40/1741/NP

NEW WORK ITEM PROPOSAL

Proposer Japan	Date of proposal April 2006
TC/SC TC40	Secretariat Netherlands
Date of circulation 2006-04-14	Closing date for voting 2006-07-14

A proposal for a new work item within the scope of an existing technical committee or subcommittee shall be submitted to the Central Office. The proposal will be distributed to the P-members of the technical committee or subcommittee for voting, and to the O-members for information. The proposer may be a National Committee of the IEC, the secretariat itself, another technical committee or subcommittee, an organization in liaison, the Standardization Management Board or one of the advisory committees, or the General Secretary. Guidelines for proposing and justifying a new work item are given in ISO/IEC Directives, Part 1, Annex C (see extract overleaf). **This form is not to be used for amendments or revisions to existing publications.**

The proposal (to be completed by the proposer)

Title of proposal
Low ESL measuring method on capacitors with lead terminal for use in electrical and electronic equipment

☒ Standard ☐ Technical Specification ☐ Publicly Available Specification

Scope (as defined in ISO/IEC Directives, Part 2, 6.2.1)
This standard provides a low ESL measuring method of a lead terminal type capacitor use in electrical and electronic equipment.
This method is applicable to only capacitor with lead terminal spacing of 3,5 mm and 5,0 mm on reason such as a measurement jig.

Purpose and justification, including the market relevance and relationship to Safety (Guide 104), EMC (Guide 107), Environmental aspects (Guide 109) and Quality assurance (Guide 102) . (attach a separate page as annex, if necessary)
The operation speed of central processing unit (CPU) of IT apparatus including a personal computer becomes much faster like anything. Lager and more stable electric power are needed to drive CPU with speed upped CPU operation. The power supply circuit that consisted of a DC-DC converter, choke coils, capacitors, etc. is bearing the supply. In this type of CPU, while drive voltage fell, the permission voltage variation range is narrowed.
For this reason, it is necessary to suppress the voltage variation applied to this CPU to the minimum, and, high-speed correspondence is called for a power supply circuit as well as CPU. Now, the high-speed correspondence reaches a nano second level.
Although the capacitor which has the low ESR (equivalent series resistance) characteristic in this power supply circuit use has been called for from the former, the capacitor of low loss in which frequency has the characteristic of further low ESR in the high frequency domain of MHz is called for by improvement in the speed. Since such a high frequency domain turns into a domain of an inductance for a capacitor, the capacitor of low ESL (equivalent series inductance) is called for.
On the other hand, in order to have measured the low ESL characteristic of a very small capacitor in this frequency domain, it is beyond the guarantee limit of a measuring instrument, and it turned out by the conventional measuring method that it cannot respond.

Target date	for first CD 2006-08	for IS 2007.12
Estimated number of meetings	Frequency of meetings: per year	Date and place of first meeting: 2006-05, Korea
Proposed working methods	☒ E-mail	☐ ftp

Relevant documents to be considered
IEC 60384-1

Relationship of project to activities of other international bodies

Liaison organizations | **Need for coordination within ISO or IEC**

Preparatory work Ensure that all copyright issues are identified. Check one of the two following boxes ☒ A draft is attached for comment ☐ An outline is attached We nominate a project leader as follows in accordance with ISO/IEC Directives, Part 1, 2.3.4 (name, address, fax and e-mail): Name: Hiroyuki Omura, Address: 6-4,Osaki 5-Chome, Sinagawa-ku, Tokyo 141-8605,Japan, Fax: +81-3-5436-7513, E-mail: omu@nippon,chemi-con.co.jp

Concerns known patented items (see ISO/IEC Directives, Part 2) ☐ yes If yes, provide full information as an annex ☒ no	**Name and/or signature of the proposer** Takanori Kondo	
Comments and recommendations from the TC/SC officers		
1) Work allocation ☒ Project team	☐ New working group	☐ Existing working group no:
2) Draft suitable for direct submission as ☒ CD	☐ CDV	☐ Publication as a PAS
3) General quality of the draft (conformity to ISO/IEC Directives, Part 2) ☒ Little redrafting needed	☐ Substantial redrafting needed	☐ no draft (outline only)
4) Relationship with other activities In IEC In other organizations		
Remarks from the TC/SC officers The TC40 Secretariat fully supports this NP, which was announced by the JNC during the IEC TC40 meeting in May 2005 in Delft, Netherlands.		

Elements to be clarified when proposing a new work item

Title

Indicate the subject matter of the proposed new standard.

Indicate whether it is intended to prepare a standard, a technical report or an amendment to an existing standard.

Scope

Give a clear indication of the coverage of the proposed new work item and, if necessary for clarity, exclusions.

Indicate whether the subject proposed relates to one or more of the fields of safety, EMC, the environment or quality assurance.

