2023 IEEE International Conference on Information Technologies – InfoTech 2023
September 20-21, 2023

E07. Statistical analysis of the influence of the amount of bismuth in a combined solder paste footprint on the content of voids in the solder

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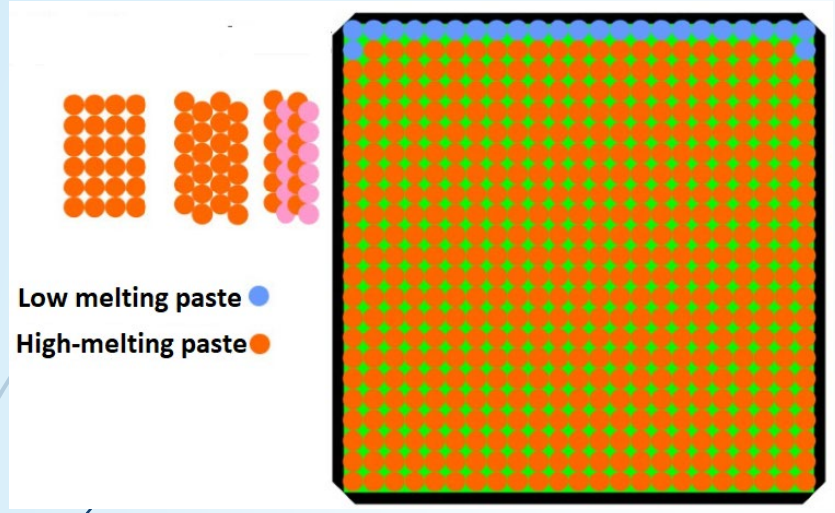
GOAL :

The effect of bismuth content in a combined footprint of standard and low-temperature solder pastes on the content of voids in solder joints using standard electronic components - resistors, capacitors and transistors of different packages.

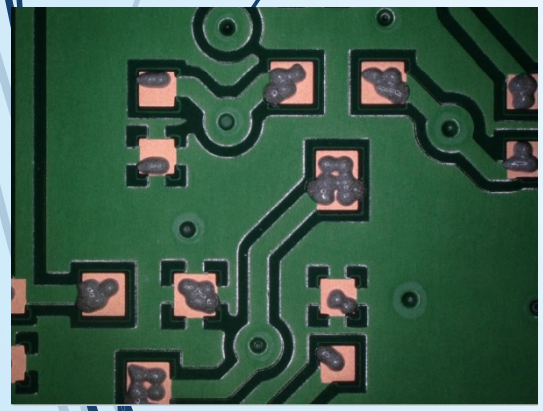
TASKS :

1. *Design and realization with an jet printer of a combined footprint of standard (SAC 305) and low temperature (58Bi42Sn) solder pastes in different quantitative ratios on a printed circuit board of a real product with OSP finish;*
2. *Assembly of standard widely used electronic components (resistors, capacitors and transistors) with different packages;*
3. *Soldering the electronic components of the printed circuit board with a reflow process using a vapor phase oven;*
4. *Measurement of the content of voids during the soldering of the various electronic components;*
5. *Statistical processing of the obtained results for the content of voids at different quantitative content of bismuth in the solders;*
6. *Analysis of the statistically processed results for the content of voids in the solders when using solders with different bismuth content;*
7. *Conclusions regarding the use of bismuth in low-temperature soldering.*

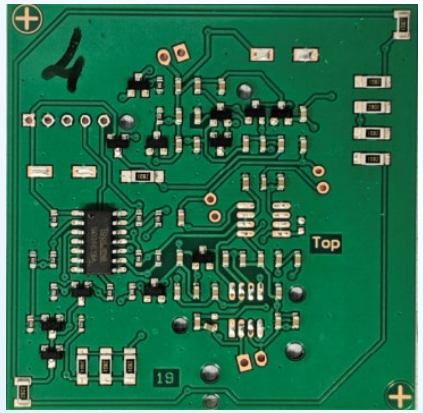
Experiment – PCBA with combined footprint



