



Purchase Contract

(hereafter the “Contract”)

1. CONTRACTUAL PARTIES

1.1 Fyzikální ústav AV ČR, v. v. i. (Institute of Physics of the Czech Academy of Sciences),

with registered offices at: Na Slovance 1999/2, 182 00 Praha 8, Czech Republic,
represented by: RNDr. Michael Prouza, Ph.D., Director,
registered in the Register of public research institutions of the Ministry of Education, Youth and Sports
of the Czech Republic.
ID No.: 68378271

Bank: [REDACTED]

Account No.: [REDACTED]

(hereinafter referred to as the “Buyer”)

and

1.2 H TEST a.s.,

with registered offices at: Na Hřebenkách 1206/25, 150 00 Praha 5, Czech Republic,
represented by: Ing. Václav Haasz, Chairman of the Board,
registered in the Commercial Register at the Municipal Court in Prague, under file No. B 6041.
ID No.: 25784480
Tax ID No.: CZ25784480

Bank: [REDACTED]

Account No.: [REDACTED]

(hereinafter referred to as the “Seller”)

(the Buyer and the Seller are hereinafter jointly referred to as the “Parties” and each of them
individually as a “Party”).

2. FUNDAMENTAL PROVISIONS

- 2.1 The Buyer is *the Beneficiary* of the project "Investment for RI CERN-CZ (CERN-INV)" under the *Operational Programme Jan Amos Komenský* within the framework of EU funds, project registration number CZ.02.01.01/00/23_015/0008198 (hereinafter referred to as the “Project”). The subject of performance under this Contract is intended for the Project and mainly financed from the support provided for its implementation.





- 2.2 The Seller has been selected as the winner of a public procurement procedure announced by the Buyer in accordance with Act No. 134/2016 Coll., on Public Procurement, as amended (hereinafter the “**Act**”), for the public contract with the title “**Precision LCR meters**” (hereinafter the “**Procurement Procedure**”).
- 2.3 The documentation necessary for the implementation of the subject of performance hereof consist of
- 2.3.1 **Technical specifications** of the subject of performance hereof attached as **Annex 1** hereto.
- 2.3.2 The Seller’s bid submitted within the Procurement Procedure in its parts which describe the subject of performance in technical detail (hereinafter the “**Seller’s Bid**”); the Sellers’s Bid forms **Annex 2** to this Contract and is an integral part hereof.

In the event of a conflict between the Contract and its Annex or between the Contract’s Annexes, the technical specification / requirement of the higher level / quality shall prevail.

- 2.4 The Seller acknowledges that it is essential for the Buyer that the Seller delivers and handovers the subject of performance within the specified time and in the specified quality as stated in Annexes 1 and 2 of this Contract (including invoicing). If the Seller fails to comply with the contractual requirements, the Buyer may incur damages.

3. SUBJECT-MATTER OF THE CONTRACT

- 3.1 The subject of this Contract is the Seller’s obligation to deliver and transfer into the Buyer’s ownership:
- a **precision LCR meters** specified in detail in Annexes 1 and 2 hereto
(hereinafter the “**Equipment**”)
- and the Buyer’s obligation to accept the Equipment and to pay the Seller the purchase price as defined below.
- 3.2 The following activities are an integral part of the performance to be provided by the Seller:
- 3.2.1 Transport of the Equipment incl. all accessories specified in Annexes 1 and 2 hereto to the place of delivery;
- 3.2.2 Telephone or on-line assistance with the installation of the Equipment;
- 3.2.3 Delivery of detailed instructions and manuals for operation and maintenance in Czech or English language, in electronic or hardcopy (printed) versions;
- 3.2.4 Free-of-charge warranty service during the warranty term;
- 3.2.5 Provision of free technical support in the form of consultations, e.g. regarding fine tuning of the Equipment. The Seller shall provide the Buyer with this free support even after the warranty expires.





- 3.3 The Seller shall be liable for the Equipment and related services to be in full compliance with this Contract, its Annexes and all valid legal regulation, technical and quality standards and shall also be liable that the Buyer will be able to use the Equipment for the defined purpose. In case of any conflict between applicable standards, it is understood that the stricter standard or its part shall always apply.

4. PERFORMANCE PERIOD

The Seller undertakes to manufacture and deliver the Equipment to the Buyer within **3 months** of the conclusion of the Contract.

5. PURCHASE PRICE, INVOICING, PAYMENTS

- 5.1 The purchase price is based on the Seller's submitted bid and amounts to **1 220 501,10 CZK** (in words: onemillion twohundredtwentythousand fivehundredandone point ten CZK) excluding VAT for the Equipment (hereinafter the "**Price**") VAT shall be settled in accordance with the valid Czech regulation.
- 5.2 The Price includes any and all performance provided by the Seller in connection with meeting the Buyer's requirements for the proper and complete delivery of the Equipment hereunder, as well as all costs that the Seller may incur in connection with the delivery of the Equipment.
- 5.3 The Seller is entitled to invoice the Price after the acceptance protocol in accordance with Section 10.4 will have been signed. In case the Equipment will be delivered with minor defects, the Price shall be invoiced after removal of these minor defects.
- 5.4 All invoices issued by the Seller must contain all information required by the applicable laws of the Czech Republic and, in addition, they must
- 5.4.1 contain registration number of this Contract, which the Buyer shall communicate to the Seller based on Seller's request before the issuance of the first invoice,
 - 5.4.2 state that the Equipment is supplied for the purposes of the project "Investment for RI CERN-CZ (CERN-INV)" with the registration number CZ.02.01.01/00/23_015/0008198,
 - 5.4.3 comply with the double taxation agreements, if applicable.
- 5.5 Buyer requests electronic invoicing to the electronic address efaktury@fzu.cz.
- 5.6 Invoices shall be payable within thirty (30) days of the date of their delivery to the above address. Payment of the invoiced amount means the date of its remittance to the Seller's account.
- 5.7 If an invoice is not issued in conformity with the payment terms stipulated by the Contract or if it does not comply with the requirements stipulated by law, the Buyer shall be entitled to return the invoice to the Seller as incomplete, or incorrectly issued, for correction or issue of a new invoice, as appropriate, within five (5) business days of the date of its delivery to the Buyer. In such a case, the Buyer shall not be in delay with the payment of the Price or part thereof and the Seller shall issue a corrected invoice with a new and identical maturity period commencing on the date of delivery of the corrected or newly issued invoice to the Buyer.





5.8 The Buyer shall be entitled to unilaterally set off any of their payments against any receivables claimed by the Seller due to:

5.8.1 damages caused by the Seller,

5.8.2 contractual penalties.

5.9 The Seller shall not be entitled to set off any of his receivables against any part of the Buyer's receivable hereunder.

6. OWNERSHIP TITLE

The ownership right to the Equipment and at the same time the associated risk of damage shall pass to the Buyer by delivery.

7. PLACE OF DELIVERY

The place of delivery of the Equipment shall be the seat of the Buyer at Na Slovance 1999/2, 182 00 Praha 8, Czech Republic.

8. NOTIFICATION OF DELIVERY

The Seller shall notify the Buyer in writing of the exact date of delivery of the Equipment at least 15 days prior to such date, ensuring that the deadline for the performance hereunder is maintained.

9. INTERACTION OF THE PARTIES

9.1 The Seller undertakes to notify the Buyer of any obstacles on his part, which may negatively influence proper and timely delivery of the Equipment.

9.2 The Seller undertakes to provide the Buyer with cooperation in the event of inspections by authorized entities in connection with the Project.

10. DELIVERY AND ACCEPTANCE

10.1 The Seller shall transport the Equipment at his own cost to the place of delivery. If the shipment is intact, the Buyer shall issue delivery note for the Seller.

10.2 The Buyer shall verify whether the Equipment is functional and meets the technical requirements set out in Annexes 1 and 2 hereof within 3 weeks of the delivery of the Equipment.

10.3 The delivery shall include all technical documentation pertaining to the Equipment, user manuals and certificate of compliance of the Equipment and all its parts and accessories with approved standards.

10.4 The procedure shall be completed by acceptance of the Equipment confirmed by the acceptance



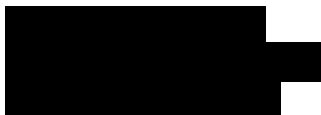


protocol. The protocol shall contain the following information:

- 10.4.1 Information about the Seller, the Buyer and any subcontractors;
 - 10.4.2 Description of the Equipment including description of all components and their serial numbers;
 - 10.4.3 List of technical documentation including the manuals;
 - 10.4.4 Eventually reservation of the Buyer regarding minor defects including the manner and deadline for their removal and
 - 10.4.5 Date and signature of the representative of the Buyer specified in Section 11.2 hereof.
- 10.5 Acceptance of the Equipment does not release the Seller from liability for defects that were not detected during the acceptance procedure.
- 10.6 The Buyer shall not be obliged to accept Equipment, which would show defects that would otherwise not form a barrier, on their own or in connection with other defects, to using the Equipment. In this case, the Buyer shall issue a record containing the reason for his refusal to accept the Equipment.

11. REPRESENTATIVES, NOTICES

- 11.1 The Seller authorized the following representatives to communicate with the Buyer in all matters relating to the Equipment delivery:



- 11.2 The Buyer authorized the following representatives to communicate with the Seller in all matters relating to the Equipment delivery:



- 11.3 The representatives according to Sections 11.1 and 11.2 can be changed by a unilateral written declaration of the Buyer / Seller delivered to the Seller / Buyer.
- 11.4 All notifications to be made between the Parties hereunder must be made out in writing and delivered by hand (with confirmed receipt) or by post (to the address of the Seller's or Buyer's registered offices), or in the form of electronic delivery incorporating electronic signature (qualified certificate) to epodatelna@fzu.cz in the case of Buyer and to info@hstest.cz in the case of the Seller.
- 11.5 In all technical and expert matters (discussions on the Equipment testing, notification of the need to provide warranty or post-warranty service, technical assistance etc.), electronic communication





between technical representatives of the Parties will be acceptable using e-mail addresses specified in Sections 11.1 and 11.2.

12. TERMINATION

- 12.1 This Contract may be terminated early by agreement of the Parties or withdrawal from the Contract on the grounds stipulated by law or in the Contract.
- 12.2 The Buyer is entitled to withdraw from the Contract without any penalty from the Seller in any of the following events:
- 12.2.1 The Seller is in delay with the delivery of the Equipment longer than 1 month after the date pursuant to Section 4. hereof.
 - 12.2.2 The technical parameters or other conditions set out in the technical specifications set out in Annexes 1 and 2 to this Contract and in the relevant applicable technical standards will not be met by the Equipment at acceptance.
 - 12.2.3 Facts emerge bearing evidence that the Seller will not be able to deliver the Equipment.
 - 12.2.4 The Seller has breached the obligations specified within the conditions of the Procurement Procedure, in particular the obligations arising from the affidavit which forms Annex 3 to this Contract, necessary for the selection of an economic operator according to Section 2.2 of this Contract.
- 12.3 The Seller is entitled to withdraw from the Contract in the event of the Buyer being in default with the payment for more than 2 months with the exception of the cases when the Buyer refused an invoice due to defect on the delivered Equipment or due to breach of the Contract by the Seller.
- 12.4 Withdrawal from the Contract becomes effective on the day the written notification to that effect is delivered to the other Party. The Party which had received performance from the other Party prior to such withdrawal shall duly return such performance.

13. INSURANCE

- 13.1 The Seller undertakes to insure the Equipment against all risks, in the amount of the Price for the entire period from the commencement of the transportation of the Equipment until duly handed over to the Buyer. In the event of a breach of this obligation, the Seller shall be liable to the Buyer for damages incurred in connection therewith.
- 13.2 The Seller is liable for the damages that he has caused. The Seller is also liable for damages caused by third parties which have undertaken to carry out performance or part thereof under this Contract.

14. WARRANTY TERMS

- 14.1 The Seller shall provide warranty for the quality of the Equipment for a period of **3 years**.