Purpose and justification

Give details based on a critical study of the following elements wherever practicable.

a) The specific aims and reason for the standardization activity, with particular emphasis on the aspects of standardization to be covered, the problems it is expected to solve or the difficulties it is intended to overcome.

b) The main interests that might benefit from or be affected by the activity, such as industry, consumers, trade, governments, distributors.

c) Feasibility of the activity: Are there factors that could hinder the successful establishment or general application of the standard?

d) Timeliness of the standard to be produced: Is the technology reasonably stabilized? If not, how much time is likely to be available before advances in technology may render the proposed standard outdated? Is the proposed standard required as a basis for the future development of the technology in question?

e) Urgency of the activity, considering the needs of the market (industry, consumers, trade, governments etc.) as well as other fields or organizations. Indicate target date and, when a series of standards is proposed, suggest priorities.

f) The benefits to be gained by the implementation of the proposed standard; alternatively, the loss or disadvantage(s) if no standard is established within a reasonable time. Data such as product volume of value of trade should be included and quantified.

g) If the standardization activity is, or is likely to be, the subject of regulations or to require the harmonization of existing regulations, this should be indicated.

If a series of new work items is proposed, the purpose and justification of which is common, a common proposal may be drafted including all elements to be clarified and enumerating the titles and scopes of each individual item.

Relevant documents

List any known relevant documents (such as standards and regulations), regardless of their source. When the proposer considers that an existing well-established document may be acceptable as a standard (with or without amendments), indicate this with appropriate justification and attach a copy to the proposal.

Cooperation and liaison

List relevant organizations or bodies with which cooperation and liaison should exist.

Preparatory work

Indicate the name of the project leader nominated by the proposer.

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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Low ESL measuring method on capacitors with lead terminal for use in electrical and electronic equipment

1 Scope

This standard provides a low ESL measuring method on capacitors with lead terminal type, herein after referred to as a capacitor, use in electrical and electronic equipment

This method is applicable to only capacitor with lead terminal spacing of 3,5 mm and 5,0 mm on reason such as a measurement jig.

2 Normative reference

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60384-1 *Fixed capacitors for use in electrical and electronic equipment Part 1: Generic specification*

3 Terms and definitions

For the purpose of this standard, terms and definitions given in IEC 60384-1 and the following apply :

3.1
ESL (Equivalent Series Inductance)
value which is transposed from the reactance of a capacitor to equivalent series inductance. It is also called as “equivalent series inductance”. The unit is Henry (H).

3.2
Low ESL
very low inductance value. The inductance values in this standard are the level of 1 nH to 10 nH.

4 Measuring instrument, jig, and spacer

4.1 Low ESL measuring equipment

The measuring equipment shall be the balanced bridge method which has the following performance.

a) Measurement frequency range shall be as inductance value can be measured up to and at a frequency of 40 MHz.

b) The impedance measurement accuracy shall be better than 3 m ohm and 0.08 % of basic accuracy.

4.2 Measurement jig (test fixture)

Measurement jig shall have the following features

a) The electrode structure shall be a countered type, and consist of fixed electrode which is fixed to the body and adjustable electrode which holds the lead terminal of capacitor to be measured.

   The adjustable electrode shall move only the direction to hold the lead terminal and shall not rotate around the electrode fixing screw and shall not move to perpendicular to the lead holding direction. (See to Note of 5.5.3)

b) The lead terminal holding method shall be screw up.

The example of a measurement jig is shown in Figure 1.

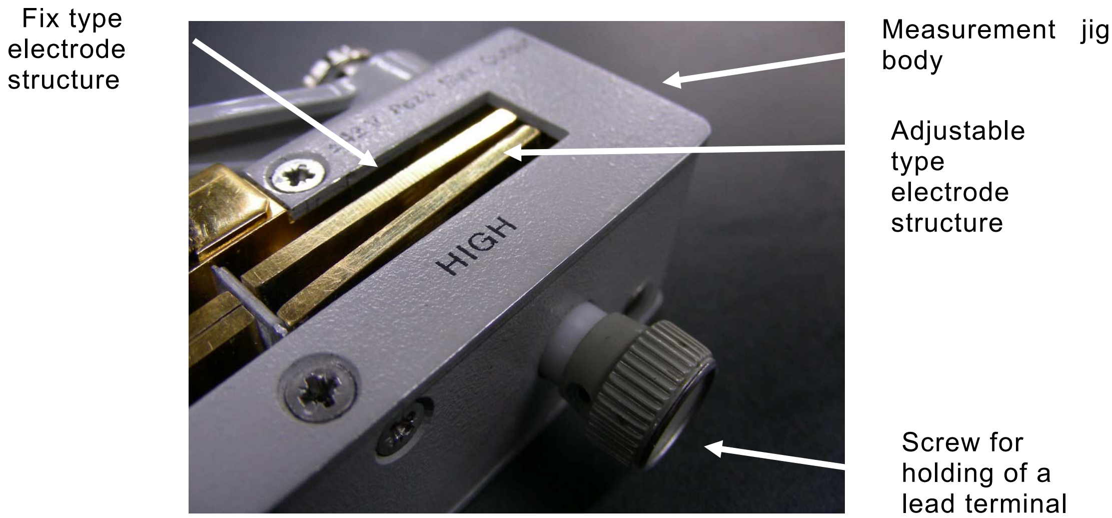


Figure 1 - Example of measurement jig (test fixture)

