MUST System II+
& Lead-Free Testing

In response to a number of comments from various customers, the following information is offered for general assistance pending the publication of revised standards.

Graham Naisbitt is Managing Director of Concoat Systems Limited and a Member of IEC TC91 WG3. He is:

- Leader of Solderability Testing Standard IEC 60068-2-69
- Co-leader of Solderability Testing Standard IEC 60068-2-54
- Member of IPC-J-STD 002 and IPC-J-STD 003

Both IEC and IPC committees are working hard to try and ensure that revisions to the existing standards are published before the July 2006 deadline, but neither group will have published documents until Spring 2006 at the earliest.

There is a good deal of misinformation regarding the Solderability test method that needs to be appreciated and, as so aptly described by Dave Hillman, Chairman of IPC-J-STD 002 and 003:

- "The JSTD-002/003 solderability test standard's purpose is to test the robustness of a finish for wettability. Too many people attempt to use and/or believe that the standards are designed to mimic production conditions, they are not. This would be 'soldering-ability' not "solderability".

  Although the IPC committee has attempted to have the standards reflect soldering-ability concerns, it is not possible or practical in terms of testing methodology to mimic production. There are so many flux/process combination that the standards would cease to be of value; they would be huge and contain a multitude of variations.

  The test parameters contained in the standards are designed to have some safety margin in terms of demonstrating the solderability of a surface - a test which gives either a false positive or false negative result is not of value to the industry."

Good metrology practice and the function of these measurement standards, is to provide a common basis whereby the same results may be obtained from different testing locations.

In 2004, the IPC J-STD-002/003 committees completed a comprehensive round robin test programme involving over 30,000 individual tests to investigate the different influences of:

1) **Alloy**
2) **Surface finish**
3) **Temperature**
4) **Flux**
5) **Gauge R&R**

It was also intended to bring wetting balance force measurement and globule testing into the IPC Standard in-line with IEC Standards, and to provide Gauge R&R to the methodology.

1 Alloy:

IPC:

Solder composition shall be Sn96.5Ag3.0Cu0.5 (SAC305) per J-STD-006.
Other lead-free solder alloys may be used upon agreement between user and vendor. The composition of the solder, including contamination levels, shall be maintained during testing… with the silver and copper element levels adjusted for alloy requirements. The lead (Pb) composition shall not exceed a 0.1 weight percentage limit.

IEC:

Solder alloy containing lead

The solder shall be Sn60Pb40A, Sn63Pb37A or Sn62Pb36Ag02B (Refer to IEC 61190-1-3 alloy name).

Note: The presence of silver in the solder reduces the dissolution effect on silver containing metallization on components and therefore should be used when required by the relevant component specification.

Lead-free solder alloy

The preferred alloy composition to be used should consist of either 3,0 wt%Ag, 0,5 wt%Cu, 96,5 wt%Sn (Sn96.5Ag3.0Cu0.5) or 0,7 wt% Cu, 99,3 wt% Sn (Sn99.3Cu0.7).(Refer to IEC 61190-1-3 for alloy name)).

Note: A solder alloy consisting of 3,0 wt% to 4,0 wt% Ag, 0,5 wt% to 1,0 wt% Cu and the remainder of Sn may also be used instead of Sn96.5Ag3.0Cu0.5. The solder alloys consist of 0,45 wt% to 0,9 wt% Cu and the remainder of Sn may be used instead of Sn99.3Cu0.7.

Solder mass for solder globule wetting balance method

For the solder globule wetting balance method, the solder shall be in the form of pellets or cut wire with a mass of:

Pin diameter (mm)	Pellet mass (mg)	Pellet mass tolerance (mg)
1	5	±1
2	25	±2.5
3.2	100	±10
4	200	±10

NOTE: Concoat Systems MUST System II+ is delivered including all 4 globules. The 1mm Globule is intended for use with 0402 and 0201 components.

