

Carbon-conductive ink SD 2843 HAL

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 even after soldering. The achieved conductivities are to a large extent dependent upon the selected curing conditions (see Item "Resistance in relation to curing conditions").

The carbon-conductive ink **SD 2843 HAL** is suitable for touch-key contacts and 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 include migration protection for silver-conductive ink, electro-mechanical keyboards, foil keyboards for computers, switch contacts, low-voltage circuits, shield areas and heating elements.

Since the performance of the carbon-conductive ink **SD 2843 HAL** largely depends on the condition of the contact module we recommend to carry out extensive trials on the cycle resistance under conditions of use.

- black, mat
- individual resistances can be adjusted by mixing with insulating paste **SD 2803 HAL**
- excellent definition
- high mechanical resistance
- excellent adhesion on many substrates
- very good adhesion on flexible base materials such as polyimide foils, thus also suitable for "static flex" circuits
- resistant to Hot-Air Levelling as well as in leaded and lead-free wave and reflow soldering processes
- stable electrical resistance even after temperature and moisture stress

The carbon-conductive ink **SD 2843 HAL** shows almost no change in resistance after soldering or Hot-Air levelling. If the interfaces between the substrate and copper have been printed over with carbon-conductive ink, the resistance may change under thermal stress such as multiple soldering, due to the difference in heat extension of copper and the base material.

- Pre-trials are mandatory given the high number of flux agents available on the market.
- Protect the carbon-conductive ink by overprinting it 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** may also be treated in chemical or electroplated surface finish processes such as CSN or ENiG provided they have been 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 coating 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 coating **ELPEGUARD® Twin-Cure® DSL 1600 E-FLZ/150** were tested as examples. Perform pre-trials when using other protective coating systems to ensure the compatibility.

Characteristics

	SD 2843 HAL	SD 2803 HAL
Colour/aspect	black, mat	colourless
Solids content, ISO 3251 (1 h, 125 °C [257 °F], 1 g weighed quantity, 75 mm dish)	75 ± 2 % by weight	74 ± 2 % by weight
Viscosity* at 20 °C [68 °F], ISO 3219	17 000 ± 2 000 mPas	4 500 ± 1 000 mPas
Density at 20 °C [68 °F], ISO 2811-1	1.27 ± 0.05 g/cm ³	1.35 ± 0.05 g/cm ³

* measured with Haake RS 600, C 20/1°, D = 100 s⁻¹, viscosity measuring unit supplied by:
Thermo Fisher Scientific, Dieselstraße 4, 76227 Karlsruhe, Germany
Phone +49 721 4094-444, Fax +49 721 4094-300, www.thermo.com

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

Physical and mechanical properties

Property	Test method	Result
Solder bath resistance	IPC-SM840E, 3.7.2 IPC-TM-650, 2.6.8	20 s at 265 °C [509 °F] 20 s at 288 °C [550.4 °F]
Resistance to solvents	IPC-TM-650, 2.3.42 Isopropanol Isopropanol/water Deionized water	passed passed passed
Moisture and insulation resistance	based on IPC-SM-840E, 3.9.1	change of layer resistance < 25 %
Cross hatch	DIN EN ISO 2409 on copper on FR 4	Gt 0 Gt 0

Resistance in relation to curing conditions

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

* resistance of a square area (area: 1 cm², layer thickness: approx. 25 μm), for further details see Report 148 "Carbon-conductive inks – fields of application and potential for rationalisation and cost reduction"

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 final resistance, thus a slightly differing resistance results depending upon the temperature profile and drying time. The reproducibility subject to the same processing and curing conditions is in the range of 2 Ohm/ \square .

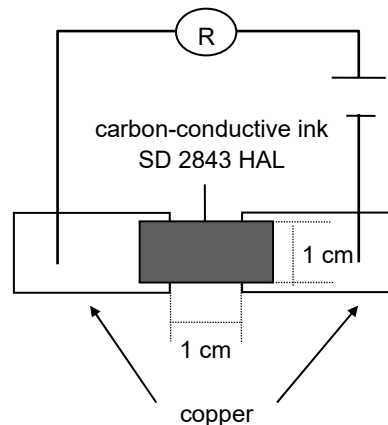


Fig. 1: Principle for measuring the resistance at a coating thickness of approx. 25 μm

When measuring resistances, this measuring principle shows direct Ohm/square values and is generally valid for any square surface. However, 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 measuring results considerably.

Increase of resistance with insulating paste SD 2803 HAL

Higher resistance values can be achieved by mixing the carbon-conductive ink **SD 2843 HAL** with insulating paste **SD 2803 HAL**. The diagram below shows the resistance values of difference mixing ratios as examples. Measuring has been made on a square surface of 1 cm² and a dry layer thickness of approx. 25 μm , measured on parallel copper contacts see fig. 1). Under temperature load, resistance values may change by up to 30 %.

→ For each batch, you should measure a series of resistance values under your production conditions.

