

## NEWSLETTER<sup>©</sup>

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### Foreword

**The electronics industry in Europe** is about to experience one of the most far-reaching regulation processes by the European legislator since the beginning of its development. On February 13, 2003, the European Parliament and the Council of Europe adopted two directives (WEEE and RoHS) which significantly extend the areas of responsibility of the manufacturers and importers of electronic products.

The Directive on the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment (RoHS), due to become effective on July 1, 2006, will mean that many branches of the industry will have to change over from the tin/lead solders used until now for the joining and assembly of printed circuit boards with electronic components to lead-free solders.

### What do RoHS and WEEE Stand for?

**RoHS** is the abbreviation for:

- DIRECTIVE 2002/95/EC OF THE EUROPEAN PARLIAMENT AND THE COUNCIL OF EUROPE on the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment.

**WEEE** is the abbreviation for Waste of Electrical and Electronic Equipment.

In the extended sense, **WEEE** is also used as the abbreviation for the corresponding:

- DIRECTIVE 2002/96/EC OF THE EUROPEAN PARLIAMENT AND THE COUNCIL OF EUROPE on Waste of Electrical and Electronic Equipment dated January 27, 2003 and
- DIRECTIVE 2003/108/EC OF THE EUROPEAN PARLIAMENT AND THE COUNCIL OF EUROPE dated December 8, 2003 for the Amendment of Directive 2002/96/EC on Waste of Electrical and Electronic Equipment.

## The European Collective Research - LEADOUT Project

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In order to be able to make RoHS-conforming terminals available **on the entire European market** from July 1, 2006, there is a need not only for the necessary product and process analyses, process modifications, EDP adjustments and inventory analyses but also for qualification and employee training measures.

At present, **the lead-free joining technology in electronics** is on the way to superseding the traditional joining technology with SnPb on the printed circuit board. Lead-free mass products are already on the market. In Japan and Europe, there are road maps for the introduction of lead-free systems for the next 1 - 2 years. A survey which Soldertec conducted in Europe at the end of 2002 indicated that 50 % of the companies questioned had still not made any plans for the changeover to the lead-free joining technology.

**LEADOUT**, the low-cost lead-free soldering technology to improve the competitiveness of European SMEs, is one of the most comprehensive projects supported by the European Union on lead-free technologies under the scope of the framework SME-oriented activities in the 6th outline research programme. The LEADOUT project is scheduled for 3 years.

**The consortium, comprising 30 partners from 10 European countries** (10 industrial and technical-scientific associations, including SMART Group, 16 SMEs and 4 research institutes), had its first meeting in October 2004.

**The main objective of the project** is to provide technical support to the widest possible user group of SMEs from the member countries of the European Union in the development of solutions for the problems resulting from the replacement of tin-lead solders in the electronics industry. The project also covers the answers to questions about the environmental impact and the life cycle as well as about the efficiency of lead-free soldering processes.

**The task of SMART Group** as a technical-scientific association is to regularly pass the results from this project on to SME members through the web site, e-mail forums, LEADOUT Seminars and regular newsletters.

*The preceding text was modified from the first LEADOUT newsletter produced by Marcus Kubanek, DVS a fellow partner in LEADOUT Project.*

## Project Coordination

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### LEADOUT Lead-Free Events/Meetings

2 <sup>nd</sup> March	Countdown To Lead-Free	Alba Centre, Livingston, Scotland
11th April	Lead-Free Reality Roadshow	Chilterns University High Wycombe
6 <sup>th</sup> April	RoHS - Practical, Legal and Operational Issues	Dublin, Ireland
23 <sup>rd</sup> May	Lead-Free Implementation	JJS Electronics, Leicestershire
9- 11 <sup>th</sup> May	SMART Group Lead-Free Experience 4	NEC, Birmingham
9-11 <sup>th</sup> May	Nepcon Process Technology Seminars	NEC, Birmingham
6 <sup>th</sup> June	Advanced Interconnection Seminar	DEK, Weymouth
26 <sup>th</sup> September	Troubleshooting Lead-Free Assembly Process	WWFC, High Wycombe

