



# RP15

**High Speed Printing and Dispensable No-Clean Solder Paste**

## **ENGINEERS' MANUAL**

*Product specifications, applications notes and test reports*

EM728 05/02

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## Main Features:

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- **High Print Speed Range (20-150mm Sec<sup>-1</sup>)**
  - **Dispensable Grade Available**
  - **Anti-tombstoning Alloy Option Available**
  - **Suitable for Fine Pitch Applications (0.4mm)**
  - **Suitable for Enclosed Squeegee Printers**
  - **Long Open and Abandon Times**
  - **IPC Type-L No Clean, J-Std-004 Type ROL1**
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<b>1</b>	<b>TECHNICAL SPECIFICATIONS</b>	
Typical Physical Properties		1.1
Standards Testing		1.2
Packaging Options		1.3
<b>2</b>	<b>GOOD WORKING PRACTICES</b>	
Storage		2.1
Before Use		2.2
Working Environment		2.3
Stirring		2.4
Thinning		2.5
Paste Life		2.6
Disposal		2.7
Cleaning		2.8
<b>3</b>	<b>APPLICATION NOTES</b>	
Stencil Types		3.1
Squeegee Blades		3.2
Printer Types		3.3
Print Speeds		3.4
Print Definition		3.5
Open and Abandon Time		3.6
Enclosed Squeegee Printing		3.7
Dispensing		3.8
Re-Flow – Air		3.9
Re-Flow - Nitrogen		3.10
<b>4</b>	<b>TROUBLESHOOTING</b>	
Printing		4.1
Dispensing		4.2
Re-Flow		4.3
<b>5</b>	<b>LABORATORY REPORTS</b>	
BELLCORE TR-NWT-000078		5.1
IPC-SF-818		5.2
J-STD-004		5.3
J-STD-005		5.4
<b>6</b>	<b>MATERIAL SAFETY DATA SHEET</b>	6.1

## Typical Physical Properties

1.1

Multicore RP15 solder paste has been developed to meet the demand for a type L flux with a wide solderability range. RP15 also has excellent print characteristics, and the unique flux medium has been designed to resist moisture absorption, thus ensuring long open and abandon times and eliminating solder beading tendency. The stable resin system and high boiling point solvents produce an inoffensive odour during re-flow. Typical properties of selected RP15 solder pastes are as follows. Full details of test methods are available on request.

Alloy		Sn62, Sn63			63S4 (Anti-tombstoning)
Metal Content %		85	89.5	90	89.5
Powder Particle size	µm	45-25			45-15mm
	code	AGS			ACP
Viscosity, 25°C					
Brookfield, KcP(1)		400	670	740	660
Malcom, P(2)		560	1,500	1,750	1400
Thixotropic index (3)		0.6	0.68	0.65	0.70
Slump, (4) IIV test method, mm					
1 hour, room temp.					
0.7mm pads		0.2	0.2	0.2	0.2
1.5mm pads		0.2	0.2	0.2	0.2
80°C, 20 minutes					
0.7mm pads		0.5	0.2	0.2	0.2
1.5mm pads		0.5	0.3	0.2	0.2
Tack (5)					
Initial tack force, g mm <sup>-2</sup>		1.36	-	1.62	1.46
Useful open time, h		>48		>48	>48

(1) Measured at 25°C, TF spindle at 5 rpm after 2 minutes

(2) Measured at 25°C and a shear rate of 6s<sup>-1</sup>

(3) The Thixotropic Index (TI) is defined as: TI = log (viscosity at 1.8s<sup>-1</sup>/viscosity at 18s<sup>-1</sup>)

(4) The slump data are expressed as the minimum spacing between pads of the size shown that does not allow bridging

(5) Tack data are derived from comparative laboratory tests and do not necessarily relate directly to particular user conditions.

PRODUCTS FOR STENCIL PRINTING			
Solder Powder Particle Size		45-25mm	45-15mm
Code	Multicore	AGS	ACP (Anti-tombstoning)
	J-STD-005	Type 3	-
Metal Content (%)		89.5	90
Viscosity (cP) ±10%		670,000	740,000
			660,000

PRODUCTS FOR DISPENSING		
Solder Powder Particle Size		45-25mm
Code	Multicore	AGS
	J-STD-005	Type 3
Metal Content (%)		85
Viscosity (cP) ±10%		400,000

### Solder Alloy Options:

RP15 is available in either SN62 (2% Ag) alloy, or SN63 (63/37). The alloy used in RP15 conforms to the purity requirements of J-STD-006 and all other relevant international standards.

### Anti-Tombstoning Alloy:

Where tombstoning is a process problem, the 63S4 alloy version of RP15 might offer an instant solution. By blending slightly different melting temperature alloys in a special mix of solder particle sizes, the 63S4 alloy artificially extends the liquidus time of the paste and can overcome the unusual surface tension forces during re-flow that lead to tombstoning defects.

### Particle Size:

RP15 is available using 45-25µm (AGS) and 45-15µm (ACP – Anti-tombstone) range solder powder. Careful control of solder powder manufacturing processes ensure the particles are 97% spherical (aspect ratio < 1.5), and that the alloy contains a typical maximum oxide level of 80ppm (expressed as oxygen in the solder).

Metal Content:

Best results have been achieved using either 89.5 or 90% metal contents, depending on the printer type being used. For enclosed squeegee printers 90% metal content is recommended and that the paste be packed air-free also. For dispensing applications, a metal content of 85% is recommended.

Standards Testing

1.2

Multicore RP15 contains a stable resin system and solvents with high boiling points. The flux has been formulated to meet the requirements of IPC (type LR3CN), J-STD-004 (type ROL1) and the Bellcore TR-NWT-000078 specifications.

Test	Specification	Results
Corrosion	DTD 599A IPC-SF-818 BS5625	Pass
Copper Mirror Corrosion	IPC-SF-818	Pass
Surface Insulation Resistance (without cleaning)	IPC-SF-819 J-STD-004 Bellcore TR-NWT-00007	Pass
Electromigration (without cleaning)	Bellcore TR-NWT-000078	Pass
Flux Activity Classification	IPC-SF-818 J-STD-004 EN 29454	LR3CN ROL1 1.1.2

Packaging Options

1.3

Multicore RP15 solder pastes are supplied in:

- 1 kg, 500g or 250g plastic jars with an insert to seal off the surface of the paste
- 1 kg, 650g or 500g vacuum filled cartridges for direct application
- 750g Proflow cassettes
- 10, 25 and 75g dispensing cartridges

Other forms of packaging may be available on request.

## Storage 2.1

It is recommended that RP15 be stored at a temperature of between 5 and 10°C to minimise solvent evaporation and reduce chemical activity during storage. RP15 can be stored at room temperature (20 – 25°C) for up to four weeks without causing deterioration if necessary though. RP15 stored in a sealed container at between 5 and 10°C can be expected to remain within spec for at least six months.

## Before Use 2.2

RP15 must be allowed to return to room temperature before use. Failure to do this may result in condensation forming on the paste. This will adversely affect the performance during printing and/or re-flow. Always allow refrigerated paste around 6 – 8 hrs to return to room temperature before use.

## Working Environment 2.3

RP15 performs best when used in a controlled environment. Maintaining an ambient temperature of between 20 and 25°C at a relative humidity of less than 55% will ensure consistent performance and maximum life of the paste.

## Stirring 2.4

To restore fresh RP15 paste to its specified rheology, it can be stirred gently for 15 – 30 seconds before being applied to the printer. Always use a non metallic or round edged spatula to avoid accidentally scratching particles off the inside of the container. RP15 dispensed from a cartridge does not require stirring as the rheology is restored during the dispensing process.

## Thinning 2.5

RP15 cannot be restored by adding thinners. The addition of any such material to the paste will alter the rheology and the paste will be damaged. If the paste fails to perform to the specifications then it has been damaged and should be disposed of.

## Paste Life 2.6

As a general rule, paste that has been in use for more than 8 hrs should be disposed of. Paste which has been on the printer for up to 4 hrs can be stored at room temperature for up to 24 hrs before being re-used. Always store used paste in a separate container. Do not mix fresh paste with used paste unless adding more to the printer itself. RP15 paste which has exceeded the specified shelf life may still be used after passing a simple coalescence test, or until a deterioration in performance can be detected.

A simple coalescence test can quickly determine the condition of solder paste after prolonged use. Simply print a small disk of paste onto a non-wettable substrate (around 4-5mm diameter and 0.2mm thick – a business card with a hole from a standard paper hole punch makes a good stencil), and re-flow as normal. Suitable non-wettable substrates include glass microscope slides and solder mask on PCBs. A single solder ball in a clear pool of residue indicates good coalescing ability. Numerous solder balls remaining in the flux residue pool indicates poor coalescing ability and the paste may have become damaged. Note this is not an absolute test of the condition of the paste. It is only a first-line check and should only be used to confirm paste failures.

## Disposal 2.7

Used RP15 should be stored in a sealed container and disposed of in accordance with local authority requirements.

## Cleaning 2.8

RP15 paste can be cleaned using aqueous or solvent type cleaners. It is recommended that all equipment is cleaned and dried thoroughly immediately after use. For best results, scrubbing in the solution by either ultrasonic action or brush will ensure all solder particles are completely removed.

## Stencil Types

3.1

Like all solder pastes, RP15 will perform best when used with good quality stencils and printing equipment. RP15 has been used successfully with chemically etched, electroformed and laser cut stencils.

## Squeegee Blades

3.2

Steel squeegee blades angled at 60° give the best print definition and correct squeegee pressure adjustment will leave a relatively clean stencil after each print pass. High squeegee pressures are not required making RP15 suitable for second side printing processes. RP15 releases from the blade well after lift-off, especially if the lift-off occurs immediately after each print pass.

## Printer Types

3.3

A wide variety of printer types have been used including manual, semi-automatic and fully automatic printers. Vertical stencil lift types allow best performance, especially when printing fine pitch (0.4mm), however RP15 has performed well on clamshell types also.

## Print Speeds

3.4

RP15 performs best at print speeds between 20mm/sec and 150mm/sec. Lower speeds will result in poor rolling in front of the squeegee and can cause skipping over stencil apertures.

## Print Definition

3.5

Print definition is high and slumping at room temperature is virtually non-existent. Tack qualities are high even after extended open time. RP15 should remain visibly moist throughout the entire printing and placement process.

## Open & Abandon Time

3.6

Tests have proven that RP15 will perform during continuous printing for up to 8 hrs. Field tests have shown that an abandon time of at least 1 hr is possible, resulting in a perfect 1st pass print on resumption of printing.

## Enclosed Squeegee Printing

3.7

RP15 has been tested and approved for use with most common enclosed squeegee printer systems. It is recommended that the paste have a 90% metal content, and that it be packaged air-free. Please request this if required when ordering.

## Dispensing

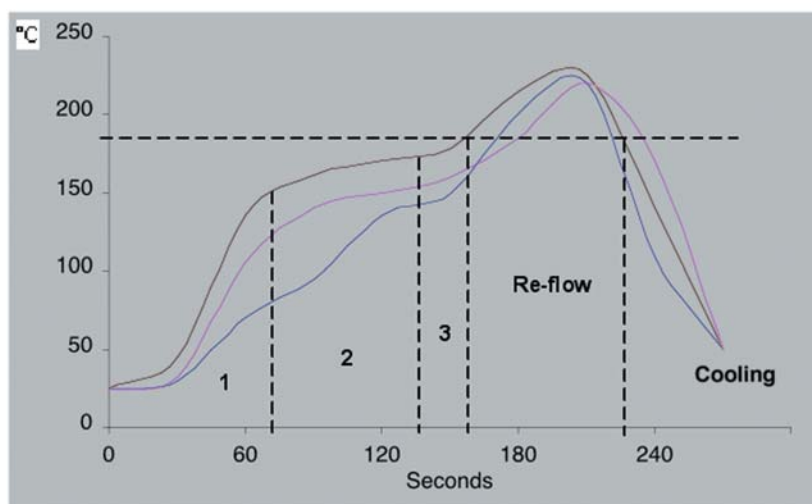
3.8

The dispensing grade of RP15 is suitable for use with 22 gauge needles or larger, and with most popular dispensing equipment types. It is essential that the dispensing mechanism and needles are clean and in good condition. Regular cleaning of the dispensing equipment is recommended before and immediately after use to prevent contamination with dry solder paste. Even relatively small amounts of contamination in the dispensing equipment and needles will cause inconsistent deposit volumes and even complete system blockage.