4.3 Short compensation jig

The short compensation jig shall be the lead wire rod which has the following features of the material and dimensions (diameter or cross-section area).

a) Material shall be the same material as the lead wire of the capacitor to be measured.
b) Shape shall be as shown in Figure 2
c) Spacing shall be the same lead spacing as the capacitor to be measured. The tolerance on the lead spacing of a short compensation jig shall be ± 0,25 mm.
d) The length of the short compensation jig shall be 5 mm to10 mm. However, the length shall be length as to the short compensation jig can be hold by the measurement jig. The straight portion of a jig is kept from bending. When the short compensation jig is bended, it corrects so that it may become straight

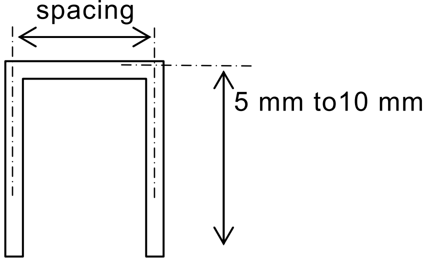


Figure 2 - Short compensation jig

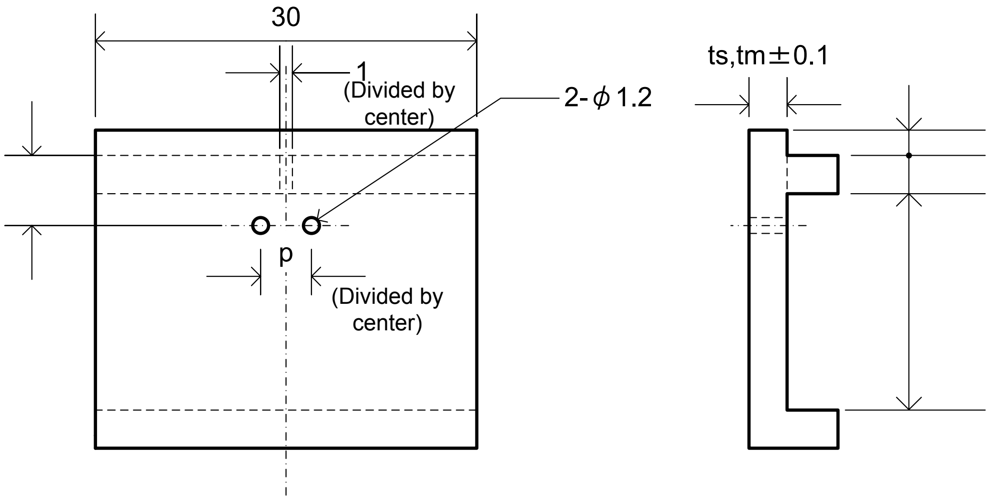
4.4 Spacer

The spacer for short compensation shall be used for short compensation and spacer for measurement shall be used for ESL measurement. These spacers shall have the suitable shape to be firmly fixed when they are put on the measurement jig. The example is shown in

Figure 3. In addition, the spacer material shall be nonmagnetic and shall be able to assure the specified tolerance.

NOTE The reason for using a spacer at the time of measurement is that the point of view for the measurement of ESL in this standard is based on the idea shown in the Annex A. After investigation on the improvement of the ESL measurement repeatability and re-productivity, spacers for short compensation and for measurement were found as solution.

Unit mm



Unit mm

P	t_s [a]	t_m [b]
3,5±0,3	1,5±0,1	3,25±0,1
5,0±0,3	1,5±0,1	4,0±0,1

a) For short compensation

b) For measurement

Figure 3 - Constructional example of the spacer for short compensation, and the spacer for ESL measurement

5 Measuring method

5.1 Measurement environment

The measurement environment examines shall be the normal condition specified in 4.2.1 of IEC 60384-1. In addition, when a doubt arises in a judgment, it measures in the state of the judgment specified in 4.2.2 of IEC 60384-1.

5.2 Preparation of sample

The lead terminal of a measured capacitor shall be cut in length of 5 mm to 10 mm. Moreover, the lead terminal at that time shall be kept from bending. When the lead terminal is bended, it corrects so that it may become straight.

NOTE Refer to the Annex C about the reason for cutting a lead terminal in short length.

5.3 Measurement point

The measurement point of ESL is egress of lead terminal of the capacitor to be measured.

NOTE Although the spacer is used at the time of measurement, measuring value is equivalent to having measured at the egress of the lead terminal of a capacitor as shown in Annex A.