A copy of all papers from previous SMART Group LEADOUT information days can be downloaded from the LEADOUT website [www.leadoutproject.com](http://www.leadoutproject.com)

### Lead-Free News Updates

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#### Hands-On Lead-Free Experience 4

Nepcon Electronics - NEC Birmingham 9 -11th May 2006



SMART Group Lead-Free Hands-On Experience 4 is being organised by popular demand for the fourth year at Nepcon. It's an ideal way to get hands-on experience with lead-free materials, components, production equipment, test/inspection and get first hand process advice. With the support of our LEADOUT project partners we are making this a truly European event with the latest research, inspection criteria and training and education material. To book your place go to [www.nepcon.co.uk](http://www.nepcon.co.uk)

#### Nepcon Process Technology Seminars feature LEADOUT Team

Nepcon Electronics - NEC Birmingham 9 -11th May 2006

"A winning combination of SMART Group, Nepcon and EM&T magazine provide the biggest and best FREE technology seminars in the industry, year on year", commented Bob Willis. "Guaranteed quality presentations, the seminars always cover the most important issues relating to current and future manufacturing challenges, before anyone else" This year we bring **LEADOUT Team** members into the mix to add technical excellence and a real European flavour to the Nepcon seminars. All seminar bookings must be made online at [www.nepcon.co.uk](http://www.nepcon.co.uk) to secure your free place.

#### SMART Group Lead-Free Experience Report FREE to Download

SMART Group has been running the Lead-Free Experience for three years, this year we have compiled a report on all the results gain so far and its FREE to download at [www.smartgroup.org](http://www.smartgroup.org) It covers testing on components, printed boards, stencils, paste, reflow and circuit board reliability. The report contains many examples of joints, sections and X-ray images

## NPL Releases Unprecedented Number of Reports that are Free to Download

National Physical Laboratory announces that the following reports have just been issued and are available to download free of charge. Chris Hunt heads up the NPL project team and is a member of the SMART Group Committee and regular speaker at its lead-free events.

Measurement of creep rates and stress relaxation for micro-sized lead-free solder joints.  
NPL Report DEPC-MPR 021

Measuring the reliability of electronics assemblies during the transition period to lead-free soldering.  
NPL Report DEPC-MPR 030

Shear strength of lead-free solder joints.  
NPL Measurement Note MN57

Measuring the effect on isotropic electrically conductive adhesive reliability of substrate and component finishes. NPL Report DEPC-MPR 031

Effect of PCB finish, processing and micro-structure on lead-free solder joint reliability.  
NPL Report DEPC-MPR 028

The Role of Permeability and Ion Transport in Conformal Coating Protection:  
NPL Report DEPC-MPR 032

Preliminary measurements of solder flux residues in an AC environment.  
NPL Report DEPC-MPR 029

Effect of voiding on lead-free reliability.  
NPL Report DEPC-MPR 033

Measuring the Impact of Component Solderability on Lead-Free Solder Joint Reliability,  
NPL Report DEPC MPR 038

To download these reports free go to [www.npl.co.uk/ei/publications](http://www.npl.co.uk/ei/publications)

## Lead-Free Big Topic on *smart-e-link* SMART Email Forum

*smart-e-link* members have made this an immensely valuable forum for the electronics manufacturing community, not just in the UK and Ireland, but all over the world. *smart-e-link* has 645 members from 20 different countries and 35 new members joining this month. Over the last few years it has seen 1000s of messages on many different subjects, especially lead-free. This will continue to be a useful resource for all and its open to anyone to join. To join the email forum go to [www.smartgroup.org/smtlink.htm](http://www.smartgroup.org/smtlink.htm)

## LEADOUT Defect of the Month at [www.leadoutproject.com](http://www.leadoutproject.com)

During the introduction to lead-free manufacture selected issues have been found which can impact their manufacturing field. Problems like fillet lifting, fillet tearing, secondary reflow and non coalescence of the solder paste are just a few.