## Re-Flow - Air

3.9

The following is purely a recommended re-flow profile for a forced air convection re-flow process, and should be used only as a guide to enable the initial setting up of the re-flow oven. The final setting up of a re-flow profile is always determined by the characteristics of the PCB, the components placed upon it, and the oven itself. RP15 solder pastes have been formulated for re-flow in air over a wide range of temperature profiles. The diagram below shows a range of re-flow profiles that have been used successfully for RP15 formulated with Sn62, Sn63 and 63S4 anti-tombstoning alloys.



**Recommended Re-Flow Profile Range – Forced Air Convection Oven**

## Ramp 1

The maximum slope for this zone should be limited to 2°C / sec. Faster heating than this may cause premature slump and lead to excessive solder balling.

## Ramp 2

Preheat should range between 100-160°C over a period of 90-150 sec depending on the characteristics of the PCB, components, and the thermal characteristics of the oven. The minimum preheat here should be selected to give acceptable peak delta temperatures across the board.

## Ramp 3

Time in this zone should be kept to below 30 sec to reduce the risk of solder ball problems. The ramp up rate should be 2.5-3°C / sec from 150°C to re-flow at 179°C (SN62 Alloy). It is important that the flux medium retains its activity during this phase to ensure the complete coalescence of the solder particles during re-flow.

## Re-flow

The peak re-flow temp should be between 210-225°C (PCB design, oven type, etc. considered). The time at this peak is not critical, however the total time above re-flow is very important and should typically be 40-60 sec for RP15 paste. This period determines the appearance of the solder joints. Excessive time above re-flow may cause a dull finish and charred flux residues. Insufficient time at re-flow may lead to poor wetting.

## Cooling

Cooling at a rate of 3°C / sec is recommended. More rapid cooling could cause damage to the PCB or components, and cooling at a slower rate will increase the likelihood of a crystalline appearance of the solder joints.

## Re-flow - Nitrogen

**3.9**

RP15 has been successfully re-flowed in inert nitrogen atmospheres and produces good wetting, shiny solder joints and minimal low colour residues. A particularly low incidence of solder beading is achievable when re-flowing in Nitrogen. Note that due to the superior wetting in Nitrogen, tombstoning tendencies may increase.

## Pin Testability

**3.10**

RP15 residues are designed to be 'brittle' and tend to shatter easily during pin testing. With correct probe design, field tests have shown low test-pin contamination with very high 1st pass yields.

## 4.1 Troubleshooting Printing

*Most SMT assembly defects can be traced back to print process faults. Care taken during the printing stage will ensure maximum yields during and after re-flow*

PROCESS	PROBLEM	POSSIBLE CAUSES	SUGGESTED REMEDIES	PREVENTATIVE ACTION
PRINTING (OPEN SQUEEGEE)	Paste does not roll consistently in front of squeegee blade	Insufficient or excess paste on the printer	A rolling action in front of the squeegee blade is necessary to ensure consistent aperture filling during printing. Check that there is sufficient paste on the printer to form a bead (8-12mm thick) extending across the width of the print area. Insufficient paste will result in the paste simply skipping or smearing across the stencil surface. Too much paste on the printer may cause the bead to accumulate up onto the blade clamp parts, and this will also prohibit a rolling action. If the distance from the blade edge to the blade clamp is less than around 15mm, the paste may tend to accumulate up on the clamp parts. Adjust the blade height if possible or try adjusting the angle of the blade to increase the blade area available for the paste to roll against.	Check paste volume on the printer regularly to ensure correct amount is present, and that the paste is rolling properly.
		Squeegee blade requires adjustment	Best results have been achieved when the blade is angled at 60° to the stencil surface. Adjust the squeegee pressure until the least amount of paste remains on the stencil after each print and without causing paste to be scoured out of the stencil apertures during printing (i.e. the top surface of the paste deposits should be as flat as possible). RP15 should leave a slightly moist residue, with only minimal solder particles being visible on the stencil surface, after each print pass.	Maintain correct squeegee angle and pressure adjustment
		Squeegee blade lift-off time, speed and/or height requires adjustment	If a double blade type print process is being used, it is necessary for the paste to drop back onto the stencil surface before the second blade commences the next print pass. See paste drop-off recommendations below.	Check and maintain squeegee lift-off parameters to ensure paste drops off correctly between print passes
		Print speed requires adjustment	RP15 performs best at print speeds of 20 –150mm/sec. Printing too slowly prohibits the paste from achieving the required rheology and this may cause skipping or smearing across the stencil surface.	Maintain print speed at between 20 mm/sec and 150mm/sec
		Stencil contamination	The stencil may have been contaminated with a cleaning solution or residue from the previous printing session. Thoroughly clean the stencil and apply fresh paste before continuing any further.	Ensure stencil is cleaned thoroughly at regular intervals
		Paste has become damaged or has expired	RP15 paste can last up to 8hr continuous printing and should withstand abandon times of up to 1hrs, however prolonged use and excessive exposure to high temperature and/or humidity will ultimately affect the rheology of the paste and printing defects will become apparent. The paste should then be removed from the printer and disposed of.	Replace paste on the printer once the stencil life time has elapsed



## 4.1 Troubleshooting Printing

*Always ensure that RP15 paste has returned to room temperature after refrigerated storage. A period of 6–8 hours may be necessary for 0.5 – 1Kg quantities.*

PROCESS	PROBLEM	POSSIBLE CAUSES	SUGGESTED REMEDIES	PREVENTATIVE ACTION
PRINTING (OPEN SQUEEGEE)	Paste does not drop off the squeegee blade properly	Blade lift-off requires adjustment	If a double blade type print process is being used, it is necessary for the paste to drop back onto the stencil surface before the second blade commences the next print pass. The “Z” axis parameters of the printer should be adjusted to ensure the blade lifts off as soon as possible after each print pass. The blade should lift perpendicular to the stencil surface and at a speed sufficient for the paste to drop easily back onto the stencil. Lift-off height should be high enough to allow the complete release of the paste from the blade, and not too high that the paste may swing excessively during the release.	Check and maintain squeegee lift-off parameters to ensure paste drops off correctly between print passes
		Print speed requires adjustment	RP15 performs best at print speeds of 20 –150mm/sec. Printing too slowly prohibits the paste from achieving the required rheology and this may cause it to remain on the squeegee blades after each print pass.	Maintain print speed at between 20 mm/sec and 150mm/sec
		Squeegee blade angle requires adjustment	Best results have been achieved when the blade is angled at 60° to the stencil surface. The steeper the blade angle, the easier the release of the paste off the blade.	Maintain optimum squeegee angle
	Paste contamination on the PCB after printing	Stencil requires cleaning	Excess paste may have found it's way onto the underside of the stencil. Thoroughly clean the stencil then resume printing.	Ensure stencil is cleaned thoroughly at regular intervals
		Poor gasketing of the stencil to the PCB surface	A poorly gasketed stencil can cause a number of printing defects – including contamination around paste deposits. Adjust the stencil pressure when placed onto the PCB to ensure best possible sealing around stencil openings. Check alignment also as paste deposited too far away from the PCB pads may cause solder balling during re-flow.	Maintain correct alignment of stencil to PCB, and correct clamping pressure
	Paste does not release properly from the stencil	Stencil apertures require cleaning	Old dried paste remaining in stencil apertures can cause the printed paste to remain in the apertures after lift off. Thoroughly clean the stencil then resume printing.	Ensure stencil is cleaned thoroughly at regular intervals
		Stencil lift off requires adjustment	The stencil should lift off the PCB as soon as possible after the print pass. A vertical lift off from the PCB is desirable – especially when printing through fine pitch apertures	Maintain correct adjustment of stencil lift-off settings
		Squeegee pressure requires adjustment	Insufficient pressure may cause poor filling of the stencil apertures. Too much paste remaining over the top surface of the stencil after the print pass may also cause the paste to remain in the apertures	Maintain correct adjustment of squeegee pressure settings

## 4.1 Troubleshooting Printing

*Solder paste print performance is determined largely by the quality and design of the stencil. Good aperture size selection and stencil manufacturing processes have a significant effect on paste print quality.*

PROCESS	PROBLEM	POSSIBLE CAUSES	SUGGESTED REMEDIES	PREVENTATIVE ACTION
PRINTING (OPEN SQUEEGEE)	Paste does not release properly from the stencil cont.	Print speed requires adjustment	RP15 paste needs to achieve a certain rheological state to enable optimum printing. Usually this is achieved through normal printing action but a slow print speed, or excessive open or abandon times may require some mixing action to restore the paste to its specified parameters.	Maintain correct adjustment of print-speed settings
		Stencil apertures poorly finished	Poorly finished laser cut stencils can cause the paste to remain in the apertures after lift off from the PCB. Non perpendicular chemically etched aperture sides may also cause the paste to hang in the openings. Carefully examine problematic stencil aperture walls and discuss with your stencil manufacturer	Only use suitable quality stencils
		Poor gasketing of the stencil to the PCB surface.	A poorly gasketed stencil can cause a number of printing defects – including poor paste adhesion to the PCB. Adjust the stencil pressure when placed onto the PCB to ensure best possible sealing around stencil openings.	Maintain correct adjustment and alignment of stencil to PCB during printing
		Stencil material too thick	If the paste tends to hang up in fine pitch apertures, the stencil material may be too thick and the aspect ratio of the holes incorrect. Thinner stencil material or step-down areas may be required. Discuss this with your stencil manufacturer.	Specify suitable stencil thickness for fine pitch applications
		Paste has become damaged or has expired	RP15 paste can last up to 8 hours continuous printing and should withstand abandon times of up to 1 hour, however prolonged use and excessive exposure to high temperature and/or humidity will ultimately affect the rheology of the paste and printing defects will become apparent. The paste should then be removed from the printer and disposed of.	Monitor paste time on stencil. Carry out coalescence test (see section 22.6)
	Paste deposits poorly defined	Stencil requires cleaning	Old or dried out paste may remain in the stencil apertures. Thoroughly clean the stencil then resume printing.	Ensure stencil is cleaned thoroughly at regular intervals

## 4.2/3 Troubleshooting Printing, Dispensing and Re-flow

PROCESS	PROBLEM	POSSIBLE CAUSES	SUGGESTED REMEDIES	PREVENTATIVE ACTION
PRINTING (OPEN SQUEEGEE)	Paste deposits poorly defined cont.	Stencil apertures poorly finished	A poorly manufactured stencil will of course produce poorly defined paste deposits. Carefully inspect the stencil openings and if poor registration or finish is evident, discuss with your stencil manufacturer.	Only use suitable quality stencils
		Squeegee pressure requires adjustment	Poor paste definition may be due to incorrect squeegee pressure. Excessive pressure may cause scouring of paste from the apertures whereas too little pressure can lead excess paste on the top side of the stencil and this will cause the paste to hang in the aperture.	Maintain correct adjustment of squeegee pressure settings
		Print speed requires adjustment	The paste may have failed to achieve the correct rheological properties due to incorrect print speed. Adjust print speed to achieve optimum result. Keep within the 20-150 mm/sec range.	Maintain correct adjustment of print-speed settings
PRINTING (ENCLOSED HEAD)	Incomplete aperture filling	Insufficient print speeds	Maintain print speed at 100-150mm Sec <sup>-1</sup>	Maintain optimum print speed
	Poor print definition	Insufficient internal head pressure	Increase internal head pressure until print definition is acceptable.	Maintain optimum internal head pressure
DISPENSING	Missed/skipped dots	Nozzle blockage	Paste in poor condition or contaminated equipment can lead to compaction within the nozzle. Clean all parts thoroughly, and use fresh paste.	Thoroughly clean nozzle parts regularly.
		Nozzle blockage	The bore size of the nozzle may be too low. While RP15 has been tested to reliably dispense through 22swg (0.41mm dia) nozzles, some applications may allow even smaller bore sizes yet others might require >22swg dia nozzles. If blocking recurs, increase nozzle bore size and re-configure the dispensing system.	Select appropriate dispensing nozzle bore diameter
	Separation of paste in cartridge	Old or incorrectly stored paste	RP15 is specially formulated and packaged to ensure the solder and flux do not separate inside the cartridge. Always check the shelf life dates on the cartridge before use, and ensure the paste has been stored at between 5 and 10°C. Allow the paste to return to normal room temperature before use also.	Store at 5-10°C and allow the paste to return to room temperature before use.
RE-FLOW	Solder joints appear to be poorly wetted	Insufficient heat during re-flow	A poorly wetted solder joint is usually caused by too little time above re-flow. The flux in RP15 requires sufficient time to prepare both surfaces for the molten solder to create the intermetallic bond necessary during re-flow. If the time above re-flow is too short, the flux may not have had enough time to perform this function. Increase the re-flow period as above and re-check the wetting. Also, the thermal requirements of either the PCB or the component may be greater than the process is achieving. Check the temperature profile for this particular solder joint and adjust to achieve the recommended temperatures.	Maintain optimum temperature profile

