

**TR TECHNICAL  
 REPORT**

1-pack carbon-conductive ink

**SD 2843 HAL**



- **black, mat**
- Resistance approx. 13 - 20 Ohm/square at 25 µm dry film thickness (dependent upon curing)
- excellent definition
- very good electrical conductivity, even after soldering
- resistant to Hot-Air Levelling as well as to leaded and lead-free wave and reflow soldering processes
- excellent adhesion and mechanically stable surface
- long shelf life: 6 months

Indices:    **SD**    =    **screen printing ink**  
                   **HAL**    =    **Hot-Air Levelling**

**Contents**


|  |   |  |   |
|--|---|--|---|
| 1. General information.....                | 2 | 8. Drying/Curing .....   | 7 |
| 2. Application.....                        | 2 | 8.1 Curing in circulating air ovens.....   | 7 |
| 3. Special notes.....                      | 2 | 8.2 IR-curing.....   | 8 |
| 4. Safety recommendations .....            | 2 | 9. Standard packaging .....  | 8 |
| 5. Characteristics .....                   | 3 | 10. Shelf life and storage conditions .....                                      | 8 |
| 6. Properties .....                        | 3 | 11. Further literature/ technical documentation.....                             | 8 |
| 6.1 General properties .....               | 3 | 12. Further products for the production of pcbs.....                             | 8 |
| 6.2 Physical and mechanical properties ... | 3 | 13. Further products for the electronics/electrical engineering industries ..... | 9 |
| 6.3 Electrical properties.....             | 4 |  |   |
| 7. Processing.....                         | 5 |  |   |
| 7.1 Adjustment of viscosity.....           | 5 |  |   |
| 7.2 Auxiliary products.....                | 6 |  |   |
| 7.3 Screen printing .....                  | 6 |  |   |



Please read this technical report, the corresponding material safety data sheet and the Technical Information sheets TI 15/11 and TI 15/13 (see Item 7) carefully before using the product.

## 1. General information

The carbon-conductive ink **SD 2843 HAL** is a 1-pack screen printing ink that, on account of selected special carbons and high-quality types of graphite, displays an excellent conductivity of approx. 13-20 Ohm/square at a coating thickness of 25 µm. The achieved conductivities are to a large extent dependent upon the selected curing conditions (see Item 6.3.2 "Resistance in relation to curing conditions").

**All symbols that are used in this technical data sheet and on our containers, such as , are explained on our website [www.peters.de](http://www.peters.de) in the section "Service – Symbols on labels".**

## 2. Application

Owing to its high mechanical strength and good electrical conductivity the carbon-conductive ink **SD 2843 HAL** enables the substitution of gold on contacts, the production of cross-over conductors (cross-over technology) as well as the creation of printed resistances.

Further applications are:

- migration protection for silver-conductive ink
- electro-mechanical keyboards
- foil keyboards for computers
- switch contacts
- low-voltage circuits
- shield areas
- heating elements.

## 3. Special notes

The carbon-conductive ink **SD 2843 HAL** is resistant to hot-air levelling (HAL) as well as to leaded and lead-free wave and reflow soldering processes and shows almost no change in resistance.



**Owing to the high number of flux agents on the market pre-trials are mandatory.**

**Protect the carbon-conductive ink by overprinting with a peelable solder resist (solder mask) if the resistance of the carbon-conductive ink changes/the resistance is insufficient or to avoid residues of fluxing agents.**

Boards that have been coated with **SD 2843 HAL** also can be treated in chemical or electro plated surface finish processes such as CSN or ENiG provided they are protected by a peelable solder mask.

For further information on suitable solder masks please see our technical report on the peelable solder masks of the series **SD 2950** and the Application Information sheet **AI 2/29** "Selection criteria and processing advice for our peelable solder resists (solder masks) of the series SD 2950".