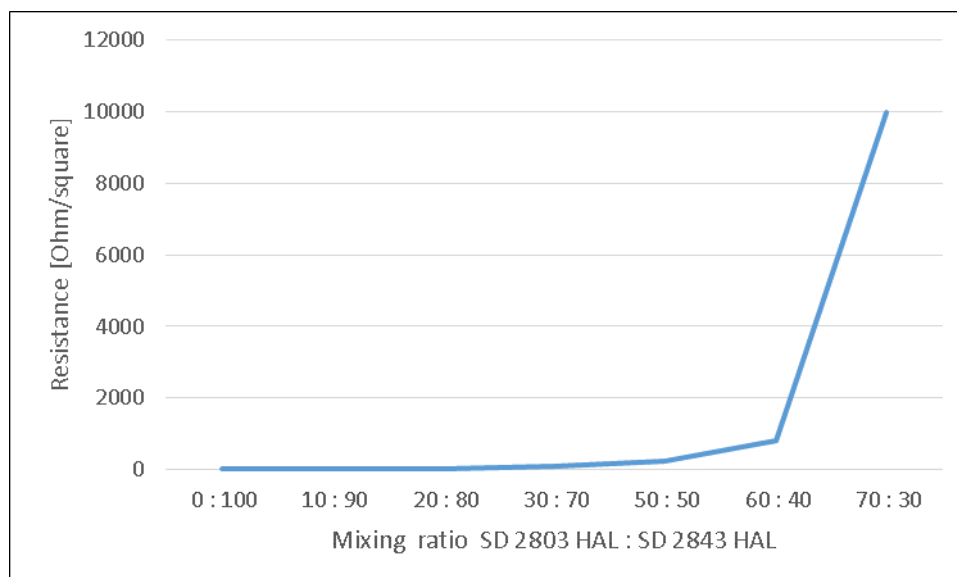


Fig. 2: Example of resistance series for mixing SD 2803 HAL and SD 2843 HAL

Processing



Please read this technical report and the publications listed below carefully before using the product. These sheets are enclosed with the first shipment of product or sample.

MSDS

The corresponding material safety data sheet contains detailed information and characteristics on safety precautions, environmental protection, transport, storage, handling and waste disposal.

TI

Technical information TI 15/3 "Protective measures when using chemicals including lacquers, casting compounds, thinners, cleaning agents"

TI

Technical information TI 15/10 "Processing of 2-pack systems"

TI

Technical information TI 15/13 "Precleaning in the pcb fabrication process"

The carbon-conductive ink SD 2843 HAL is intended for printing on copper surfaces. An application of this carbon-conductive ink on other surfaces such as ENIG is critical.

Contamination of the substrate leads to adhesion problems of the subsequently printed carbon-conductive ink. If this causes the carbon-conductive ink to peel off we recommend the pre-cleaning of the surface, e.g. by means of the cleaning agent CME 137 supplied by KIV PCB ProfiChem GmbH or KOH, e.g. stripper Ultrastrip 218 P available from Mac Dermid Electronics Solutions.

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 that were determined in laboratory conditions. 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 conditions/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.

Safety recommendations

- When using chemicals, the common precautions should be carefully noted.
- Ensure that extractor units of workplace ventilation arrangements are positioned at solvent source level.
- Please also pay attention to national guidelines or directives concerning operating safety such as the German TRBS (technical rules for operating safety) and those concerning the handling of flammable liquids as for example the German TRbF (technical rules for flammable liquids) or European directives.

Viscosity adjustment

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, see also Item "Screen printing"

- 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 retarder **VZ 5105** the solids content and thus the dry film thickness are reduced. Low layer thicknesses show a higher resistance.
- Therefore, perform pre-trials to determine the suitable quantity of retarder **VZ 5105** to be added

Auxiliary products recommended

- **Screen opener HP 5200**
highly active spray for dissolving dried screen printing inks from the screen; silicone- and grease-free, thus no surface defect/dewettings or smearing effects
- **Cleaning agent R 5899**
for screen washing equipment, simply and safely to handle, no labelling in accordance with the German dangerous goods regulations required, extremely high flash point ($> 100\text{ }^{\circ}\text{C}$), low vapour pressure $< 0.1\text{ hPa}$ at $20\text{ }^{\circ}\text{C}$, thus not affected by the EU-VOC regulation 1999/13/CE
- **Cleaning agent R 5821**
for screen washing equipment and the cleaning of work tools, high flash point ($+32\text{ }^{\circ}\text{C}$ [$89.6\text{ }^{\circ}\text{F}$])
- **Cleaning agent R 5817**
for the manual cleaning of screens and tools

Mixing with insulating paste SD 2803 HAL



Stir before use

- Mix the two products very thoroughly

Screen printing

- 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 processing viscosity is reached. During breaks and storage, the thixotropy increases again and the lacquer becomes thicker.

→ Thus, after breaks the carbon-conductive ink **SD 2843 HAL** may have to be stirred again.

The optimum processing temperature is 18-23 °C [64.4 –73.4 °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 (acc. to old nomenclature 43 – 55 T [lines/cm]) or corresponding steel fabric	150-250 mesh steel fabric, 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	

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 **SD 2843 HAL**:

- When printing on thermally curing 2-pack solder resists, it should be ensured that the solder resists have fully cured, otherwise changes in resistance may occur (see also Item "Curing in circulating air ovens").
- When overprinting carbon conductors/resistors with thermally curing inks (for instance 2-pack solder resists) the resistance may increase (see also Item "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**. 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, the silver conductor must be covered completely by the carbon-conductive ink.

Drying/Curing

The carbon-conductive ink **SD 2843 HAL** may be cured either in circulating air ovens or in IR curing units.

→ Curing conditions (temperature and time) must be kept constant to ensure that a reproducible final resistance/properties are achieved.

→ Do not cure the carbon-conductive ink **SD 2843 HAL** at the same time as other lacquer systems in the curing oven, since this may delay their curing and/or increase the resistance (see also Item "Screen printing").

Curing in circulating air ovens

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

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

IR-curing

→ Dry the carbon-conductive ink **SD 2843 HAL** in IR 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** in pre-trials.

Standard packaging

	Packaging	Selling unit
SD 2843 HAL	10 tins of 0.25 kg	2.5 kg
SD 2803 HAL	4 tins of 0.5 kg	2 kg

Partial lots of the selling unit available against surcharge.

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]

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. Labels on containers show shelf life and storage conditions.

Disclaimer

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Any questions?

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