- 14.2 The warranty term shall commence on the day following the date of signing of the acceptance protocol pursuant to Section 10.4 hereof. The warranty does not cover consumable parts. Consumable parts for the purposes of the Contract are the items contained in the Equipment which are consumed at regular intervals during the normal use of the Equipment, i.e. parts which have a specified typical lifetime, that does not exceed the warranty period provided the Equipment is used with normal frequency.
- 14.3 Should the Buyer discover a defect, he shall notify the Seller to rectify such defect using the e-mail address: info@htest.cz. The Seller is obliged to notify the Buyer without delay about any change of this e-mail address. The Seller shall be obliged to review any warranty claim within 72 hours (within business days) from its receipt and to propose solution, unless agreed otherwise by the Parties.
- 14.4 During the warranty period, the Seller shall be obliged to rectify any claimed defects within 30 days from the date on which the Equipment was delivered to the Seller for repair or within 30 days from receipt of the Buyer's notification if the Seller sends a technician to perform the repair on-site. In cases of unusual defects, the Seller shall be obliged to rectify the defect in the period corresponding to the nature of the defect and to define the deadline for the completion of the repair or for shipping of the rectified Equipment.
- 14.5 During the warranty period, any and all costs associated with defect rectification / repair including transport and travel expenses of the Seller shall be always borne by the Seller.
- 14.6 The repaired Equipment shall be delivered by the Seller to the Buyer along with a protocol confirming removal of the defect (hereinafter the "**Repair Protocol**"). If the Equipment is delivered duly repaired and defect-free, the Buyer will confirm the Repair Protocol.
- 14.7 The repaired part (component) shall be subject to a new warranty term in accordance with Section 14.1 which commences to run on the day following the date when the repaired Equipment was delivered to the Buyer. However, the aggregate warranty period for any part of the Equipment shall not exceed 60 months.
- 14.8 The Seller undertakes to provide the Buyer with updates of the software controlling the Equipment for the entire term of warranty.

15. CONTRACTUAL PENALTIES

- 15.1 The Buyer shall be entitled to a contractual penalty in the amount of 0.1 % of the Price for each commenced day of delay with the performance pursuant to the relevant part of Section 4. hereof.
- 15.2 The Buyer shall be entitled to a contractual penalty in the amount of 0.05 % of the Price for each commenced day of delay with rectifying of defects claimed within the warranty period.
- 15.3 In the event of default in payment of any due receivables (monetary debt) under the Contract, the defaulting Party (the debtor) shall be obliged to pay a contractual penalty of 0.05 % of the amount due for each commenced day of delay in payment.
- 15.4 Contractual penalties are payable within 30 days of receipt of the demand for payment.





- 15.5 Payment of the contractual penalty shall be without prejudice to the rights of the Parties to claim compensation for damages incurred.
- 15.6 Payment of any contractual penalty cannot be demanded if the breach of the contractual obligation causes force majeure.

16. **DISPUTES**

In the event that any dispute arising out of this Contract cannot be resolved by negotiations, it shall be resolved by a court in the Czech Republic; the court having jurisdiction will be the court where the seat of the Buyer is located. Disputes shall be resolved exclusively by the law of the Czech Republic.

17. **FINAL PROVISIONS**

- 17.1 This Contract constitutes the entire agreement between the Parties. The relations between the Parties not regulated by this Contract shall be governed by Czech law, in particular by the Act No. 89/2012 Coll., the Civil Code, as amended (hereinafter the “**Civil Code**”).
- 17.2 This Contract may be amended or supplemented solely by written amendments. The Parties expressly refuse to amend the Contract in any other way.
- 17.3 The Parties expressly agree that the Contract will be published in accordance with Act No. 340/2015 Coll., on special conditions for the effectiveness of some contracts, publication of these contracts and Contract Register, as amended. The Parties hereby declare that all information contained in the Contract and its Annexes is not considered trade secrets under § 504 of the Civil Code and grant permission for their use and disclosure without setting any additional conditions. The Buyer shall ensure the publication of the Contract in the Contract Register.
- 17.4 This Contract becomes effective as of the day of its publication in the Contract Register.
- 17.5 The following Annexes form an integral part of the Contract:

Annex 1: Technical specification on the subject of performance

Annex 2: Technical description of the Equipment as presented in Seller's bid

Annex 3: Affidavit according to § 6 paragraph 4 of the Act No. 134/2016 Coll.





17.6 The Parties, manifesting their consent with the entire contents of this Contract, attach their signature hereunder.

In Prague, 27. 2. 2025

In Prague, 26. 2. 2025

For the Buyer

For the Seller

RNDr. Michael Prouza, Ph.D.
Director

Ing. Václav Haasz
Chairman of the Board





Annex 1 - Technical specification on the subject of performance

Tab. 1 – The Equipment (3 LCR meters) must meet the technical conditions and include components listed in this table.

No.	Description and minimum specification of the Equipment as defined by the Buyer	Description and specification of the Equipment offered by the Seller	Complies YES/NO
1	Implemented test cable lengths: 0 m, 1 m, 2 m, 4 m	Implemented test cable lengths: 0 m, 1 m, 2 m, 4 m	YES
2	Available trigger modes: Internal trigger, manual trigger, external trigger, GPIB trigger	Available trigger modes: Internal trigger, manual trigger, external trigger, GPIB trigger	YES
3	Available measurement parameters Cp-D, Cp-Q, Cp-G, Cp-Rp Cs-D, Cs-Q, Cs-Rs Lp-D, Lp-Q, Lp-G, Lp-Rp, Lp-Rdc Ls-D, Ls-Q, Ls-Rs, Ls-Rdc R-X Z-θ_d, Z-θ_r G-B Y- θ_d, Y-θ_r Cp Capacitance value measured with parallel-equivalent circuit model Cs Capacitance value measured with series-equivalent circuit model Lp Inductance value measured with parallel-equivalent circuit model Ls Inductance value measured with series-equivalent circuit model D Dissipation factor Q Quality factor (inverse of D) G Equivalent parallel conductance measured with parallel-equivalent circuit model Rp Equivalent parallel resistance measured with parallel-equivalent circuit model Rs Equivalent series resistance measured with series-equivalent circuit model Rdc Direct-current resistance R Resistance X Reactance Z Impedance Y Admittance θ_d Phase angle of impedance/admittance (degree) θ_r Phase angle of impedance/admittance (radian) B Susceptance	Available measurement parameters Cp-D, Cp-Q, Cp-G, Cp-Rp Cs-D, Cs-Q, Cs-Rs Lp-D, Lp-Q, Lp-G, Lp-Rp, Lp-Rdc Ls-D, Ls-Q, Ls-Rs, Ls-Rdc R-X Z-θ_d, Z-θ_r G-B Y- θ_d, Y-θ_r Cp Capacitance value measured with parallel-equivalent circuit model Cs Capacitance value measured with series-equivalent circuit model Lp Inductance value measured with parallel-equivalent circuit model Ls Inductance value measured with series-equivalent circuit model D Dissipation factor Q Quality factor (inverse of D) G Equivalent parallel conductance measured with parallel-equivalent circuit model Rp Equivalent parallel resistance measured with parallel-equivalent circuit model Rs Equivalent series resistance measured with series-equivalent circuit model Rdc Direct-current resistance R Resistance X Reactance Z Impedance Y Admittance θ_d Phase angle of impedance/admittance (degree) θ_r Phase angle of impedance/admittance (radian) B Susceptance	YES
4	Available equivalent circuits for measurements: Parallel and Serial	Available equivalent circuits for measurements: Parallel and Serial	YES
5	Measurement frequency (frequency of the test signal) between 20 Hz and 2 MHz	Measurement frequency (frequency of the test signal) between 20 Hz and 2 MHz	YES



6	Measurement frequency resolution: 0.01 Hz for (20 Hz - 99.99 Hz), 0.1 Hz for (100 Hz - 999.9 Hz), 1 Hz for (1 kHz - 9.999 kHz), 10 Hz for (10 kHz - 99.99 kHz), 100 Hz for (100 kHz - 999.9 kHz), 1 kHz for (1 MHz - 2 MHz)	Measurement frequency resolution: 0.01 Hz for (20 Hz - 99.99 Hz), 0.1 Hz for (100 Hz - 999.9 Hz), 1 Hz for (1 kHz - 9.999 kHz), 10 Hz for (10 kHz - 99.99 kHz), 100 Hz for (100 kHz - 999.9 kHz), 1 kHz for (1 MHz - 2 MHz)	YES
7	Minimal test frequency measurement accuracy: +/-0.01%	Minimal test frequency measurement accuracy: +/-0.01%	YES
8	Test signal voltage 0 Vrms - 2.0 Vrms	Test signal voltage 0 Vrms - 2.0 Vrms	YES
9	Test signal voltage resolution: 100 uVrms <0 Vrms, 0.2 Vrms>, 200 uVrms (0.2 Vrms, 0.5 Vrms>, 500 uVrms (0.5 Vrms, 1 Vrms>, 1 mVrms (1 Vrms, 2 Vrms>	Test signal voltage resolution: 100 uVrms <0 Vrms, 0.2 Vrms>, 200 uVrms (0.2 Vrms, 0.5 Vrms>, 500 uVrms (0.5 Vrms, 1 Vrms>, 1 mVrms (1 Vrms, 2 Vrms>	YES
10	Minimal accuracy of test signal voltage +/- (10% + 1 mVrms)	Minimal accuracy of test signal voltage +/- (10% + 1 mVrms)	YES
11	Test signal current 0 Arms - 20 mArms	Test signal current 0 Arms - 20 mArms	YES
12	Test signal current resolution: 1 uArms <0 Arms, 2 mArms>, 2 uArms (2 mArms, 5 mArms>, 5 uArms (5 mArms, 10 mArms>,, 10 uArms (10 mArms, 20 mArms>,,	Test signal current resolution: 1 uArms <0 Arms, 2 mArms>, 2 uArms (2 mArms, 5 mArms>, 5 uArms (5 mArms, 10 mArms>,, 10 uArms (10 mArms, 20 mArms>,,	YES
13	Minimal accuracy of test signal current +/- (10% + 10 uArms)	Minimal accuracy of test signal current +/- (10% + 10 uArms)	YES
14	DC bias signal 0 V to +2 V	DC bias signal 0 V to +2 V	YES
15	DC bias accuracy 0.1% + 2 mV for temperatures <18-28°C> (0.1% + 2 mV) × 4 for temperatures <0-18°C> and (28-55°C>	DC bias accuracy 0.1% + 2 mV for temperatures <18-28°C> (0.1% + 2 mV) × 4 for temperatures <0-18°C> and (28-55°C>	YES
16	Available compensation functions: OPEN compensation, SHORT compensation, LOAD compensation	Available compensation functions: OPEN compensation, SHORT compensation, LOAD compensation	YES
17	Available interfaces for communication with LCR meters: GPIB (IEEE Std 488.1, 2 and SCPI), USB (USB 2.0 or faster) LAN (10/100 BaseT Ethernet)	Available interfaces for communication with LCR meters: GPIB (IEEE Std 488.1, 2 and SCPI), USB (USB 2.0 or faster) LAN (10/100 BaseT Ethernet)	YES





Tab. 2 – Data on the evaluation criteria “New / Refurbished LCR meters” and “Technical characteristics of the bid”

Description	Value
<i>New / Refurbished LCR meters</i>	
Number of new LCR meters to be supplied (<i>out of 3</i>)	3
<i>Technical characteristics of the bid</i>	
Test signal voltage range above the required 0 Vrms to 2.0 Vrms (<i>in Vrms</i>)	0
DC bias signal range wider than the required 0 V to +2 V (<i>in V, positive or negative</i>)	0
Test signal current range above the required 0 Arms to 20 mArms (<i>in mArms</i>)	0





Annex 2

The Seller's bid in the extent it describes technical parameters of the Equipment

3 pcs of NEW precision LCR meters Keysight E4980B



E4980B Precision LCR Meter

20 Hz to 2 MHz

E4980BL Precision LCR Meter

20 Hz to 300 kHz/500 kHz/1 MHz



Fully compliant to
LXI Class C specification



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Definitions

All specifications apply to the conditions of a 0 to 55°C temperature range, unless otherwise stated, and 30 minutes after the instrument has been turned on.

Specifications (spec.): Warranted performance. Specifications include guardbands to account for the expected statistical performance distribution, measurement uncertainties, and changes in performance due to environmental conditions.

Supplemental information is provided as information that is useful in operating the instrument but is not covered by the product warranty. This information is classified as either typical or nominal.

Typical (typ.): Expected performance of an average unit without taking guardbands into account.

Nominal (nom.): A general descriptive term that does not imply a level of performance.

How to Use Tables

When measurement conditions fall under multiple categories in a table, apply the best value.