5.4 Measurement conditions

Unless otherwise specified in the product specification, measurement conditions shall be as follow.

a) The measurement frequency shall be 40 MHz

b) The signal level of an oscillation of a measuring instrument shall be set 0,5 V r.m.s. to 1,0 V r.m.s..

5.5 Measurement procedure

The measurement shall be performed in the order of open compensation, short compensation, and measurement.

At this time, according to the instructions of the measuring instrument to be used besides the measurement conditions specified in 5.4, the suitable number of times to average, integration time, etc. shall be set up so that measurement accuracy may become less than 2%.

NOTE Refer to the Annex D about the verification about the number of times of to average and integration time, and measurement accuracy.

5.5.1 Open compensation

Install measuring jig specified in 4.2 to the measuring instrument and tighten the screw for adjustable electrode with nothing in between electrodes. Open compensation shall be performed according to instructions of the measuring instrument in use.

5.5.2 Short compensation

Install short compensation spacer specified in 4.4 to the measurement jig specified in 4.2 then insert short compensation jig specified in 4.3 through the spacer, and tighten the screw for adjustable electrode. Short compensation shall be performed according to instructions of the measuring instrument in use.

The example of the short compensation method is shown in Figure 4.

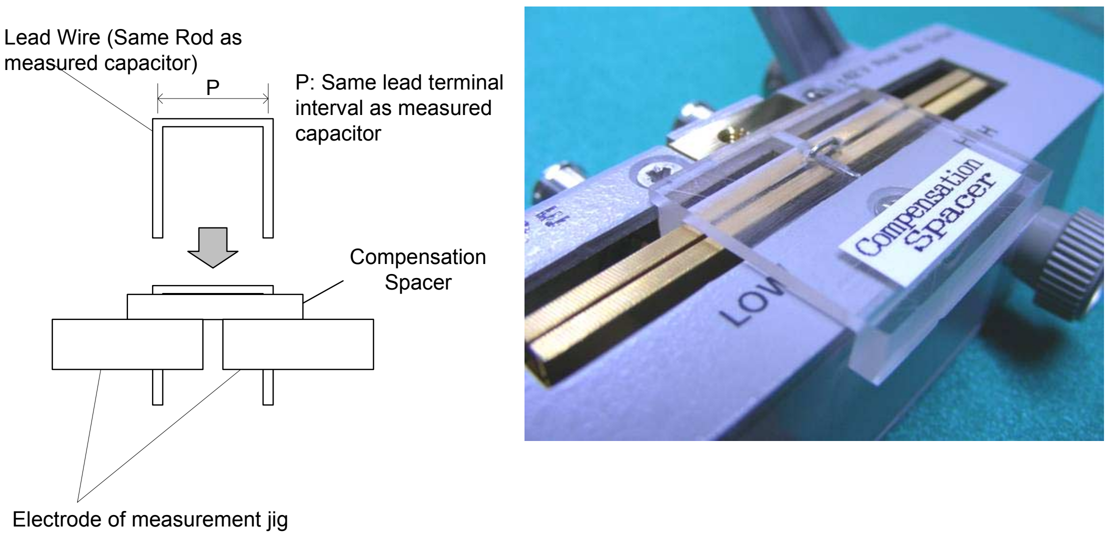


Figure 4 - Method of short compensation

5.5.3 Measurement

After performing the compensation proofreading specified in 5.5.1 and 5.5.2, replace short compensation spacer with the spacer for measurement specified in 4.4 then insert the lead terminal of the capacitor to be measured which is prepared according to 5.2 to the measurement jig and tighten the screw for adjustable electrode. The example is shown in Figure 5.

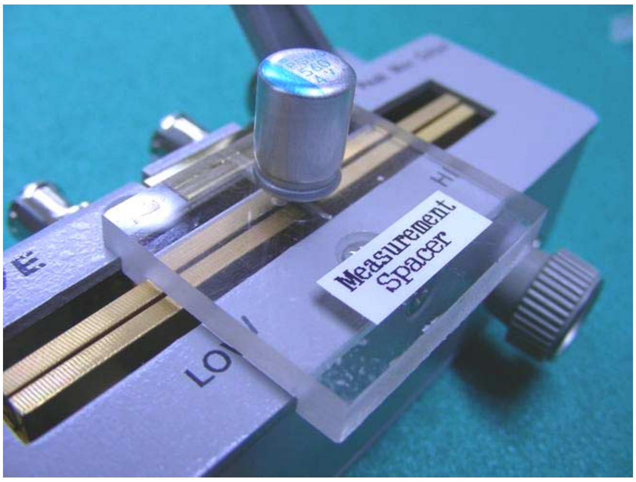


Figure 5 - ESL measurement

Care shall be taken so that the electrode of the measurement jig does not rotate and prevent from the shifting as shown in Figure 6, when insert lead terminal of the capacitor to be measured.

Note - When the electrode of a measurement jig shifts from the position at the time of short compensation, it becomes the factor of measurement variation.

