

MSL Proficiency Test MSL-PT-E01-2023

6.5 Digit Multimeter

(Draft 2.1, 17 August 2023)

Technical Protocol

1. Introduction

The purpose of the proficiency test is to verify the calibration capabilities of participants with respect to a widely used multifunction 6.5 digit multimeter. This proficiency test is carried out with support from IANZ and will provide objective evidence in support of participants' claimed measurement capabilities.

The digital multimeter can measure dc voltage, dc current, ac voltage, ac current, and resistance. Only a limited selection of possible points will be used to keep the process manageable.

Following initial calibration at MSL, the digital multimeter will be circulated to each participating laboratory. After measurement at two or three laboratories, the multimeter will be returned to MSL for a stability and damage check before being dispatched to the next participant. Finally, the multimeter will be recalibrated by MSL to determine any possible drift.

2. Equipment and Handling

Artefact: Hewlett Packard 34401A Digital Multimeter, serial number <tba>.

After arrival of the instrument, it should be checked for any physical damage. Check that the instrument is functioning correctly. Report any problems immediately to MSL.

The multimeter should be allowed to stabilise in a temperature and, if possible, humidity-controlled environment for at least 24 hours before commencing measurements.

Each laboratory is allowed two weeks to complete the measurements and one week to ensure the instrument is available to the next participant. The cost to send the instrument to the next participant is covered by each laboratory. Typical freight cost is expected to be around \$xxx <tba>.

Once measurements are completed, repack the artefact in the original packaging and according to the schedule either dispatch to the next participant or return by courier to:

Cheng Yang,
Measurement Standards Laboratory
Callaghan Innovation
69 Gracefield Road,
Lower Hutt 5010.

Packaging

The instrument will be transported in a hard plastic case with dimensions and weight as follows: <tblc>.

- Exterior length: 56.0 cm
- Exterior width: 45.5 cm
- Exterior depth: 26.5 cm
- Weight = 9.1 kg + 3.6 kg = 12.7 kg

3. Quantities to be Measured

- **Participants must NOT attempt to perform any maintenance of the instrument or calibration adjustments.**
- **Participants must NOT discuss results with other participants before the final report is issued.**

In this proficiency test only a subset of the measurement points described in the Service Guide of the 34401A will be evaluated together with some power frequency points at 53 Hz. Each participant should calibrate the digital multimeter at least at the points given in the table below (the meter range will be specified for each point). You may use your own standard (automated) procedures that cover additional points, but these will not be used for analysis in this proficiency test.

Parameter	Nominal value
DC Voltage ^{Note 1}	100 mV, 1 V, 10 V, –10 V, 100 V and 1000 V
DC Current ^{Note 1}	10 mA and 1 A
DC Resistance ^{Note 1}	100 Ω, 100 kΩ and 10 MΩ (using 4-wire)
AC Voltage	53 Hz: ^{Note 2} 10 V, 100 V and 700 V 1 kHz: 100 mV, 1 V, 10 V, 100 V and 700 V 50 kHz: 100 mV, 1 V, 10 V, 100 V
AC Current	53 Hz: ^{Note 2} 1 A 1 kHz: 100 mA and 1 A

Note 1: All dc measurements must be corrected for zero offsets to ensure the reported value is the change in reading corresponding to the change in applied stimulus from zero to the nominal value.

Note 2: 53 Hz is not specified in the Service Guide set of verification points but is important to support electrical power measurements. If 53 Hz is not in your scope these measurements may be omitted.

For the purposes of this proficiency test, it is acceptable to report results outside the range of the measurand on your scope of accreditation.

Setting Up

Use your own leads to connect the output of a source or artefact to the input sockets of the instrument. The reference plane for all measurements is the front panel of the instrument.

You will need to provide your own mains power cord to operate the instrument.

In general:

- Reset the instrument to default settings before starting measurements.
- The front input terminals must be used for all measurements.
- Fixed range selection must be made for all measurements. Ensure the appropriate range (according to the Results Sheet) is selected before applying the test signal to the multimeter.

More specific instructions and instrument settings will be provided in the final version of this protocol.

Measurement Conditions

It is expected the measurements will be carried out in environmental conditions consistent with the participant's scope of accreditation. To avoid significant environmental corrections to be applied (and the associated increase in uncertainty) it is strongly recommended that all measurements should be made in the range:

- Temperature: 20 °C to 23 °C
- Relative humidity: 40 % to 60 %.