For example, basic accuracy A_b is 0.10% under the following conditions:

Measurement time mode	SHORT
Test frequency	125 Hz
Test signal voltage	0.3 Vrms

E4980B/E4980BL Model and Option Numbers

The E4980B is the model number of the 20 Hz to 2 MHz frequency range LCR meter. The E4980BL is the model number of the 20 Hz to 300 kHz, 500 kHz or 1 MHz frequency range LCR meter. See the E4980B/E4980BL Configuration Guide (3124-1418) for more details.

Frequency range	Model number and option
20 Hz to 2 MHz	E4980B
20 Hz to 1 MHz	E4980BL-102
20 Hz to 500 kHz	E4980BL-052
20 Hz to 300 kHz	E4980BL-032

Basic Specifications

Measurement functions

Measurement parameters

- Cp-D, Cp-Q, Cp-G, Cp-Rp
- Cs-D, Cs-Q, Cs-Rs
- Lp-D, Lp-Q, Lp-G, Lp-Rp, Lp-Rdc
- Ls-D, Ls-Q, Ls-Rs, Ls-Rdc
- R-X
- Z- θ_d , Z- θ_r
- G-B
- Y- θ_d , Y- θ_r
- Vdc-Idc ¹

Definitions

Cp	Capacitance value measured with parallel-equivalent circuit model
Cs	Capacitance value measured with series-equivalent circuit model
Lp	Inductance value measured with parallel-equivalent circuit model
Ls	Inductance value measured with series-equivalent circuit model
D	Dissipation factor
Q	Quality factor (inverse of D)
G	Equivalent parallel conductance measured with parallel-equivalent circuit model
Rp	Equivalent parallel resistance measured with parallel-equivalent circuit model
Rs	Equivalent series resistance measured with series-equivalent circuit model
Rdc	Direct-current resistance
R	Resistance
X	Reactance
Z	Impedance
Y	Admittance

1. E4980B-001 is required.

θ_d	Phase angle of impedance/admittance (degree)
θ_r	Phase angle of impedance/admittance (radian)
B	Susceptance
V _{dc}	Direct-current voltage
I _{dc}	Direct-current electricity

Deviation measurement function: Deviation from reference value and percentage of deviation from reference value can be output as the result.

Equivalent circuits for measurement: Parallel, Series

Impedance range selection: Auto (auto range mode), manual (hold range mode)

Trigger mode: Internal trigger (INT), manual trigger (MAN), external trigger (EXT), GPIB trigger (BUS)

Table 1. Trigger delay time

Range	0 s – 999 s
Resolution	100 μ s (0 s $\leq$ - $\leq$ 100 s)
	1 ms (100 s < - $\leq$ 999 s)

Table 2. Step delay time

Range	0 s – 999 s
Resolution	100 μ s (0 s $\leq$ - $\leq$ 100 s)
	1 ms (100 s < - $\leq$ 999 s)

Measurement terminal: Four-terminal pair

Test cable length: 0 m, 1 m, 2 m, 4 m

Measurement time modes: Short mode, medium mode, long mode.

Table 3. Averaging

Range	1 – 256 measurements
Resolution	1

Test signal

Table 4. Test frequencies

Test frequencies	20 Hz - 2 MHz (E4980B) 20 Hz - 1 MHz (E4980BL-102) 20 Hz - 500 kHz (E4980BL-052) 20 Hz - 300 kHz (E4980BL-032)
Resolution	0.01 Hz (20 Hz - 99.99 Hz) 0.1 Hz (100 Hz - 999.9 Hz) 1 Hz (1 kHz - 9.999 kHz) 10 Hz (10 kHz - 99.99 kHz) 100 Hz (100 kHz - 999.9 kHz) 1 kHz (1 MHz - 2 MHz)
Measurement accuracy	± 0.01%

Table 5. Test signal modes

Normal	Program selected voltage or current at the measurement terminals when they are opened or short-circuited, respectively.
Constant ¹	Maintains selected voltage or current at the device under test (DUT) independently of changes in impedance of DUT.

Signal Level

Table 6. Test signal voltage

Range	0 Vrms – 2.0 Vrms		
Resolution	100 µVrms (0 Vrms ≤ - ≤ 0.2 Vrms) 200 µVrms (0.2 Vrms < - ≤ 0.5 Vrms) 500 µVrms (0.5 Vrms < - ≤ 1 Vrms) 1 mVrms (1 Vrms < - ≤ 2 Vrms)		
Accuracy	Normal	± (10% + 1 mVrms)	Test frequency ≤ 1 MHz: spec. Test frequency > 1 MHz: typ.
	Constant ¹	± (6% + 10 µArms)	Test frequency ≤ 1 MHz: spec. Test frequency > 1 MHz: typ.

Table 7. Test signal current

Range	0 Arms - 20 mArms		
Resolution	1 µArms (0 Arms ≤ - ≤ 2 mArms) 2 µArms (2 mArms < - ≤ 5 mArms) 5 µArms (5 mArms < - ≤ 10 mArms) 10 µArms (10 mArms < - ≤ 20 mArms)		
Accuracy	Normal	± (10% + 10 µArms)	Test frequency ≤ 1 MHz: spec. Test frequency > 1 MHz: typ.
	Constant ¹	± (6% + 10 µArms)	Test frequency ≤ 1 MHz: spec. Test frequency > 1 MHz: typ.

1. When auto level control function is on and no warning message is displayed.

Output impedance: 100 Ω (nominal)

Test signal level monitor function

- Test signal voltage and test signal current can be monitored.
- Level monitor accuracy (see next page)

Table 8. Test signal voltage monitor accuracy (Vac)

Test signal voltage ²	Test frequency	Specification
5 mVrms - 2 Vrms	≤ 1 MHz	$\pm$ (3% of reading value + 0.5 mVrms)
	> 1 MHz	$\pm$ (6% of reading value + 1 mVrms)

Table 9. Test signal current monitor accuracy (Iac)

Test signal voltage ²	Test frequency	Specification
50 μ Arms - 20 mArms	≤ 1 MHz	$\pm$ (3% of reading value + 5 μ Arms)
	> 1 MHz	$\pm$ (6% of reading value + 10 μ Arms)

Measurement display ranges

Table 10 shows the range of measured value that can be displayed on the screen. For the effective measurement ranges, refer to Figure 1 impedance measurement accuracy example.

Table 10. Allowable display ranges for measured values

Parameter	Measurement display range
Cs, Cp	± 1.000000 aF to 999.9999 EF
Ls, Lp	± 1.000000 aH to 999.9999 EH
D	± 0.000001 to 9.999999
Q	± 0.01 to 99999.99
R, Rs, Rp, X, Z, Rdc	± 1.000000 a Ω to 999.9999 E Ω
G, B, Y	± 1.000000 aS to 999.9999 ES
Vdc	± 1.000000 aV to 999.9999 EV
Idc	± 1.000000 aA to 999.9999 EA
θ_r	± 1.000000 arad to 3.141593 rad
θ_d	± 0.0001 deg to 180.0000 deg
$\Delta\%$	$\pm 0.0001\%$ to 999.9999%

a: 1×10^{-18} , E: 1×10^{18}

1. When auto level control function is on.

2. This is not an output value but rather a displayed test signal level.

Absolute measurement accuracy

The following equations are used to calculate absolute accuracy.

Absolute accuracy Aa of |Z|, |Y|, L, C, R, X, G, B (L, C, X, and B accuracies apply when $Dx \leq 0.1$, R and G accuracies apply when $Qx \leq 0.1$)

When $Dx \geq 0.1$, multiply Acal by $\sqrt{1+Dx^2}$ for L, C, X, and B accuracies

When $Qx \geq 0.1$, multiply Acal by $\sqrt{1+Qx^2}$ for R and G accuracies

Under an AC magnetic field, the following equation is applied to the measurement accuracy.

$$A \times (1 + B \times (2 + 0.5 / Vs))$$

Where A Absolute accuracy

B Magnetic flux density [Gauss]

Vs Test signal voltage level [Volts]

Equation 1. $Aa = Ae + Acal$

Aa Absolute accuracy (% of reading value)

Ae Relative accuracy (% of reading value)

Acal Calibration accuracy (%)

where G accuracy is applied only to G-B measurements.

D accuracy (when $Dx \leq 0.1$)

Equation 2. $De + \theta_{cal}$

Dx Measured D value

De Relative accuracy of D

θ_{cal} Calibration accuracy of θ (radian)

when $0.1 < Dx \leq 1$, multiply θ_{cal} by $(1 + Dx)$

Q accuracy (When $Qx \times Da < 1$)¹

Equation 3.

$$\pm \frac{(Qx^2 \times Da)}{(1 \mp Qx \times Da)}$$

Qx Measured Q value

Da Absolute accuracy of D

¹ When $Qx \times Da \geq 1$, Q accuracy = $\pm \infty$

θ accuracy

Equation 4. $\theta_e + \theta_{cal}$

θ_e Relative accuracy of θ (degree)

θ_{cal} Calibration accuracy of θ (degree)

G accuracy (when $D_x \leq 0.1$)

Equation 5. $B_x + D_a$ (S)

$$B_x = 2\pi f C_x = \frac{1}{2\pi f L_x}$$

D_x Measured D value

B_x Measured B value (S)

D_a Absolute accuracy of D

f Test frequency (Hz)

C_x Measured C value (F)

L_x Measured L value (H)

where the accuracy of G is applied to Cp-G measurements.

Absolute accuracy of R_p (when $D_x \leq 0.1$ and $D_x > D_a$) ¹

Equation 6. $\pm \frac{R_{px} \times D_a}{D_x \mp D_a} (\Omega)$

R_{px} Measured R_p value (Ω)

D_x Measured D value

D_a Absolute accuracy of D

¹ When $D_x \leq D_a$, R_p accuracy = $\pm \infty$

Absolute accuracy of Rs (when Dx ≤ 0.1)

Equation 7. $X_x \times D_a \quad (\Omega)$

$$X_x = \frac{1}{2\pi f C_x} = 2\pi f L_x$$

Dx	Measured D value
Xx	Measured X value (Ω)
Da	Absolute accuracy of D
f	Test frequency (Hz)
Cx	Measured C value (F)
Lx	Measured L value (H)

Relative accuracy

Relative accuracy includes stability, temperature coefficient, linearity, repeatability, and calibration interpolation error. Relative accuracy is specified when all of the following conditions are satisfied:

- **Warm-up time:** 30 minutes
- **Test cable length:** 0 m, 1 m, 2 m, or 4 m (Keysight Technologies, Inc. 16048A/D/E)
- A "Signal Source Overload" warning does not appear. When the test signal current exceeds a value in table 11 below, a "Signal Source Overload" warning appears.

Table 11.