Basically, a subsequent protective lacquering can be applied without interfering with the resistance. The **ELPEGUARD®** conformal coatings of the series **SL 1301 ECO-FLZ** and **SL 1301 ECO-BA-FLZ** as well as the thick film lacquer **TWIN-CURE® DSL 1600 E-FLZ/150** were tested as examples. Perform pre-trials when using other protective lacquer systems to ensure the compatibility.

## 4. Safety recommendations

- Please read the corresponding material safety data sheet where you will find detailed specifications of safety precautions, environmental protection, waste disposal, storage, handling, transport as well as other characteristics.
- When using chemicals, the common precautions should be carefully noted.
- Solvent vapours are heavier than air, thus when planning workplace ventilation arrangements, ensure that extractor units are positioned at worktop height.
- Please also pay attention to national guidelines or directives concerning the handling of flammable liquids as for example the German TRbF (technical regulations for flammable liquids) or European directives.

## 5. Characteristics

|  |                               |
|--|-------------------------------|
| Colour/appearance  | black, mat                    |
| Solids content, ISO 3251<br>(1 h, 125 °C [257 °F], 1 g weighed quantity, 75 mm dish) | 75 ± 2% by weight             |
| Viscosity at 20 °C [68 °F], ISO 3219   | 17 000 ± 2 000 mPas           |
| Density at 20 °C [68 °F], ISO 2811-1   | 1.27 ± 0.05 g/cm <sup>3</sup> |

\* measured with Haake RS 600, C 20/1°, D = 100 s<sup>-1</sup>, viscosity measuring unit supplied by:  
Thermo Electron (Karlsruhe) GmbH (formerly Haake-Messtechnik GmbH + Co)  
Dieselstraße 4, 76227 Karlsruhe, Germany  
Phone +49 (0) 721 - 40 94 - 0; Fax +49 (0) 721 - 40 94 - 300  
www.thermo.com

## 6. Properties

The carbon-conductive ink **SD 2843 HAL** is distinguished by the following properties:

### 6.1 General properties

- does not contain substances listed in the RoHS directive 2002/95/EC, EU End-Of-Life Vehicle directive 2000/53/EC and WEEE directive 2002/96/EC
- 1-pack system; thus advantages in processing (no mixing, no increase in viscosity caused by polymerisation, thus always virtually identical processing conditions)
- very good printing performance; no smearing
- excellent definition due to high thixotropy
- excellent mechanical strength of the surface
- excellent adhesion to nearly all substrates
- high chemical and heat resistance
- resistant to Hot-Air Levelling (HAL) as well as to leaded and lead-free wave and reflow soldering processes, almost no change in resistance
- very good adhesion to flexible base material, such as polyimide foil, thus also suitable for “static flex” applications
- stable electrical resistance performance even after temperature and moisture stress

### 6.2 Physical and mechanical properties

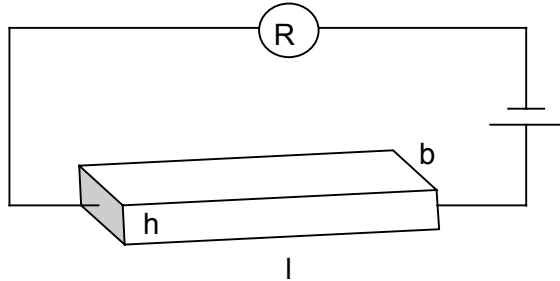
| Property                           | Test method   | Result   |
|------------------------------------|---|--|
| Solder bath resistance             | IPC-SM840D, 3.7.2<br>IPC-TM-650, 2.6.8                                    | 20 s at 265 °C [509 °F]<br>20 s at 288 °C [550.4 °F] |
| Resistance to solvents             | IPC-TM-650, 2.3.42<br>Isopropanol<br>Isopropanol/water<br>Deionized water | passed<br>passed<br>passed                           |
| Moisture and insulation resistance | based on<br>IPC-SM-840 D, 3.9.1   | no changes in resistance                             |
| Cross hatch                        | DIN EN ISO 2409<br>on copper<br>on FR 4                                   | Gt 0<br>Gt 0   |