The environmental conditions at the time of the measurements must be reported with the results, and please note that temperature coefficient effects can be a significant contributor to the claimed measurement uncertainty.

4. Documents to be Submitted

Within three weeks of completion of the measurements, participating laboratories are required to submit their results to MSL in the form of a calibration report as routinely provided to customers. Results should also be reported in a Results Sheet provide by MSL and submitted with the calibration report (these documents can be sent by email – see *Contact Information* below). The traceability of the results must be described in this report.

Uncertainties should be calculated using your usual method, which should be consistent with the method in the *ISO Guide to the Expression of Uncertainty in Measurement*. Uncertainties must be reported as expanded uncertainties at the 95% level of confidence.

Note: *It is acceptable for the purposes of this proficiency test to report an uncertainty below that on your scope of accreditation or to report results outside the range of the measurand on your scope of accreditation, but such points should be clearly identified.*

5. Further Information

Schedule

The proficiency test is scheduled to start mid-September 2023. A travelling schedule will be proposed after consultation with participating laboratories. All laboratories should ensure the instrument reaches the subsequent participant by the date shown in the schedule.

Analysis

Results from all participating laboratories will be compared to the values measured by MSL. The results will be reported as a table of normalised error (E_n) values, which are given by:

$$E_n = \frac{LAB-REF}{\sqrt{U_{LAB}^2+U_{REF}^2}},$$

where: LAB = participating laboratory's value, REF = MSL's reference value, U_{LAB} = participating laboratory's expanded uncertainty, U_{REF} = MSL's expanded uncertainty.

Reporting

A draft final report will be compiled once all participating laboratories have completed their calibrations. Laboratories will be given three weeks to comment on the draft final report, after which a final report will be issued.

The report will list all participants in alphabetical order but will identify results only by a randomised laboratory number which will be communicated to each participant prior to release of the report. The same report will be issued to all participants.

Note: If any participant makes changes to submitted data between the interim and final reports, this will be noted in the final report.

Contact information

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RESULTS SHEET

HP 34401A 6.5 Digit Multimeter, serial number tbc.

Laboratory Name:

Report Number:

Calibrated Date:

Calibrated By:

Ambient Temperature and Humidity
(with uncertainty):

Nominal Value	Applied Value	DMM Range	DMM Reading	Reported ⁽¹⁾ Uncertainty	Least ⁽²⁾ Uncertainty
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DC Voltage

100 mV		100 mV			
1 V		1 V			
10 V		10 V			
-10 V		10 V			
100 V		100 V			
1000 V		1000 V			

DC Current

10 mA		10 mA			
1 A		1 A			

DC Resistance (4-wire)

100 Ω		100 Ω			
100 kΩ		100 kΩ			
10 MΩ		10 MΩ			

AC Voltage @ 53 Hz

10 V		10 V			
100 V		100 V			
700 V		750 V ⁽³⁾			

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RESULTS SHEET

HP 34401A 6.5 Digit Multimeter, serial number tbc.

Laboratory Name:

Report Number:

Calibrated Date:

Calibrated By:

Ambient Temperature and Humidity
(with uncertainty):

Nominal Value	Applied Value	DMM Range	DMM Reading	Reported ⁽¹⁾ Uncertainty	Least ⁽²⁾ Uncertainty
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AC Voltage @ 1 kHz

100 mV		100 mV			
1 V		1 V			
10 V		10 V			
100 V		100 V			
700 V		750 V ⁽³⁾			

AC Voltage @ 50 kHz

100 mV		100 mV			
1 V		1 V			
10 V		10 V			
100 V		100 V			

AC Current @ 53 Hz

1 A		1 A			
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AC Current @ 1 kHz

100 mA		1 A			
1 A		1 A			

Notes:

1. The reported uncertainty is the calculated uncertainty for this calibration. It is acceptable for the purposes of a measurement audit to report an uncertainty below that on your Scope of Accreditation.
2. The least uncertainty is the laboratory's accredited least uncertainty of measurement (from Scope of Accreditation).
3. The Service Guide refers to the 750 V range for ac, while the meter will return the range as 1000 V.

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RESULTS SHEET

HP 34401A 6.5 Digit Multimeter, serial number tbc.

Laboratory Name:

Report Number:

Calibrated Date:

Traceability Information

DC Voltage	
DC Current	
DC Resistance	
AC Voltage	
AC Current	