Test signal voltage	Test frequency	Condition ¹
≤ 2 Vrms	—	—
> 2 Vrms	≤ 1 MHz	The smaller value of either 110 mA or 130 mA - 0.0015 × Vac × (Fm / 1 MHz) × (L_cable + 0.5)
	> 1 MHz	70 mA - 0.0015 × Vac × (Fm / 1 MHz) × (L_cable + 0.5)

1. When the calculation result is a negative value, 0 A is applied.

Vac [V]	Test signal voltage
Fm [Hz]	Test frequency
L_cable [m]	Cable length

- OPEN and SHORT corrections have been performed.
- Bias current isolation: Off
- The DC bias current does not exceed a set value within each range of the DC bias current
- The optimum impedance range is selected by matching the impedance of DUT to the effective measuring range.

|Z|, |Y|, L, C, R, X, G, and B accuracy (L, C, X, and B accuracies apply when $Dx \leq 0.1$, R and G accuracies apply $Qx \leq 0.1$)

When $Dx > 0.1$, multiply Ae by $\sqrt{1+Dx^2}$ for L, C, X, and B accuracies

When $Qx > 0.1$, multiply Ae by $\sqrt{1+Qx^2}$ for R and G accuracies

Relative accuracy Ae is given as:

Equation 8. $Ae = [Ab + Zs / |Zm| \times 100 + Yo \times |Zm| \times 100] \times Kt$

Zm Impedance of DUT
 Ab Basic accuracy
 Zs Short offset
 Yo Open offset
 Kt Temperature coefficient

D accuracy

D accuracy De is given as - when $Dx \leq 0.1$

Equation 9. $De = \pm Ae/100$

Dx Measured D value
 Ae Relative accuracies of |Z|, |Y|, L, C, R, X, G, and B
 When $0.1 < Dx \leq 1$, multiply De by $(1 + Dx)$

Q accuracy (when $Q \times De < 1$)¹

Q accuracy Qe is given as:

Equation 10. $Qe = \pm \frac{(Qx^2 \times De)}{(1 \mp Qx \times De)}$

Qx Measured Q value
 De Relative D accuracy

1. When $Qx \times De \geq 1$, $Qe = \pm \infty$

θ accuracy

θ accuracy θ_e is given as:

Equation 11.
$$\theta_e = \frac{180 \times A_e}{\pi \times 100} \quad (\text{deg})$$

A_e Relative accuracies of |Z|, |Y|, L, C, R, X, G, and B

1. When Q_x × D_e ≥ 1, Q_e = ± ∞

G accuracy (when D_x ≤ 0.1)

G accuracy G_e is given as:

Equation 12.
$$G_e = B_x \times D_e \quad (\text{S})$$
$$B_x = 2\pi f C_x = \frac{1}{2\pi f L_x}$$

G_e Relative G accuracy

D_x Measured D value

B_x Measured B value

D_e Relative D accuracy

f Test frequency (Hz)

C_x Measured C value (F)

L_x Measured L value (H)

R_p accuracy (when D_x ≤ 0.1 and D_x > D_e)¹

R_p accuracy R_{pe} is given as:

Equation 13.
$$R_{pe} = \pm \frac{R_{px} \times D_e}{D_x \mp D_e} \quad (\Omega)$$

R_{pe} Relative R_p accuracy

R_{px} Measured R_p value (Ω)

D_x Measured D value

D_e Relative D accuracy

¹ When D_x ≤ D_a, R_p accuracy = ± ∞

Rs accuracy (when Dx ≤ 0.1)

Rs accuracy Rse is given as:

Equation 14. $Rse = Xx \times De$ (Ω)

$$Xx = \frac{1}{2\pi f Cx} = 2\pi f Lx$$

Rse Relative Rs accuracy

Dx Measured D value

Xx Measured X value (Ω)

De Relative D accuracy

f Test frequency (Hz)

Cx Measured C value (F)

Lx Measured L value (H)

Example of C-D accuracy calculation

Measurement conditions

Test frequency: 1 kHz

Measured C value: 100 nF

Test signal voltage: 1 Vrms

Measurement time mode: Medium

Measurement temperature: 23 °C

$$Ab = 0.05\%$$

$$|Zm| = 1 / (2\pi \times 1 \times 10^3 \times 100 \times 10^{-9}) = 1590 \Omega$$

$$Zs = 0.6 \text{ m}\Omega \times (1 + 0.400/1) \times (1 + \sqrt{(1000/1000)}) = 1.68 \text{ m}\Omega$$

$$Yo = 0.5 \text{ nS} \times (1 + 0.100/1) \times (1 + \sqrt{(100/1000)}) = 0.72 \text{ nS}$$

$$\text{C accuracy: } Ae = [0.05 + 1.68 \text{ m}/1590 \times 100 + 0.72 \text{ n} \times 1590 \times 100] \times 1 = 0.05\%$$

$$\text{D accuracy: } De = 0.05/100 = 0.0005$$

Basic Accuracy

Basic accuracy A_b is given from Table 12, 13, 14 and 15.

Table 12. Measurement time mode = SHORT

Test frequency [Hz]	Test signal voltage				
	5 mVrms $\leq - < 50$ mVrms	50 mVrms $\leq - < 0.3$ Vrms	0.3 Vrms $\leq - \leq 1$ Vrms	1 Vrms $< - \leq 10$ Vrms	10 Vrms $< - \leq 20$ Vrms
$20 \leq - < 125$	$(0.6\%) \times$ (50 mVrms/Vs)	0.60%	0.30%	0.30%	0.30%
$125 \leq - \leq 1$ M	$(0.2\%) \times$ (50 mVrms/Vs)	0.20%	0.10%	0.15%	0.15%
1 M $< - \leq 2$ M	$(0.4\%) \times$ (50 mVrms/Vs)	0.40%	0.20%	0.30%	0.30%

Table 13. Measurement time mode = MED, LONG

Test frequency [Hz]	Test signal voltage				
	5 mVrms $\leq - < 30$ mVrms	30 mVrms $\leq - < 0.3$ Vrms	0.3 Vrms $\leq - \leq 1$ Vrms	1 Vrms $< - \leq 10$ Vrms	10 Vrms $< - \leq 20$ Vrms
$20 \leq - < 100$	$(0.25\%) \times$ (30 mVrms/Vs)	0.25%	0.10%	0.15%	0.15%
$100 \leq - \leq 1$ M	$(0.1\%) \times$ (30 mVrms/Vs)	0.10%	0.05%	0.10%	0.15%
1 M $< - \leq 2$ M	$(0.2\%) \times$ (30 mVrms/Vs)	0.20%	0.10%	0.20%	0.30%

Vs [Vrms] Test signal voltage

Effect by impedance of DUT

Table 14. For impedance of DUT below 30 Ω , the following value is added.

Test frequency [Hz]	Impedance of DUT	
	$1.08 \Omega < Z_x < 30 \Omega$	$ Z_x \leq 1.08 \Omega$
$20 \leq - \leq 1$ M	0.05%	0.10%
1 M $< - \leq 2$ M	0.10%	0.20%

Table 15. For impedance of DUT over 9.2 k Ω , the following value is added.

Test frequency [Hz]	Impedance of DUT	
	$9.2 \text{ k}\Omega < Z_x < 92 \text{ k}\Omega$	$92 \text{ k}\Omega \leq Z_x $
$10 \text{ k} \leq - \leq 100 \text{ k}$	0%	0.05%
$100 \text{ k} < - \leq 1$ M	0.05%	0.05%
1 M $< - \leq 2$ M	0.10%	0.10%

Effect of cable extension

When the cable is extended, the following element is added per one meter.

$$0.015 \% \times (F_m/1 \text{ MHz})^2 \times (L_{\text{cable}})^2$$

F_m [Hz] Test frequency

L_{cable} [m] Cable length

Short offset Zs

Table 16. Impedance of DUT > 1.08 Ω

Test frequency [Hz]	Measurement time mode	
	SHORT	MED, LONG
20 – 2 M	$2.5 \text{ m}\Omega \times (1 + 0.400/V_s) \times (1 + \sqrt{(1000/F_m)})$	$0.6 \text{ m}\Omega \times (1 + 0.400/V_s) \times (1 + \sqrt{(1000/F_m)})$

Table 17. Impedance of DUT $\leq 1.08 \Omega$

Test frequency [Hz]	Measurement time mode	
	SHORT	MED, LONG
20 – 2 M	$1 \text{ m}\Omega \times (1 + 1/V_s) \times (1 + \sqrt{(1000/F_m)})$	$0.2 \text{ m}\Omega \times (1 + 1/V_s) \times (1 + \sqrt{(1000/F_m)})$

V_s [Vrms] Test signal voltage

F_m [Hz] Test frequency

Effect of cable extension (Short offset)

Table 18. When the cable is extended, the following value is added to Zs (independent of the measurement time mode).

Test frequency [Hz]	Cable length			
	0 m	1 m	2 m	4 m
$20 \leq - \leq 1 \text{ M}$	0	0.25 m Ω	0.5 m Ω	1 m Ω
$1 \text{ M} < - \leq 2 \text{ M}$	0	1 m Ω	2 m Ω	4 m Ω

Open offset Y_o

Table 19. Test signal voltage ≤ 2.0 Vrms

Test frequency [Hz]	Measurement time mode	
	SHORT	MED, LONG
$20 \leq - \leq 100$ k	$2 \text{ nS} \times (1 + 0.100/V_s) \times (1 + \sqrt{(100/F_m)})$	$0.5 \text{ nS} \times (1 + 0.100/V_s) \times (1 + \sqrt{(100/F_m)})$
$100 \text{ k} < - \leq 1$ M	$20 \text{ nS} \times (1 + 0.100/V_s)$	$5 \text{ nS} \times (1 + 0.100/V_s)$
$1 \text{ M} < - \leq 2$ M	$40 \text{ nS} \times (1 + 0.100/V_s)$	$10 \text{ nS} \times (1 + 0.100/V_s)$

Table 20. Test signal voltage > 2.0 Vrms

Test frequency [Hz]	Measurement time mode	
	SHORT	MED, LONG
$20 \leq - \leq 100$ k	$2 \text{ nS} \times (1 + 2/V_s) \times (1 + \sqrt{(100/F_m)})$	$0.5 \text{ nS} \times (1 + 2/V_s) \times (1 + \sqrt{(100/F_m)})$
$100 \text{ k} < - \leq 1$ M	$20 \text{ nS} \times (1 + 2/V_s)$	$5 \text{ nS} \times (1 + 2/V_s)$
$1 \text{ M} < - \leq 2$ M	$40 \text{ nS} \times (1 + 2/V_s)$	$10 \text{ nS} \times (1 + 2/V_s)$

V_s [Vrms] Test signal voltage

F_m [Hz] Test frequency

Note: The Open Offset may become three times greater in the ranges of 40 to 70 kHz and 80 to 100 kHz due to residual response.

Effect of cable length

Table 21. When the cable is extended, multiply Y_o by the following factor.

Test frequency [Hz]	Cable length			
	0 m	1 m	2 m	4 m
$100 \leq - \leq 100$ k	1	$1 + 5 \times F_m/1 \text{ MHz}$	$1 + 10 \times F_m/1 \text{ MHz}$	$1 + 20 \times F_m/1 \text{ MHz}$
$100 \leq - \leq 100$ k	1	$1 + 5 \times F_m/1 \text{ MHz}$	$1 + 10 \times F_m/1 \text{ MHz}$	$1 + 20 \times F_m/1 \text{ MHz}$
$100 \leq - \leq 100$ k	1	$1 + 5 \times F_m/1 \text{ MHz}$	$1 + 10 \times F_m/1 \text{ MHz}$	$1 + 20 \times F_m/1 \text{ MHz}$

F_m [Hz] Test frequency

Temperature factor K_t

Table 22. Temperature factor K_t .

Temperature [°C]	K_t
$0 \leq - < 18$	4
$18 \leq - \leq 28$	1
$28 < - \leq 55$	4

Calibration Accuracy Acal

Calibration accuracy Acal is given below. For impedance of DUT or test frequency on the boundary line, apply the smaller value.

Table 23. Impedance range = 0.1, 1, 10 Ω

Test frequency [Hz]						
	20 – 1 k	1 k – 10 k	10 k – 100 k	100 k – 300 k	300 k – 1 M	1 M – 2 M
Z [%]	0.03	0.05	0.05	$0.05 + 5 \times 10^{-5} F_m$	$0.05 + 5 \times 10^{-5} F_m$	$0.1 + 1 \times 10^{-4} F_m$
θ [radian]	1×10^{-4}	2×10^{-4}	3×10^{-4}	$3 \times 10^{-4} + 2 \times 10^{-7} F_m$	$3 \times 10^{-4} + 2 \times 10^{-7} F_m$	$6 \times 10^{-4} + 4 \times 10^{-7} F_m$

Table 24. Impedance range = 100 Ω

Test frequency [Hz]						
	20 – 1 k	1 k – 10 k	10 k – 100 k	100 k – 300 k	300 k – 1 M	1 M – 2 M
Z [%]	0.03	0.05	0.05	$0.05 + 5 \times 10^{-5} F_m$	$0.05 + 5 \times 10^{-5} F_m$	$0.1 + 1 \times 10^{-4} F_m$
θ [radian]	1×10^{-4}	2×10^{-4}	3×10^{-4}	3×10^{-4}	3×10^{-4}	6×10^{-4}

Table 25. Impedance range = 300, 1 k Ω

Test frequency [Hz]						
	20 – 1 k	1 k – 10 k	10 k – 100 k	100 k – 300 k	300 k – 1 M	1 M – 2 M
Z [%]	0.03	0.03	0.05	0.05	0.05	0.1
θ [radian]	1×10^{-4}	1×10^{-4}	3×10^{-4}	3×10^{-4}	3×10^{-4}	6×10^{-4}

Table 26. Impedance range = 3 k, 10 k Ω

Test frequency [Hz]						
	20 – 1 k	1 k – 10 k	10 k – 100 k	100 k – 300 k	300 k – 1 M	1 M – 2 M
Z [%]	$0.03 + 1 \times 10^{-4} F_m$	$0.03 + 1 \times 10^{-4} F_m$	$0.03 + 1 \times 10^{-4} F_m$	$0.03 + 1 \times 10^{-4} F_m$	$0.03 + 1 \times 10^{-4} F_m$	$0.06 + 2 \times 10^{-4} F_m$
θ [radian]	$(100 + 2.5 F_m) \times 10^{-6}$	$(100 + 2.5 F_m) \times 10^{-6}$	$(100 + 2.5 F_m) \times 10^{-6}$	$(100 + 2.5 F_m) \times 10^{-6}$	$(100 + 2.5 F_m) \times 10^{-6}$	$(200 + 5 F_m) \times 10^{-6}$

Table 27. Impedance range = 30 k, 100 k Ω

Test frequency [Hz]						
	20 – 1 k	1 k – 10 k	10 k – 100 k	100 k – 300 k	300 k – 1 M	1 M – 2 M
Z [%]	$0.03 + 1 \times 10^{-3} F_m$	$0.03 + 1 \times 10^{-3} F_m$	$0.03 + 1 \times 10^{-3} F_m$	$0.03 + 1 \times 10^{-3} F_m$	$0.03 + 1 \times 10^{-4} F_m$	$0.06 + 2 \times 10^{-4} F_m$
θ [radian]	$(100 + 20 F_m) \times 10^{-6}$	$(100 + 20 F_m) \times 10^{-6}$	$(100 + 20 F_m) \times 10^{-6}$	$(100 + 20 F_m) \times 10^{-6}$	$(100 + 2.5 F_m) \times 10^{-6}$	$(200 + 5 F_m) \times 10^{-6}$
Fm[kHz]	Test frequency					

Measurement accuracy

The impedance measurement calculation example below is the result of absolute measurement accuracy.