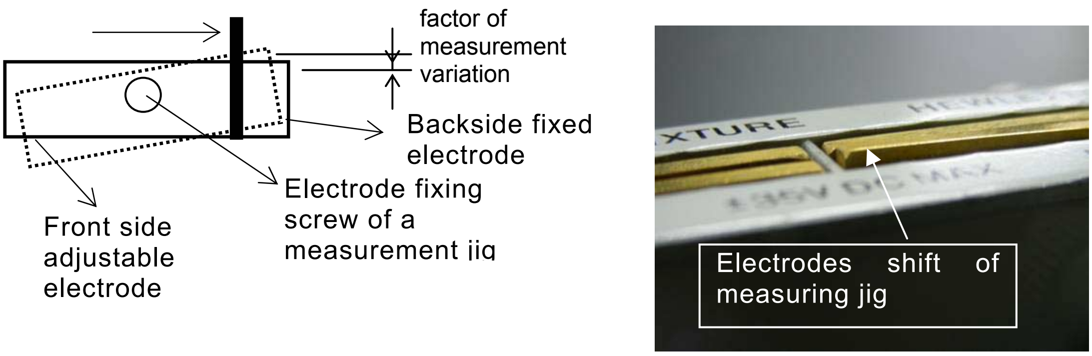


Figure 6- Example in state where electrode of measurement jig shifted

6 Items to be indicated in test result report

When a test result report is required, the items to be reported are selected from the followings based upon the agreement between trading partners.

a) Examination date

b) A testing body name or an examination site place

c) The name, the kind, the rating, and the size of a capacitor

d) The name and kind of measuring instrument

e) The name of a measurement jig
f) Measurement frequency and a measurement signal level
g) Measurement ESL value

7 Items specified to product specifications

a) Measurement conditions (5.3)

Annex A
(Informative)

The fundamental view of an ESL measuring method

A.1 Scope

This Annex indicates the fundamental view of the measuring method of ESL

A.2 Fundamental view of ESL measurement

The fundamental view of an ESL measuring method is shown in Figure A.1. The point of measurement of low ESL of a measured capacitor is egress of lead terminal of the capacitor to be measured.

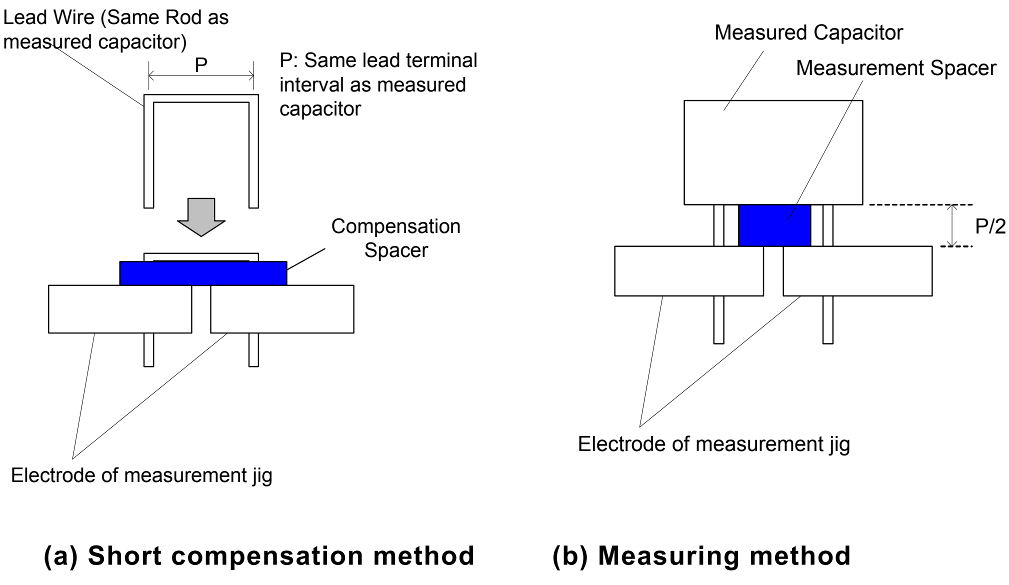
Note - ESL of the capacitor measured by this measuring method is based on egress of lead terminal or lead terminal position of the seating plane in the case of capacitor equipped air drainage rubber and such. When a capacitor body is mounted away from the PC board or soldered at opposite side of the PC board where the capacitor is mounted and such, ESL of the capacitor becomes higher by the amount of ESL of the lead which is inserted between a circuit and a capacitor.

The summary for short compensation is as follows;

a) Use same material and dimensions (diameter or cross section) as use in the capacitor to be measured and formed into shape as to Figure 2.

b) Spacing (p) shall be same as the capacitor to be measured.

c) Put in the spacer of *P*/2 of height between a measurement jig and a capacitor at the time of measurement.