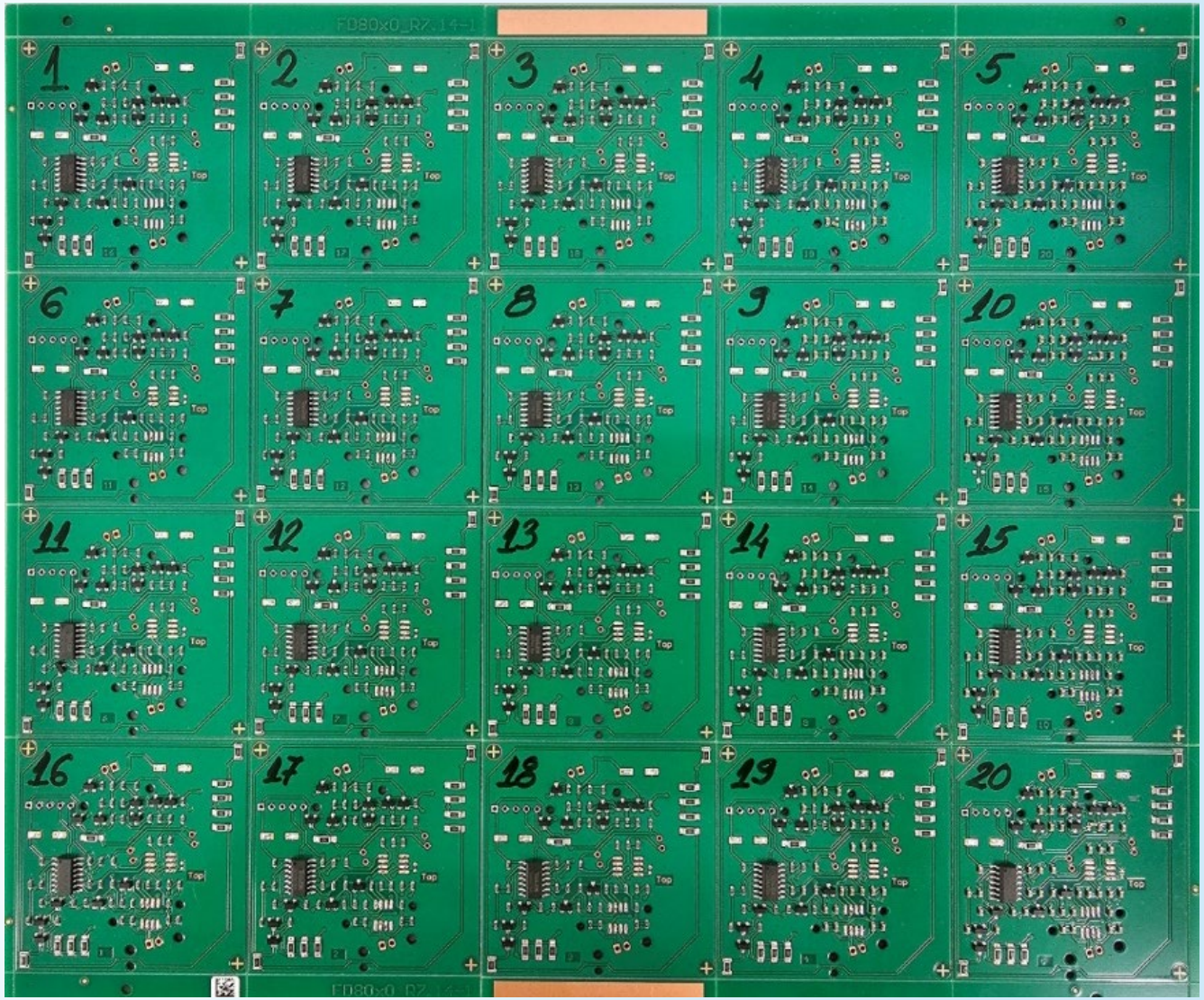
Combined footprint principle



Combined footprint
large diameter dots are of low-melting solder paste

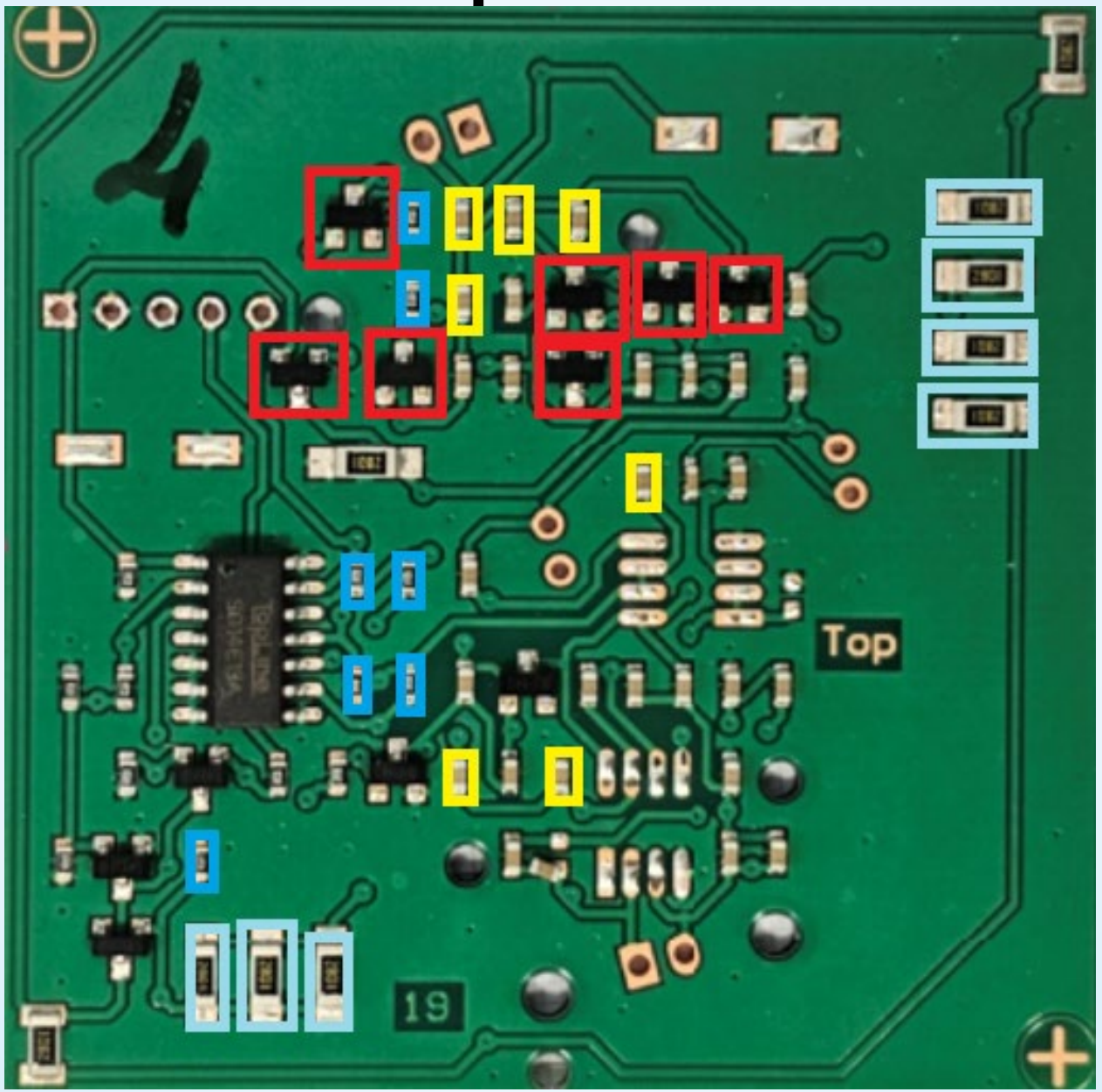


Tested board



Experiment - Combined footprint – Bi content