### 6.3 Electrical properties

#### 6.3.1 Measuring resistances with square surfaces (resistance/square) – layer resistance

- The resistance is defined as:

$$R = \rho \cdot \frac{l}{A}$$



$$\rho = \text{specific resistance} \left[ \frac{\Omega \cdot \text{cm}^2}{\text{cm}} \right]$$

$$l = \text{length of resistance [cm]}$$

$$R = \text{resistance } [\Omega]$$

$$A = \text{cross-section area [cm}^2\text{]}$$

$$b = \text{width of resistor [cm]}$$

$$h = \text{height of resistor [cm]}$$

- where:

$$A = b \cdot h$$

- thus is valid:

$$R = \rho \cdot \frac{l}{b \cdot h}$$

- In case of a square surface of the resistor the following applies:

$$b = l, \text{ that means, } \frac{l}{b} = 1.$$

- and the result is:

$$R = \rho \cdot \frac{1}{h}$$

With square surfaces the resistance of the carbon-conductive ink is – at a given coating thickness (as a rule approx. 25 µm) – a material constant.

This quantity is called layer resistance and is expressed in the unit  $\Omega/\square$  or  $\Omega/\text{square}$ .

In case of simple non-square geometries the layer resistance is expressed and described by a corresponding multiple (e.g. 3-square, etc.).

#### 6.3.2 Resistance in relation to curing conditions

| Curing parameters  | Test method                              | Result                           |
|--|--|----------------------------------|
| Circulating air curing<br>(45 min/130 - 140 °C [266 - 284 °F]) | measured over parallel copper contacts * | approx. 20 $\Omega/\square$      |
| Circulating air curing<br>(45 min/150 °C [302 °F])             | measured over parallel copper contacts * | approx. 13 $\Omega/\square$      |
| IR curing<br>(at least 2 min/180 °C [356 °F])                  | measured over parallel copper contacts * | approx. 13 - 20 $\Omega/\square$ |

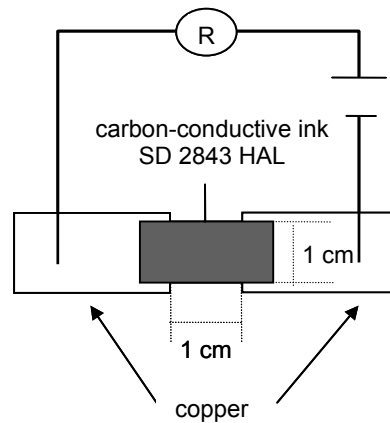
\* resistance of a square area (area: 1 cm<sup>2</sup>, layer thickness: approx. 25 µm)

In case of higher temperatures and/or longer curing times changes in resistance may occur.

Besides the physical evaporation of solvents and the chemical reaction of binding agents, the carbon particles go through a sintering process during **IR curing**

This temperature-induced sintering process is mainly responsible for the resulting resistance, thus a slightly differing resistance results depending upon the temperature profile and drying time. The reproducibility in case of the same processing and curing conditions is in the range of  $\pm 2 \text{ Ohm}/\square$ .

Especially with base material-copper interfaces that have been overprinted with carbon-conductive ink, variations in resistance may occur in case of increased temperature stress, as for instance multiple soldering, due to the different thermal expansion of copper and base material.



**Fig. 1: Measuring principle for measuring the resistance at a coating thickness of approx. 25 µm**

#### Note:

When measuring resistances, this measuring principle shows direct Ohm/square values and is generally valid for any square surfaces. But the edge length should not fall below approx. 0.8 cm, as otherwise influences from the screen printing process and/or contact resistances on the copper may falsify the measured values considerably.