2 Surface Finish:

There is no difference in the components used in lead-free processes, only the surface finish, consequently we do not need to change our MUST tables. However, there are Table changes that have been implemented in the IEC Standards that are:

Table 1 (IEC Table 3)

Recommended solder globule wetting balance test conditions

Component [a]		Dipping angle [b]	Figure	Immersion depth (mm)	Pin size (mm)	Globule weight (mg)	Remarks
Capacitors	1005 (0402)	Horizontal or Vertical	2A, 2B	0,10	2	25	
	1608 (0603)						
	2012 (0805)	Horizontal	2A		3,2 or 4	100 or 200	
	3216 (1206)				4	200	
Resistors	1005 (0402)	Horizontal	2B	0,10	2	25	
	1608 (0603)	Horizontal or Vertical	2A, 2B				
	2012 (0805)		2A,2B,2H [c]		3,2 or 4	100 or 200	
	3216 (1206)				4	200	
Tantalum capacitors, LEDs	Case sizes A [d],B,C,D	Vertical	2H [c]	0,10	4	200	
Leaded SMD	SOT 23, 25, 26, 323, 343, 353, 363	20 - 45	2D	0,10	2	25	
	SOT 89,		2F	0,20	4	200	1 outer pin only
	SOT 223, 523			0,25			
	Gull wing diode						
	Any SOIC VSO QFP, SOP		2D	0,20			Remove sufficient leads to avoid bridging between tested leads
	PLCC, SOJ	Horizontal	2E	0,10			
	QFN	Horizontal	2H [c]	0,10	2	25	Caution from bridging
	Cylindrical SMD	Horizontal or Vertical	2A , 2B	0,25	4	200	
	SOD 80	Vertical	2B	0,20	4	200	
	Any BGA,CSP or LGA [e]	Horizontal	2G	0,10	2	25	Only peripheral balls can be tested, and only test down to 1.0mm pitch

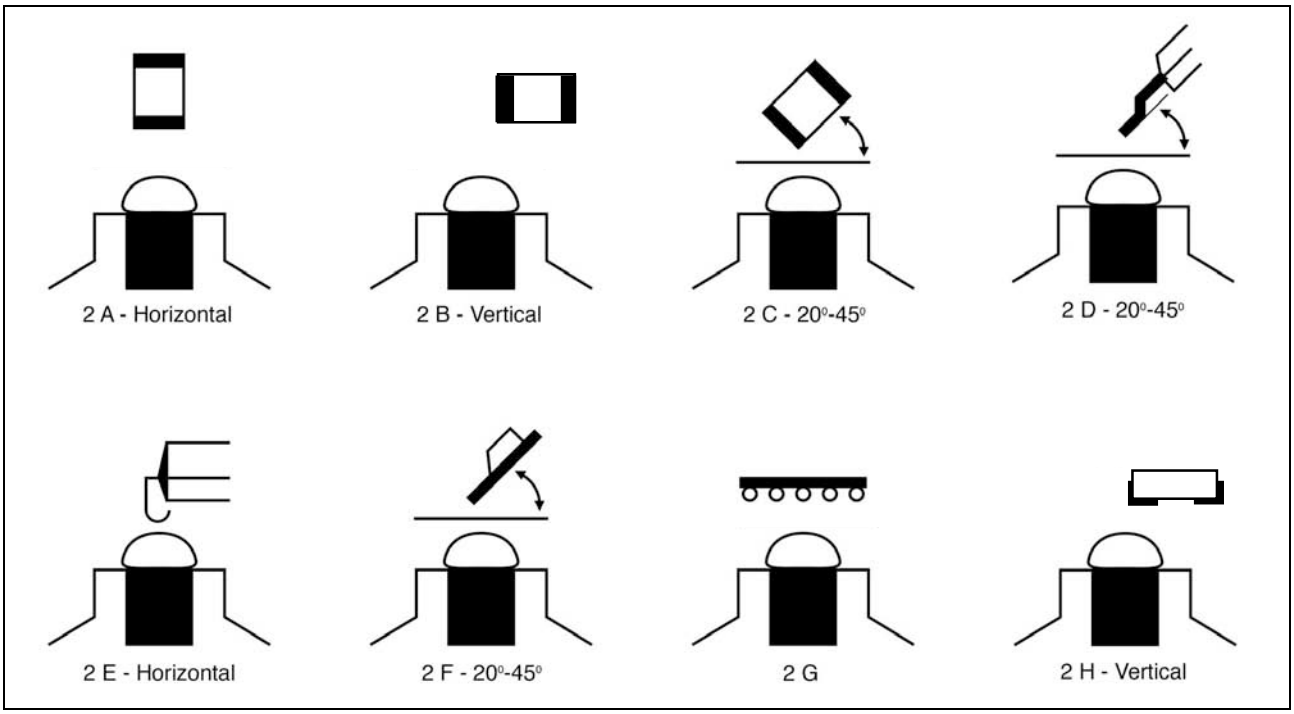
Not recommended for sizes below 1005 (0402).

