



Australian Government

**National Measurement
Institute**

**Certificate of Verification of a Reference Standard of Measurement in accordance
with Regulation 13 of the *National Measurement Regulations 1999* (Cth) in
accordance with the *National Measurement Act 1960* (Cth)**

Certificate Number RN170995

Description of standard of measurement: Leica TS30 Electronic Distance Measuring (EDM)
instrument with Leica GPH 1P prism

Permanent distinguishing marks: Serial No. (EDM): 364182
Serial No. (prism): 100

Date of verification: 14 June 2017

Period of certificate: From date of verification until 14 June 2019

Value(s) of standard of measurement: As stated in Report RN170995 of the National
Measurement Institute

Accuracy of verification: Uncertainty of value(s) as stated in Report
RN170995 of the National Measurement Institute

Values and uncertainties of relevant influence factors:
As stated in Report RN170995 of the National
Measurement Institute

Signature:

A handwritten signature in blue ink, appearing to read 'Peter Cox'.

Date: 23 June 2017

Name of Signatory: Mr Peter Cox

Being a person with powers delegated by the Chief Metrologist acting under section 18D of the *National Measurement Act 1960* (Cth) in respect of regulation 13 of the *National Measurement Regulations 1999* (Cth), I hereby certify that the above standard is verified as a reference standard of measurement in accordance with the regulations.

Note: Report RN170995 of the National Measurement Institute forms part of this Certificate.



Australian Government

Department of Industry,
Innovation and Science

**National
Measurement
Institute**

MEASUREMENT REPORT ON

Leica TS30 Electronic Distance

Measuring Instrument

Serial number: 364182



Accredited for compliance with ISO/IEC 17025.

Accreditation Number 1.

The National Measurement Institute is responsible for Australia's units and standards of measurement.

The measurement results presented in this report are traceable to Australia's primary standards.

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For: Landgate, Head Office
1 Midland Square
Morrison Road (cnr Gt Northern Hwy)
MIDLAND WA 6056

Description: TS30 Electronic Distance Measuring (EDM) instrument and a GPH 1P prism reflector

Manufacturer: Leica

Serial Number: EDM serial no: "364182" and barcode "S1000320"
Prism serial no: "100" and "1"

Previous Report: RN150413 dated 18 June 2015

Date(s) of Test: 13 June 2017 to 14 June 2017

General Condition

The instrument settings used at the time of measurement are given in Table 1.

Table 1: Instrument Settings

Parameter	Value	Parameter	Value
EDM type:	Reflector (IR)	ATR settings:	OFF
EDM mode:	Precise	Automation:	None
Reflector:	Leica circular prism	Geo. ppm correction:	0.0
Additive constant:	0.0 mm	Refraction correction:	ON
Air Temperature:	12°C	Refraction coeff. (k):	0.13
Air Pressure:	1013.3 mbar	Compensator:	ON
Relative humidity:	60%	Hz correction:	ON
Atm. ppm correction:	0.0	Scale at C.M.:	1.000 000 000

Details of Test

The instrument's frequency modulation deviation was measured by comparison with the 10MHz reference signal generated by the Australian National Frequency Standard (see Note 2).

A functional test was performed over the range 20 m to 649 m using the NMI 7 pillar baseline and the supplied reflector assembly to determine the instrument's zero point correction and standard deviation (see Notes 3, 4, 5 and 6).

Results

The results and uncertainties of measurement are given in Table 2 where the frequency modulation deviation is expressed as a length dependent scale correction factor. In Table 3 the results of the statistical tests recommended in ISO17123-4:2012 are included for information purposes only. The residual errors from the least squares fit for the measured baseline distances are shown in Figure 1.

Table 2: Results of Measurement

Item	Result of Measurement	Uncertainty	Coverage Factor
Scale correction factor	0.999 999 86	$\pm 0.000\ 000\ 17$	2.1
Zero point correction, δ	+ 0.45 mm	± 0.21 mm	2.1
Standard deviation, s	0.20 mm (degrees of freedom = 14)		

Table 3: Statistical Tests (for information only)

Test I.D.	Null Hypothesis	Result	Confidence Level
A	Standard deviation, $s <$ manufacturer's specified standard deviation (taken to be 0.6 mm)	Accept	95%
B	Standard deviation, s , belongs to the same population as the standard deviation obtained in the previous report for this instrument	Accept	95%
C	Zero point correction, $\delta = 0$ as specified by the manufacturer	Reject	95%