(a) Short compensation method **(b) Measuring method**

Figure A.1 - Fundamental view of ESL measurement

Note - In this short compensation, it means that a part for the inductance of a lead equal to the length of a lead terminal spacing was deducted superfluously. At the time of measurement, a measured capacitor is measured in the state where the height (*P*/2) of the half of a lead terminal spacing was floated. A part for the inductance superfluously rectified by this was added, and it was considered that it was equivalent to having measured at the egress of a capacitor lead terminal.

Annex B
(Informative)

The example of verification with the case where it computes from an ESL measuring method and a circuit

B.1 Scope

This Annex indicates the example of verification with the case where it computes from an ESL measuring method and a circuit.

B.2 Comparison verification with ESL value computed from output ripple of DC-DC converter, and ESL value measured with measuring instrument

About the output ripple voltage of a DC-DC converter, not only capacitance value and ESR of the output smoothing capacitor but also by ESL affect it. Then, the ESL value of a capacitor was calculated from V_{ripple}(ESL), which is the ESL ingredient of this output ripple voltage waveform and comparison examination of the ESL value measured with the measuring instrument based on the view shown in Annex A was carried out.

V_{ripple} (ESL) of an output ripple voltage waveform of the DC-DC converter shown in Figure B.1 appears when flowing current transit under affect of ESL, and can be calculated by the following formula.

$$V(\mathrm{L}) = (I/T) \times L$$

Where V(L) :
I :
T :
L : ESL

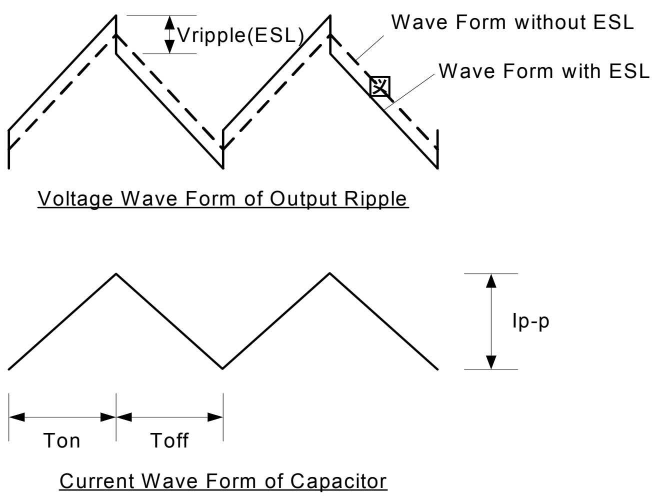


Figure B.1 - Wave of DC-DC converter

Considering waveform using a capacitor with very low ESL close to zero, voltage waveform could be like dotted line shown in Figure B.1, which is formed by the capacitance and ESR of the capacitor. On the other hand a capacitor with ESL is not negligible; voltage waveform could be like solid line shown in Figure B.1 due to the voltage under the affect of ESL superimposed on during the current flow through the capacitor is changing.

The value of V_{ripple} (ESL) is read from an output ripple voltage waveform of Figure B.1 and T_{on}, T_{off}, and I_{p-p} are read from current wave form of Figure B.1, then the ESL value is calculated using the following formula.

$$V_{\text{ripple}}(\text{ESL}) = \left[\left(\frac{I_{\text{p-p}}}{I_{\text{on}}}\right) \times L\right] + \left[\left(\frac{I_{\text{p-p}}}{I_{\text{off}}}\right) \times L\right]$$

$$L = \frac{T_{on} \times T_{off} \times V_{ripple}(ESL)}{(T_{\text{on}} + T_{\text{off}}) \times I_{\text{p-p}}}$$

Where L : ESL
V_{ripple} (ESL) : Ripple voltage by ESL ingredient
T_{on} : Current rise time
T_{off} : Current fall time
I_{p-p} : Current change

DC-DC-converter circuit conditions: A Buck form, 7 V to15 V_{in}, 5V_{out}, f= 200 kHz to 800 kHz.

ESL value was measured under the following conditions based on the view in Annex A.

Measurement result : Average value of n = 3 pcs.,

Measuring instrument :A company; 4194A, B company;4192A

Measurement frequency: 10 MHz, measurement jig:16047C

The result of the measured value by a measuring instrument and the calculation value from the output ripple voltage waveform of a DC-DC converter are shown in Table B.1.

Table B.1— Comparison with ESL value measured with ESL value calculated from output ripple of DC-DC converter, and measuring instrument

Specimen size (lead wire terminal spacing) mm	The measurement result of A company	The measurement result of B company	Calculated ESL from wave form
φ8×12L(3,5)	4,36 nH	4,44 nH	4,69 nH

From this result, ESL measurement values using this method seem feasible to use as a reference parameter for circuit simulation.

Annex C
(Informative)

The example of a check by the difference in the length of a lead wire terminal

C.1 Scope

This Annex indicates the example of the ESL measurement by difference in length of the lead terminal of capacitor to be measured.