### 4.3 Troubleshooting Re-Flow

*When diagnosing re-flow faults, it is important that accurate temperature measurements can be made - at the joint in question. Temperatures can vary across most PCB assemblies. Always measure temperatures on a normally populated PCB assembly during the re-flow process to achieve an accurate re-flow profile*

PROCESS	PROBLEM	POSSIBLE CAUSES	SUGGESTED REMEDIES	PREVENTATIVE ACTION
RE-FLOW	Solder joints appear to be poorly wetted cont	Poor solderability surfaces	Observe where the poor wetting is occurring. If the component has not wetted correctly, check any other same components on the PCB for wetting also. If all same components exhibit poor wetting, contact your component supplier and request solderability specifications. Alternatively it may be necessary to use a higher activity paste. Contact your paste supplier to discuss. If the PCB appears to show poor wetting, a number of solderability issues may cause this. Old or poorly stored PCBs could have low solderability. Some special plating materials (e.g. gold flash over nickel) can become difficult to solder – especially if the gold plating is poor quality or porous. Damaged OSP coatings can also lead to poor solderability problems. If the PCB has already been exposed to thermal cycles (such as a SMT adhesive cure cycle), the OSP could have failed and allowed the wettable surfaces to oxidise. In extreme cases, carry out solderability tests on the PCB and discuss with your supplier. Also consult your paste supplier to explore higher activity flux options	Always specify quality finishes on PCBs and components. Store and handle PCB's and components carefully, in dry conditions
	Dewetting on soldered surfaces	Excessive heat	Dewetting can occur during re-flow where excessive heat has been applied. The effect of rapid intermetallic formation can cause the solder to retreat from an already wetted surface – especially if the flux has been damaged prior to the cooling phase. Check the peak re-flow temperature, and time in re-flow, and adjust as recommended.	Maintain optimum temperature profile
		Dewetting already present on the PCB	Check the PCB surface prior to assembly. HASL boards can sometimes show signs of dewetting. Discuss with your PCB supplier.	Always specify quality finishes on PCBs
	Dull solder joints	Excessive heat causing flux to become exhausted	RP15 should produce shiny looking solder joints with minimal low colour residues. A dull finish can be caused by too much heat being applied during re-flow, which destroys the protective qualities of the flux and allows the molten solder to oxidise. Check the peak re-flow temperature, time in re-flow and the ramp up to re-flow period to ensure the correct amount of temperature is applied throughout the re-flow process.	Maintain optimum temperature profile
		Slow cooling causing crystalline structure in solder joints	If the solder joint is not cooled quickly enough, a metallic crystalline structure can develop within the solder joint. Usually caused by extended high temperature. Check all the parameters as above.	Maintain optimum temperature profile

4.3 Troubleshooting Re-Flow

When setting up a re-flow profile, it is important to make adjustments to only one parameter at a time, and observe the effects of the changes thoroughly before making the next adjustment. Always document the results of each change so that an upper and lower limit of each parameter can be established.

PROCESS	PROBLEM	POSSIBLE CAUSES	SUGGESTED REMEDIES	PREVENTATIVE ACTION
RE-FLOW	Mid-Chip beading	Excess paste applied to the PCB	Most beading faults can be traced back to the printing process. The size of the apertures may need to be reduced so that a lower volume of paste is deposited on the pad. RP15 has excellent stencil release characteristics and this may exacerbate the problem when switching from another paste type. Check the recommended pad : aperture ratio for each component.	Specify correct stencil geometry
		High component placement pressure	Excessive placement pressure can cause the deposited paste to squeeze under the component. As the paste approaches re-flow and the component settles onto the wetted pads, the displaced solder may not be able to return to the pads and is forced out the side of the component. Check placement machine settings and adjust if possible. Alternatively reduce the amount of paste deposited as above.	Optimise placement pressure and maintain correct volume of paste applied to the PCB pads
		Poor stencil alignment	Mis-registration of the stencil during printing may cause poor gasketing and/or incorrect placement of paste onto the solder mask. Check alignment and adjust if required.	Maintain correct alignment of stencil to PCB, and correct clamping pressure
		Paste contamination on underside of stencil	If the underside of the stencil has been contaminated by paste during printing, this will be transferred onto the PCB and lead to beading or balling defects during re-flow. Excessive squeegee pressure can lead to under-side contamination also. Clean the underside of the stencil, check alignment and squeegee pressure , then resume printing.	Ensure stencil is cleaned thoroughly at regular intervals and maintain optimum squeegee pressure
		Expired or damaged solder paste	Prolonged use on the printer may cause the paste to deteriorate. Test the paste for coalescence by carrying out the simple test previously referred to in section 2.6.	Monitor paste time on stencil. Carry out coalescence test (see section 2.6)
	Solder Balling	Re-flow profile requires adjustment	A ramp up to re-flow which is too steep could cause outgassing and spitting which might carry solder particles too far away from the wettable surfaces. It may be necessary to extend the ramp up to re-flow so that more of the volatiles are released from the paste. Take care not to destroy the flux however.	Maintain optimum temperature profile
		See solder beading above	Solder balls are distinct from beads referred to above in that they are usually smaller and tend to appear at random around the periphery, or within the flux residue pool of the solder joint. The three main causes are stencil contamination, damaged solder paste, or re-flow issues. Poor coalescence during re-flow can be due to insufficient time during re-flow to allow all the molten particles to join the main solder mass. Check the re-flow temperature and time in re-flow and adjust to the recommended settings.	Maintain optimum temperature profile, ensure stencil is cleaned regularly and check paste condition (see section 2.6)

### 4.3 Troubleshooting Re-Flow

PROCESS	PROBLEM	POSSIBLE CAUSES	SUGGESTED REMEDIES	PREVENTATIVE ACTION
RE-FLOW	Bridging between adjacent solder joints	Excess paste applied to the PCB	The main causes of bridging are most often print-process related and are similar to those of mid-chip beading. Refer to previous comments (mid-chip beading).	Specify correct stencil geometry
		Poorly aligned components during placement	Poor alignment may cause the paste to be dragged away from the pad area and this might lead to bridging during re-flow. Check the placement and adjust.	Optimise component placement settings
		Paste contamination on underside of stencil	If the underside of the stencil has been contaminated by paste during printing, this will be transferred onto the PCB and lead to beading or balling defects during re-flow. Excessive squeegee pressure can lead to under-side contamination also. Clean the underside of the stencil, check alignment and squeegee pressure, then resume printing.	Ensure stencil is cleaned thoroughly at regular intervals and maintain optimum squeegee pressure
	Tombstoning (Manhattan effect)	Poor PCB design	It is essential that pad sizes remain balanced – especially at either end of a small, low mass component. If the wettable area at one end of a small component is greater than the other, the surface tension of the molten solder will flip the component up and away from the lower volume end where it will remain. Similarly if a large thermal mass is able to draw heat away from one end of a small component, the opposite end will re-flow first and again flip the component up and away from its correct position. Observe the temperatures at each end of a tombstone susceptible component and if necessary, modify the PCB design. If process adjustment cannot eliminate the tombstoning defects, changing to the 63S4 Anti-tombstoning alloy might solve the problem also.	Ensure opposite pads of each component achieve similar temperatures when designing the PCB layout.
		Inconsistent solderability	The wetting ability of opposite ends of a component, or of adjacent pads on the PCB, may vary sufficiently to cause random tombstoning. This may show that the activity level of the flux is working near its limit and either an adjustment of the re-flow profile to prolong the flux activity level as much as possible might be required, or a more active flux may be necessary. If process adjustment cannot eliminate the tombstoning defects, changing to the 63S4 Anti-tombstoning alloy might solve the problem also.	Maintain optimum temperature profile

4.3 Troubleshooting Re-Flow

PROCESS	PROBLEM	POSSIBLE CAUSES	SUGGESTED REMEDIES	PRVENTATIVE ACTION
RE-FLOW	Apparent poor coalescence of solder particles	Insufficient heat	Where extremes of thermal mass on a board can lead to the higher thermal capacity joints not actually reaching sufficient peak temperature to re-flow the paste, increase the preheat and/ or time above liquidus.	Maintain optimum temperature profile
	Apparent poor coalescence – incomplete re-flow	Excessive heat	The solder joint may appear not to have re-flowed at all, especially in fine pitch applications. This is due to the activators in the flux expiring prior to the joint reaching the solder liquidus temperature and although the particles do in fact melt, they fail to coalesce. Reduce the time above re-flow and/or the peak temperature.	Maintain optimum temperature profile

## Laboratory Report Bellcore TR-NWT-000078

5.1

Number: 9259	Security Category: 3	Author: P Hedges	Date: 15/4/98
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To: Dr M Warwick	Cs: B Watson, Anita Choo, M Brownlee, File
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References: Project 97U055	Keywords: Bellcore TR-NWT-000078 RP15
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**OFFICIAL TEST REPORT ON MULTICORE RP15 NO-CLEAN SOLDER CREAM MEDIUM TO THE BELLCORE SPECIFICATION****TESTING OF RP15 SOLDER CREAM MEDIUM TO BELL TELEPHONE SPECIFICATION TR-NWT-000078 ISSUE 3 (DECEMBER 1991)**

**Note:** Tests 13.1.1 to 13.1.3 inclusive were carried out on 35% solution of the flux in 2-propanol

**13.1.1.1 Copper Mirror Test****Method**

A copper mirror consisting of a vacuum deposited film of copper (having a thickness equivalent to  $10 \pm 5\%$  transmission of normal incident light of 5000 Ångströms) on one side of a plain sheet of transparent, polished glass, is visually checked for the presence of an excessive oxide film. This film is cleaned off by immersing the copper mirror in a 5% solution of the disodium salt of ethylenediamine tetraacetic acid (EDTA). The mirror is then washed thoroughly in running deionised water and immersed in clean ethanol prior to drying with clean, oil-free air. The mirror can then be used if no oxide film and no damage to the copper is visible.

One drop of approximately 0.05ml of flux under test is placed in the centre of one half of a copper mirror, not allowing the dropper to touch the surface of the mirror. On the other half of the mirror is placed 1 drop of a 35% solution of WW rosin in 99% 2-propanol. The mirror is then stored in a horizontal position (copper face-up) in a clean environment at  $23 \pm 2^\circ\text{C}$  and  $50 \pm 5\%$  relative humidity for 24 hours.

On removal from these conditions, the residues are removed from the mirror by gently agitating the mirror in clean 99% 2-propanol. The mirror is then examined visually against a white background. Any complete removal of the copper film shall be deemed a fail. Discoloration of the copper due to superficial reaction, or partial reduction of the thickness of the copper film, shall be deemed a pass. If the control fails, the test is repeated on a new mirror.