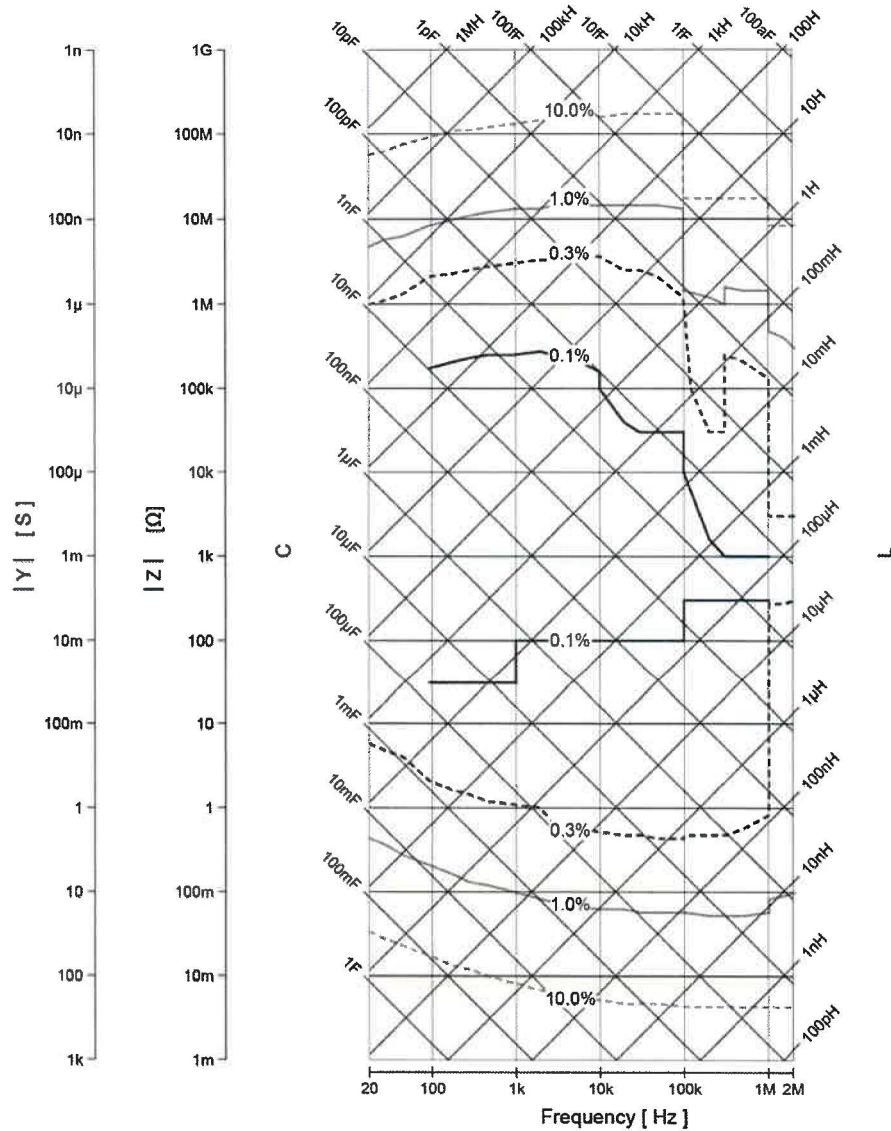


Figure 1. Impedance measurement accuracy (Test signal voltage = 1 Vrms, cable length = 0 m, measurement time mode = MED)

Compensation function

Table 28. The E4980B/E4980BL provides three types of compensation functions: OPEN compensation, SHORT compensation, and LOAD compensation.

Type of compensation	Description
OPEN compensation	Compensates errors caused by the stray admittance (C, G) of the test fixture.
SHORT compensation	Compensates errors caused by the residual impedance (L, R) of the test fixture.
LOAD compensation	Compensates errors between the actual measured value and a known standard value under the measurement conditions desired by the user.

List sweep

Points: There is a maximum of 201 points.

First sweep parameter (primary parameter): Test frequency, test signal voltage, test signal current, test signal voltage of DC bias signal, test signal current of DC bias signal, DC source voltage.

Second sweep parameter (secondary parameter): None, impedance range, test frequency, test signal voltage, test signal current, test signal voltage of DC bias signal, test signal current of DC bias signal, DC source voltage.

Note:

- A parameter selected for one of the two parameters cannot be selected for the other parameter. It is not possible to set up a combination of test signal voltage and test signal current or one of test signal voltage of DC bias signal and test signal current of DC bias.
- The secondary parameter can be set only with SCPI commands.

Trigger mode

Sequential mode: When the E4980B/E4980BL is triggered once, the device is measured at all sweep points. /EOM/INDEX is output only once.

Step mode: The sweep point is incremented each time the E4980B/E4980BL is triggered. /EOM/INDEX is output at each point, but the result of the comparator function of the list sweep is available only after the last /EOM is output.

Comparator function of list sweep: The comparator function enables setting one pair of lower and upper limits for each measurement point.

You can select from: Judge with the first sweep parameter/Judge with the second parameter/Not used for each pair of limits.

Time stamp function: In the sequential mode, it is possible to record the measurement starting time at each measurement point by defining the time when FW detects a trigger as 0 and obtain it later with the SCPI command.

Comparator function

Bin sort: The primary parameter can be sorted into 9 BINS, OUT_OF_BINS, AUX_BIN, and LOW_C_REJECT. The secondary parameter can be sorted into HIGH, IN, and LOW. The sequential mode and tolerance mode can be selected as the sorting mode.

Limit setup: Absolute value, deviation value, and % deviation value can be used for setup.

BIN count: Countable from 0 to 999999.

DC bias signal

Table 29. Test signal voltage

Range	0 V to +2 V
Resolution	0 V / 1.5 V / 2 V only
Accuracy	0.1% + 2 mV (23°C ± 5 °C) (0.1% + 2 mV) × 4 (0 to 18 °C or 28 to 55 °C)

Output impedance: 100 Ω (nominal)

Measurement assistance functions

Data buffer function: Up to 201 measurement results can be read out in a batch.

Save/Recall function:

- Up to 10 setup conditions can be written to/read from the built-in non-volatile memory.
- Up to 10 setup conditions can be written to/read from the USB memory.
- Auto recall function can be performed when the setting conditions are written to Register 10 of the USB memory.

Key lock function: The front panel keys can be locked.

GPIO: 24-pin D-Sub (Type D-24), female; complies with IEEE488.1, 2 and SCPI

USB host port: Universal serial bus jack, type-A (4 contact positions, contact 1 is on your left), female (for connection to USB memory only).

USB interface port: Universal serial bus jack, type mini-B (4 contact positions); complies with USBTMC-USB488 and USB 2.0; female; for connection to the external controller.

USBTMC: Abbreviation for USB Test & Measurement Class

LAN: 10/100 BaseT Ethernet, 8 pins (two speed options)

LXI Compliance: Class C (only applies to units with firmware revision A.02.00 or later)

Options

Frequency options

E4980B	20 Hz to 2 MHz
E4980BL-032	20 Hz to 300 kHz
E4980BL-052	20 Hz to 500 kHz
E4980BL-102	20 Hz to 1 MHz

Table 30. Installable options

Options	E4980B	E4980BL
Power and DC bias enhancement (001)	Installable	Not installable
Handler interface (201)	Installable	Installable
Scanner interface (301)	Installable	Installable

Interface options

- Option 201 (Handler interface)
 - Adds handler interface.
- Option 301 (Scanner interface): Adds scanner interface.
- Option 710 (No interface)
 - An option with no interface.
 - Up to 2 interface options can be installed in the interface connector on the rear panel.
- When no interface is installed, two of the option 710 are installed. When one interface is installed, the option number of its interface and one option 710 are installed.

Other options

Option 001 (Power and DC Bias enhancement): Increases test signal voltage and adds the variable DC bias voltage.

Power and DC bias enhancement specification

Increases test signal voltage and adds the variable DC bias voltage function. The Vdc-Idc measurement function is available when the option 001 is installed.

Measurement parameters

The following parameters can be used.

- Lp-Rdc
- Ls-Rdc
- Vdc-Idc

where

Rdc Direct-current resistance (DCR)

Vdc Direct-current voltage

Idc Direct-current electricity

Test signal

Signal level

Table 31. Test signal voltage

Range		0 Vrms to 20 Vrms (test frequency $\leq$ 1 MHz) 0 Vrms to 15 Vrms (test frequency $>$ 1 MHz)
Resolution		100 μ Vrms (0 Vrms $\leq$ $- \leq$ 0.2 Vrms) 200 μ Vrms (0.2 Vrms $< - \leq$ 0.5 Vrms) 500 μ Vrms (0.5 Vrms $< - \leq$ 1 Vrms) 1 mVrms (1 Vrms $< - \leq$ 2 Vrms) 2 mVrms (2 Vrms $< - \leq$ 5 Vrms) 5 mVrms (5 Vrms $< - \leq$ 10 Vrms) 10 mVrms (10 Vrms $< - \leq$ 20 Vrms)
Setup accuracy	Normal	$\pm$ (10% + 1 mVrms) (test signal voltage $\leq$ 2 Vrms) (test frequency $\leq$ 1 MHz: spec., test frequency $>$ 1 MHz: typ.)
	Constant ¹	$\pm$ (10% + 10 mVrms) (Test frequency $\leq$ 300 kHz, test signal voltage $>$ 2 Vrms) (spec.)

Table 32. Test signal voltage

Range		0 Arms - 100 mArms
Resolution		1 μ Arms (0 Arms $\leq - \leq$ 2 mArms) 2 μ Arms (2 mArms $< - \leq$ 5 mArms) 5 μ Arms (5 mArms $< - \leq$ 10 mArms) 10 μ Arms (10 mArms $< - \leq$ 20 mArms) 20 μ Arms (20 mArms $< - \leq$ 50 mArms) 50 μ Arms (50 mArms $< - \leq$ 100 mArms)
Setup accuracy	Normal	$\pm$ (10% + 10 μ Arms) (test signal current $\leq$ 20 mArms) (test frequency $\leq$ 1 MHz: spec., test frequency $>$ 1 MHz: typ.) $\pm$ (10% + 100 μ Arms) (test frequency $\leq$ 300 kHz, test signal current $>$ 20 mArms) (spec.) $\pm$ (15% + 200 μ Arms) (test frequency $>$ 300 kHz, test signal current $>$ 20 mArms) (test frequency $\leq$ 1 MHz: spec., test frequency $>$ 1 MHz: typ.)
	Constant ¹	$\pm$ (6% + 10 μ Arms) (test signal current $\leq$ 20 mArms) (test frequency $\leq$ 1 MHz: spec., test frequency $>$ 1 MHz: typ.) $\pm$ (6% + 100 μ Arms) (test frequency $\leq$ 300 kHz, test signal current $>$ 20 mArms) (spec.) $\pm$ (12% + 200 μ Arms) (test frequency $>$ 300 kHz, test signal current $>$ 20 mArms) (test frequency $\leq$ 1 MHz: spec., test frequency $>$ 1 MHz: typ.)