Each month the LEADOUT Team publish a new "Defect of the Month" on the project web site [www.leadoutproject.com](http://www.leadoutproject.com) Engineers can download the defect sheets and collect them for use in their own company. They are ideal in assisting staff have a better understanding of what to expect during the transition to lead-free manufacture. Selected examples of these defects are shown below.



## RoHS Wake Up Call For Plastics Industry

The forthcoming RoHS Directive has significant implications for the plastics industry. It is important that all parts of the industry supply chain understand their responsibilities and the impact this Directive may have on them. Tin Technology believes that many companies are still unaware of the full implications of the Directive and should be taking the necessary steps to meet the deadline date.

RoHS (Restriction of use of certain Hazardous Substances in Electrical and Electronic Equipment) is an EU Directive that restricts the use of 6 hazardous materials in the manufacture of various types of electronic and electrical equipment. It is one of a series of EU environmental Directives and is closely linked with the WEEE (Waste Electrical and Electronic Equipment) Directive.

Electrical and electronic equipment must not contain more than the permitted concentrations of the following substances: Lead (Pb), Mercury (Hg), Cadmium (Cd), Hexavalent Chromium (Cr(VI)), Polybrominated Biphenyls (PBB) and Polybrominated Diphenyl Ethers (PBDE).

Suppliers of polymeric materials into the electrical and electronic manufacturing industry will be asked to show that their product conforms to the RoHS Directive or be prepared to lose customers. Electronic and electrical equipment suppliers can be fined or have their product withdrawn from the European market if they do not comply with this legislation. Lead can be present as a stabiliser or lubricant. Cadmium is still used as a pigment, typically in reds or yellows but has been found in greens. Chromium and Mercury are rarely found. However brominated flame retardants can be found in many applications. Whilst only PBB & PBDE are banned, screening equipment is unlikely to be capable of distinguishing between these two banned FRs and the permitted ones. This subtle point needs to be understood before more expensive chemical analysis is undertaken. Failure to comply could lead to loss of business; so what will industry do? The favoured choice will be to ask the original polymer supplier for a compliance declaration. But there will be times when this is just not feasible, so on occasions testing will be the only route possible.

There is no simple and cheap test for RoHS compliance. The most accurate techniques are destructive, costly and time consuming. Most companies however require a simple, cost-effective screening method that quickly identifies any "suspect" products. XRF (X-ray fluorescence) is a quick, easy and non-destructive screening technique that is now widely used to screen for RoHS compliance. The electrons in the shell of the elements present in a sample are disrupted by a low energy X-ray. Each element responds by producing X-rays at a unique set of energies, allowing the concentration of each element to be measured. However because the method only looks at atoms on or close to the surface it is only useful as a first step detection method. If part per million analysis to pick up trace quantities of restricted materials is required then ICP (Induction Coupled Plasma) should be used. It is unlikely that any laboratory will offer a compliance declaration certificate, but they will offer some form of report that indicated the presence or non presence of the banned materials and this should become part of the technical compliance file for that component.

The plastics and rubber supply chain is beginning to wake up to the need for RoHS compliance. The use of alternatives to lead as a stabilizer in PVC such as calcium/zinc stearates is growing. Cadmium is still used for colouring low temperature application plastics for which organic pigments are now widely available. Even continued use of brominated flame retardants such as PBB & PBDE is being questioned as halogen-free systems are introduced into the market from a number of suppliers.

Envirowise, in partnership with Intellect is running a free series of seminars that provide detailed background and advice on complying with the directives. Now is the time to start talking to suppliers or start getting product tested.