**Result**

No complete removal of the copper film was observed when RP15 was tested as above. RP15 therefore passes this test.

**13.1.1.2 Halide Test (Silver Chromate Paper Method)****Method**

One drop of approximately 0.05ml of flux under test is placed onto a strip of dry silver chromate test paper. The flux is allowed to remain for 15 seconds after which time the test paper is immersed in clean 99% 2-propanol for 15 seconds. The test paper is allowed to dry for 10 minutes.

Once dry, the test paper is visually examined for discoloration. A change in colour to off-white or yellow-white is indicative of the presence of chlorides or bromides. Such a discoloration (for example, greater than that conferred by 100ppm of chloride or 200ppm of bromide or iodide ) on both sides of the test paper shall be deemed a fail.

**Result**

No discoloration was observed on the paper when RP15 was tested as above. RP15 therefore passes this test.

**Fluoride Test****Method**

A spot test is used, utilising a zirconium-alizarin purple lake that is discoloured to yellow in the presence of fluorides. A fresh zirconium-alizarin lake is prepared in each of 3 spots of a white spot plate by adding 1 drop of each of:

- 1) Solution of 0.05g sodium alizarin sulphonate in 50ml deionised water.
- 2) Solution of 0.05g zirconium nitrate in 50ml deionised water, acidified with 10ml hydrochloric acid.
- 3) Deionised water.

One drop of the flux under test is added to each of the spots. A change in colour of the lake to yellow is an indication of the presence of fluoride.

**Result**

No colour change was noted in any of the three lakes when one drop of RP15 was added. RP15 therefore passes the fluoride test.



### 13.1.3 & 13.1.4 Insulation Resistance Test

#### Method

Six interlocking comb test patterns per flux (as below) are thoroughly cleaned with a bristle brush under running deionised water at 15.5 to 26.7°C. They are then dried with oil-free compressed air; dipped in 99% 2-propanol; dried with oil-free compressed air and then dried in an oven at 49 to 60°C for 1 hour.



The boards are separated into two groups of three. Group A is left unprinted and unsoldered. The cream under test is printed over the conductors of the remaining three combs (sample group B) to give a deposit thickness of approximately 150nm, using a screen printer and suitable screen with the comb image. Each test pattern is then passed through an infra red re-flow oven to re-flow the cream and form the final test piece (see enclosed temperature profile). If any solder bridging of the conductors occurs the patterns shall be discarded and a replacement prepared (3 patterns per sample group shall be tested).

Tinned conductors are soldered to the land areas of all the patterns using WW rosin (or a 35% solution of WW rosin in 99% 2-propanol) and a 25 to 40W soldering iron. The patterns should be shielded from flux spitting (not allowing the shield to touch the pattern). The flux should not spread onto the test pattern and shall not be removed.

The insulation resistance test is performed on all patterns. The test patterns are placed in a temperature/humidity chamber in a suitable rack which maintains them at least 25mm apart and does not obstruct the airflow. The rack is placed in the centre of the chamber and the connecting wires are led outside the chamber.

The chamber is closed and set to 35°C and 85% relative humidity and allowed to stabilise for 24 hours after which time the insulation resistance is measured at an applied voltage of 100V DC for 1 minute. A bias of 50V DC is then applied to all parallel conductors during the entire conditioning period. Terminals 2 and 4 shall be at one potential, Terminals 1, 3 and 5 at the opposite.

After 4 days, the bias is removed and the insulation resistance measured (under test conditions) using an applied voltage of 100V DC for 1 minute with the polarity opposite to that when conditioning.

The test results are averaged for each group, omitting data which are manifestly erroneous, indicating PCB damage or contamination etc. (as allowed by Paragraph 13.1.4.2.8 of the test method).

As a guide, acceptable measurements should fall within a decade range. At least 10 of the 12 measurements must be valid or the test shall be repeated. Any invalid results shall be reported and possible reasons for erroneous measurements given.

The average insulation resistance for each group shall be greater than  $1 \times 10^5 \text{ M}\Omega$ .

The average insulation resistance ( $IR_{avg}$ ) is calculated from:

$$IR_{avg} = 10 \exp \left( \frac{1}{n} \sum_{i=1}^n \log IR_i \right)$$

where  $n$  = number of test points (12 nominally)

$IR_i$  = individual insulation resistance measurement

After electrical measurements the test pieces are removed from the chamber and visually examined. Discoloration of the patterns (green, blue-green, blue or blue-black coloration of the conductors) shall be deemed a failure.

#### Conditions used:

Cream designation: Sn62RP15AGS90  
 Batch number: 1070660  
 Weight cream deposited: 0.21 g/comb  
 Print thickness: 170µm  
 Re-flow oven: BTU K99  
 Belt speed: 35 in/min  
 Temperature settings: See profile

## Results

GROUP	BOARD	TEST POINT	INITIAL SIR (24h at 35°C 85% RH no bias) $\Omega$	AVERAGE SIR (of all 12 readings) $\Omega$	AGED SIR (96h at 35°C 85% RH 50V bias) $\Omega$	AVERAGE SIR (of all 12 readings) $\Omega$
A CONTROL	1	1-2	$5.5 \times 10^{10}$	$4.8 \times 10^{10}$	$5.4 \times 10^{10}$	$1.0 \times 10^{11}$
		2-3	$1.1 \times 10^{10}$		$6.2 \times 10^{10}$	
		3-4	$9.5 \times 10^9$		$5.3 \times 10^{10}$	
		4-5	$9.6 \times 10^9$		$3.1 \times 10^{10}$	
	2	1-2	$4.9 \times 10^{11}$		$2.4 \times 10^{11}$	
		2-3	$7.5 \times 10^{11}$		$2.3 \times 10^{11}$	
		3-4	$1.4 \times 10^{11}$		$2.1 \times 10^{11}$	
		4-5	$2.5 \times 10^{11}$		$2.6 \times 10^{11}$	
	3	1-2	$2.0 \times 10^{11}$		$3.9 \times 10^{10}$	
		2-3	$1.3 \times 10^{10}$		$2.5 \times 10^{10}$	
		3-4	$1.0 \times 10^{10}$		$3.8 \times 10^{10}$	
		4-5	$1.3 \times 10^{11}$		$1.6 \times 10^{11}$	
B PRINTED AND RE-FLOWED	4	1-2	$1.9 \times 10^{11}$	$9.2 \times 10^{10}$	$2.9 \times 10^{11}$	$3.6 \times 10^{11}$ (Passmark = $1.0 \times 10^{11}$ )
		2-3	$7.0 \times 10^{11}$		$2.8 \times 10^{11}$	
		3-4	$4.5 \times 10^{11}$		$3.5 \times 10^{11}$	
		4-5	$5.8 \times 10^{10}$		$3.9 \times 10^{11}$	
	5	1-2	$1.4 \times 10^{10}$		$4.8 \times 10^{11}$	
		2-3	$2.1 \times 10^{11}$		$4.4 \times 10^{11}$	
		3-4	$1.2 \times 10^{11}$		$5.1 \times 10^{11}$	
		4-5	$3.2 \times 10^{11}$		$4.4 \times 10^{11}$	
	6	1-2	$3.6 \times 10^{10}$		$3.1 \times 10^{11}$	
		2-3	$7.5 \times 10^{10}$		$3.4 \times 10^{11}$	
		3-4	$2.5 \times 10^{10}$		$2.5 \times 10^{11}$	
		4-5	$1.4 \times 10^{10}$		$3.2 \times 10^{11}$	

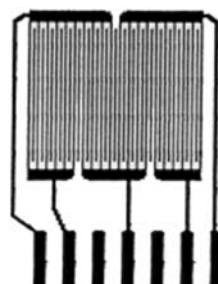
No visible discoloration or corrosion was observed on any of the test combs.

Thus RP15 passes this test.

### 13.1.3 & 13.1.5 Electromigration Resistance Test

#### Method

Six interlocking comb test patterns per flux (IPC-B-25 type E as below) are thoroughly cleaned with a bristle brush under running deionised water at 15.5 to 26.7°C (60 to 80°F). They are then dried with oil-free compressed air; dipped in 99% 2-propanol; dried with oil-free compressed air and then dried in an oven at 55°C for 3 hours.



The boards are separated into two groups of three. Group A is left unprinted and unsoldered. The cream under test is printed over the conductors of the remaining three combs (sample group B) to give a wet print thickness of approximately 150µm, using a screen printer and suitable screen with the comb image. Each test pattern is then passed through an infra red re-flow oven to re-flow the cream and form the final test piece (see enclosed temperature profile). If any solder bridging of the conductors occurs the patterns shall be discarded and a replacement prepared (3 patterns per sample group shall be tested).

Tinned conductors are soldered to the land areas of all the patterns using WW rosin (or a 35% solution of WW rosin in 99% 2-propanol) and a 25 to 40W soldering iron. The patterns should be shielded from flux spitting (not allowing the shield to touch the pattern). The flux should not spread onto the test pattern and shall not be removed.

The electromigration resistance test is performed on all 6 patterns. The test patterns are placed in a temperature/humidity chamber in a suitable rack which maintains them at least 1/2" apart and does not obstruct the airflow. The rack is placed in the centre of the chamber and the patterns are led outside the chamber.

The chamber is closed and set to 85°C and 85% relative humidity and allowed to stabilise for 96 hours after which time the insulation resistance is measured at an applied voltage of 100V DC for 1 minute with 1MΩ current limiting resistors in circuit. A bias of 10V DC is then applied to all parallel conductors during the entire conditioning period. Terminals 2 and 4 shall be at one potential, Terminals 1,3 and 5 at the opposite.

After 500 hours, the bias is removed and the insulation resistance measured (under test conditions) using an applied voltage of 100V DC for 1 minute with the polarity the same as that when conditioning.

The test results are averaged for each group, allowing data to be omitted which are manifestly erroneous, indicating PCB damage or contamination etc. (as allowed by Paragraph 13.1.5.3.2 of the test method).

As a guide, acceptable measurements should fall within a decade range. At least 10 of the 12 measurements must be valid or the test shall be repeated. Any invalid results shall be reported and possible reasons for erroneous measurements given.

The average insulation resistance for each group shall not degrade by more than a decade as a result of the applied bias.

$$IR_{final} \geq \frac{9 \times IR_{initial}}{10}$$

The average insulation resistance ( $IR_{avg}$ ) is calculated from:

$$IR_{avg} = 10 \exp \left( \frac{1}{n} \sum_{i=1}^n \log IR_i \right)$$

where  $n$  = number of test points (12 nominally)  
 $IR_i$  = individual insulation resistance measurement

After completion of the electromigration test, the test samples are removed from the chamber and examined at 10x magnification with back lighting. There shall be no evidence of electromigration (filament growth) that reduces conductor spacings by more than 20%.

Discoloration of the patterns (green, blue-green, blue or blue-black coloration of the conductors) shall be deemed a fail.