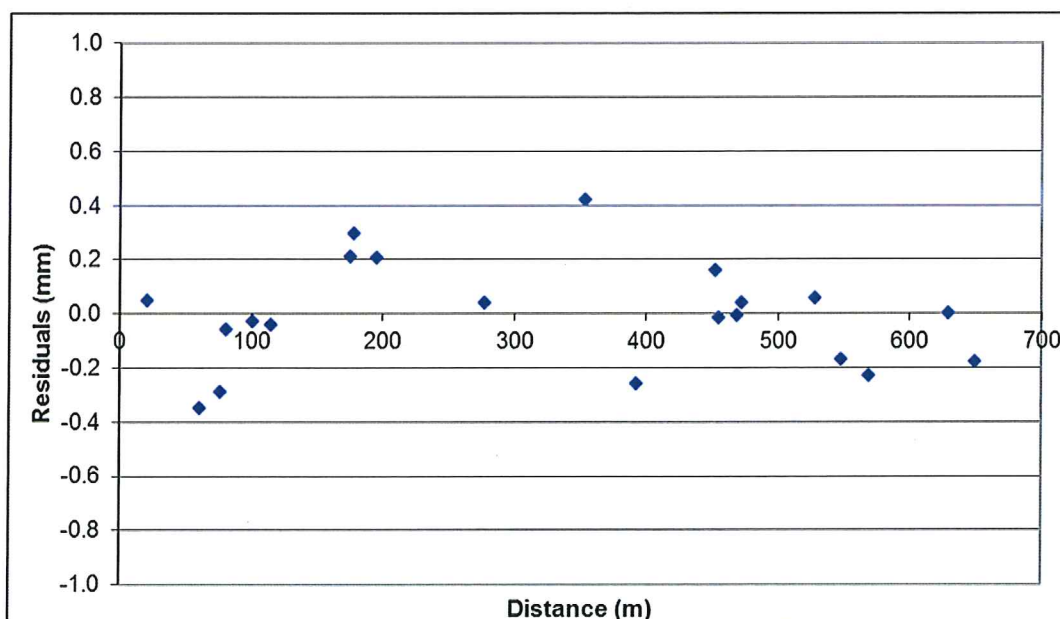


Figure 1: Residuals from least squares fit of the baseline measurements

Notes

1. The uncertainties stated in this Report have been calculated in accordance with the principles in *JCGM 100:2008 – Evaluation of measurement data – Guide to the expression of uncertainty in measurement*, and give intervals estimated to have a level of confidence of 95%. Unless otherwise stated, a coverage factor (k) of 2.0 has been used. The uncertainties apply at the time of measurement only and take no account of any drift or other effects that may apply afterwards. When estimating the uncertainty at any later time, other relevant information should also be considered, including, where possible, the history of the performance of the instrument and the manufacturer's specifications.
2. The instrument's modulated frequency was measured at intervals of 1 to 2 minutes by switching the instrument into Test mode for periods of approximately 10 seconds duration. Between measurements the instrument was left switched on but switched out of Test mode to avoid excessive heating of the instrument's oscillator. Measurements were continued for a period of approximately 30 minutes. During this time, the ambient laboratory temperature was within the range $(20.3 \pm 0.3) ^\circ\text{C}$.
3. The calibration was performed following the procedures given in Test Method PM-LEN-8.2.26-V6-EDM Long of the Melbourne Physical Metrology site operations manual. The method is based on the full test procedure and the statistical tests described in ISO17123-4 *Optics and optical instruments – Field procedures for testing geodetic and surveying instruments – Part 4: Electro-optical distance meters (EDM measurements to reflectors)*, 2nd edition, 2012-06-01.
4. Baseline measurements were carried out on 14th June over the period 8 am to 11 am under overcast conditions. Ambient atmospheric conditions during the measurements varied as follows: air temperature $(14.3 \pm 4.0) ^\circ\text{C}$, air pressure $(1023.5 \pm 0.2) \text{ hPa}$ and relative humidity $(84 \pm 15) \%$.
5. The baseline measurements were corrected for ambient atmospheric conditions using a nominal carrier wavelength of 658 nm. After applying the scale correction factor, the distances were referred to a common height and axis.
6. The uncertainty for the inter pillar baseline measurements is given by Equation (1):

$$U(L) = \pm \sqrt{0.36^2 \text{ mm} + (0.7 \times 10^{-3} L)^2} \quad (1)$$

Where L is the measured distance in metres. The coverage factor associated with the above uncertainty is, $k = 2.0$.

7. The calibration was conducted at the National Measurement Institute (NMI) Physical Metrology Branch, 36 Bradfield Road, West Lindfield, NSW, 2070.

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Mr Peter Cox
for Dr P T H Fisk
Chief Metrologist



Mr Peter Cox
NMI approved signatory
Length



Mr Stephen Quigg
NMI approved signatory
Time & Frequency