of industry standards and validation technology, and possessing the necessary equipment, might have the ability to perform measurements with the intention of validating their welding equipment. It is possible, however, that an inspector will not accept the validation as being legitimate.
ISO/IEC Standard 17025 defines general requirements for the competence of testing and calibration laboratories. Requirements for issuing certificates of the work performed are also called out. Miller recommends for equipment owners to have validations performed by accredited service facilities or instrumentation laboratories that are in compliance with these requirements.

SECTION 4 – SUMMARY

⚠️ Read and follow all labels and the Owner’s Manual carefully before installing, operating, or servicing units. Only qualified persons should install, operate, maintain, or repair units, or perform calibration, validation, and certification activities.

For help in locating service support, please contact Miller Customer Support at 866–931–9733.

It is the responsibility of the equipment owner to determine which standard applies to a given work location or welding process and to interpret the related requirements for welding equipment verification. Miller will only provide guidance with regard to service and repair procedures for its products.

When needed, certification services must be provided by a qualified service facility or instrumentation laboratory to be selected by the machine owner.

Certificates of Conformity for welding equipment manufactured by Miller are available on request. Certificates of Conformity are specific to machines by serial number. These certificates establish the initial validation for control settings and weld variable indicating/recording devices installed by Miller at the time of production.

Information on testing, troubleshooting and repair is provided in the Technical Manuals for Miller products. The appropriate technical manual (check effective serial number) must be consulted for information on individual equipment design and service procedures.

Calibration is the process of comparing meter indications on a piece of welding equipment under load to indications of a certified instrument to determine if the meter indications are within tolerance. Physical adjustment of electrical components is not required in order for the process to meet the definition of calibration. The calibration test answers the question, “Does the meter acceptably indicate the actual output?”

Validation is the process of comparing the output of the welding equipment to measurements with a certified instrument to determine whether the accuracy of control settings are within required tolerances. The validation test answers the question, “Does the control setting give an output that corresponds to the set point marking of the control?”

Recertification is the process of performing calibration or validation of equipment after entry into service and providing documentation of the work performed and results observed. This service must be provided by a third party other than Miller Electric Mfg. LLC.

Electrical testing and repair of equipment built by Miller Electric Mfg. LLC should only be performed by a qualified person who has received instruction in electrical theory and safe work practices. This person must be properly trained and equipped in accordance with applicable standards.

Miller products meet the accuracy standards for control settings, and indication and recording functions as delivered from the factory. A statement of Miller’s validation practices during the manufacturing process is available upon request.

SECTION 5 – REFERENCE RESOURCES

For assistance in locating or interpreting standards, contact the agencies listed below:

ANSI – American National Standards Institute, website: https://ansi.org
AWS – American Welding Society, website: www.aws.org
CENELEC – European Committee for Electrotechnical Standardization, website: https://www.cenelec.eu/