### Conditions used

Cream designation:	Sn62RP15AGS90
Batch number:	1070660
Weight cream deposited:	0.21 g/comb
Print thickness:	170μm
Re-flow oven:	BTU K99
Belt speed:	35 in/min
Temperature settings:	See profile

## Results

GROUP	BOARD	TEST POINT	INITIAL SIR (96h at 85°C 85% RH no bias)	AVERAGE SIR (of all 12 readings)	AGED SIR (96h at 85°C 85% RH 50V bias)	AVERAGE SIR (of all 12 readings)
			$\Omega$	$\Omega$	$\Omega$	$\Omega$
A CONTROL	1	1-2	$1.3 \times 10^{10}$	$1.4 \times 10^{10}$	$8.1 \times 10^{10}$	$8.47 \times 10^{10}$
		2-3	$7.4 \times 10^9$		$6.7 \times 10^{10}$	
		3-4	$6.5 \times 10^9$		$8.0 \times 10^{10}$	
		4-5	$1.8 \times 10^{10}$		$9.5 \times 10^{10}$	
	2	1-2	$1.4 \times 10^{10}$		$7.7 \times 10^{10}$	
		2-3	$1.6 \times 10^{10}$		$8.5 \times 10^{10}$	
		3-4	$2.4 \times 10^{10}$		$1.0 \times 10^{10}$	
		4-5	$2.4 \times 10^{10}$		$9.1 \times 10^{10}$	
	3	1-2	$2.5 \times 10^{10}$		$1.0 \times 10^{11}$	
		2-3	$1.3 \times 10^{10}$		$8.2 \times 10^{10}$	
		3-4	$1.2 \times 10^{10}$		$8.6 \times 10^{10}$	
		4-5	$1.0 \times 10^{10}$		$7.9 \times 10^{10}$	
B PRINTED AND RE-FLOWED	4	1-2	$8.6 \times 10^9$	$5.8 \times 10^9$	$1.1 \times 10^{11}$	$9.79 \times 10^{10}$ (Passmark = $1 \times 10^8$ )
		2-3	$1.0 \times 10^{10}$		$1.0 \times 10^{11}$	
		3-4	$9.8 \times 10^9$		$8.9 \times 10^{10}$	
		4-5	$5.2 \times 10^9$		$8.6 \times 10^{10}$	
	5	1-2	$4.7 \times 10^9$		$1.0 \times 10^{11}$	
		2-3	$5.6 \times 10^9$		$1.1 \times 10^{11}$	
		3-4	$7.9 \times 10^9$		$1.2 \times 10^{11}$	
		4-5	$8.6 \times 10^9$		$1.0 \times 10^{11}$	
	6	1-2	$5.2 \times 10^9$		$8.6 \times 10^{10}$	
		2-3	$3.3 \times 10^9$		$8.9 \times 10^{10}$	
		3-4	$1.9 \times 10^9$		$1.0 \times 10^{11}$	
		4-5	$6.1 \times 10^9$		$9.1 \times 10^{10}$	

No visible discoloration or corrosion was observed on any of the test combs.

Thus RP15 passes this test after 500 hours under 10V DC bias.

### Conclusion

The results show that Multicore Solder's RP15 no-clean solder cream medium passes Bell Telephones Specification TR-NWT-000078 Issue 3 (December 1991) and the flux can be deemed to be compliant and non-corrosive.

P. Hedges

Product Development Manager

Dr M. Warwick

International Director Product Development

## Laboratory Report IPC-SF-818

5.2

Number: 9260	Security Category: 3	Author: P Hedges	Date: 15/4/98
To: Dr M Warwick		Cs: Mr B Watson, File	
References: Project 97U055		Keywords: RP15 IPC-SF-818	

## OFFICIAL TEST REPORT ON MULTICORE SOLDERS RP15 HIGH SPEED PRINTING SOLDER CREAM MEDIUM TO IPC-SF-818

### TESTING OF RP15 TO ANSI/IPC-SF-818 (JANUARY 1988)

**Note:** All tests (except copper corrosion and SIR) were carried out on a 35% solution of the medium in 2-propanol.

#### 2.3.32 Flux Induced Corrosion (Copper Mirror)

##### Method

The mirror can then be used if no oxide film and no damage to the copper is visible. A copper mirror consisting of a vacuum deposited film of copper (having a thickness equivalent to  $10 \pm 5\%$  transmission of normal incident light of 5000 Ångstroms) on one side of a plain sheet of transparent, polished glass, is visually checked for the presence of an excessive oxide film. This film is cleaned off by immersing the copper mirror in a 5% solution of ethylene diamine tetraacetic acid (EDTA). The mirror is then washed thoroughly in running deionised water and immersed in clean ethanol prior to drying with clean, oil-free air.

One drop of approximately 0.05 ml of flux under test is placed in the centre of one half of a copper mirror, not allowing the dropper to touch the surface of the mirror. On the other half of the mirror is placed 1 drop of a 35% solution of WW rosin in 99% 2-propanol. The mirror is then stored in a horizontal position (copper face up) in a clean environment at  $23 \pm 2^\circ\text{C}$  and  $50 \pm 5\%$  relative humidity for 24 hours  $\pm 1/2$  hour.

On removal from these conditions, the residues are removed from the mirror by gently agitating the mirror in clean 99% 2-propanol. The mirror is then examined visually against a white background. Any complete removal of the copper film shall be deemed a fail. Discoloration of the copper due to superficial reaction, or partial reduction of the thickness of the copper film, shall be deemed a pass. If the control flux fails, the test is repeated on a new mirror.

##### Result

No complete removal of the copper film was observed when RP15 was tested as above. RP15 therefore passes this test.

#### 2.3.33 Presence of Halides in Flux (Silver Chromate Paper)

##### Method

One drop of approximately 0.05 ml of flux under test is placed onto a strip of dry silver chromate test paper. The flux is allowed to remain for 15 seconds, after which time the test paper is immersed in clean 99% 2-propanol for 15 seconds. The test paper is allowed to dry for 10 minutes. Once dry, the test paper is visually examined for discoloration. A change in colour to off-white or off-yellow is indicative of the presence of chloride or bromide. Such a discoloration (for example, greater than that conferred by 100ppm of chloride or 200ppm of bromide or iodide) on both sides of the paper shall be deemed a fail.

##### Result

No discoloration was observed on the paper when RP15 was tested as above. Therefore, RP15 passes this test.

#### 2.3.35 Halide Content

##### Method

A known weight (approximately 5 grams) of flux is pipetted into a 100 ml separatory funnel. To this is added 25 ml of chloroform, the contents are mixed by shaking, and an aliquot of 15 ml of deionised water added and shaken for 10 seconds. The funnel is allowed to stand until the layers have completely separated.

The chloroform layer is drawn off and saved for further extraction; the water layer is transferred to a 100 ml Erlenmeyer flask. The chloroform layer is extracted with two further 15 ml portions of water, each time the water extract portion being added to the Erlenmeyer flask.

##### Method

The water extracts in the Erlenmeyer flask are heated to remove any chloroform present (not allowing the temperature to exceed  $80^\circ\text{C}$ ) and cooled to room temperature. To the solution are added 2 drops of 0.03M phenolphthalein solution and then 1M sodium hydroxide until the solution turns red. 0.2M nitric acid is added dropwise until the red colour is completely gone. The solution is then diluted with deionised water to about 60 ml, 6 drops of 1M potassium dichromate added and the resulting solution titrated with standardised 0.1M silver nitrate until a red-brown end point is reached. The percentage halide as chloride is found by:

$$\frac{3.55 \times \text{volume of silver nitrate used (ml)} \times \text{molarity of silver nitrate} \times 100}{\text{mass of flux sample (g)} \times \text{percentage of solids in flux}}$$

**Result**

0.11% Halide.

**2.6.15 Flux Corrosion****Method**

A coupon of 99% pure copper of 0.020" thickness and 2" square is cut and a circular depression made in the centre to a depth of 1/8". One corner of the coupon is bent up to allow easy handling with tongs.

The test piece is degreased with acetone, immersed in 5% v/v sulphuric acid at 65°C for 1 minute and then immersed in a solution of 25% m/v ammonium persulphate at 23°C for 1 minute to etch the surface. The coupon is then rinsed under running tap water for 5 seconds before immersing in 5% v.v. sulphuric acid at 23°C. Again the coupon is rinsed for 5 seconds with tap water and then thoroughly rinsed with deionised water. Finally, the coupon is rinsed with acetone and allowed to dry in clean air.

Approximately 0.035g of solder cream medium is weighed into the depression of the coupon. Pellets of 60/40 Sn/Pb solder are degreased in acetone and a total of 1 gram weighed into the depression. The test panel is then placed on a solder bath at 235°C ± 5°C for 5 seconds to allow the solder to re-flow. The test panel is then heated to 40°C for 30 minutes prior to placing vertically in a humidity chamber at 40°C and 93 ± 2% relative humidity. Panels are removed from these conditions after 3 and 10 days.

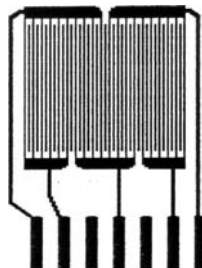
Once removed, the panels are inspected under 20X magnification for evidence of corrosion, i.e., green-blue or white spots in or around the flux residues and on the copper.

**Result**

No evidence of corrosion was observed after 240 hours when RP15 was tested to the above method.

**2.6.3.3 Moisture and Surface Insulation Resistance****Method**

Six interlocking comb test patterns per flux (IPC-B-25 type B or E as below) are thoroughly cleaned with a soft bristle brush under running deionised water, rinsed with deionised water, rinsed with 2-propanol and dried in an air circulating oven for 3 hours at 55°C.



The cream under test is printed onto the conductors of three of the combs to give a wet print thickness of approximately 150µm using a screen printer and suitable screen with the comb image. The remaining three combs are left unprinted as controls. Each test pattern is then passed through an infra-red oven to re-flow the cream and form the final test piece. If any solder bridging of the conductors occurs the pattern shall be discarded and a replacement prepared.

The combs are allowed to stabilise at ambient conditions for at least 4 hours before carrying out surface insulation resistance testing.

Single stranded insulated wires are soldered to each of the connection points on all the combs using water-white rosin, not allowing the residues to spread onto the test pattern, and not removing the residues. The initial surface insulation resistance is found by applying 100 volts DC for 1 minute with readings taken from 1 to 2, 2 to 3, 3 to 4, and 4 to 5. Test points 1, 3 and 5 are connected to the positive terminal, and 2 and 4 to the negative.

The test combs are then placed in a suitable rack which maintains the patterns vertical, at least 1/2 inch apart, and which does not obstruct the air flow. The rack is placed in the centre of the temperature/humidity chamber and the patterns aligned parallel to the air flow. A drip shield is placed above the combs to prevent condensation from falling onto the combs.

The chamber is set to 85°C and 85% relative humidity. A 50 volt DC polarising voltage is applied to all leads with 1, 3 and 5 connected to one potential, and 2 and 4 to the other.

Measurements of surface insulation resistance are made after 24, 96 and 168 hours under the humidity conditions with the measurements being made at 100 volts DC reverse polarity. Any odd figures are discarded with the reason being noted. The reading after 24 hours is allowed to fall below the minimum requirement of  $1 \times 10^8$  ohms as long as it recovers by 96 hours. The mean average value of all valid measurements is calculated.

Result

The results are summarised below and are quoted in ohms.

Board	Initial	24 hrs	96 hrs	168 hrs
Sample	1.69x10 <sup>13</sup>	7.21x10 <sup>9</sup>	4.63x10 <sup>9</sup>	5.43x10 <sup>9</sup>
Control (unprinted)	2.26x10 <sup>12</sup>	8.20x10 <sup>9</sup>	4.74x10 <sup>9</sup>	4.83x10 <sup>9</sup>
Passmark	Not applicable	1.0x10 <sup>8</sup>	1.0x10 <sup>8</sup>	1.0x10 <sup>8</sup>

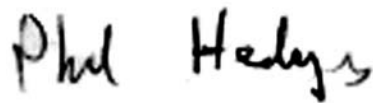
N.B. All measurements taken were valid.

Conclusion

It can be seen from the results enclosed that Multicore Solder's RP15 solder cream medium meets IPC-SF-818 (January 1988) to the following classes:-

Flux  
RP15

Designation  
LR3CN



P. Hedges  
Product Development Manager



Dr M. Warwick  
International Director Product Development



## Laboratory Report J-STD-004

5.3

Number: 9261	Security Category: 3	Author: P Hedges	Date: 15/4/98
To: Dr M.Warwick	Cs B Watson, File		
References:	Project 97U055	Keywords: RP15 J-STD-004	

## Official Test Report On Multicore Solders RP15 Flux Medium To Joint Industry Standard J-Std-004 (January 1995)

### 3.2.4.1 Flux Induced Corrosion (Copper Mirror)

#### Method

A copper mirror consisting of a vacuum deposited film of copper (having a thickness equivalent to  $10 \pm 5\%$  transmission of normal incident light of 500 nm) on one side of a plain sheet of clear, transparent, polished glass, is visually checked for the presence of an excessive oxide film. This film is removed by immersing the copper mirror in a 5% aqueous solution of the disodium salt of ethylenediaminetetraacetic acid (EDTA). The mirror is then washed thoroughly in running, deionised water and immersed in clean 2-propanol prior to drying with clean, oil-free air. The mirror can then be used if no oxide film and no damage to the copper are visible.

