

**EIA/ECA MEETING****Up date of the measurement  
method of low ESL capacitor****in JEITA****April. 2006****Solid Electrolytic Capacitors  
with Polymerized Organic Semiconductor**

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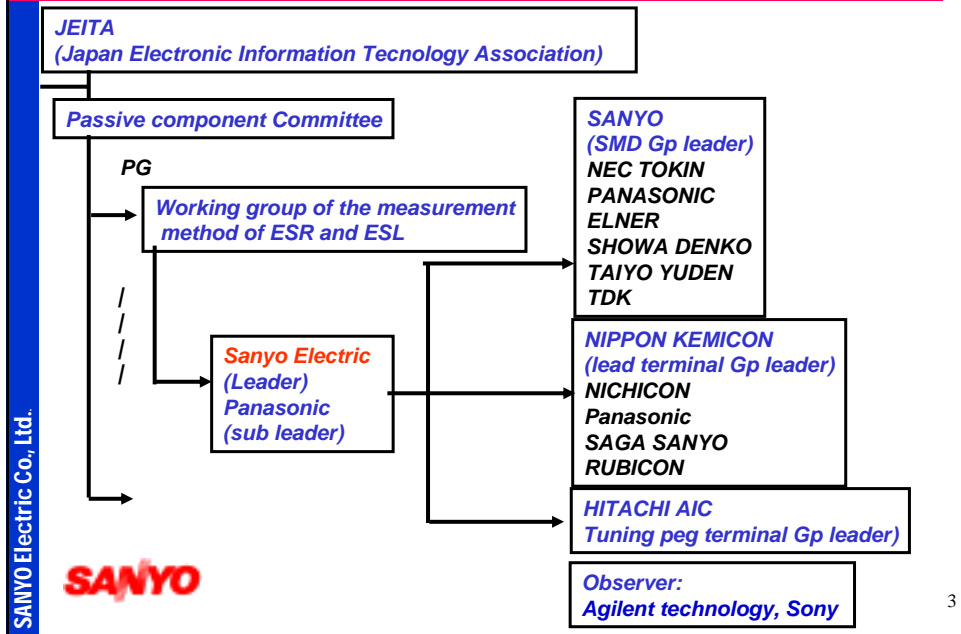
**Agenda**

- (1) Organization of JEITA**
- (2) History and Road Map of ESL Measurement  
Standardization**
- (3) Measurement equipment and principle of lead terminal GP**
- (4) Measurement equipment and principle of SMD terminal GP**
- (5) Verification of measured value**
- (6) Wish of corporation**

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## (1) Organization of JEITA

No.01-11



## (2) History and Road Map of ESL Measurement Standardization

2003.4 Pre-meeting (to identify the need for ESL Measurement Standardization)

2003.7 1<sup>st</sup> meeting: Establish three interconnected groups:

Lead terminal capacitor group

: Fixture 16047 Agilent technology

SMD Group (tantalum/aluminum polymer cap, MLCC)

: Fixture SANYO original

Screw formed terminals type

: Fixture 16047E Agilent technology

2003.10 2<sup>nd</sup> meeting: Test result (Lead terminal GP & Screw type GP)

2003.12 3<sup>rd</sup> meeting: Test result (SMD GP)

2004.2 4<sup>th</sup> meeting: Test result (Lead terminal GP, Screw GP)

2004.3 5<sup>th</sup> meeting: Lead terminal GP, Screw GP only

2004.6 6<sup>th</sup> meeting: First report of round robin test 2

2004.8 7<sup>th</sup> meeting: Second report of round robin test 2

## **(2) History and road map of standardization**

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- 2004.10 8<sup>th</sup> Meeting pending. Calibrate measurement values of ESL within the participating companies.**
- 2005.3 9<sup>th</sup> Submit the final report.**  
**(2005 4 introduce for IEC by PANASONIC)**
- 2005.6 10<sup>th</sup> Draft deliberations on written standards**
- 2005.8 11<sup>th</sup> Written-standards issue**
- 2005.9 12<sup>th</sup>**
- 2005.12 13<sup>th</sup> calibrating the ESL value of short-jig**
- 2006.1 14<sup>th</sup> real ESL value of short-jig**
- 2006.3 15<sup>th</sup> approve the document of lead terminal group**

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## **(2) History and road map of standardization**

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- 2006.4 ad hoc meeting of SMD: relation between the position of DUT and ESL value**
- 2006.4 approach to IEC**  
**(International Electro technical Commission)**  
**lead terminal GP: 40/1741/NP(New work item proposal)**

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### (3) Measurement equipment and principle of lead terminal GP

**Measurement equipment :**  
**Impedance analyzer 4294 (Agilent technology)**  
**fixture :**



Figure 1 - Example of measurement jig (test fixture)