## 7. Processing

The carbon-conductive ink **SD 2843 HAL** must be processed acc. to the following instructions:



**Since the many different permutations make it impossible to evaluate the whole spectrum (parameters, reactions with materials used, chemical processes and machines) of processes and subsequent processes in all their variations, the parameters we recommend are to be viewed as guidelines only. We advise you to determine the exact process limitations within your production environment, in particular as regards compatibility with your specific follow-up processes, in order to ensure a stable fabrication process and products of the highest possible quality.**

**The specified product data is based upon standard processing/test conditions of the mentioned norms and must be verified observing suitable test conditions on processed printed circuit boards.**

**Feel free to contact our application technology department (ATD) if you have any questions or for a consultation.**

### 7.1 Adjustment of viscosity

The carbon-conductive ink **SD 2843 HAL** is adjusted in such a manner that it can normally be processed in the condition supplied.



#### Stir before use

→ Please consider that owing to its high thixotropy the carbon-conductive ink **SD 2843 HAL** has to be stirred prior to processing which reduces the viscosity considerably.

If necessary, its viscosity can be reduced for processing purposes by adding the retarder **VZ 5105**.



#### To be thinned with retarder VZ 5105

→ Please note that by adding the retarder **VZ 5105** the solids content and thus the dry film thickness are reduced. Lower layer thicknesses show a higher resistance.

→ Therefore, perform pre-trials to determine the suitable quantity of retarder **VZ 5105** to be added.

## 7.2 Auxiliary products

For the processing of the carbon-conductive ink **SD 2843 HAL** the following auxiliary products are recommended:

- **Screen opener HP 5200**

The screen opener **HP 5200** is a highly active spray for dissolving dried screen-printing inks immediately and safely from clogged screens. **HP 5200** is silicone-free and does not contain oils or oily substances, so that no smearing occurs. To prevent the screen opener from affecting the conductivity values, several paper prints should be performed after its use.

- **Cleaning agents R 5899, R 5821 and R 5817**

The cleaning agent **R 5899** does not have to be marked according to German dangerous goods regulations and can be handled simply and safely. Owing to its high flash point ( $> 100\text{ }^{\circ}\text{C}$  [ $> 212\text{ }^{\circ}\text{F}$ ]) it is especially suitable for use in screen washing equipment. The cleaning agent **R 5899** is particularly distinguished by a low vapour pressure ( $< 0.1\text{ hPa}$  at  $20\text{ }^{\circ}\text{C}$  [ $68\text{ }^{\circ}\text{F}$ ]) and thus is not affected by the EU-VOC regulation 1999/13/EG which judges solvents by their percentage of volatile organic compounds (VOC = volatile organic compounds).

Furthermore, the cleaning agent **R 5821** is available which, owing to its high flash point of  $+32\text{ }^{\circ}\text{C}$  [ $89.6\text{ }^{\circ}\text{F}$ ], is also suitable for use in screen washing equipment as well as for cleaning work tools. For the manual cleaning of screens and tools we recommend our cleaning agent **R 5817** with its fast and thorough cleaning properties.



**Do not use cleaning agent as a thinner or for washing hands since solvents remove the natural grease from skin.**

Special technical reports for these products are available upon request. Further information regarding the content and consequences of the EU-VOC regulation can be found in our technical information sheet TI 15/110 E "EU-VOC regulations – Content and consequences for the PCB industry". In our report manual these technical publications are filed under group 5 and 15. On our report manual CD you will find technical reports in the "Products" section and technical information sheets in the "Service" section.

## 7.3 Screen printing

→ Please read our **Technical Information sheets TI 15/11 "The screen printing stencil in the pcb industry"** and **TI 15/13 "Precleaning in the pcb industry"**. In our report manual these technical information sheets are filed under group 15. On our report manual CD, technical information sheets can be accessed in the "Service" section.

→ Ensure that the surface to be coated is clean, dry and grease-/oxide-free and that copper surfaces preferably have an average surface roughness of  $2\text{ }\mu\text{m}$ .



**Stir before use**

→ Stir the carbon-conductive ink **SD 2843 HAL** thoroughly.