C.2 Length of lead terminal of measured capacitors

In the stage of examining the measurement factor to at any time, the direction of a lead terminal with the short longer lead terminal showed that measured value was stabilized. For this reason, variation in measurement examination that made the length of a lead terminal the parameter was checked. The result is shown in Figure C.1.

The following can be said from the result.

When a lead terminal is long, the contact position of the electrode of a measurement jig and a lead terminal may vary, and this is the reason for variation on the measurement results. The length of a lead terminal affects the contact state of a lead terminal to the electrodes of the measurement jig. The examples of contact state differences are shown in Figure C.1.

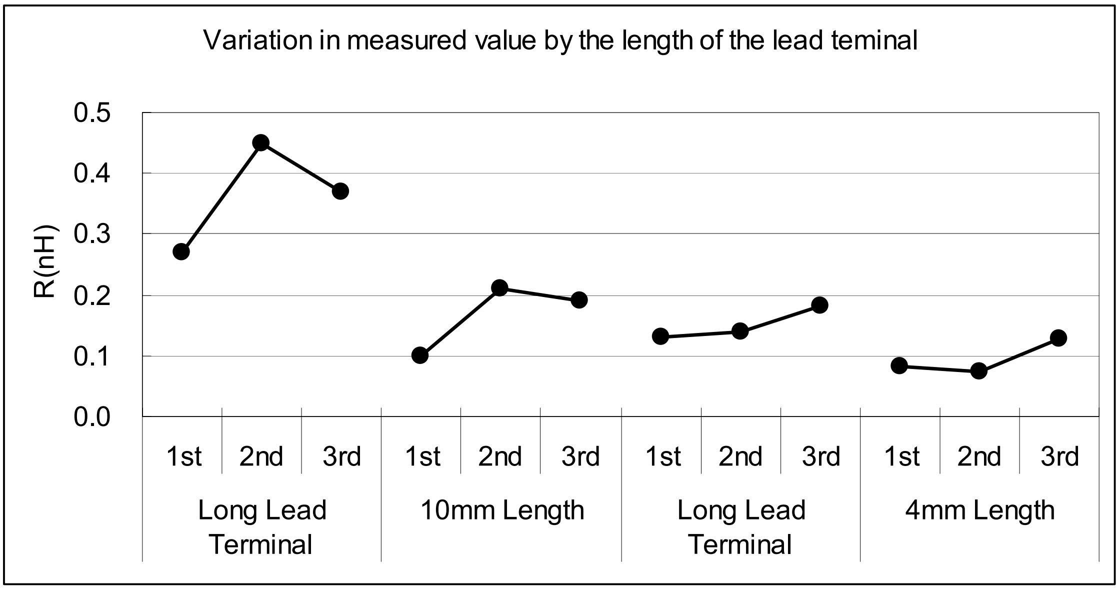


Figure C.1 - Variation in ESL measured value by length of lead wire

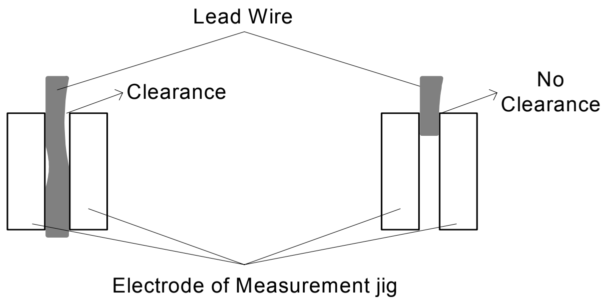


Figure C.2 - Contact position of electrode of measurement jig and lead wire by length of lead wire terminal

Annex D
(Informative)

The number of times to average of a measuring instrument and the example of investigation of reset time

D.1 Scope

This Annex indicates the example of verification by the difference between the number of times to average of a measuring instrument, and integration time.

