RoHS Roadmap

Technical and logistics implementation of EC Directives

The European RoHS Directive (EC Directive on the Restriction and Use of Certain Hazardous Substances in Electrical and Electronic Devices) will be coming into effect on July 1, 2006.

This EC Directive prohibits the use of specific heavy metals, such as:

- Lead, mercury, cadmium and hexavalent chromium (chromium VI)

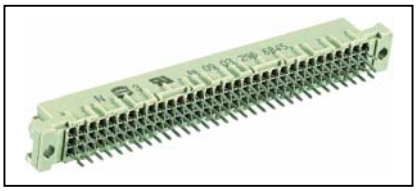
and certain flame retardant substances in plastic, such as:

- Polybromide biphenyl (PBB) und Polybromide diphenylether (PBDE)

The environmental management of the HARTING group is certified to DIN EN ISO 14001, and, at a very early stage, had started to dispense with the use of environmentally harmful substances. Based on this ecological approach, HARTING has made it a corporate principle to refrain from the use of substances such as PBB and PBDE, or heavy metals such as mercury and cadmium in the company's products.

At HARTING, the list of materials pending prohibition is restricted to:

Lead
in the field of surface coating
in electronic connectors
and system components



Chromium VI
in the field of surface coating
and heavy-duty connectors

Dear customer:

On the next pages, we would like to explain which alternative technical materials HARTING will be using to replace "lead or chromium VI". We consider it our duty to provide you with comprehensive and technically substantiated information on our qualification measures.
If your main interest is on the aspect of logistics implementation, we recommend you continue directly with the section "Logistics implementation of EC Directives."

Content

Overview

Introduction of lead-free products

The prohibition of lead definitely has the most significant impact on the electronics industry, in particular in the field of solder technology. New solder materials (primarily SnCu, SnAgCu or SnCuNi) with significantly higher processing temperatures will find their way into the processes. For reliable reflow soldering, processing temperatures between 240°C and 270°C must be taken into account. There is a rising trend towards pure Sn in the surface finish of connectors.
HARTING has taken up these issues at a very early stage, and, in cooperation with electrolyte manufacturers, institutes and customers, examined the compatibility of pure Sn both in leaded and lead-free soldering processes.
These examinations were accompanied by a continuous comparison to SnPb and noble metal finish materials such as Au, AuPd or Pd.
HARTING approaches "the lead-free era" with a strong commitment to ensuring proven product quality and long-term reliability. In this context, the objective was set on the optimization of galvanization processes, and on soldering capabilities and whisker-proof quality comparable to SnPb, by using the latest materials for pure tin coating.

In solder-free connection techniques HARTING supplies products with an alternative surface finish, as far as the have been in use for many years, or have been safely qualified in the context of lead-free examinations.

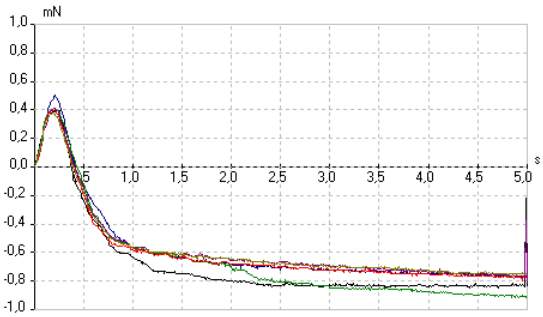
In the following, we will introduce the most important qualification examinations, and the resulting product modifications.

Connectors for soldering technology

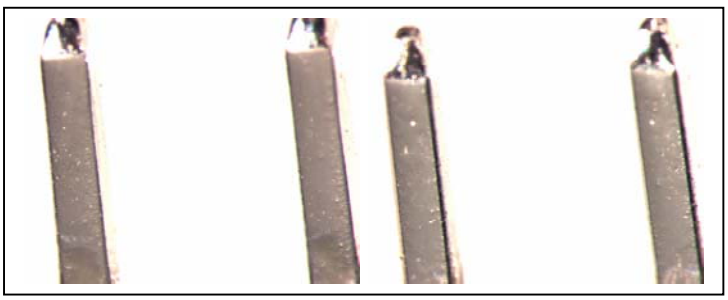
HARTING has qualified preferably a dull pure Sn for those products.