Compared to conventional screen printing lacquers, the carbon-conductive ink **SD 2843 HAL** displays a considerably higher thixotropy. By means of thorough mixing, the thixotropy is reduced and the processing viscosity reached. During breaks and storage the thixotropy increases and the lacquer becomes thicker.

→ Thus, after breaks the carbon-conductive ink **SD 2843 HAL** should be stirred again prior to processing.

Processing can be effected on manual printing tables as well on semi and fully automatic screen printing machines. The optimum processing temperature is  $18\text{--}23\text{ }^{\circ}\text{C}$  [ $64.4\text{--}73.4\text{ }^{\circ}\text{F}$ ], with a humidity in the range of 50-70 % r. h.

| Printing parameters | Standard process   | Proven parameters from practical experience     |
|---------------------|--|---|
| Screen fabric       | polyester 43-80 to 55-65<br>(acc. to old nomenclature 43 – 55 T<br>[lines/cm]) or corresponding steel fabric | 150 – 200 mesh steel fabric,<br>angled at 22.5° |
| Screen tension      | min. 25 N/cm or acc. to the recommendations given by the screen fabric manufacturer                          |   |
| Squeegee            | 75 – 80 Shore-A hardness with angular cut  |   |
| Squeegee angle      | 75 – 80°   |   |
| Squeegee pressure   | as low as possible, to avoid smearing  |   |

Dry film thicknesses around 25 µm and the associated resistance values of approx. 13-20 Ohm/square can be realized with 43-80 to 45-70 fabrics (acc. to old nomenclature 43 to 45 T fabrics). A very low stencil build-up or the use of thin steel stencils, a steep squeegee angle, a sharp squeegee edge and a low squeegee pressure contribute to a high resolution.

→ If possible, print control areas that enable a measurement of the resistance at parallel copper conductors to determine resistances and for process control.

The following **specialities** have to be observed when processing carbon-conductive ink **SD 2843 HAL**:

- When printing on thermally curing 2-pack solder resists, it should be ensured that the solder resists have previously been fully cured, otherwise changes in resistance may occur (see also Item 8.1 "Curing in circulating air ovens").
- When overprinting carbon conductors/resistors with thermally curing inks (for instance 2-pack solder resists) increases in resistance may occur (see also Item 8.1 "Curing in circulating air ovens").
- We suggest using our UV curing solder resists of the series **SD 2368 UV** or **SD 2460/201 UV-FLEX** ~~or the 2-pack solder resists of the series **SD 2460 FLEX**~~. The flexible solder resists (Index FLEX) are to be preferred for overprinting in cross-over technology. A coating thickness of 25 - 30 µm should be applied in order to ensure perfect insulation. These coating thicknesses are achieved by employing polyester fabrics of 54-64 to 68-55 (according to old nomenclature 54 T to 68 T [lines/cm]). (UV) curing should be effected directly after printing in order to prevent the carbon-conductive ink from being penetrated by liquid solder resist components.
- When using the carbon-conductive ink **SD 2843 HAL** as migration protection, it must be ensured that the silver conductor is covered completely by the carbon-conductive ink.

Special technical reports on the above mentioned products are available upon request. In our report manual these technical data sheets are filed under group 2. On our report manual CD, technical reports can be accessed in the "Products" section.

## 8. Drying/Curing

→ The curing conditions (temperature and time) must be observed in any case so that a reproducible final resistance is achieved.



**Shorter curing times and lower temperatures effect a higher resistance.**

### 8.1 Curing in circulating air ovens

→ Cure the carbon-conductive ink **SD 2843 HAL** in a circulating air oven under the following conditions:  
**45 min\* at 130 - 150 °C [266 - 302 °F]** (see also Item 6.3.2 "Resistance in relation to curing conditions").

\* Object holding time: The curing time is measured from the point when the panels reach the curing temperature.