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### (3) Measurement equipment and principle of lead terminal GP

#### **Open compensation :**

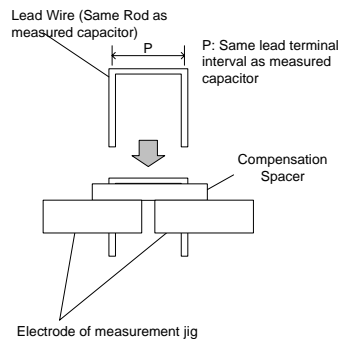
*Install measuring jig specified in 4.2 to the measuring instrument and tighten the screw for adjustable electrode with nothing in between electrodes. Open compensation shall be performed according to instructions of the measuring instrument in use.*

#### **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.*



Figure 4 - Method of short compensation

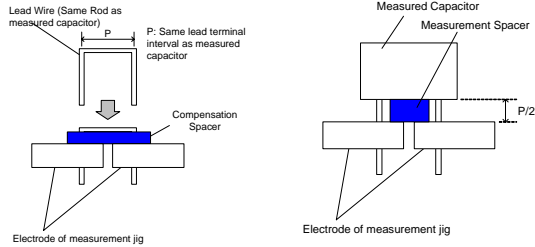
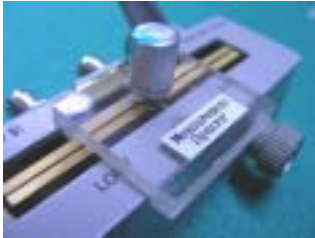


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### (3) Measurement equipment and principle of lead terminal GP

#### 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.



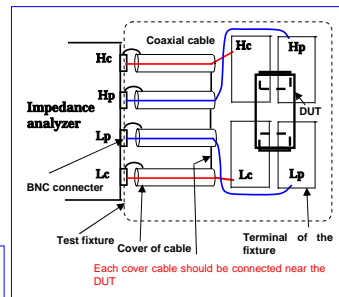
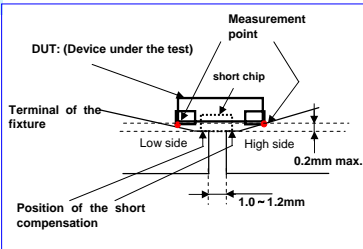
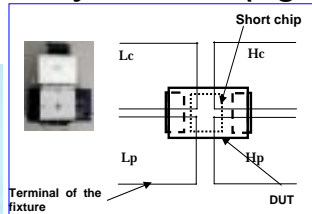
•Figure 5 - ESL measurement

### (4) Measurement equipment and principle of SMD terminal GP

#### Measurement equipment : Impedance analyzer 4294 (Agilent technology) fixture :



Figure 1 - Example of measurement jig (test fixture)

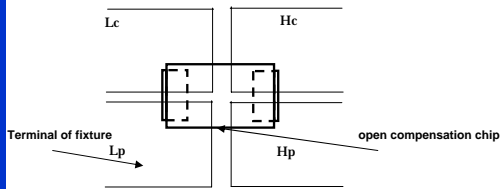


#### (4) Measurement equipment and principle of SMD terminal GP

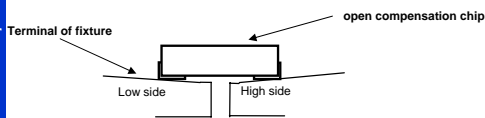
### Open compensation :

*Put the jig on the fixture to make the short circuit of Lc,Lp and Hc,Hp.*

*Open compensation shall be performed according to instructions of the measuring instrument in use.*



4.Upper surface figure



5.Elevational view



6.Upper surface figure



7.Bottom view

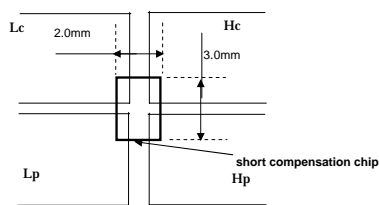
#### (4) Measurement equipment and principle of SMD terminal GP

### Short compensation :

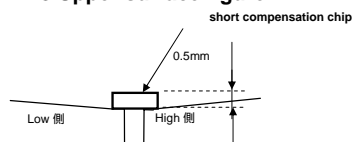
*Put short compensation spacer on the jig then locked with cover.*

*The typical ESL value of short jig should be added to the measured value.*

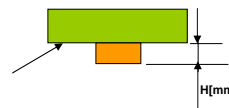
*The typical ESL value of short jig should be showed in the specification.*



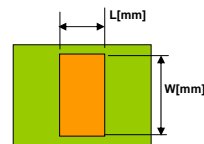
8.Upper surface figure



9.Elevational view



10.Upper surface figure



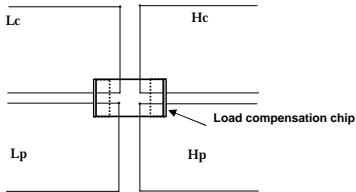
11.Bottom view

**(4) Measurement equipment and principle of SMD terminal GP**

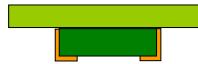
**Load compensation :**

Put on the load compensation jig to measure at 40MHz measurement frequency.