The connectors were soldered on our customers' plants and according to the respective, existing process parameters, and were assessed and released. Beforehand, the connectors were exposed to dry and humid heat in a test facility in accordance with the usual climatic tests to IEC, in order to simulate a minimum shelf time of two years under different climatic conditions.
HARTING examined the entire spectrum of eventualities: compatibility with the existing SnPb process (reverse compatibility), compatibility with the new lead-free process using solder materials based on SnCu, SnAgCu and SnCuNi, diverse lead-free PCB surfaces, different active flux agents, the large bandwidth in processing speeds, temperatures and other device and equipment settings.

Preselection in the lab



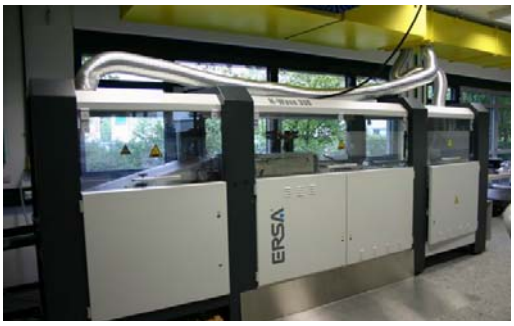
Solder weighing test: wetting diagram of aged contacts



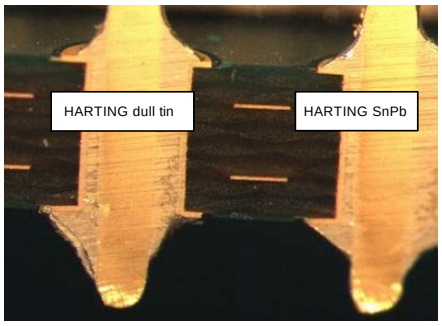
Visual inspection of aged contacts

We determined the wetting times based on the solder weighing test, and then inspected the wetted surface visually. Based on a selection of different materials and diverse configurations in the galvanization process, we subsequently determined the optimal material for the following field test.

Soldering trials in the field



Wave soldering plant



Polished section of solder connections on aged contacts

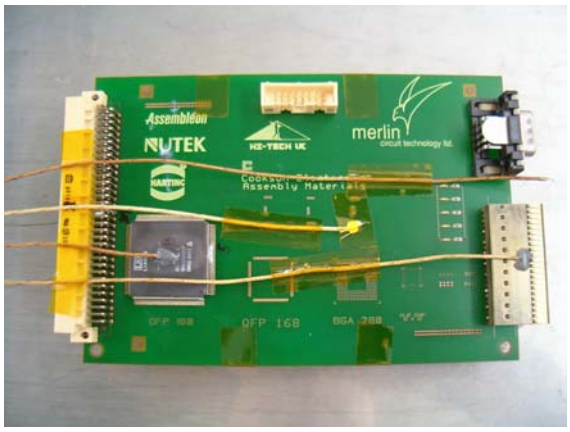
The Sn surface qualified by HARTING returned convincing results under all field test conditions. The lead-free surface was consequently compared with the conventional SnPb in use today.

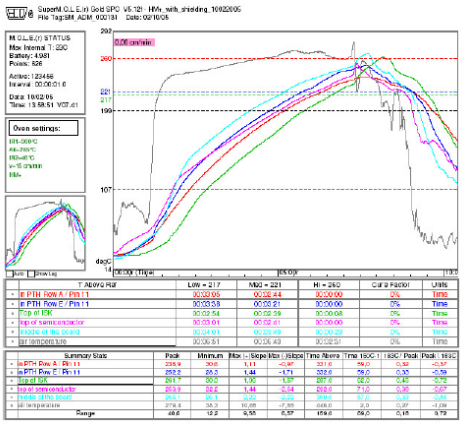
Altogether more than 50,000 solder points were inspected at the accredited HARTING laboratory!
A corresponding comprehensive report is in preparation and will be available in April.