The carbon-conductive ink **SD 2843 HAL** should not be cured at the same time as 2-pack solder resists based on epoxy resins in one curing oven, since this may delay their curing and/or an increase in resistance may occur (see also Item 7.3 "Screen printing").

Low molecular residues from 2-pack solder resists based on epoxy resins may collect in the carbon-conductive ink and increase its resistance.

## 8.2 IR-curing

The carbon-conductive ink **SD 2843 HAL** is also suitable for curing in IR curing units.

- Dry the carbon-conductive ink **SD 2843 HAL** in infrared curing units for at least **2 min at 180 °C [356 °F]**.
- Determine the optimum temperature profile of the oven for curing the carbon-conductive ink **SD 2843 HAL** by means of pre-trials.

## 9. Standard packaging

The carbon-conductive ink **SD 2843 HAL** is packed for delivery as follows:

10 tins of 0.25 kg in one carton = 2.5 kg = 1 selling unit.

Partial lots of the selling unit may be ordered but will entail surcharges to cover repackaging costs

## 10. Shelf life and storage conditions

Labels on containers show shelf life and storage conditions.



**Shelf life: In sealed original containers at least 6 months**



**Storage conditions: +5 °C to +25 °C [+41 °F to +77 °F]**



**Protect against humidity**

For warehousing reasons, isolated cases may occur where the shelf life upon shipment is less than the shelf life indicated in this technical report. However, it is ensured that our products have **at least** two-thirds of their shelf life remaining when they leave our company.

## 11. Further literature/ technical documentation

In addition to the recommendations given in this technical report, we can provide technical papers and information sheets written and compiled by members of our staff. A list of the technical publications available can be found in **TI 15/101 E** (technical papers) and **TI 15/100 E** (technical information sheets).

In our report manual all technical information sheets (**TI's**) are filed under group 15. Alternatively, visit our website at <http://www.peters.de> or click on the "Service" section on our report manual CD.

## 12. Further products for the production of pcbs

We offer a wide range of **etch resists** (photoimageable, UV curing, conventional curing), **plating resists**, **solder resists** (photoimageable, UV curing, conventional curing) as well as **peelable solder masks**, **marking inks** (photoimageable, UV curing, conventional curing), **carbon-conductive inks**, **via hole fillers** (purely thermal curing), **thick film fillers**, **plugging pastes**, **heatsink pastes**, **special strippers for solder resists** and further auxiliary products for screen printing (e. g. cleaning agents, thinners).

Special technical reports are also available for these products and can be provided on request. On our report manual CD you will find technical reports in the "Products" section.



### **13. Further products for the electronics/electrical engineering industries**

We boast a wide range of **conformal coatings, thick film lacquers, casting compounds, casting resins, electro pastes, insulating lacquers, impregnating varnishes, adhesive lacquers and auxiliary products for electronics.**

Special technical reports are also available for these products and can be provided on request. On our report manual CD you will find technical reports in the "Products" section.

### **Any questions?**

We would be pleased to offer you advice and assistance in solving your problems. Free samples and technical literature are available upon request.

The above information as well as advice given by our Application Technology Department whether in verbal or written form or during product evaluations is provided to the best of our knowledge, but must be regarded as non-binding recommendations, also with respect to possible third-party proprietary rights.

The products are exclusively intended for the applications indicated in the corresponding technical data sheets.

The advisory service does not exempt you from performing your own assessments, in particular of our material safety data sheets and technical information sheets, and of our products as regards their suitability for the applications intended. The application, use and processing of our products and of the products manufactured by you based on the advice given by our Application Technology Department are beyond our control and thus entirely your responsibility. The sale of our products is effected in accordance with our current terms of sale and delivery.

**Lackwerke Peters GmbH + Co KG**

**Hooghe Weg 13, 47906 Kempen**

**Internet: [www.peters.de](http://www.peters.de)**

**E-Mail: [peters@peters.de](mailto:peters@peters.de)**

**Phone: 0049-21 52-20 09-0**

**Fax: 0049-21 52-20 09-70**