Tested board – all controlled components

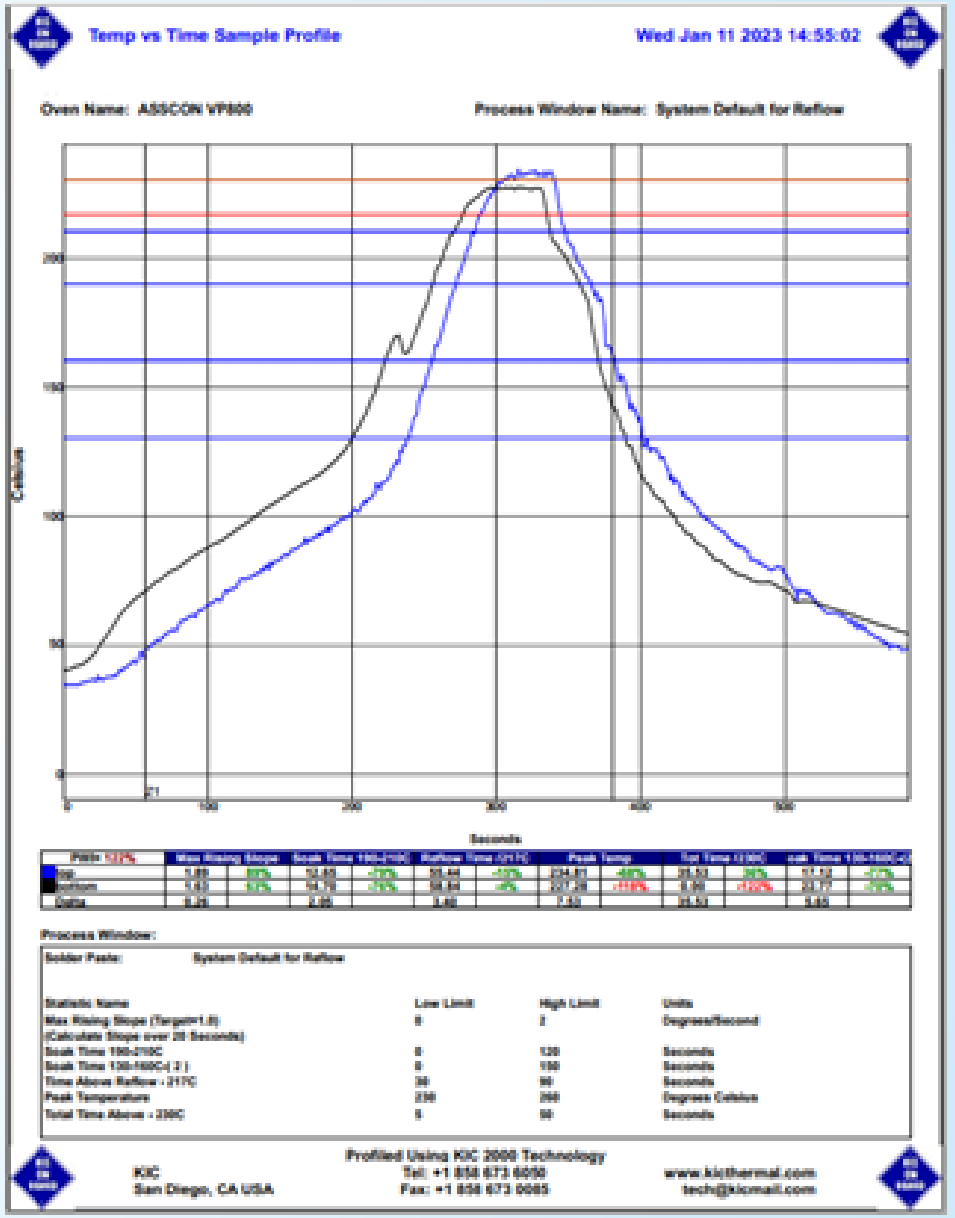


Resistors 1206	
Ratio	Ratio (%)
6SAC305:3BiSn	57 : 43
8SAC305:2BiSn	73 : 27
9SAC305:3BiSn	66 : 34
15SAC305:2BiSn	83 : 17
Resistors 0603	
Ratio	Ratio (%)
1SAC305	100
3SAC305	100
1SAC305:1BiSn	40 : 60
1SAC305:2BiSn	25 : 75
2SAC305:1BiSn	57 : 43
2SAC305:2BiSn	40 : 60
3SAC305:1BiSn	67 : 33
Capacitators 0603	
Ratio	Ratio (%)
1SAC305	100
3SAC305	100
1SAC305:1BiSn	40 : 60
1SAC305:2BiSn	25 : 75
2SAC305:1BiSn	57 : 43
2SAC305:2BiSn	40 : 60
3SAC305:1BiSn	67 : 33