Connectors for reflow soldering technology

As mentioned earlier, temperatures between 240°C and 270°C must be expected in the lead-free reflow soldering process, depending on the type of process. Most of the HARTING connectors capable of being processed in reflow soldering are made of LCP (Liquid Crystal Polymer.) This high-performance material forms the ideal basis for handling the future temperature range. Various products are currently made of an alternative high-temperature forming material on PES base. The new conditions do not allow a general specification with respect to thermal deformation resistance. The result is determined by numerous factors such as the shape, size and wall thickness of the connector, the design and size of the PCB, the number and size of further components, the type of reflow process (steam phase or convection), the temperature profile and the dwell time.
In this context, a solution could be the product-specific and individual qualification at the reflow plants of our customers.
Connectors which are not based on LCP may also undergo an initial qualification at the HARTING test lab, based on a user-specific temperature profile.

HARTING offers test equipment (Super Mole Gold temperature profile recorder) to record the temperature profiles of user-specific boards either at the customer's site, or on the convection soldering system at the HARTING test lab (Forced Convection system SEF 548.10), and to subsequently discuss processing solutions based on those results.





The figure shows a board assembly with temperature sensors and a diagram of temperature profiles recorded at different positions.

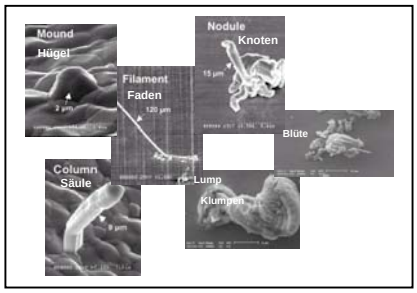
Utilization of new materials

In addition to the optimization of processes, HARTING runs extensive test series on new materials, with the focus set on the adaptation of all products to the high temperatures to be expected. Certain processing guidelines may have to be observed.

Whisker-proofing* with pure Sn

HARTING has paid extremely critical attention to this aspect at an early stage. Neither the wide range of so-called low whisker electrolytes offered on the market, nor the dynamic marketing strategies of large-scale vendors in the pure Sn segment, has convinced us to follow this emerging trend without conducting our own tests.

**Whiskers are monocrystals which may grow out of galvanized surfaces. They assume many shapes, such as mounds, nodules, trees and filaments. The filament variant represents a problem that has caused electrical short-circuits and subsequent device failure.*



Whisker shapes

Qualification of a suitable surface

The low whisker electrolytes offered on the market were initially selected based on conventional industrial climatic tests and the specific climatic test environment of HARTING.
Next, we optimized the galvanization technology in cooperation with the manufacturers of electrolytes, and defined the parameters for stress-free layer ablation. In addition to nickel priming, the elimination of inherent stress forms a vital factor in achieving a low-whisker surface finish.
To support our examinations, we contracted several research institutes in order to take advantage of their leading edge measuring and analysis technologies.
Based on the results of our Research and Development Department, and in close cooperation with our suppliers, it was subsequently possible to define an optimal process.

Worldwide, there are many international industry and standardization committees such as ZVEI, NEMI, JEDEC, CALCE; JEITA, IEC etc. that are currently working on the definition of a reliable whisker test. The results of current whisker tests show that whiskers with a length of < 50 µm evident on completion of the test programs can be considered non-critical.

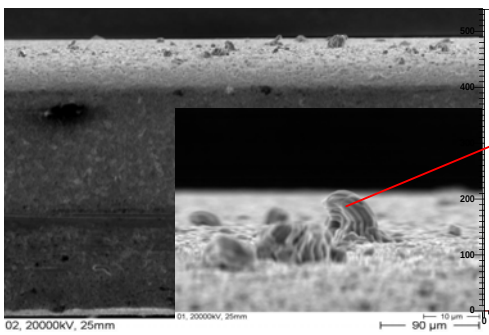
After having passed the usual industrial tests, the material qualified and coated by HARTING showed no evidence of any whiskers which could be identified by light-optical microscopy. We are therefore in a position to offer whisker-proof products.
For the sake of completeness, it must be stated that the formation of whiskers can not be fully excluded at the current state-of-the-art. However, based on the measures taken we can exclude any practical risk, as the maximum length of 50 µm is not exceeded.