A 35% wt/wt solution of the flux medium under test is prepared in 2-propanol with ultra-sonic agitation.

One drop (approximately 0.05 ml) of this 35% wt/wt solution is placed in the centre of one half of the copper mirror, not allowing the dropper to touch the surface of the mirror. A drop of a control solution of 35% WW rosin in 2-propanol is placed on the other half of the mirror. The mirror is stored in a horizontal plane (copper mirror face up) in a clean environment at  $50 \pm 5\%$  relative humidity and  $23 \pm 2^\circ\text{C}$  for  $24 \pm 0.5$  hours.

On removal from these conditions, the residues are freed from the mirror by gently agitating the mirror in clean 99% 2-propanol. The mirror is inspected against a white background for removal of copper. Any complete removal of the copper film is deemed a fail.

Discoloration of the copper due to a superficial reaction, or partial reduction of the thickness of the copper film, is deemed a pass. If the control flux fails, the test is repeated on a new mirror.

#### Result

No complete removal of the copper film was observed when RP15 was tested as above. Therefore, RP15 passed and achieved Flux Type 'L' compliance for the copper mirror test.

### 3.2.4.2.1 Presence of Halide in Flux (Silver Chromate Paper Method)

#### Method

One drop of approximately 0.05ml of the 35% wt/wt solution under test is placed onto a strip of dry silver chromate test paper. The solution is allowed to remain for 15 seconds, after which time the test paper is immersed in clean 99% 2-propanol for 15 seconds. The test paper is allowed to dry for 10 minutes. Once dry, the test paper is inspected for discoloration. A change in colour to off-white or yellow-white, is indicative of the presence of chlorides or bromides. Such a discoloration (for example, greater than that conferred by 100ppm of chloride or 200ppm of bromide or iodide) on both sides of the test paper is deemed a fail.

#### Result

No discoloration was observed on the paper when RP15 was tested as above. Therefore, RP15 passed and achieved Flux Type 'L' and Flux Activity '0' compliance for the halide test.

### 3.2.4.2.2 Fluoride Test (Slightly modified)

A spot test is used, which utilises the discoloration of a zirconium-alizarin purple lake in the presence of fluorides.

#### Method

A fresh zirconium-alizarin lake is prepared in each of 3 spots of a white spot plate, by adding a drop of each of the following reagents to each spot:

- solution of 0.05 g of sodium alizarin sulphonate in 50ml deionised water;
- solution of 0.05 g of zirconium nitrate in 50 ml deionised water, acidified with 10ml of hydrochloric acid (1M);
- deionised water.

One drop of the 35% wt/wt solution under test is added to each of the spots. A change in colour of the lake to yellow is an indication of the presence of fluorides.



## Result

No colour change was observed in any of the three lakes when a drop of RP15 was added to each. Therefore, RP15 passed and achieved Flux Type 'L' and Flux Activity '0' compliance for the fluoride test.

### 3.2.4.3.1 Halide content

#### Method

A known weight (approximately 5 grams) of flux under test is pipetted into a 100ml separatory funnel.

To this 25ml of chloroform is added. The contents are mixed by shaking and an aliquot of 15ml of deionised water is added. The mixture is shaken for 10 seconds. The funnel is allowed to stand until the layers have completely separated.

The chloroform layer is drawn off and saved for further extraction. The water layer is transferred to a 100ml Erlenmeyer flask. The chloroform layer is extracted with two further 15ml portions of water, each time the water extract portion being added to the Erlenmeyer flask.

The water extracts in the Erlenmeyer flask are heated to remove any chloroform present (not allowing the temperature to exceed 80°C) and cooled to room temperature. 2 drops of 0.03M phenolphthalein solution are added to the water extract. Sodium Hydroxide (1M) is added until the solution turns red. Nitric acid (0.2M) is added dropwise until the red colour disappears. The solution is diluted with deionised water to about 60ml, and 6 drops of Potassium Dichromate solution is added.

The resulting solution is titrated with standardised 0.1M Silver Nitrate solution until a red/brown end-point is reached. The percentage halide as chloride is determined by the following equation:-

$$\% \text{ halide} = \frac{3.55 (M.V)}{m \times s} \times 100 \quad \text{where} \quad \begin{array}{l} M = \text{molarity of Silver Nitrate solution} \\ V = \text{volume of Silver Nitrate solution used (ml)} \\ m = \text{mass of flux sample (g)} \\ s = \text{percentage solids in flux} \end{array}$$

## Results

The halide content of RP15 was found to be 0.07% Therefore RP15 can be defined as flux type "L1"

### 3.2.4.3.3 Flux Solids (Non-volatile) Determination (Modified)

#### Method

Approximately 2g of flux medium is accurately weighed into a clean metal dish which is placed in an oven at 145°C for 2 hours. The dish is allowed to cool in a clean dry desiccator and re-weighed. The solids' content is calculated from the following equation:-

$$\text{Solids content} = \frac{\text{Final mass of flux medium} \times 100 \%}{\text{Initial mass of flux medium}}$$

## Result

The solids content of RP15 was found to be 63%

### 3.2.4.4 Flux Corrosion

#### Method

A coupon of 99% pure copper, of  $0.50 \pm 0.05$  mm thickness and 51 x 51 mm is cut and a circular depression made in the centre, to a depth of 3.0 mm. One corner of the coupon is bent up to allow easy handling with tongs.

The test piece is degreased with acetone, immersed in 5% v/v sulphuric acid at 65°C for 1 minute, to remove any tarnish. It is immersed in a solution of 25% m/v ammonium persulphate at 23°C for 1 minute to etch the surface. The coupon is rinsed under running tap water for 5 seconds before immersing in 5% v/v sulphuric acid at 23°C. The coupon is rinsed for 5 seconds with tap water and then thoroughly with deionised water. The coupon is rinsed with acetone and allowed to dry in clean air.

Approximately 0.05 grams of flux medium is weighed into the depression of the coupon. Rings of 60/40 Sn/Pb solder wire are degreased in acetone and a total of 1 gram weighed into the depression. The test panel is placed on a solder bath at  $235 \pm 5^\circ\text{C}$  to allow the solder to re-flow and then removed after 5 seconds. The test panel is pre-heated for 30 minutes in an oven at 40°C. The test panel is conditioned in a humidity chamber at 40°C and  $93 \pm 2\%$  relative humidity, for 240 hours (10 days). The test is done in triplicate.

## Result

No corrosion was seen when RP15 was tested as above. RP15 therefore passes this test.

### 3.2.4.5 Moisture and Surface Insulation Resistance

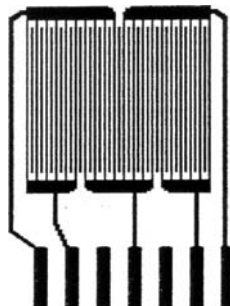
#### Method

A test pattern of type IPC-B-25 (Type B or E as below) is used, which consists of a series of interlocking conductor lands. Six boards are thoroughly cleaned with a soft bristle brush under running deionised water. Subsequently, they are placed in an ionic contamination tester (Multicore CM11 Contaminometer), containing 75% 2-propanol and 25% deionised water and processed until all ionics are removed. The cleaned combs are allowed to dry in an air-circulating oven for 3 hours at 55°C.

The boards are separated into two groups. Group A (3 boards) are left unfluxed and unsoldered.

Group B (3 boards) have solder paste sample applied onto the interlocking copper tracks of the comb patterns by printing through a stainless steel wire mesh screen with an emulsion image of the comb pattern to give a wet print thickness of approximately 150µm. The print is made with a rubber squeegee with an appropriate speed and sufficient pressure to just wipe the screen surface clean after the print pass.

The solder paste is then re-flowed by passing the boards through an infra red re-flow oven with the attached temperature profile.



Single-stranded insulated wires were soldered to each of the connection points on all the boards using WW rosin. The residues are not removed and are not allowed to spread onto the test pattern.

The specimens are placed vertically in an environment chamber, such that the air flow is parallel to the direction of the board. The chamber is set to  $85 \pm 2^\circ\text{C}$  and 20% RH, and allowed to stabilise for 3 hours. Subsequently, the humidity is ramped to 85% over a minimum of 15 minutes. The specimens are allowed to equilibrate for an hour, after which a bias voltage of 50V DC is applied.

Measurements are taken of the specimens - whilst they are held at test conditions - after 24, 96 and 168 hours. The bias voltage is replaced by a test voltage of 100V DC, of the opposite polarity, when the measurements of surface insulation resistance are taken.

Values may be deleted because of scratches, condensation, bridged conductors, outlying points etc. if the reason is noted. However, if more than 2 results are rejected for a given condition, then the test must be repeated.

To pass, readings should not fall below  $1 \times 10^8 \Omega$  for Group B, and not below  $1 \times 10^9 \Omega$  for Group A which is acting as a control.

#### Result

RP15 passed the test requirements in the uncleaned state. This is consistent with Flux Type 'L'. Results (in  $\Omega$ ) are summarised below.

Group	Printed	Reflowed	24 Hrs*	96 Hrs	168 Hrs
B	Yes	Yes	$7.21 \times 10^9$	$4.63 \times 10^9$	$5.43 \times 10^9$
A	No	No	$8.20 \times 10^9$	$4.74 \times 10^9$	$4.83 \times 10^9$

\* The 24 hour results do not have to meet the passmarks.

When viewed under a microscope, there was no evidence of dendritic growth or corrosion.

Thus RP15 passes this test confirming flux classification type "L"

#### CONCLUSION

It can be seen from the results enclosed that Multicore Solders RP15 flux medium meets the Joint Industry Standards J-STD-004 (January 1995) to category "L1"

Flux  
RP15

Flux Type  
L1

As RP15 is a rosin (RO) based flux its full classification is ROL1

*Phil Hedges*

P. Hedges  
Product Development Manager

*M. Warwick*

Dr M. Warwick  
International Director Product Development

## Laboratory Report J-STD-004

5.4

Number: 12261 | Security Category: 2 | Author: G. Freeman, L. West | Date: 22/06/01

To: Dr M. Warwick | Cs: Discussion Forum, File

References: Project 96U014 | Keywords: RP15 testing, J-STD-005

**Testing of Sn62RP15AGS89.5 Solder Paste to the J-STD-005 (IPC-TM-650) Specification (January 1995)****Introduction**

This report details the testing of three batches of Sn62RP15AGS89.5 solder paste to the J-STD-005 (IPC-TM-650) specification. Four tests were conducted;

- Metal Content by Weight – Test Method 2.2.20
- Slump Test – Test Method 2.4.35
- Solder Balling Test – Test Method 2.4.43
- Tack Test – Test Method 2.4.44

**Solder Paste Details**

Three Sn62RP15AGS89.5 solder paste batches were tested with the following batch numbers – B0510128, B0510130 and B0510132.

**Solder Paste Testing**

The tests described in the introduction were carried out. Descriptions of the test methods are given in the following sections, but for a more detailed description, the J-STD-005 document should be referenced.

**Test Method 2.2.20 – Solder Paste Metal content by Weight.****Method**

10g to 50g of the sample under test is weighed into a tared vessel suitable for melting the solder paste. The vessel is placed on a hot plate set at a temperature of 205°C (25°C above the liquidus of the alloy) and the solder paste melted. The vessel is removed from the heat source, and the solder allowed to solidify.