Transistors SOT23		
Large contact pad ratio	Ratio (%)	Small contact pad ratio
3SAC305:2BiSn	50 : 50	2SAC305:1BiSn
4SAC305:1BiSn	73 : 27	2SAC305:1BiSn
4SAC305:2BiSn	57 : 43	2SAC305:1BiSn
5SAC305:2BiSn	62 : 38	3SAC305:1BiSn
6SAC305	100	3SAC305
6SAC305:2BiSn	67 : 33	3SAC305:1BiSn
6SAC305:2BiSn	67 : 33	3SAC305:2BiSn

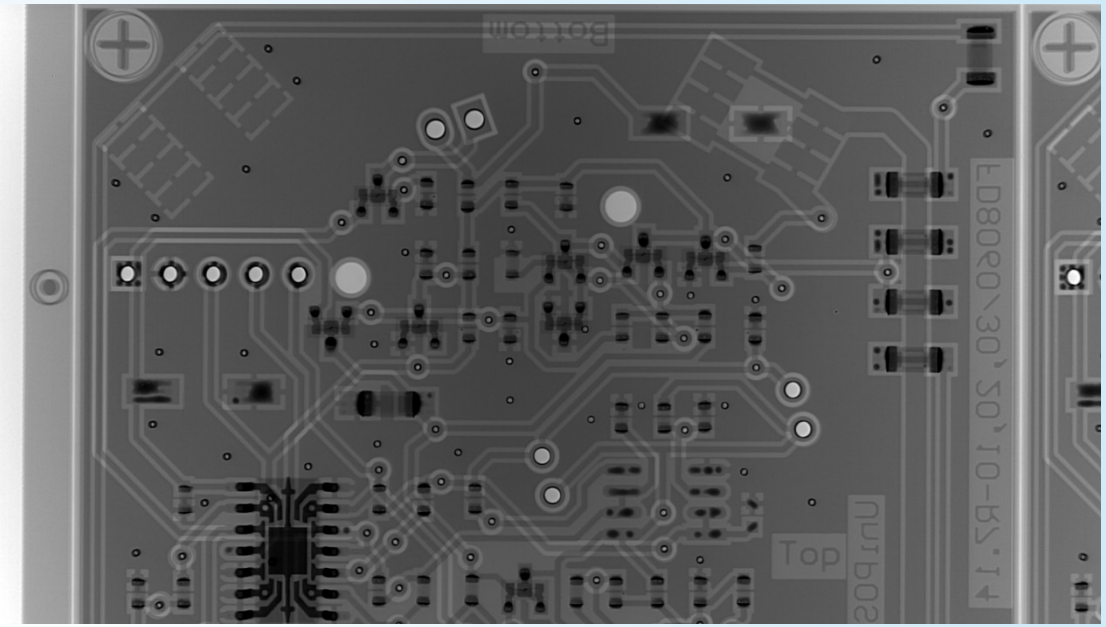
Experiment - Reflow process (vapor phase oven)