Accompanying examinations in cooperation with Research Institutes

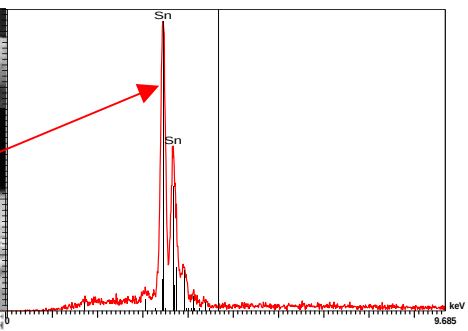
The materials on which we were able to grow whiskers were examined in cooperation with the Fraunhofer Institute ISiT in Itzehoe, Germany, and with the "Swiss Federal Laboratories for Materials Testing and Research" (EMPA.) The influence of light elements with nuclear charge numbers < 10 (typically H_2, C, N_2,O_2) was examined by means of EDX Analysis (Energy Dispersive X-ray.) For this analysis, ultra-thin slices with a thickness of approx. 100 nm are taken from the material, in order to examine the crystal structure and chemical compounds of those test objects.

Examinations at the Fraunhofer Institute

Qualified material without the growth of whiskers after climatic tests



REM recording:
Micro whisker, length of approx. 20 µm



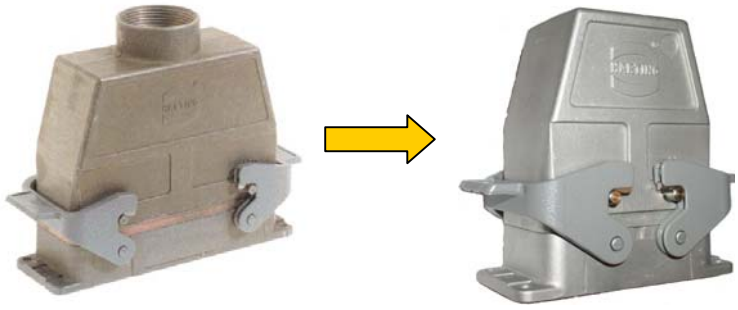
REM Spectrum analysis

Introduction of surfaces which are free of chromium VI

In the course of complying with the RoHS Directive with respect to industrial connectors, HARTING will be making changes to the following products:

Industrial connectors for EMC applications (Han® EMC)

At the same time as retaining their first-class characteristics with regard to shielding properties and protection against environmental influences, the housings will in future be manufactured from a high-quality aluminium alloy. Utilised in various applications including under-floor areas of luxury-class cars, this tempered alloy has proven that it has sufficient performance potential for connector applications. The housings surfaces are shot peened to achieve comparable corrosion protection, which results in the previously "gold/brown" colour now having a "shiny silver" appearance. This change affects connector types Han EMC/B and Han EMC/HP.



Industrial connectors for aggressive environmental requirements (Han® M)

Industrial connectors from the product range Han® M are designed for use in hostile climatic atmospheres and aggressive environmental conditions. The increased protection against corrosion, which until now consisted of a standard alloy plus additional chromate coating, will in future be achieved by means of a corrosion-resistant aluminium alloy. We will continue to use a high-quality powder coating for the surface finish.

State of the conversion to RoHS-compliant products

Many products are, or were already lead-free, irrespective of the EC initiative.
As of May 1, information on the current state of conversion is available in the HARTING online catalog "HARKIS®" under www.harkis.harting.com.
Please feel free to contact our Customer Service for information on the conversion status.

Between May 1, 2005 and July 1, 2005, HARTING plans to convert all product lines to lead-free-/ chromium VI free variants.
Although we shall only be producing lead-free-/ chromium VI free products which are compliant with RoHS, the warehouses may still contain certain lead-/ chromium VI containing products. Therefore, mixed deliveries may occur.

Our worldwide Supply Chain Management will do their utmost to minimize this transitional period.
Products in stock will consequently be shipped on the First in/ First out principle.

We assume that we can deliver all A and B products, i.e. 90% of the turnover volume RoHS compliant, ex warehouse by July / August 2005.