The metal is extracted from the residual flux with a suitable solvent, dried and then weighed to determine the % metal content. The calculation is shown below;

$$\frac{\text{Weight of extracted metal}}{\text{Weight of original sample}} \times 100 = \% \text{ metal}$$

**Results**

Paste Batch	Test Number	Paste Weight (g)	Extracted Metal Weight (g)	Metal Content (%)	Average Metal Content (%)
B0510128	1	13.76	12.25	89.0	89.2
	2	12.52	11.18	89.3	
	3	13.40	11.94	89.1	
	4	13.43	12.01	89.4	
B0510130	1	13.17	11.79	89.5	89.4
	2	13.10	11.74	89.6	
	3	14.55	12.98	89.2	
	4	12.54	11.19	89.2	
B0510132	1	12.55	11.22	89.4	89.3
	2	12.10	10.80	89.3	
	3	13.28	11.85	89.2	
	4	11.97	10.69	89.3	

## Test Method 2.4.35 – Solder Paste Slump Test.

### Method.

The solder paste under test is stencilled in duplicate onto ceramic substrates with dimensions 50 x 25 x 1mm (specification requires the substrate to be 76 x 25 x 1mm, but these were unavailable at the time of testing), using the IPC-A-21 stencil. (The stencil pattern is shown in Figure 1). Both ceramic test pieces are examined for printing defects, before being stored prior to final examination. The test pieces are stored for a period of 15 minutes at  $25 \pm 5^\circ\text{C}$  and 50%RH. After this time the first test piece is examined, while the second is placed in an air-circulating oven preheated to  $150^\circ\text{C}$  for 10 minutes. After this 10 minute period, the second test piece is also examined. The test pieces were examined under 10x magnification, and the minimum spacing without bridging of the solder paste was noted.

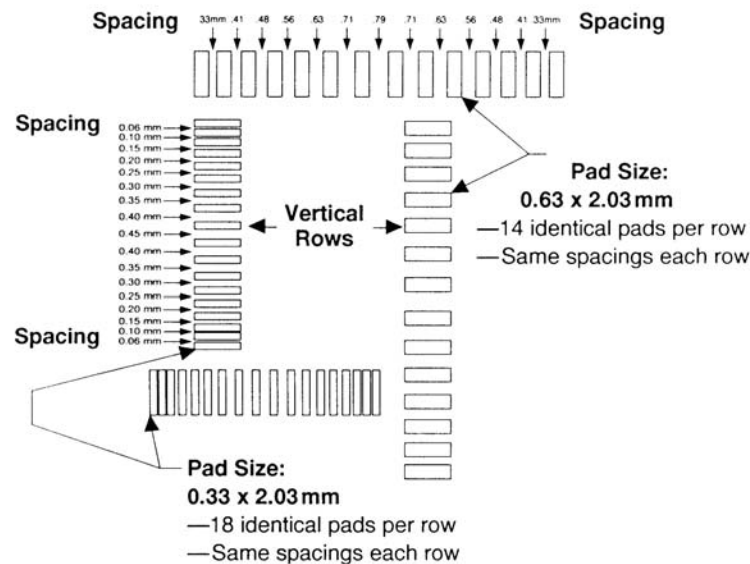


Figure 1 – IPC-A-21 Test Pattern

### Results.

Bridges were noted on the smallest spacings of the small pads, although these were considered to be printing defects. When subjected to the initial storage conditions described above, Sn62RP15AGS89.5 did not exhibit any further bridging, and was considered not to slump. When stored for 10 minutes at  $150^\circ\text{C}$  a small amount of slump was observed with each of the three pastes tested. This is summarised in the table on the following page;

#### Slump Summary at $150^\circ\text{C}$ Storage for 10 minutes

Sn62RP15AGS89.5		B0510128		B0510130		B0510132	
Stencil		Minimum pad spacing without bridging of the printed deposit					
		0.63 x 2.03 mm pads	0.33 x 2.03 mm pads	0.63 x 2.03 mm pads	0.33 x 2.03 mm pads	0.63 x 2.03 mm pads	0.33 x 2.03 mm pads
IPC-21-A	Horizontal	0.41mm	0.10mm	0.41mm	0.20mm	0.41mm	0.15mm
	Vertical	0.31mm	0.10mm	0.41mm	0.15mm	0.41mm	0.15mm

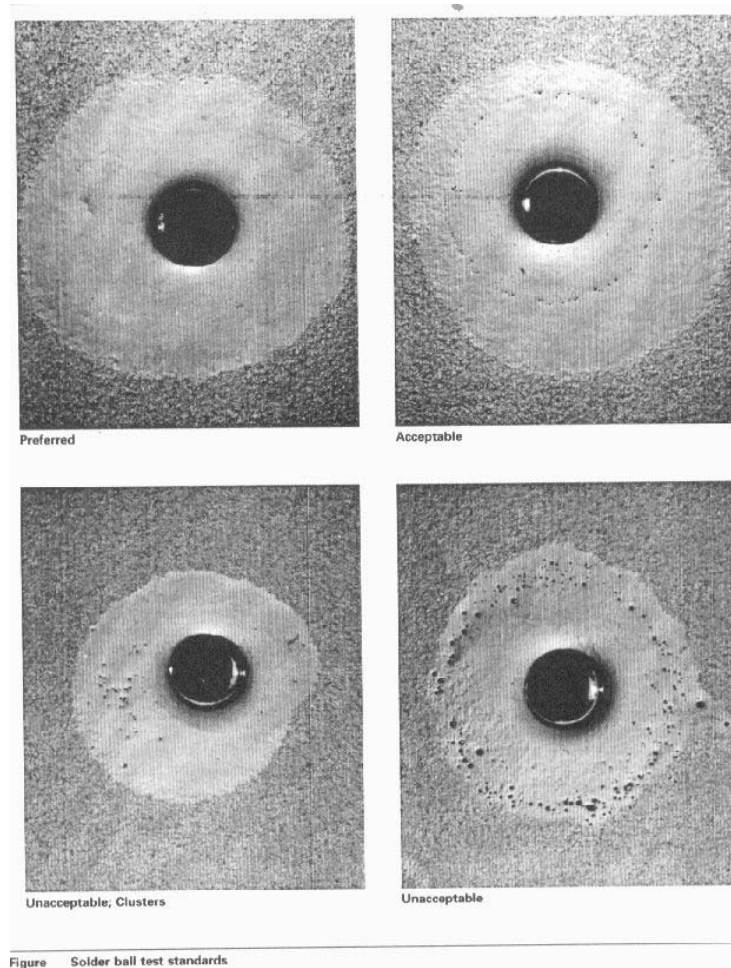
## Test Method 2.4.43 – Solder Ball Test.

### Method.

This test is carried out to determine the re-flow properties of the solder paste. A stencil having dimensions of 76 x 25 x 0.2mm with 4 round apertures of 6.5mm diameter with a minimum distance between the centres of 10mm, was used to deposit the solder paste under test onto a ceramic substrate of dimensions 50 x 25 x 1mm. (Specification requires the substrate to be 76 x 25 x 0.6 - 0.8mm, but these were unavailable at the time of testing).

Two test pieces were prepared, one of which was re-flowed immediately after printing on a solder bath at a temperature of  $205^\circ\text{C}$  ( $25^\circ\text{C}$  above the solder alloy liquidus). The second test piece was stored for 4 hours at  $25^\circ\text{C}$ , 50% RH before being re-flowed in the same manner described above.

The re-flowed test pieces were examined at 10x magnification. The solder ball size and number should be compared with Figure 2 on the following page;



**Figure 2 – Solder Balling Pass/Fail Criteria**

### Results

For the three paste batches, each of the initially re-flowed ceramic substrates showed a solder balling result as per the 'preferred' diagram (top left corner above). After the 4 hour storage at 25°C, 50%RH, the solder balling of the re-flowed substrates had slightly deteriorated, but still gave an 'acceptable' result (top right corner above). Sn62RP15AGS89.5 therefore passes this test. A summary is provided below;

Paste Batch	Initial Reflow	Reflow after 4hrs at 25°C, 50%RH
B0510128	Pass – Preferred appearance	Pass – Acceptable appearance
B0510130	Pass – Preferred appearance	Pass – Acceptable appearance
B0510132	Pass – Preferred appearance	Pass – Acceptable appearance

### Test Method 2.4.44 – Solder Paste Tack Test.

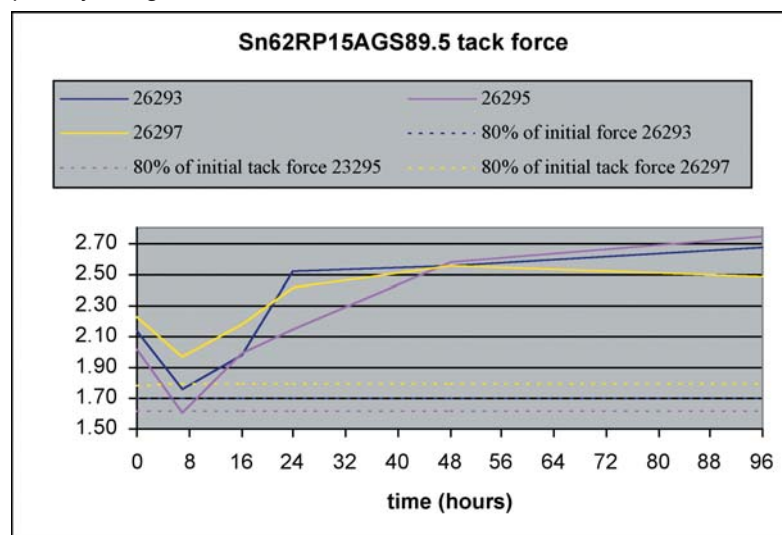
#### Method

This test is carried out to determine the tackiness properties of the solder paste being assessed. Three solder paste deposits were made through a 0.2mm thick stencil with a single circular aperture of 13mm diameter, onto FR4 test pieces for each storage period. (The measurements were made after 0, 7, 16, 24, 48 and 96 hour storage). The testing was carried out by placing the probe of the tester onto the surface of the solder paste deposit, applying a force of 300g and then withdrawing the probe at a rate of 2.5mmmin<sup>-1</sup>. Five measurements were made at each storage period. The results are summarised below;

## Results.

Storage Period (Hrs)	0	7	16	24	48	96
B0510128	37	32	35	45	47	52
	40	35	42	50	52	55
	45	35	40	47	50	55
	40	35	40	55	55	55
	47	35	37	50	47	45
<b>Tack Force (gmm<sup>-2</sup>)</b>	<b>2.13</b>	<b>1.75</b>	<b>1.98</b>	<b>2.52</b>	<b>2.56</b>	<b>2.67</b>
B0510130	37	27	40	52	52	52
	42	30	35	57	47	55
	37	30	42	37	52	52
	40	30	37	30	52	55
	42	40	42	35	50	55
<b>Tack Force (gmm<sup>-2</sup>)</b>	<b>2.02</b>	<b>1.60</b>	<b>2.00</b>	<b>2.15</b>	<b>2.58</b>	<b>2.74</b>
B0510132	47	57	40	35	47	50
	40	32	42	90	52	50
	42	32	42	35	52	40
	50	35	40	37	55	52
	40	37	50	40	45	52
<b>Tack Force (gmm<sup>-2</sup>)</b>	<b>2.23</b>	<b>1.97</b>	<b>2.18</b>	<b>2.41</b>	<b>2.56</b>	<b>2.49</b>

The results are shown graphically in Figure 2 below;



**Figure 2 – Tack Profile**

The above graph shows that the RP15 solder paste remains tacky for a considerable time period. The testing should be continued until a value of 80% of the initial tack force is reached. However, it can be seen from the traces above, that the tackiness of the RP15 solder paste is still increasing slightly after a period of 96 hours storage. The test was therefore stopped at this point.

### Conclusions

The Sn62RP15AGS89.5 solder pastes performed very well in each of the tests carried out. Solder balling performance was good, with acceptable results being seen even after 4 hours storage at 25°C, 50%RH, the metal content was within specification and the tackiness did not drop below 80% of its original value even after 96 hours ambient storage. A small amount of hot slump was measured (which was expected) but this would not be sufficient to affect the print quality.

