Specific Accreditation Criteria

ISO/IEC 17025 Application Document

Calibration - Annex

Electrical metrology

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Electrical metrology

Purpose

In addition to the *ISO/IEC 17025 Standard Application Document* (SAD) and the accompanying Calibration - Appendix, this document provides interpretative criteria and recommendations for electrical metrology for both applicant and accredited facilities.

Facilities must comply with all relevant documents in the NATA Accreditation Criteria (NAC) package for Calibration (refer to *NATA Procedures for Accreditation).*

For ease of use and to avoid fragmentation of the information, the relevant clause numbers of ISO/IEC 17025 have not been included.

Measurement Traceability

Artefact calibration

Some digital instruments are adjusted by a process usually referred to as 'artefact calibration'. This typically consists of connecting the instrument with one or more reference devices such as a dc voltage reference and a standard resistor. While this procedure is specified by the manufacturer and should be performed at the specified intervals, it does not constitute an adequate calibration by itself. It is still necessary to perform the full calibration (verification) of the instrument as specified by the manufacturer.

Global Navigation Satellite System, (GNSS) devices as traceable standards

(GNSS) devices may be used as traceable standards and to check the operation of a calibrated standard. Two traceability paths are possible:

- via calibration of the GNSS device; or
- by operation of the GNSS device in conjunction with careful validation of its outputs.

The most direct traceability path is obtained by calibration of a GNSS device to a national standard. Less frequent calibration may be acceptable, given that the device may not be subject to significant long-term drift. The uncertainty budget will need to take into account variability in operating conditions, such as that due to the ionosphere. It is strongly recommended that the device status be logged and verified for correct operation during use. Status information such as the number of satellites tracked and the accuracy of the timing solution is greatly preferred over simply verifying that the device is 'locked'. The availability of such diagnostics should be considered when purchasing equipment.

In principle, a GNSS device can also be used as a standard traceable to UTC (AUS) without independent calibration.

Note: In the case of GPS, the link to UTC (AUS) is via UTC: the offset between UTC (AUS) and UTC and the offset between UTC (USNO) (which GPS time is steered to) and UTC are published, allowing the two to be linked. Similar data exist for

BeiDou and GLONASS. For convenience, data linking UTC (AUS) and GPS are published on the NMI Time and Frequency ftp server.

The uncertainty budget also needs to account for uncertainties in the link between a GNSS time scale and a device's outputs; which will typically be the largest source of uncertainty.

Note: Guidance on uncertainties can be obtained from the APMP Technical Committee for Time and Frequency's web pages: http://www.apmpweb.org/fms/guidelines3.php

When using a GNSS device as a traceable standard without independent calibration, the device's output should be compared during use with at least one other independent GNSS device. Each device should be configured to use a single, different GNSS system (e.g. one device using GPS and the other using GLONASS), for maximum independence. Correlations may still exist (e.g. single-frequency receivers will be using approximately the same ionosphere correction) and these should be accounted for in the uncertainty budget.

Traceability of ac current calibrations using multi-turn coils and multifunctional calibrators

The following approach is recommended:

- calibrate the coil at a lower than nominal current;
- check the calibrator's ability to produce maximum required current and its accuracy with the coil in place;
- rely on the current independence of the coil ratio.

An example of the practical realisation of this approach is as follows.

To calibrate a 1000 A current range realised by a calibrator and a coil with a turn ratio of 100:1 and a 10 A rated primary current:

1) calibrate a clamp meter, or another suitable transfer standard, at 10 A by directly connecting it to a traceably calibrated calibrator;
2) calibrate the same clamp meter at 10 A using the coil and a calibrator set to 0.1 A;
3) apply 10 A from the calibrator to a series combination of a coil and an ammeter (or the same clamp meter) and verify that the difference between the calibrator output current between 1 and 3 is within the acceptable limits.

Steps 1) and 2) give the error of the coil whilst step 3) checks the accuracy of the calibrator when supplying coil current.

In addition, an uncertainty component due to the positioning of the clamp is then determined. Normally a current clamp is calibrated with the conductors (core of the calibration coil) perpendicular to and centrally located within the aperture of the clamp. To determine the positioning uncertainty, the jaws of the clamp are moved around to find the largest difference. This is accounted for as a rectangular distributed uncertainty component.

Resistive Voltage Dividers (self calibrating)

When used as a dc voltage reference, resistive voltage dividers based on various internal bridge configurations may introduce measurement errors due to a number of factors:

- the difference between the internal reference voltage (~20 V) and the operating voltage (up to 1000 V) leads to a self heating effect of the resistors;
- the leakage of the switches used to set the resistors in the divider due to aging and contamination;
- degradation of the null detector;
- input bias current (dc current through the “high” and the “low” terminals of the null detector due to the imperfection of the analogue electronics at the input of the null detector);
- common mode current (mains-frequency current flowing from the “low” input of the null detector to the mains earth safety conductor);

To address these possible sources of error, calibration using at least one technique at the operating voltage is required together with performing the self adjustment immediately before calibration at each ratio and the monitoring of leakage of the switches as per the manufacturer’s procedure.

References

This section lists publications referenced in this document. The year of publication is not included as it is expected that only current versions of the references shall be used.

Standards

ISO/IEC 17025	General requirements for the competence of testing and calibration laboratories

NATA Publications

NATA Accreditation Criteria (NAC) package for Calibration

General Accreditation Criteria	ISO/IEC 17025 Standard Application Document
Specific Accreditation Criteria	ISO/IEC 17025 Standard Application Document, Calibration - Appendix

Amendment Table

The table below provides a summary of changes made to the document with this issue.

AMENDMENT TABLE	
Section or Clause	**Amendment**
Resistive voltage dividers	New section.
Whole document	Addition of Security Classification Label