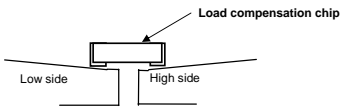
Because of the characteristics of test fixture, 10MHz is the limit when this compensation is not done.



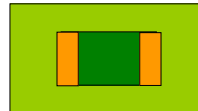
12.Upper surface figure



14.Upper surface figure



13.Elevational view



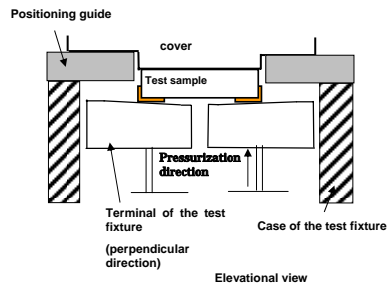
15.Bottom view

**(4) Measurement equipment and principle of SMD terminal GP**

**Measurement**



Figure 1 - Example of measurement jig (test fixture)



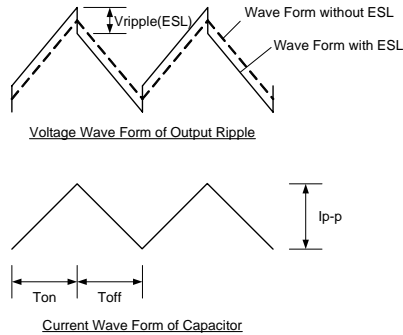
## (5) Verification of measured value

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### 1. 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  $V_{\text{ripple}}(\text{ESL})$ , 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.

$V_{\text{ripple}}(\text{ESL})$  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.



•Figure B.1 - Wave of a DC-DC converter

## (5) Verification of measured value

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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.

•Then, the value of  $V_{\text{ripple}}(\text{ESL})$  of an output ripple voltage waveform of this attached Figure B.1 and  $T_{\text{on}}$ ,  $T_{\text{off}}$  and  $I_{\text{p-p}}$  was read, and the ESL value was computed using the following formula.

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

$$\bullet \text{ESL} = [T_{\text{on}} \times T_{\text{off}} \times V_{\text{ripple}}(\text{ESL})] / [(T_{\text{on}} + T_{\text{off}}) \times I_{\text{p-p}}]$$

•Where,  $V_{\text{ripple}}(\text{ESL})$  : Ripple voltage by ESL ingredient

• $T_{\text{on}}$  : standup time of current

• $T_{\text{off}}$  : falling time of current

• $I_{\text{p-p}}$  : current change

•DC-DC-converter circuit conditions: A Buck form, 7 V to 15 V<sub>in</sub>, 5V<sub>out</sub>, 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

Part size (lead wire terminal interval) mm	Result of A company	The measurement result of B company	Calculation ESL
• 8 x 12L(3.5)	•4.36 nH	•4.44 nH	•4.69 nH

•It seems that the ESL value measured from this result is applicable enough as a reference value of the circuit constant of the side to be used.

**(5) Verification of measured value**

Measurement machine and test fixture:  
 impedance analyzer (Agilent 4294A) + test fixture for SMD type  
 net work analyzer (Agilent 8753ES, 2 port reflection/ transmitting method)  
 start frequency of measurement : 30kHz  
 stop frequency of measurement : 100MHz

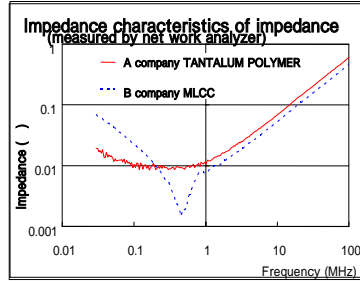
Measured point : 201  
A company(7343 Size)  
 impedance analyzer + SMD test fixture  
 : 0.55nH  
 Net work analyzer  
 : 0.85nH

Distance was 0.3nH

B company MLCC (4532 Size)  
 impedance analyzer + SMD test fixture  
 : 0.55nH  
 Net work analyzer  
 : 0.83nH

Distance was 0.28nH

**This value is the same as the calculated ESL value of short jig.**



**(5) Wish of corporation**

*Plan:*

*SMD terminal GP : target of NP ; end of April*

*2006.4 up date of the activity of JEITA to EIA/ECA*

*2006.6 report for TC40 meeting in Korea (IEC)*

***Please cooperate with world standard decision***

**Thank you for your  
attention.**