*Graham Freeman*

Graham Freeman

Customer Product Development Manager

*Elizabeth West*

Liz West

Product Development Scientist



## Material Safety Data Sheet

6.1

## Product Information

## 1. IDENTIFICATION OF THE SUBSTANCE / PREPARATION AND OF THE COMPANY / UNDERTAKING

**Product Name:** Multicore 63S4 RP15 Solder Creams

Multicore's product coding system enables the features of a particular grade of cream to be precisely defined.

Example: 63S4RP15ACS89.5      63S4    Alloy present in the cream  
    RP15    Flux-medium type  
    ACS     Solder powder size range  
    9.5 Nominal metal content of the cream (% w/w)

The solder powder size range and the metal content do not affect the health and safety properties of the cream.

**Manufacturer**    Multicore Solders, Kelsey House, Wood Lane End,  
                          Hemel Hempstead, Herts, HP2 4RQ, United Kingdom.  
                          Telephone +44 (0) 1442 233233.

## 2. COMPOSITION / INFORMATION ON INGREDIENTS

Alloy	Nominal Concentration of Elements Present in the Alloy (% w/w)		
	Tin	Lead	Silver
63S4	62.8	36.8	0.4

The above figures are nominal concentrations. Reference should be made to the appropriate technical specification for the levels of permitted impurities.

Flux Medium	Concentration of Substances Present (% w/w)		
	Rosin	Modified Rosins	Malonic Acid
RP15	20 - 30	25 - 30	1 - 2

Component	CAS No.	Classification Symbol	Risk Phrases
Lead alloy powder	7439-92-1	-	-
Rosin	8050-09-7	Xn	R 42/43
Modified rosin	*	Xn	R 42/43
Malonic acid	141-82-2	Xn	R 22-36

\* The CAS No. is variable and depends on the exact identity of modified rosin used. In the absence of evidence to the contrary, modified rosins are classified as sensitisers.

Risk phrases

R22    Harmful if swallowed.  
 R36    Irritating to eyes  
 R42/43 May cause sensitisation by inhalation and skin contact.

## 3. HAZARDS IDENTIFICATION

The cream contains rosin and modified rosins. Prolonged or repeated skin contact may cause an allergic reaction to develop. The flux fumes may cause irritation and rash on exposed skin. Inhalation of the flux fumes given off during re-flow will irritate the respiratory system. Repeated or prolonged exposure to flux fumes may cause an allergic reaction leading to occupational asthma. Solder alloys containing lead give off negligible lead fume at normal re-flow temperatures and at temperatures up to 500°C. Lead is harmful if absorbed into the body and can cause birth defects and other reproductive harm.

## 4. FIRST-AID MEASURES

**Inhalation**      Flux fumes emitted during re-flow irritate the nose and throat and may cause an asthmatic type reaction.  
 Remove affected person to fresh air. Obtain medical attention if there is any respiratory distress.

**Ingestion**      Will irritate the gastric tract.  
 Encourage the affected person to rinse the mouth with water several times, taking care not to swallow.  
 Do not induce vomiting or give anything to drink if the patient finds it difficult to swallow. Obtain urgent medical attention.

- Skin Contact** Rosin may cause a rash to develop. The solvents present may cause skin irritation.
- Wash hands with soap and warm water after handling solder cream. If any skin irritation develops seek medical advice.
- Eye Contact** The cream is irritating and abrasive. The flux fumes may irritate the eyes.
- Flush immediately with plenty of water. Ensure that the eyeball and the inside of the eyelids are properly bathed by gently prising open the eyelids. Also make sure that the contaminated water runs off the face away from the eyes. Seek medical attention.

## 5. FIRE FIGHTING MEASURES

- Extinguishers** Suitable - dry chemical, carbon dioxide, water spray or foam.
- Unsuitable - water jet.
- Temperatures above 500°C may produce heavy metal dust, fumes and /or vapours. The flux medium will give rise to irritating fumes. Fire fighters should wear full protective clothing and positive pressure breathing apparatus.

## 6. ACCIDENTAL RELEASE MEASURES

Avoid contact with skin. Scrape up and place in a closed container for subsequent metal recovery or waste disposal.

## 7. HANDLING AND STORAGE

The fumes produced during re-flow should be extracted away from the breathing zone of the operators. Avoid inhaling flux fumes. Ensure that the general area is well ventilated. Wash hands with soap and warm water after handling solder cream, particularly before eating, drinking or smoking. The cream should be stored in a cool, dry area. Keep out of reach of children and away from food and drink.

## 8. EXPOSURE CONTROLS / PERSONAL PROTECTION

In normal re-flow operations where the temperature is below 500°C the exposure to lead will be minimal and the risks from the toxic effects of lead insignificant. (Ref.: Approved Code of Practice supporting the Control of Lead at Work Regulations 1998.) Suitable extraction should be provided to control exposure to flux fumes.

### Occupational Exposure Limits

Substance	Long-term exposure limit (8 hour TWA)	Short term exposure limit(15 minute)
Lead <sup>1</sup>	0.15 mg/m <sup>3</sup> (MEL)	-
Rosin flux fume (as total resin acids) <sup>2</sup>	0.05 mg/m <sup>3</sup> (MEL)	0.15 mg/m <sup>3</sup> (sensitiser)

<sup>(1)</sup> Appendix 1 of the Approved Code of Practice supporting the Control of Lead at Work Regulations

<sup>(2)</sup> EH40: Occupational Exposure Limits (revised annually)

Employees should be under medical surveillance if the risk assessment made under the Control of Lead at Work Regulations indicates they are likely to be exposed to significant concentrations of lead, or if an Employment Medical Advisor or appointed doctor so certifies.

A woman employed in work that exposes her to lead should notify her employer as soon as possible if she becomes pregnant. The Employment Medical Advisor/Appointed Doctor should be informed of the pregnancy.

Under the Management of Health and Safety at Work (Amendment) Regulations, employers are required to assess the particular risks to health at work of pregnant workers and workers who have recently given birth or who are breast feeding.

**Respiratory Protection:** Necessary if there is a risk of exposure to high concentrations of flux fumes.

**Eye Protection:** Operators should wear safety glasses or goggles.

**Skin Protection:** Butyl rubber gloves and suitable workwear to protect personal clothing are recommended.

Under the Control of Substances Hazardous to Health Regulations 1994, there is a requirement for personnel who are exposed to substances hazardous to health to be under appropriate health surveillance. Guidance on this can be found in the HSE publication Preventing Asthma at Work - How to Control Respiratory Sensitisers.

## 9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance	Grey paste
Odour	Mild
Boiling range	274°C
Flash point	124°C
Solubility in water	Insoluble



## 10. STABILITY AND REACTIVITY

### Conditions to Avoid

If solder is exposed to temperatures above 500°C then lead dust, fume and/or vapour may be produced.

### Materials to Avoid

Solder alloy will react with concentrated nitric acid to release toxic fumes of nitric oxide, which oxidises to nitrogen dioxide, a red gas with a pungent odour. If personnel are exposed to these gases then immediate medical attention should be sought, as symptoms can be delayed for a considerable time and can be fatal.

The solder cream will react with strong oxidising agents, possibly with explosive violence.

## 11. TOXICOLOGICAL INFORMATION

### Acute Toxicity

The flux fumes produced during re-flow will irritate the nose and throat. For personnel that have become sensitised to rosin fumes, further exposure can cause symptoms of asthma (attacks of wheezing, chest tightness and breathlessness), alveolitis (breathlessness, and flu-like symptoms), or rhinitis and conjunctivitis (runny or stuffy nose and watery or prickly eyes typical of hay fever.) Rosin can also cause sensitisation by skin contact causing skin rash, weals and / or pustules to develop.

Lead can cause weakness, pains in the joints, vomiting, loss of appetite and stupor.

LD<sub>50</sub> (oral, rat): Modified rosin >2500 mg/kg

### Chronic Toxicity

Prolonged or repeated exposure to rosin flux fume may cause some workers to develop occupational asthma. Cases of occupational asthma due to inhalation of rosin fumes produced from solder fluxes are reportable under the Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995.

Lead can cause weakness, insomnia, headache and possible paralysis. Chronic overexposure to lead may result in damage to the blood forming, nervous, urinary and reproductive systems. Lead is classified as a 2B carcinogen by the IARC (1987); i.e. evidence for carcinogenicity is adequate in animals but inadequate for humans. Severe lead toxicity has long been known to cause sterility, abortion and neonatal mortality and morbidity.

## 12. ECOLOGICAL INFORMATION

Lead is not degradable and will persist in the environment. Lead is insoluble in water and is not attacked by most inorganic acids and bases.

## 13. DISPOSAL CONSIDERATIONS

Wherever possible unwanted solder cream should be recycled for recovery of metal. Otherwise disposal should be in accordance with local and national legislation. In the UK this is the Special Waste Regulations 1996.

## 14. TRANSPORT INFORMATION

The solder cream is not classified as a material hazardous for transport.

## 15. REGULATORY INFORMATION

Classification according to the Chemicals (Hazard Information and Packaging for Supply) Regulations 1994:



- |         |   |
|---------|---|
| R 42/43 | May cause sensitisation by inhalation (flux fumes) and skin contact |
| S 23    | Do not breathe fumes  |
| S 24    | Avoid contact with skin   |
| S 37    | Wear suitable gloves  |

### Applicable EC Directives

Directive 82/605/EEC on the protection of workers from the risks related to the exposure to metallic lead and its ionic compounds at work.

Directive 80/1107/EEC on the protection of workers from the risk related to exposure to physical, chemical and biological agents at work.

Directive 92/85/EEC on the introduction of measures to encourage improvements in the safety and health at work of pregnant workers and workers who have recently given birth or are breastfeeding.

Applicable UK Legislation

The Health and Safety at Work etc. Act 1974

The Control of Lead at Work Regulations 1998

The Control of Substances Hazardous to Health Regulations 1994

The Management of Health and Safety at Work Regulations 1992

The Management of Health and Safety at Work (Amendment) Regulations 1994

The information presented in this safety data sheet is accurate to the best of knowledge and belief of Multicore Solders. As we cannot anticipate all conditions under which this information and our products, or the products of other manufacturers in combination with our products, are used this safety data sheet cannot constitute the user's assessment of workplace risk. Users are advised to make their own tests to determine the safety and suitability of each product or product combination for their own purposes.

## 16. OTHER INFORMATION

### Recommended Uses

This product has been formulated as a high activity, anti-tombstoning, no-clean solder cream for high speed printing applications in microelectronics. Further information on application and use can be obtained from Multicore Technical Data Sheets or the Multicore Technical Sales Team.

### Further Detailed Guidance from the UK Health and Safety Executive

Approved Code of Practice - Management of Health and Safety at Work

General Approved Code of Practice to the COSHH Regulations

Health Surveillance Under COSHH: Guidance for Employers

HS (G) 37: An Introduction to Local Exhaust Ventilation

HS (G) 53: Respiratory Protective Equipment - a Practical Guide for Users

HS (G) 61: Surveillance of People Exposed to Health Risks at Work

HS (G) 97: A Step by Step Guide to the COSHH Regulations

L55 Preventing Asthma at Work: How to Control Respiratory Sensitisers

L73 A Guide to the Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995

MS24: Medical Aspects of Occupational Skin Diseases

MS25: Medical Aspects of Occupational Asthma

EH26: Occupational Skin Diseases: Health and Safety Precautions

EH40: Occupational Exposure Limits (revised annually)

IND (G) 95L: Respiratory Sensitisers: A Guide for Employers

IND (G) 172L: Breathe Freely - A Workers' Information Card on Respiratory Sensitisers

IND (G) 248L: Solder Fume and You.

IND (G) 249L: Controlling Health Risks from Rosin (Colophony) Based Solder Flux Fume

MDHS 83: Method for the Determination of Hazardous Substances. Resin Acids in Rosin (Colophony) Solder Flux Fume

Engineering Sheet No. 17: Assessing Exposure to Rosin (Colophony) Based Solder Flux Fume

This safety data sheet complies with the Chemicals (Hazard Information and Packaging for Supply) Regulations 1994, (Commission Directive 91/155/EEC, as amended by Directive 93/112/EEC.)