From July 1st 2006 any new product "put onto the market" in Europe must be compliant ie products that are:

- imported into EU member states, or
- manufactured in EU member states and available for sale

For further details contact Tom Perrett Soldertec [www. www.lead-free.org](http://www.lead-free.org)

## Lead-Free Awareness A Snapshot View of the UK

Sadly, there are still many companies that have adopted a “head-in-the-sand” attitude to implementing Lead-free soldering and it is therefore always a surprise to see so many delegates at SMART Group dissemination events. Nevertheless, many of the industry sectors that are technically exempt today are, in fact, in a good position to implement if necessary. The classic example is the aerospace/avionics industry and, although its members can hardly be classified as SME’s they show an interesting trend and this is reflected in their choices of CEM partner since very few of them manufacture products themselves.

One such CEM, a SMART Group member, is STI who specialise in highly complex assemblies for the defence and aerospace industries amongst others. Over a two year period, STI have steadily evolved a lead-free strategy that allows both exempt and non-exempt business to be handled simultaneously. Merely segregating Sn/Pb and SAC alloy production lines is by no means the whole story. Proper control of component inventories and data tracking is essential plus regular checks on the materials are required. The sudden appearance, without warning, of a SAC alloy balled BGA in a Sn/Pb process that was previously all Sn/Pb can cause all kinds of process problems.

STI has found it necessary to forge stronger links than before with component and materials suppliers to try to ensure accurate data before production commences. This style of life will be the norm for STI and similar companies until all exemptions are removed. At such a time, they will have only one process to control whereas, today, they have two.

### Project Answers Pb-Free Transition Concerns

A comprehensive study of lead contamination in lead-free joints has been carried out by National Physical Laboratory as part of a project in the MPP Programme of the UK Department of Trade and Industry. Technical support, co-operation and funding were received from 15 manufacturer project partners. Material support was provided by 7 companies.

One of the participating project partners, Hansatech, was asked to comment on their work. Rex Waygood, Technical Manager stated “We got involved with this studio project at a very early stage when we had discovered a paper on the web concerning Pb contamination in a Pb-free joint which indicated there may be a problem with reliability/joint strength. When talking to Chris Hunt and Martin Wickham [both of the NPL] about this, when the studio project was at the point of conception, we did not feel it fully covered the concerns about the transition. From memory it was more looking at new PbF finishes in SnPb solder. Chris and his colleagues then expanded the studio to cover the full transition concerns. It was at that point that we decided to join the studio and also persuaded one of our major customers to participate. Hansatech volunteered to assemble the boards and got involved in the PCB design for a unique part (CBGA) that both we and our customer wanted testing”.

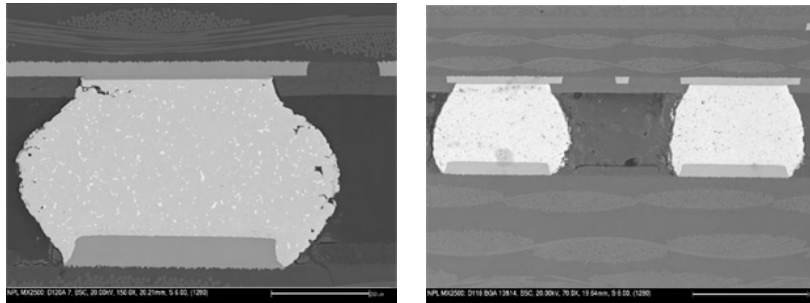
“The logistics of running this variety of assemblies, ensuring that the correct build standards were followed, and ensuring that quality and process were controlled absolutely was handled by Simon Thorn and an NPI (New Product Introduction) team at Poole. It was a novel event for us and it was an excellent team effort to bring it all together. I believe there were no Hansatech generated faults in about 250,000 joints. There was a great sense of achievement by everyone involved, it was a good experience and raised the profile of RoHS/Pb-free within the company”.

“Joining the studio also assisted Hansatech in talking to customers about the transition to PbF. As the studio developed and data started to become available we were able to talk to our customers with some authority about alloy mixing/contamination. The studio project effectively demonstrated that Hansatech had a Pb-free process fit for use by our customers and again raised our profile with our customers”.