1. When auto level control function is on and no warning message is displayed.

Test signal level monitor function

- Test signal voltage and test signal current can be monitored.
- Level monitor accuracy:

Table 33. Test signal voltage monitor accuracy (Vac)

Test signal voltage ²	Test frequency	Specification
5 mVrms to 2 Vrms	≤ 1 MHz	± (3% of reading value + 0.5 mVrms)
	> 1MHz	± (6% of reading value + 1 mVrms)
> 2 Vrms	≤ 300 kHz	± (3% of reading value + 5 mVrms)
	> 300 kHz	± (6% of reading value + 10 mVrms) ³

1. When auto level control function is on and no warning message is displayed.
 2. This is not an output value but a displayed test signal level.
 3. Typ. when test frequency is > 1 MHz with test signal voltage > 10 Vrms.

Table 34. Test signal current monitor accuracy (Iac)

Test signal voltage ²	Test Frequency	Specification
50 μ Arms to 20 mArms	≤ 1 MHz	± (3% of reading value + 5 μ Arms)
	> 1MHz	± (6% of reading value + 10 μ Arms)
> 20 mArms	≤ 300 kHz	± (3% of reading value + 50 μ Arms)
	> 300 kHz	± (6% of reading value + 100 μ Arms)

DC bias signal

Table 35. Test signal voltage

Range	-40 V to +40 V	
Resolution	Setup resolution: 100 μ V, effective resolution: • 330 μ V $\pm$ (0 V $\leq$ - $\leq$ 5 V) • 1 mV $\pm$ (5 V < - $\leq$ 10 V) • 2 mV $\pm$ (10 V < - $\leq$ 20 V) • 5 mV $\pm$ (20 V < - $\leq$ 40 V)	
Accuracy	Test signal voltage $\leq$ 2 Vrms	0.1% + 2 mV (23 °C $\pm$ 5 °C) (0.1% + 2 mV) $\times$ 4 (0 to 18 °C or 28 to 55 °C)
	Test signal voltage > 2 Vrms ²	0.1 % + 4 mV (23 °C $\pm$ 5 °C) (0.1% + 4 mV) $\times$ 4 (0 to 18 °C or 28 to 55 °C)

Table 36. Test signal current

Range	-100 mA - 100 mA	
Resolution	Setup resolution: 1 μ A, effective resolution: • 3.3 μ A $\pm$ (0 A $\leq$ - $\leq$ 50 mA) • 10 μ A $\pm$ (50 mA < - $\leq$ 100 mA)	

1. This is not an output value but a displayed test signal level
 2. Nominal when test frequency is >1 MHz or test signal voltage is >10 Vrms.

DC bias voltage level monitor Vdc

$(0.5\% \text{ of reading value} + 60 \text{ mV}) \times Kt$

When using Vdc-Idc measurement: (spec.)

When using level monitor: (typ.)

Kt Temperature coefficient

DC bias current level monitor Idc

$(A [\%] \text{ of the measurement value} + B [A]) \times Kt$

When using Vdc-Idc measurement: (spec.)

When using level monitor: (typ.)

A [%] When the measurement time mode is SHORT: 2%

When the measurement time mode is MED or LONG: 1%

B [A] given below

Kt Temperature coefficient

When the measurement mode is SHORT, double the following value.

Table 37. Test signal voltage ≤ 0.2 Vrms (measurement time mode = MED, LONG)

DC bias current range	Impedance range [Ω]				
	< 100	100	300, 1 k	3 k, 10 k	30 k, 100 k
20 μ A	150 μ A	30 μ A	3 μ A	300 nA	45 nA
200 μ A	150 μ A	30 μ A	3 μ A	300 nA	300 nA
2 mA	150 μ A	30 μ A	3 μ A	3 μ A	3 μ A
20 mA	150 μ A	30 μ A	30 μ A	30 μ A	30 μ A
100 mA	150 μ A	150 μ A	150 μ A	150 μ A	150 μ A

Table 38. 0.2 Vrms < test signal voltage ≤ 2 Vrms (measurement time mode = MED, LONG)

DC bias current range	Impedance range [Ω]				
	< 100	100, 300	1k, 3 k	10k, 30 k	100 k
20 μ A	150 μ A	30 μ A	3 μ A	300 nA	45 nA
200 μ A	150 μ A	30 μ A	3 μ A	300 nA	300 nA
2 mA	150 μ A	30 μ A	3 μ A	3 μ A	3 μ A
20 mA	150 μ A	30 μ A	30 μ A	30 μ A	30 μ A
100 mA	150 μ A	150 μ A	150 μ A	150 μ A	150 μ A

Table 39. Test signal voltage > 2 Vrms (measurement time mode = MED, LONG)

DC bias current range	Impedance range [Ω]			
	≤ 300	1 k, 3 k	10k, 30 k	100 k
20 μ A	150 μ A	30 μ A	3 μ A	300 nA
200 μ A	150 μ A	30 μ A	3 μ A	300 nA
2 mA	150 μ A	30 μ A	3 μ A	3 μ A
20 mA	150 μ A	30 μ A	30 μ A	30 μ A
100 mA	150 μ A	150 μ A	150 μ A	150 μ A

Table 40. Input impedance (nominal)

Input impedance	Conditions
0 Ω	Other than conditions below.
20 Ω	Test signal voltage ≤ 0.2 Vrms, Impedance range ≥ 3 k Ω , DC bias current range ≤ 200 μ A
	Test signal voltage ≤ 2 Vrms, Impedance range ≥ 10 k Ω , DC bias current range ≤ 200 μ A
	Test signal voltage > 2 Vrms, Impedance range = 100 k Ω , DC bias current range ≤ 200 μ A

DC source signal

Table 41. Test signal voltage

Range	–10 V to 10 V
Resolution	1 mV
Accuracy	0.1% + 3 mV (23 °C $\pm$ 5 °C) (0.1% + 3 mV) $\times$ 4 (0 to 18 °C or 28 to 55 °C)

Table 42. Test signal voltage

Range	–45 mA to 45 mA (nominal)
-------	---------------------------

Output impedance: 100 Ω (nominal)

DCR measurement specification

DC resistance (R_{dc}) accuracy

Absolute measurement accuracy A_a

Absolute measurement accuracy A_a is given as

Equation 15. $A_a = A_e + A_{cal}$

A_a Absolute accuracy (% of reading value)

A_e Relative accuracy (% of reading value)

A_{cal} Calibration accuracy

Relative measurement accuracy A_e

Relative measurement accuracy A_e is given as

Equation 16. $A_e = [A_b + (R_s / R_m) + G_o \times |R_m| \times 100] \times K_t$

R_m Measurement value

A_b Basic accuracy

R_s Short offset [Ω]

G_o Open offset [S]

K_t Temperature coefficient

Calibration accuracy A_{cal}

Calibration accuracy A_{cal} is 0.03%.

Basic accuracy A_b

Table 43. Basic accuracy A_b.

Measurement time mode	Test signal voltage	
	≤ 2 Vrms	> 2 Vrms
SHORT	1.00%	2.00%
MED	0.30%	0.60%

Open offset Go

Table 44. Open offset Go.

Measurement time mode	Test signal voltage	
	$\leq 2 \text{ Vrms}$	$> 2 \text{ Vrms}$
SHORT	50 nS	500 nS
MED	10 nS	100 nS

Short offset Rs

Table 45. Short offset Rs.

Measurement time mode	Test signal voltage	
	$\leq 2 \text{ Vrms}$	$> 2 \text{ Vrms}$
SHORT	25 m Ω	250 m Ω
MED	5 m Ω	50 m Ω

Effect of cable length (Short offset)

Table 46. Values added to Rs when the cable is extended.

Cable length		
1 m	2 m	4 m
0.25 m Ω	0.5 m Ω	1 m Ω

Temperature coefficient Kt

Table 47. Temperature coefficient Kt.

Temperature [°C]	Kt
$0 \leq - < 18$	4
$18 \leq - \leq 28$	1
$28 < - \leq 55$	4

General Specifications

Table 48. Power source

Rated voltage	100 – 240 VAC
Voltage range	90 – 264 VAC
Rated frequency	50 / 60 Hz
Frequency range	47 – 63 Hz
Power consumption	Max. 150 VA

Table 49. Operating environment

Temperature	0 – 55 °C
Humidity (≤ 40 °C, no condensation)	15% – 85% RH
Altitude	0 m – 2000 m

Table 50. Storage environment

Temperature	-20 – 70 °C
Humidity (≤ 60 °C, no condensation)	0% – 90% RH
Altitude	0 m – 4572 m

Outer dimensions: 375 (width) x 105 (height) x 390 (depth) mm (nominal)

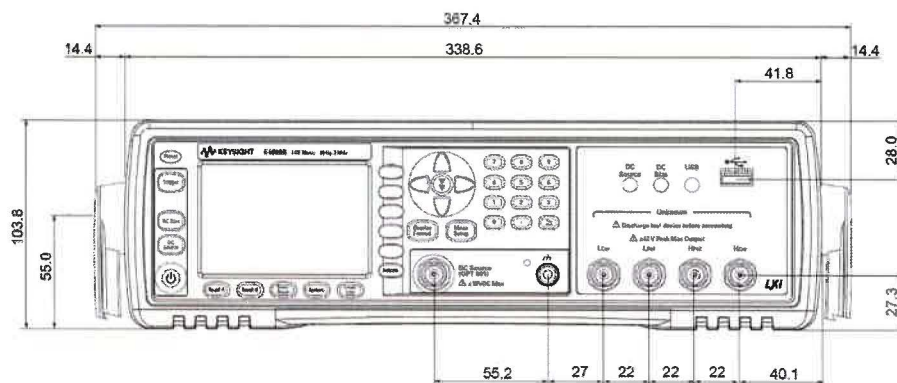


Figure 2. Dimensions (front view, with handle and bumper, in millimeters, nominal)

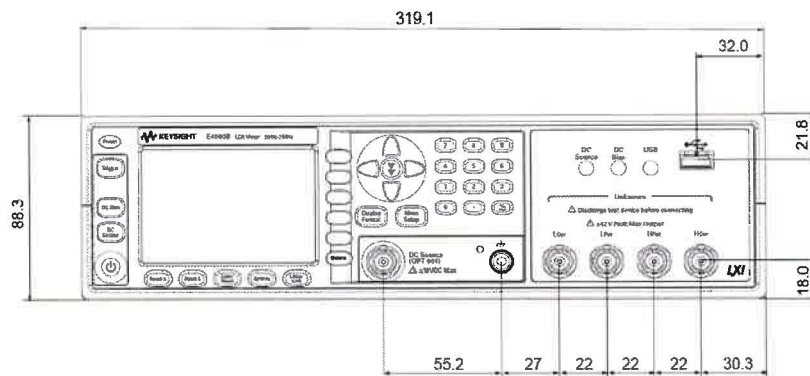


Figure 3. Dimensions (front view, without handle and bumper, in millimeters, nominal)

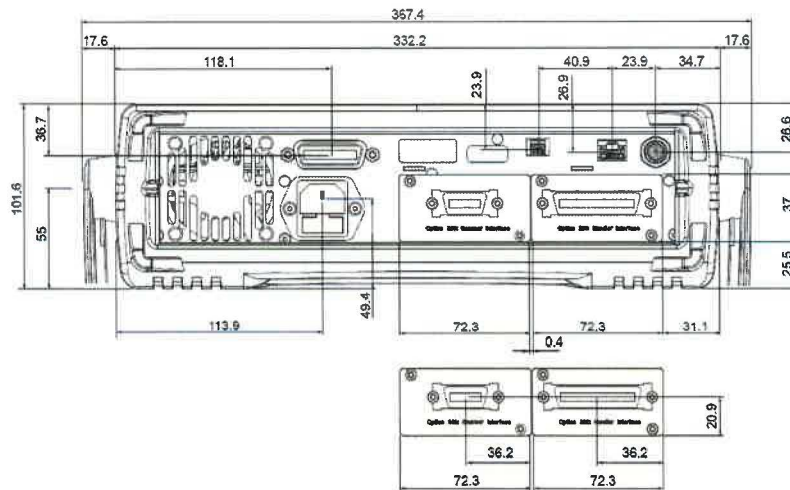


Figure 4. Dimensions (rear view, with handle and bumper, in millimeters, nominal)