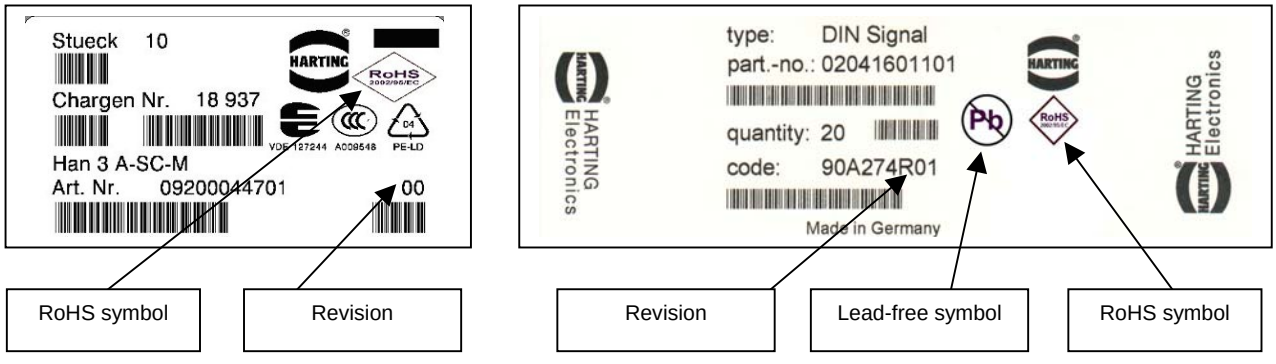
Our target is set as January 2006 for worldwide delivery of lead-free / RoHS-compliant articles only.

Logistics

We will be retaining the article numbers, as we do not expect any modifications by our clients thanks to the compatibility to existing processes.
All RoHS-compliant products (the new pure Sn solder connectors or chromium VI free EMV housings, for example) are supplied under the same order number as the old variants. It will be possible to differentiate between a mixed stock or old and new products on the basis of two criteria:

- Revision status
  The 'revision status' is printed on the identification/bar-code label for traceability and differentiation purposes. HARTING will store all products in its supply depot separately according to the 'revision status'.
- RoHS symbol
  The RoHS symbol will be included on the labels of RoHS conforming products. (The responsible legislative EU committee has yet to reach a final decision regarding the design of this symbol)

Examples:



Conclusion

At HARTING the major concern is on maintaining proven product reliability.
Consequently, we have made very extensive and intensive efforts in preparing ourselves for the migration of our products to the RoHS-compliant era.

Extensive field tests at our customers' sites formed a vital aspect.
Our installed processes and extensively tested materials now facilitate the rapid and uninterrupted conversion of all products to the lead-free versions.

The applications and existing production processes of our clients do not play any role in this context.
All product versions are forward and backward compatible.

The European Parliament is acting to protect and improve the quality of the environment, to protect human health and to utilise natural resources prudently and rationally. Steps toward this action include two major directives:

- The RoHS (Restriction of the use of certain Hazardous Substances) – Directive 2002/95/EG
- The WEEE (Waste Electrical and Electronic Equipment) – Directive 2002/95/EG

The RoHS directive becomes effective July 1st, 2006. The directive contains prohibition and reduction of certain materials in certain products for example heavy metals such as lead, mercury and cadmium or flame retardent plastics such as Polybromide Biphenyl (PBB). The effectiveness of the second directive starts August 13th, 2005. The WEEE addresses the retrieval and recycling of electric and electronic devices. The recycling target is e.g. 4 kg per citizen per year. The WEEE hopes to reach this goal no later than December 31st, 2006. For recycling it is necessary to declare the material content of a product.

Summary of European Regulation

RoHS **(effectiveness 1 st July 2006)**	**WEEE** **(effectiveness 13 th August 2005)**
Prohibition / Reduction **Certain materials in certain products** a) Heavy metals Lead Mercury Cadmium Hexavalent Chromium (Chromium VI) b) Flame Retardent in plastics Polybromide Biphenyl (PBB) Polybromide Diphenyl Ether (PBDE)	**Retrieval and Recycling** **Electric and electronic devices** Recycling target : 4 kg per citizen per year . Achievement date : No later than end of 2006 For recycling it is necessary to declare the material content of a product .

Categories of electrical and electronic equipment covered by these directives

RoHS	WEEE
Large household appliances	
Small household appliances	
IT and Telecommunications devices (no infrastructure equipment)	
Entertainment devices (TV, ...)	
Lighting equipment	
Electrical and electronic tools (exception stationary large industrial tools)	
Toys, leisure and sport devices	
today not included in RoHS	Medical devices
today not included in RoHS	Monitoring and control instruments
Automatic dispenser	

More detailed categories list can be found in annex IB of the Directive 2002/96/EG dated 27 January 2003.

The environmental management of the HARTING group is certified according to DIN EN ISO 14001
and fully supports this ecological approach.