“Hansatech got a lot out of this studio because we put a lot in. I am pleased with the returns we got for the effort and money invested. As an incidental, the involvement in the studio brought Hansatech into contact with several other members where those communication lines have been useful with other technical problems. The conclusion to this studio is probably slightly ‘flat’ as it did not uncover some huge pitfall. However it did remove several concerns about reliability during the transition”.

Another partner was Dolby Laboratories. Chris James, Engineering Services Manager commented: “We saw the project as an opportunity to benchmark work we were carrying out ourselves and perhaps verify, dispel or clarify, often varying and sometimes conflicting issues being propagated by the electronics industry media and the www. It was also a good opportunity to network with the other partners and work with the excellent staff of the NPL whilst at the same time contributing to this national asset”.

“The scope of the work was set by the partners, within the constraints of the budget and time available. We did not ourselves feel anything was omitted that we would like to have seen included. The summary conclusion to the project, I think all would agree, is that there are no major foreseeable issues to surprise us during any transition period assembly. Whilst there were no substantial issues discovered, the results of the work have certainly given us a reassurance about our approach and findings in our work with lead-free assembly. We certainly all feel it was well worth it, very good value and technically interesting to the extent we have signed up for the next studio project looking at PCB laminate materials in relation to lead-free work”.

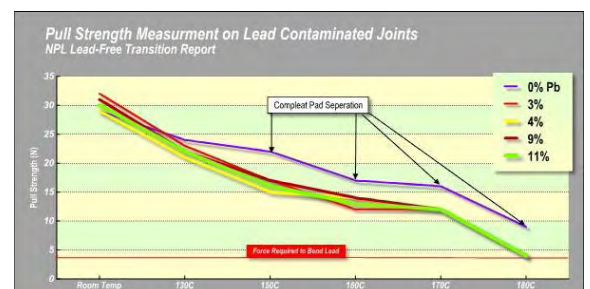


### The project

Over 200,000 solder joints on assemblies incorporating the main types of surface mount and through-hole components, have been manufactured with SnPb and pb-free terminated components using SnPb, Pb-free and mixed alloy systems. The work has included manufacture of joints with specifically controlled levels of Pb-contamination between 1 and 10%. All these assemblies have subsequently been thermally cycled (-55 to 125 degrees C) to 2000 cycles, continuity tested, pull tested and vibration tested. The work has indicated that there should be few solder joint reliability problems when mixing SnPb and Pb-free components and solder alloys (with Pb contamination in the range 1 to 10%). Very few thermal cycle fatigue failures were experienced other than within two components groups. Shear testing of chip resistor components showed no difference in crack propagation rated between any of the component/alloy combinations. No failures were generated during vibration testing.

Some ball grid array joints did fail but these were largely restricted to SnPb alloy dominated systems, ie SnPb terminated components soldered with SnPb or SAC alloy solder pastes. Uncontaminated SAC systems or those systems contaminated with low levels of Pb showed fewer failures. Failures in Sn-plated QFP components were probably due to batch related solderability issues.

Work with hot peel testing of SOIC components has indicated that Pb-contamination may cause end-users problems during processing. The addition of small quantities of Pb (<10%) to a LF joint significantly reduces its peel strength above 180 degrees C. This may cause the first side solder joint to separate or deform during second side reflow, if the assembly is subjected to mechanical forces during assembly.



The project partners included: Aeroflex, Alcatel, BAE (INSYTE), BAe Systems, Bookham, Bosch, Celestica, Dolby Laboratories, Inc. (UK), Eurotherm Controls Ltd, Goodrich Engine Controls, Hansatech Ltd, MBDA, Rolls Royce, Thales Defence Electronics, TRW Automotive.

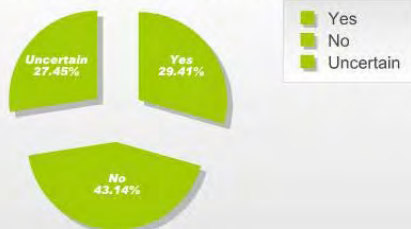
Material support was provided by: CML Microcircuits (UK) Ltd, Cemco-FSL, Henkel Loctite, Grosvenor Solder, Invotec Group, Rohm and Hans Electronic Materials Europe Ltd, Vitronics Soltec BV.