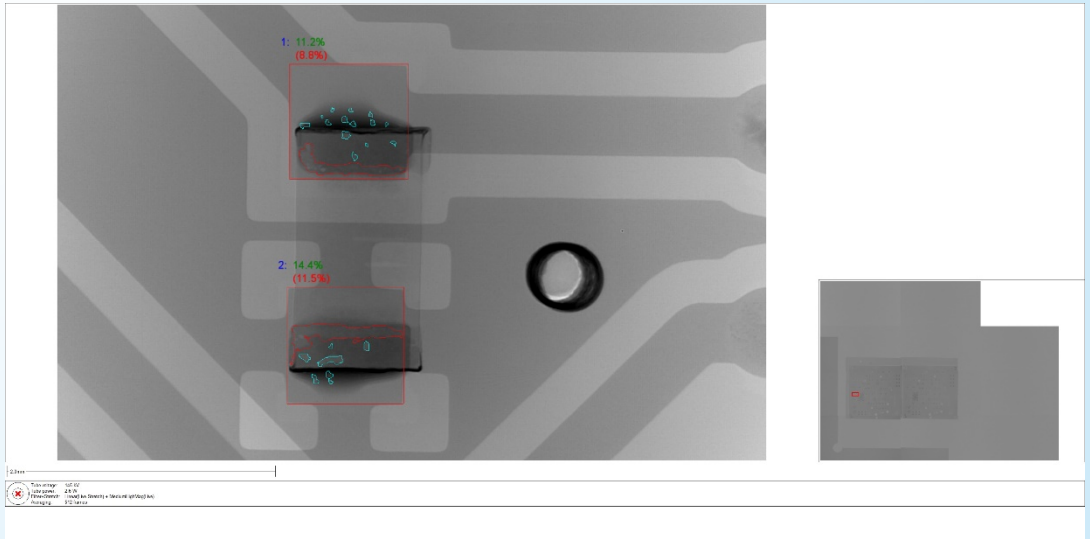
Galden - 240 degrees



Experiment - Measurement of the void content

Xray machine Nordson Dage XD7500VR





Results and analyses – Resistors and capacitors

PCB №	Contents of void R1206, %
2 6(SAC305):3(58Bi42Sn) all voids	7.03
2 6(SAC305):3(58Bi42Sn) max single void	1.39
2 8(SAC305):2(58Bi42Sn) all voids	8.47
2 8(SAC305):2(58Bi42Sn) max single void	1.91
2 9(SAC305):3(58Bi42Sn) all voids	6.12
2 9(SAC305):3(58Bi42Sn) max single void	1.23
2 15(SAC305):2(58Bi42Sn) all voids	2.91
2 15(SAC305):2(58Bi42Sn) max single void	0.66

Measurement of the content of voids for R1206, R0603 and C0603

PCB №	Content of voids R0603, %
2 1(SAC305)	11.26
2 1(SAC305)	6.64
2 1(SAC305):1(58Bi42Sn)	12.38
2 1(SAC305):1(58Bi42Sn)	5.87
2 1(SAC305):2(58Bi42Sn)	18.99
2 1(SAC305):2(58Bi42Sn)	6.29
2 2(SAC305):1(58Bi42Sn)	12.87
2 2(SAC305):1(58Bi42Sn)	5.66
2 2(SAC305):2(58Bi42Sn)	11.70
2 2(SAC305):2(58Bi42Sn)	2.67
2 3(SAC305):1(58Bi42Sn)	17.70
2 3(SAC305):1(58Bi42Sn)	6.30

PCB №	Content of voids C0603, %
2 1(SAC305)	0.95
2 1(SAC305)	0.33
2 3(SAC305)	2.30
2 3(SAC305)	1.60
2 1(SAC305):1(58Bi42Sn)	2.48
2 1(SAC305):1(58Bi42Sn)	0.78
2 1(SAC305):2(58Bi42Sn)	7.47
2 1(SAC305):2(58Bi42Sn)	1.72
2 2(SAC305):1(58Bi42Sn)	3.81
2 2(SAC305):1(58Bi42Sn)	1.75
2 2(SAC305):2(58Bi42Sn)	11.60
2 2(SAC305):2(58Bi42Sn)	2.20
2 3(SAC305):2(58Bi42Sn)	5.70
2 3(SAC305):2(58Bi42Sn)	1.00

CONCLUSIONS

1. *Applying a Pareto analysis to the results, it can be concluded that a higher content of bismuth in the combined footprint leads to an increase in the content of voids in the solders;*
2. *The maximum : minimum ratio is different for different elements - capacitors (11.60:0.95), resistors (8.47:2.91 to 18.99:11.26).*

Future development

In order to exploit main advantages of the combined footprint (low soldering temperature, soldering material collection, low energy consumption, little soldering material oxidation), research should continue with the following objectives:

- *Reduction of void formation with optimization of combined footprint composition, optimal reflow parameters and appropriate PCB design.*
- *Optimum parameters of the combined footprint to obtain suitable solders with different geometry of the pads and when soldering different elements.*
- *Creating design rules for using a combined footprint.*

Thank you for your attention!

An African proverb: ***"He who looks well will finally see."***

This research is supported by Bulgarian National Science Fund in the scope of the project "Exploration the application of statistics and machine learning in electronics" under contract number КП-06-Н42/1.