Bath method is preferred for capacitors 3216 (1206) size.

The recommended dwell time is 5 s, except for SOT 89 and SOT 223 components where 10 s is recommended.

For Figure 2B, rightward offset distance from the crest of the solder globule shall be 0 % to 15 % of the pin diameter and shall avoid leftward offset.

[a] Component names in parentheses, dimensions are expressed in Imperial.
[b] Orientation of the specimen terminals or leads towards the solder surface.
[c] Figure 2H is applicable to the components which do not have electrode toward the solder surface when Figure 2B is applied.
[d] This test may only be applicable with certain test equipment.
[e] This test is recommended only for those balls and bumps that will not melt at the respective temperature and are not designed to melt during reflow operation.



3 Temperature:

IPC:

Solder Temperatures: Solderability testing shall be done at a solder temperature of 245 ± 5°C [473 ± 9°F] for Sn/Pb . A temperature of 260 ± 5°C [500 ± 9°F] shall be used for Test Method D.

IEC:

Unless otherwise specified in the relevant specification, the temperature of the solder prior to the test shall be 245 °C ± 3 °C for Sn96.5Ag3.0Cu0.5 solder and 250 °C ± 3 °C for Sn99.3Cu0.7 solder.

The following test temperatures are also under consideration: 225 °C, 235°C, 245°C and 250°C.

4 Flux:

IPC:

A new flux, Actiec 5, improved the overall test variability over the results obtained using the "R" (SMNA) flux for a wide variety of finishes the industry is, or was, using.

IEC:

The flux used for the test shall be either rosin based or carboxylic acid based. The rosin based flux is either non-activated or activated. The carboxylic acid based flux is either water solution or alcohol solution.

Rosin based flux

Non-activated: consist of 25 wt % colophony in 75 wt % of 2-propanol (isopropanol) or of ethyl alcohol (as specified in Appendix C of IEC 60068-2-20).

SMNA - Activated flux: the activated flux which is above flux with the addition of diethylammonium chloride (analytical reagent grade), up to amount of 0,2 % or 0,5 % chloride (expressed as free chlorine based on the colophony content).

Carboxylic acid based flux

water solution: consist of 90,1% De-ionised Water, 5,0% Glycol Ester (CAS No.34590-94-8) 1,6% Adipic Acid, 1,6% Succinic Acid, 1,6% Glutaric Acid and 0,1% alcohol ethoxylate surfactant (CAS no 68131-39–5).

Actiec 2 or Actiec 5 - alcohol solution: consist of 94% Propan-2-ol, 1,5% Adipic Acid, 1,5% Succinic Acid, 1,5% Glutaric Acid and 1,5% Rosin.

5 Gauge R&R:

IPC:

Users who might actually believe that the "Dip & Look" methodology has a respectable Gauge R&R would be in for an extreme shock. The IPC committees have also voted that no new solderability test methods will be introduced into the standards without a demonstrated, industry acceptable Gauge R&R value."

IEC:

This is not presently included in the IEC Standards but, as the committee have agreed that we shall commence a further revision within 2 years, instead of the normal 5 years, it is something that will be included at that time.

IMPORTANT

When switching to Lead-Free, even the smallest amount of lead (Levels as low as 0.01% of Lead (Pb)) will pollute your tests and produce inaccurate data.

As many customers will undoubtedly need to run comparative data sets with both types of alloy, Concoat Systems now provide colour-coded solder baths and globules, so as to minimise the risk of polluted tests.

In addition, the software has been further updated to permit up to 8 globules and 2 solder baths to be used on the same instrument.

If you have a MUST System II+ having a Serial Number after 2069, then we can offer to upgrade your system to the very latest software and hardware versions.

Lead-Free Accessories Kits	Lead-Free Bath & Globule Set
	
Windows XP / Lead-Free Upgrade	Bath & Globule Set (SnPb)
	

We hope that this information will be useful to you, and that if you have any questions you will not hesitate to contact us:

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Measuring Electronics Reliability