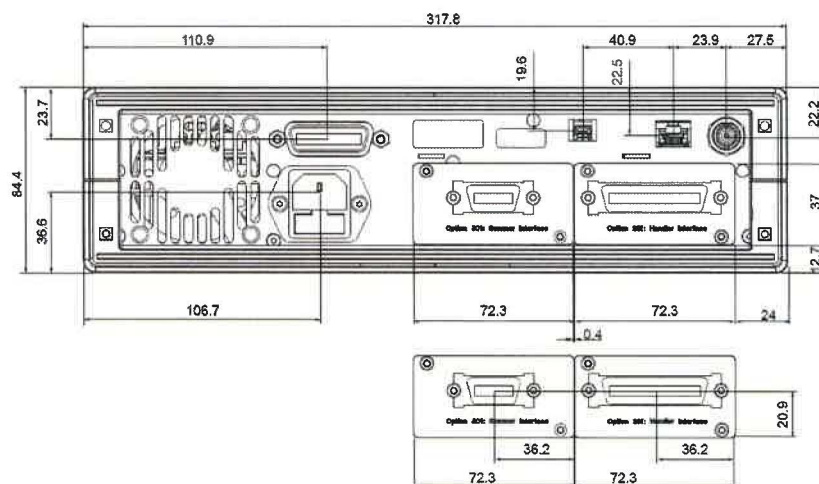


Figure 5. Dimensions (rear view, with handle and bumper, in millimeters, nominal)

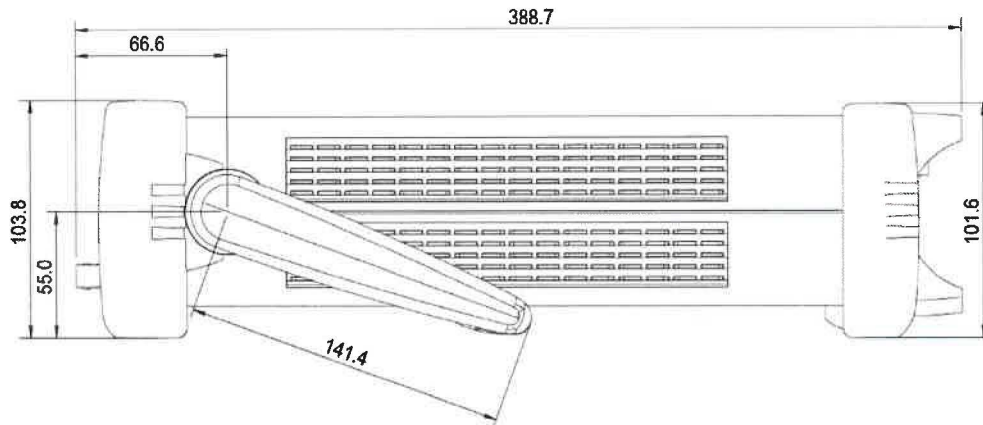


Figure 6. Dimensions (side view, with handle and bumper, in millimeters, nominal)

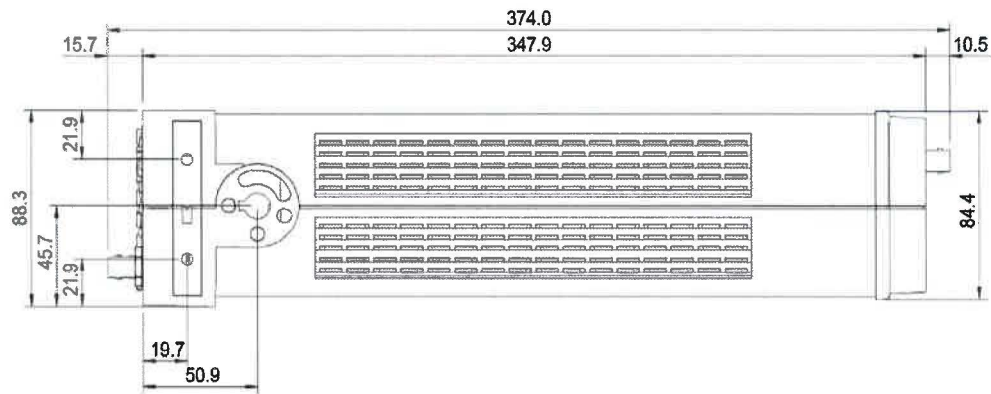


Figure 7. Dimensions (side view, without handle and bumper, in millimeters, nominal)

Weight: 4.9 kg (without Front, Rear Bumper, and Handle)

5.8 kg (with Front, Rear Bumper, and Handle)

Display: LCD, 320 × 240 (pixels), RGB color

Note: Effective pixels are more than 99.99%. There may be 0.01% (approx. 7 pixels) or smaller missing pixels or constantly lit pixels, but this is not a malfunction.

The following items can be displayed:

- Measurement value
- Measurement conditions
- Limit value and judgment result of comparator
- List sweep table
- Self-test message

EMC ¹

Complies with the essential requirements of the European EMC Directive as well as current editions of the following standards (dates and editions are cited in the Declaration of Conformity).



The CE mark is a registered trademark of the European Community (if accompanied by a year, it is the year when the design was proven). This product complies with all relevant directives.

- IEC 61326-1
- CISPR 11 Group 1, Class A



UK conformity mark is a UK government owned mark. When affixed to the product is declaring all applicable Directives and Regulations have been met in full.

CAN ICES/NMB-001(A)

This ISM device complies with Canadian ICES-001.
Cet appareil ISM est conforme a la norme NMB du Canada.



The RCM mark is a registered trademark of the Australian Communications and Media Authority.

- AS/NZS CISPR 11



South Korean Certification (KC) mark; includes the marking's identifier code: R-R-Kst-xxxxxxx

South Korean Class A EMC declaration:

Information to the user:

This equipment has been conformity assessed for use in business environments. In a residential environment this equipment may cause radio interference.

※ This EMC statement applies to the equipment only for use in business environment.

사용자 안내문

이 기기는 업무용 환경에서 사용할 목적으로 적합성평가를 받은 기기로서 가정용 환경에서 사용하는 경우 전파간섭의 우려가 있습니다.

※ 사용자 안내문은 “업무용 방송통신기자재”에만 적용한다.

Safety ¹

Complies with the essential requirements of the European Low Voltage Directive as well as current editions of the following standards (dates and editions are cited in the Declaration of Conformity).

This product is designed for use in INSTALLATION CATEGORY II and POLLUTION DEGREE 2 and MEASUREMENT CATEGORY NONE per IEC standards.

This product is intended for indoor use.



IEC/EN 61010-1



The CSA mark is a registered trademark of the CSA International.

- Canada: CSA C22.2 No. 610610-1
- USA: UL std no. 61010-1

To find a current Declaration of Conformity for a specific Keysight product, go to:

<http://www.keysight.com/go/conformity>.

Environment



This product complies with the WEEE Directive (2002/96/EC) marking requirements. The affixed label indicates that you must not discard this electrical/electronic product in domestic household waste.

Product Category: With reference to the equipment types in the WEEE Directive Annex I, this product is classed as a "Monitoring and Control Instrumentation" product.

Supplemental Information

Settling time

Table 51. Test frequency setting time

Test frequency setting time	Test frequency (Fm)
5 ms	$F_m \geq 1 \text{ kHz}$
12 ms	$1 \text{ kHz} > F_m \geq 250 \text{ Hz}$
22 ms	$250 \text{ Hz} > F_m \geq 60 \text{ Hz}$
42 ms	$60 \text{ Hz} > F_m$

Table 52. Test frequency setting time

Test signal voltage setting time	Test frequency (Fm)
11 ms	$F_m \geq 1 \text{ kHz}$
18 ms	$1 \text{ kHz} > F_m \geq 250 \text{ Hz}$
26 ms	$250 \text{ Hz} > F_m \geq 60 \text{ Hz}$
48 ms	$60 \text{ Hz} > F_m$

Switching of the impedance range is as follows: $\leq 5 \text{ ms}$ / range switching

Measurement circuit protection

The maximum discharge withstand voltage, where the internal circuit remains protected if a charged capacitor is connected to the UNKNOWN terminal, is given below.

Table 53. Maximum discharge withstand voltage

Maximum discharge withstand voltage	Range of capacitance value C of DUT
1000 V	$C < 2 \mu\text{F}$
$\sqrt{2/c} * V$	$2 \mu\text{F} \leq C$

Note: Discharge capacitors before connecting them to the UNKNOWN terminal or a test fixture to avoid damages to the instrument.

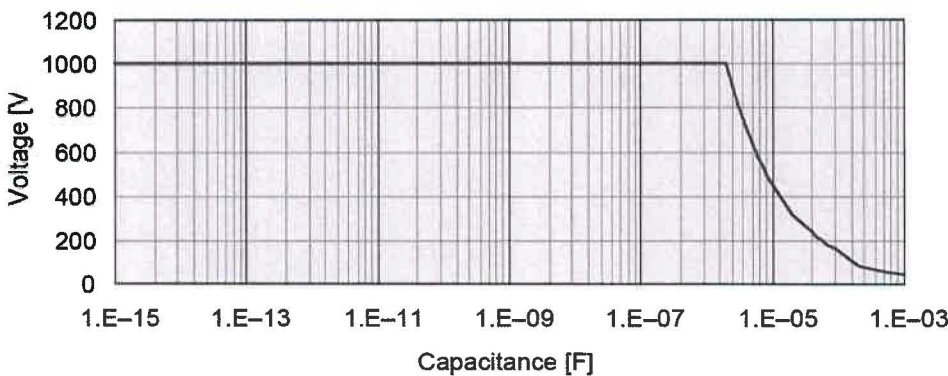


Figure 8. Maximum discharge withstand voltage

Measurement time

Definition

This is the time between the trigger and the end of measurement (EOM) output on the handler interface.

Conditions

Tables 54 and 55 show the measurement time when the following conditions are satisfied:

- Normal impedance measurement other than Ls-Rdc, Lp-Rdc, Vdc-Idc
- Impedance range mode: hold range mode
- DC bias voltage level monitor: OFF
- DC bias current level monitor: OFF
- Trigger delay: 0 s
- Step delay: 0 s
- Calibration data: OFF
- Display mode: blank

Table 54. E4980B measurement time [ms] (DC bias: OFF)

Measurement time mode		Test frequency						
		20 Hz	100 Hz	1 kHz	10 kHz	100 kHz	1 MHz	2 MHz
1	LONG	480	300	240	230	220	220	220
2	MED	380	180	110	92	89	88	88
3	SHORT	330	100	20	7.7	5.7	5.6	5.6

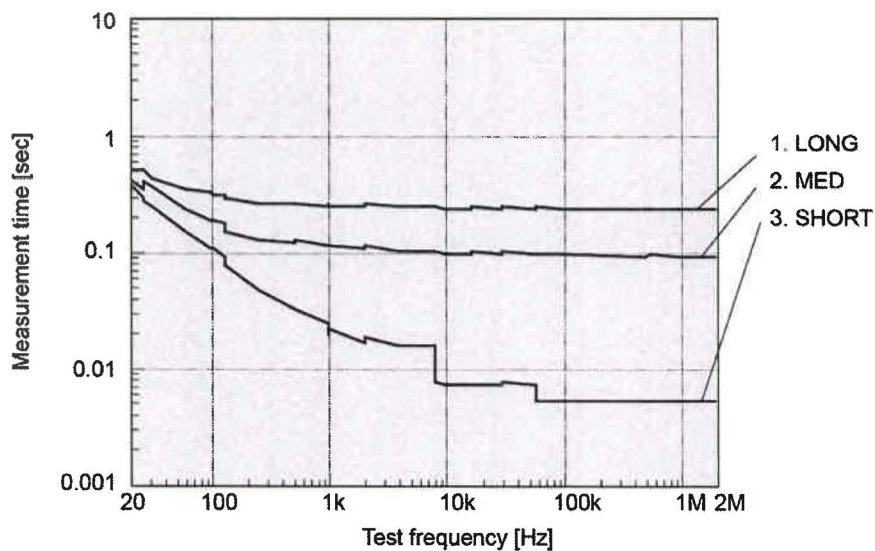


Figure 9. Measurement time (E4980B, DC bias: OFF)

Table 55. E4980BL measurement time [ms] (DC bias: OFF)