Grateful thanks to Tim Fryer – Editor Electronics Manufacture & Test magazine

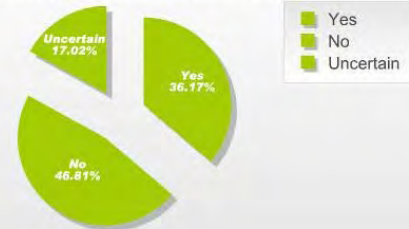
## High Percentage of Companies Admit They Will Not Be Compliant By July 1<sup>st</sup>

A survey conducted by the SMART Group at its annual Lead-Free Seminar in February showed that industry will either not be ready (43%) or is uncertain that it will meet the looming compliance deadline. A high percentage of companies (36%) believe they are still exempt from the Directive. Only seven companies thought they would be 90% compliant. The greatest challenges to being non-compliant by July 1<sup>st</sup> were availability of lead-free components, compliance issues, cost of stock to support spares, uncertain reliability, moisture sensitive devices and rework of products.

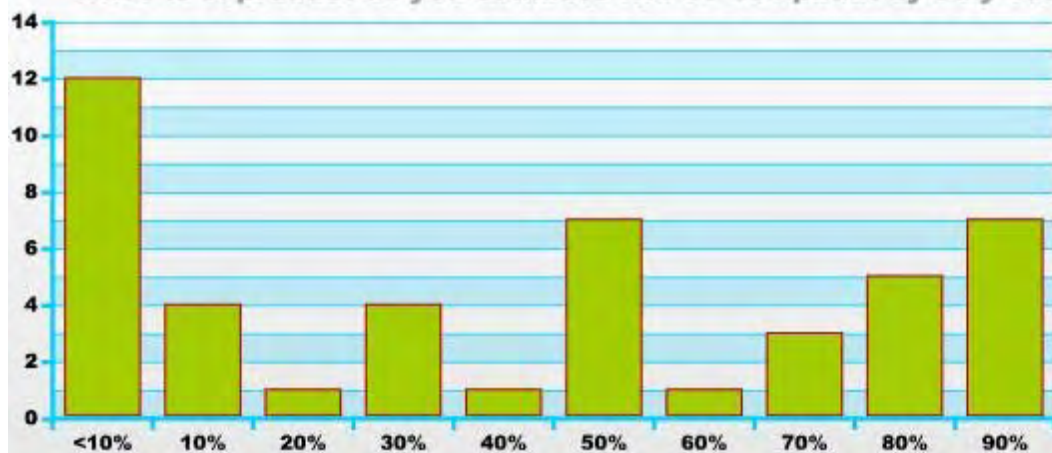
**SMART Group Lead-Free Survey 2006**  
Will all your products be compliant by July 1<sup>st</sup>?



**SMART Group Lead-Free Survey 2006**  
Do you believe you are exempt from the Directive?



**SMART Group Lead-Free Survey 2006**  
What % of product do you estimate will be compliant by July 1<sup>st</sup>



## Bob Willis Receives International Lead-Free Award from SOLDERTEC/Tin Technology

Soldertec Global/Tin Technology has announced their Annual Lead-Free Solder Awards and Bob Willis proudly receives the 'Process Development Award' in recognition of his many achievements and enthusiasm in assisting industry in the preparation for the implementation of lead-free legislation. Bob coordinates the SMART Group activity for the EU project LEADOUT, currently Europe's largest funded research project.

Tom Perrett, Soldertec Global Marketing Manager commented, "Bob's enthusiasm is infectious. He gets things done and has contributed so much to enable our industry to meet the challenge of the impending legislation. His standing by his peers is second to none and we are delighted to announce his well deserved award".