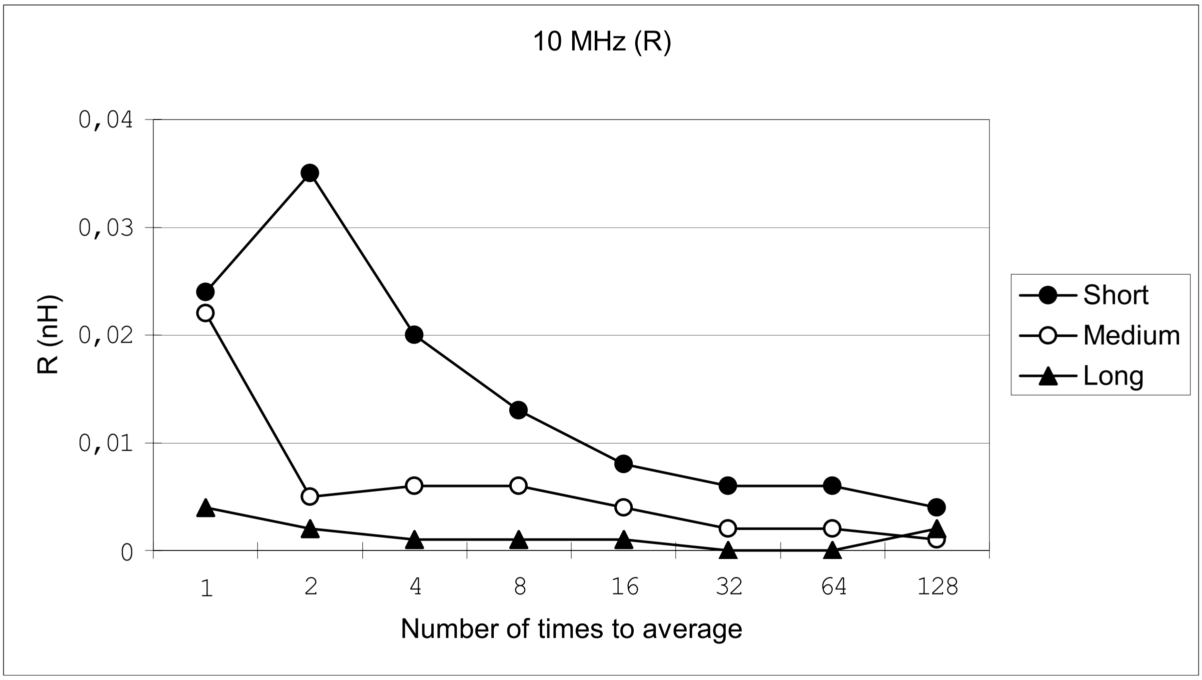
D.2 The number of times to average of measuring instrument, and investigation of integration time

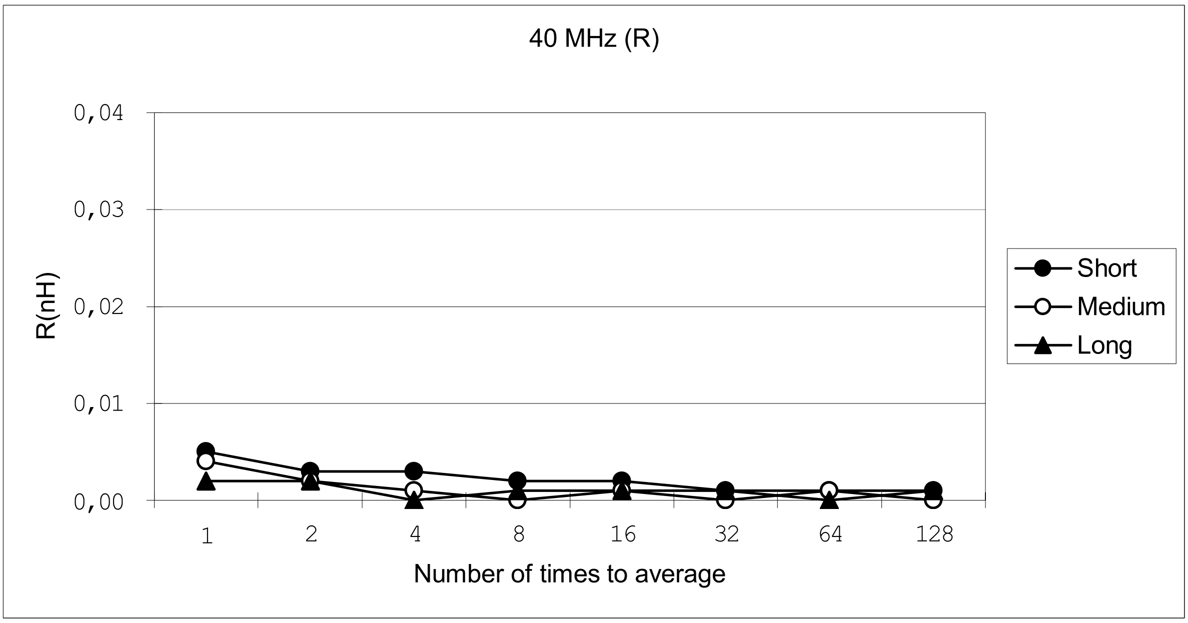
The number of times to average and integration time of a measuring instrument investigated about the influence that it has on measured value variation. Fixing one of product size φ8x12L to a measurement jig, the number of times to average (1 to 128) and integration time (Short, Medium and Long) were changed, and it was considered as the index of measurement variation in quest of range *R* (maximum - minimum) when measuring 10 times, respectively. As a result, therefore, the next conclusion was obtained.

a) When the number of times to average is increased, and when integration time is lengthened, the variation in measurement becomes small.

b) By making 40MHz of measurement frequency high from 10 MHz, the variation in measurement becomes small.

c) It is necessary to choose the number of times to average suitable for measurement, and integration time with a measuring instrument.





NOTE R is the difference of a maximum and minimum value among 10 measurements.

Figure D.1 - Examination of the number of times to average, and integration time