Measurement time mode		Test frequency					
		20 Hz	100 Hz	1 kHz	10 kHz	100 kHz	1 MHz
1	LONG	729	423	363	353	343	343
2	MED	650	250	140	122	119	118
3	SHORT	579	149	26	14	12	12

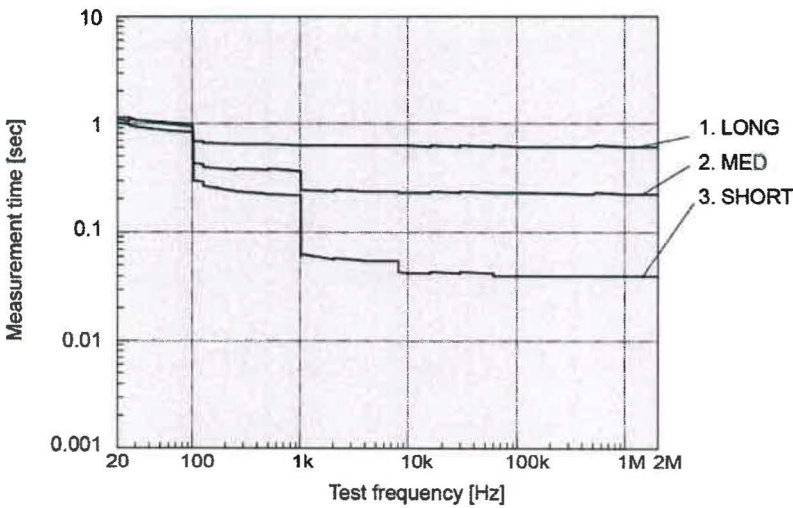


Figure 10. Measurement time (E4980BL)

When DC bias is ON, the following time is added:

Table 56. Additional time when DC bias is ON [ms]

Test frequency						
20 Hz	100 Hz	1 kHz	10 kHz	100 kHz	1 MHz	2 MHz
30	30	10	13	2	0.5	0.5

When the number of averaging increases, the measurement time is given as

Equation 17. $MeasTime + (Ave - 1) \times AveTime$

MeasTime Measurement time calculated based on Table 54, 55 and 56

Ave Number of averaging

AveTime Refer to Table 57

Table 57. Additional time per averaging [ms]

Measurement time mode	Test frequency						
	20 Hz	100 Hz	1 kHz	10 kHz	100 kHz	1 MHz	2 MHz
SHORT	51	11	2.4	2.3	2.3	2.2	2.2
MED	110	81	88	87	85	84	84
LONG	210	210	220	220	220	210	210

Table 58. Measurement time when Vdc-Idc is selected [ms]

Measurement time mode	Test frequency						
	20 Hz	100 Hz	1 kHz	10 kHz	100 kHz	1 MHz	2 MHz
SHORT	210	46	14	14	14	14	14
MED	210	170	170	170	170	170	170
LONG	410	410	410	410	410	410	410

Add the same measurement time per 1 additional average.

Additional Measurement time when the Vdc and Idc monitor function is ON. Add SHORT mode of Table 58. When using only Vdc or Idc, add a half of SHORT mode of Table 58.

Table 59. Measurement time when Ls-Rdc or Lp-Rdc is selected [ms]

Measurement time mode	Test frequency						
	20 Hz	100 Hz	1 kHz	10 kHz	100 kHz	1 MHz	2 MHz
SHORT	910	230	43	24	22	22	22
MED	1100	450	300	280	270	270	270
LONG	1400	820	700	670	660	650	650

Add the three times of Table 57 Additional Time per 1 additional average number.

Display time

Except for the case of the DISPLAY BLANK page, the time required to update the display on each page (display time) is as follows. When a screen is changed, drawing time and switching time are added. The measurement display is updated about every 100 ms.

Table 60. Display time

Item	When Vdc, Idc monitor is OFF	When Vdc, Idc monitor is ON
MEAS DISPLAY page drawing time	10 ms	13 ms
MEAS DISPLAY page (large) drawing time	10 ms	13 ms
BIN No. DISPLAY page drawing time	10 ms	13 ms
BIN COUNT DISPLAY page drawing time	10 ms	13 ms
LIST SWEEP DISPLAY page drawing time	40 ms	—
Measurement display switching time	35 ms	—

Measurement data transfer time

This table shows the measurement data transfer time under the following conditions. The measurement data transfer time varies depending on measurement conditions and computers.

Table 61. Measurement transfer time under the following conditions

Host computer	HP Z440 Workstation, Xeon CPU E5-1620 0 v3 @3.50 GHz
OS	Windows 10 Enterprise, Version 22H2
Display	OFF
Impedance range mode	AUTO (The overload has not been generated.)
OPEN/SHORT/LOAD compensation	OFF
Test signal voltage monitor	OFF

Table 62. Measurement data transfer time [ms]

Interface	Data transfer format	Using: FETC? command (one point measurement)			Using data buffer memory (list sweep measurement)		
		Comparator ON	Comparator OFF	10 points	51 points	128 points	201 points
GPIB	ASCII	1	1	3	7	16	27
	ASCII Long	2	1	3	9	21	33
	Binary	2	2	3	7	15	24
USB	ASCII	1	1	1	2	4	5
	ASCII Long	1	1	1	2	4	6
	Binary	2	2	3	3	3	3
LAN	ASCII	3	3	3	4	8	11
	ASCII Long	3	3	3	6	9	13
	Binary	7	8	8	8	9	9

DC bias test signal current (1.5 V/2.0 V)

Output current: Max. 20 mA

Option 001 (Power and DC Bias enhance): DC bias voltage: DC bias voltage applied to DUT is given as:

Equation 18. $V_{dut} = V_b - 100 \times I_b$

V_{dut} [V] DC bias voltage

V_b [V] DC bias setting voltage

I_b [A] DC bias current

DC bias current: DC bias current applied to DUT is given as:

Equation 19. $I_{dut} = V_b / (100 + R_{dc})$

I_{dut} [A] DC bias current

V_b [V] DC bias setting voltage

R_{dc} [Ω] DUT's DC resistance

Maximum DC bias current

Table 63. Maximum DC bias current when the normal measurement can be performed.

Impedance range [Ω]	Bias current isolation		
	ON	OFF	
		Test signal voltage ≤ 2 Vrms	Test signal voltage > 2 Vrms
0.1	Auto range mode: 100 mA	20 mA	100 mA
1		20 mA	100 mA
10		20 mA	100 mA
100	Hold range mode: its values for the range.	20 mA	100 mA
300		2 mA	100 mA
1 k		2 mA	20 mA
3 k		200 μ A	20 mA
10 k		200 μ A	2 mA
30 k		20 μ A	2 mA
100 k		20 μ A	200 μ A

When DC bias is applied to the DUT, add the following value to the absolute accuracy Ab.

Table 64. Only when $F_m < 10 \text{ kHz}$ and $|V_{dc}| > 5 \text{ V}$

SHORT		MED, LONG	
$0.05\% \times (100 \text{ mV/Vs}) \times (1 + \sqrt{(100/F_m)})$		$0.01\% \times (100 \text{ mV/Vs}) \times (1 + \sqrt{(100/F_m)})$	
F_m [Hz]	Test frequency		
V_s [V]	Test signal voltage		

Relative measurement accuracy with bias current isolation

When DC bias Isolation is set to ON, add the following value to the open offset Y_o .

Equation 20. $Y_{o_DCI1} \times (1 + 1/(V_s)) \times (1 + \sqrt{(500/F_m)}) + Y_{o_DCI2}$

Z_m [Ω]	Impedance of DUT
F_m [Hz]	Test frequency
V_s [V]	Test signal voltage
$Y_{o_DCI1,2}$ [S]	Calculate this by using Table 65 and 66
I_{dc} [A]	DC bias isolation current

Table 65. Y_{o_DCI1} value

DC bias current range	Measurement time mode	
	SHORT	MED, LONG
20 μA	0 S	0 S
200 μA	0.25 nS	0.05 nS
2 mA	2.5 nS	0.5 nS
20 mA	25 nS	5 nS
100 mA	250 nS	50 nS

Table 66. Y_{o_DCI2} value

DC bias current range	Measurement time mode			
	$\leq 100 \Omega$	300 Ω , 1 k	3 k Ω , 10	30 k Ω , 100 k Ω
20 μA	0 S	0 S	0 S	0 S
200 μA	0.25 nS	0.05 nS	0 S	0 S
2 mA	2.5 nS	0.5 nS	0 S	3 nS
20 mA	25 nS	5 nS	30 nS	30 nS
100 mA	250 nS	50 nS	300 nS	300 nS

DC bias settling time

When DC bias is set to ON, add the following value to the settling time:

Table 67. DC bias settling time

	Bias	Settling time
1	Standard	Capacitance of DUT × 100 × loge (2/1.8 m) + 3 m
2	Option 001	Capacitance of DUT × 100 × loge (40/1.8 m) + 3 m

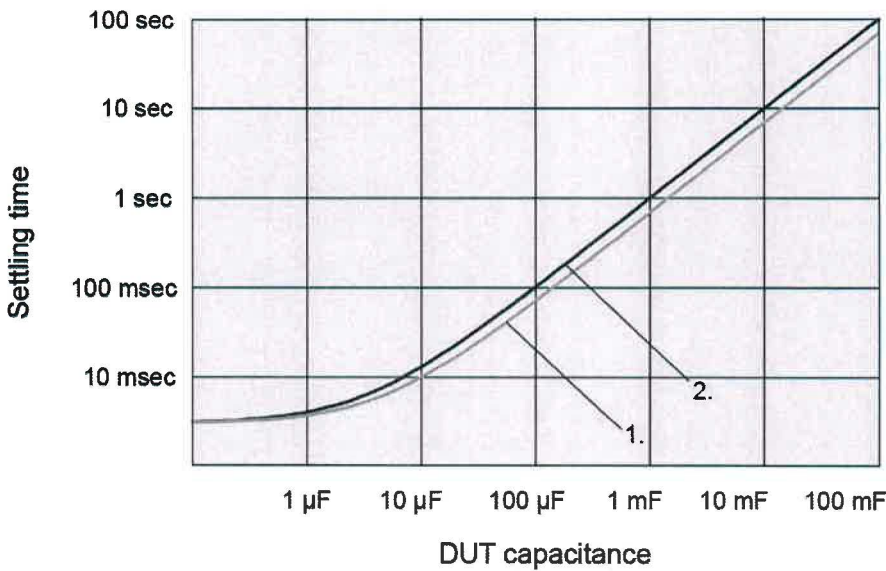


Figure 11. DC bias settling time

Web Resources

Visit our Web sites for additional product information and literature.

- E4980B Precision LCR Meter www.keysight.com/find/E4980B
- E4980BL Precision LCR Meter www.keysight.com/find/E4980BL
- LCR Meters & Impedance Measurement Products www.keysight.com/find/impedance
- RF & MW test accessories www.keysight.com/find/mta



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Annex 3

Affidavit according to § 6 paragraph 4 of the Act No. 134/2016 Coll.

Public Contract name:	Precision LCR meters
-----------------------	-----------------------------

Bidder / Supplier

Registered company name / Trade name / Name:	H TEST a.s.
Registered Office:	Na Hřebenkách 1206/25, 150 00 Praha 5, Czech Republic
(Company) Identification No.:	25784480

The Supplier of the above-mentioned Public Contract undertakes to:

- a) ensure compliance with all labour law regulations (concerning remuneration, working hours, rest periods between shifts, paid overtime), as well as regulations concerning employment and safety and health protection for the entire duration of the contractual relationship established on the basis of this Public Contract, to all persons involved in the performance of the contract (regardless of whether the activities will be performed by the Supplier himself or his subcontractors) and
- b) ensure compliance with legal regulations in the field of environmental law, which meets the objectives of environmental policy related to climate change, use of resources and sustainable consumption and production. The Supplier must therefore take all measures that can reasonably be required of him to protect the environment and reduce the damage caused by pollution, noise and other activities, and must ensure that emissions, soil pollution and waste water from his activities do not exceed the values laid down in the relevant legislation.

At the same time, the Supplier acknowledges that a breach of the above obligations may be a reason for the Contracting Authority to withdraw from the Purchase Contract in accordance with its relevant provisions.

Signature of the person authorized to represent the Supplier:	
Place:	Prague
First name, Surname, Position in the company:	Ing. Václav Haasz, Chairman of the Board
Signature:	