### Lead-Free Text Books

There are a wide selection of text books covering all aspects of lead-free technology. Each has been reviewed to help engineers make the right selection. For a review of the following titles visit [www.smartgroup.org](http://www.smartgroup.org)

Lead-Free Solder Interconnection Reliability  
 Edited by Dongkai Shangguan  
 Published by ASM International

Lead-Free Soldering in Electronics –  
 Science, Technology and Environmental Impact  
 Edited by Katsuaki Sukanuma

Lead-Free Handbook  
 Katsuaki Sukanuma, Osaka University  
 Horizon Inc., K Books Series

Implementing Lead-Free Electronics  
 Author: Jennie S Hwang  
 Publisher by McGraw-Hill Professional

Lead-Free Electronics - 2004 Edition  
 Edited by Sanka Ganesan & Michael Pecht  
 Published by CALCE EPSC Press

Handbook of Lead-Free Soldering Technology  
 for Microelectronic Assemblies  
 Edited by Karl Puttlitz and Kathleen Stalter  
 Published by Marcel Dekker

Environmental-Friendly Electronics  
 Lead-Free Technology  
 Author: Jennie S. Hwang  
 Electrochemical Publications

Reflow Soldering Processes & Troubleshooting:  
 SMT, BGA, CSP and Flip Chip Technologies  
 Author: Ning-Cheng Lee  
 Published by Newnes

Electronics Manufacturing with Lead-Free  
 Halogen Free & Conductive Adhesive  
 Authors: John Lau, Ricky Lee, Ning Chang Lee  
 Published by McGraw-Hill

Structural Integrity & Reliability in Electronics  
 W.J Plumbridge, R.J. Matela & Angus Westwater  
 Published by Kluwer Academic Publishers

Guide To Lead-Free Soldering for  
 Assemblers & Sub-Contractors  
 Authored & published by Roger Bilham



Books are available direct from the publisher or online book sale websites, they are not available for purchase from the SMART Group

### Lead-Free Interactive CD-ROMs

The following lead-free interactive training CD-ROMs are available from SMART Group. They have been created by organisations like Soldertec/Tin Technology and NPL leaders in lead-free research to support the industry.

PCB Design & Lead-Free Defect Guide 2  
 Soldertec Hand Soldering/De-Soldering Lead-Free  
 NPL Lead-Free Soldering "Cook Book 3"  
 Soldertec Lead-Free Reflow Soldering  
 Conventional/ SMT & Lead-Free Animations

Lead-Free Assembly and Soldering Photo Album  
 Soldertec Lead-Free Wave Soldering  
 BGA Inspection and Lead-Free Defect Guide

## LEADOUT Recent Seminars

**SMART Group Ireland/LEADOUT “Transition to Lead-Free with LEADOUT”, 1<sup>st</sup> December, Cork, Ireland**



**SMART Group/LEADOUT “Hands On Wave Soldering Workshop”, 19<sup>th</sup> January, St Albans**



**SMART Group/LEADOUT “Annual Lead-Free Seminar & Exhibition”, 16<sup>th</sup> February, High Wycombe**



A copy of papers, photographs and a seminar report for each of above seminars is available to download from the LEADOUT website [www.leadoutproject.com](http://www.leadoutproject.com)

## Internet Addresses / Links

There are a wide range of websites offering material and advice on lead-free, some of which are listed here for reference:

DTI Department of Trade & Industry	<a href="http://www.dti.gov.uk/sustainability">www.dti.gov.uk/sustainability</a>
IPC	<a href="http://www.ipc.org">www.ipc.org</a>
LEADOUT	<a href="http://www.leadoutproject.com">www.leadoutproject.com</a>
NPL National Physical Laboratory	<a href="http://www.npl.co.uk/ei">www.npl.co.uk/ei</a>
Soldertec/Tin Technology	<a href="http://www.lead-free.org">www.lead-free.org</a>
SMART Group	<a href="http://www.smartgroup.org">www.smartgroup.org</a>
SMART Group Ireland	<a href="http://www.leadfree.ie">www.leadfree.ie</a>
TWI	<a href="http://www.twi.co.uk">www.twi.co.uk</a>

### **Acknowledgement**

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