ELPEGUARD®
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TR TECHNICAL REPORT

Silicone thick film lacquers
of the series

ELPEGUARD® DSL 1706 FLZ

Base: Polyorganosiloxane

- **colourless transparent, fluorescent**
- excellent corrosion protection (e.g. electro corrosion and migration) of assembled pcbs/flat packs
- solvent-free/**VOC**-free (**V**olatile **O**rganic **C**ompounds)
- highly elastic, thus also suitable for flexible circuits
- fast cross-linking at room temperature
- very good chemical and thermal resistance
- **thermal class H = 180 °C [356 °F]**
- correspond with the best flame class V-0 acc. to UL 94

This technical report refers to the following adjustments:

- **DSL 1706 FLZ,** colourless, fluorescent
- **DSL 1706 NV-FLZ,** colourless, fluorescent
- **DSL 1706 HV-FLZ,** colourless, fluorescent

Indices:			
	DSL	**=**	**thick film lacquer**
	FLZ	**=**	**fluorescent**
	NV	**=**	**low viscosity**
	HV	**=**	**high viscosity**

LP 071207 E-3 / 0108400e.003

Contents

Please read this technical report and the material safety data sheet according to directive 1991/155/EEC carefully before using the product.

1. General information

The silicone thick film lacquers of the series **ELPEGUARD® DSL 1706 FLZ** are solvent-free, colourless transparent, fluorescent, condensation cross-linking 1-pack conformal coatings that already cross-link at room temperature under separation of alcohol.

All symbols that are used in this technical data sheet and on our containers, such as , are explained on our website www.peters.de in the section "Service – Symbols on labels".

2. Application

The silicone thick film lacquers of the series **ELPEGUARD® DSL 1706 FLZ** are protective lacquers for thick film application that are distinguished by a high chemical and thermal stability as well as by an excellent resistance to weathering and UV radiation.

Therefore, the silicone thick film lacquers of the series **ELPEGUARD® DSL 1706 FLZ** are used as permanent electric insulation and reliable protection against high moisture stress and other aggressive environmental conditions. They are suitable for the coating of rigid and flexible circuits as well a high number of hybrid circuits and ceramic substrates that have to fulfil extremely high requirements regarding quality and service life.

The lacquers of the series **ELPEGUARD® DSL 1706 FLZ** are particularly suitable to protect sensitive components due to the fact that they are highly elastic materials. This elasticity and flexibility is permanently maintained within a broad temperature range so that almost no material tension occurs during curing or in case of temperature changes. On the contrary, the lacquers of the series **ELPEGUARD® DSL 1706 FLZ** have a stress-compensating effect on temperature shocks and vibration.

The silicone thick film lacquers of the series **ELPEGUARD® DSL 1706 FLZ** can be used within a temperature range of -55 up to +200 °C [-67 up to 392 °F] while at the lower and upper end of this range the performance and efficiency of the material may be affected in case of some applications. In these cases additional pre-trials and controls are required. In case of permanent temperature changes during operation the application field decreases to -40 up to +180 °C [-40 up to 356 °F].

The ever increasing requirements on conformal coatings for even higher quality and extended service life at high ambient temperatures can be fulfilled by the silicone thick film lacquers of the series **ELPEGUARD® DSL 1706 FLZ**, so that these ink systems are particularly suitable for the following applications:

- automotive electronics
- lighting electronics/LED technology
- electronics for the military sector
- electronics for shipbuilding and off-shore technology
- electronics for air and space craft
- high performance electronics
- electronics that have to withstand permanently changing climates with simultaneously high atmospheric humidity.

3. Special notes

The silicone thick film lacquers of the series **ELPEGUARD® DSL 1706 FLZ** correspond to the best flame class V-0 in accordance with UL 94 and show an excellent dielectric performance. Over a wide temperature range the dielectric constant is virtually independent of the temperature and frequency; that means that the dissipation factor tan δ that is important for signal transfer has a very low value that is also virtually independent of the temperature and frequency (see Item 6.3 "Electrical properties").

Since these are solvent-free systems they are from a technological as well as from the economic point of view a useful solution, among others with a view to the EU VOC regulation (VOC = Volatile Organic Compounds), which aims to determine and reduce solvents.

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 this technical publication is filed under group 15.

If the high temperature resistance of a silicone conformal coating is not required a whole range of colourless and coloured transparent **ELPEGUARD®** conformal coatings based on polyurethane, acrylic and epoxy resins is available as low-cost alternatives that also offer excellent protection against corrosion. Special attention should be paid to our **ELPEGUARD®** thick film lacquers of the series **TWIN-CURE® DSL 1600 E-FLZ**, a solvent-free 1-pack system based on a copolymerisate of polyurethane and acrylate with the resistance of 2-pack systems, that due to two optimally synchronised curing mechanisms enable the thick film application up to 2000 µm at simultaneously short processing times. Special technical reports for these products are available upon request. In our report manual these technical data sheets are filed under group 1. On our report manual CD, technical reports can be accessed in the "Products" section.

4. Safety recommendations

→ Please read our material safety data sheet according to directive 1991/155/EEC 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.

→ 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

	DSL 1706 FLZ	DSL 1706 NV-FLZ	DSL 1706 HV-FLZ
Colour/appearance	colourless transparent, fluorescent (in the condition supplied colourless to light yellow, slightly milky)		
Solids content	100%		
Viscosity* at 20 °C [68 °F] EN ISO 3219/ISO 3219	400 ± 100 mPas	140 ± 40 mPas	12 500 ± 2 500 mPas
Density at 20 °C [68 °F] ISO 2811-1	0.99 ± 0.05 g/cm³	0.96 ± 0.05 g/cm³	1.00 ± 0.05 g/cm³

* measured with Haake RS 600, C 35/1°, D = 100 s^{-1},
with the exception of DSL 1706 HV-FLZ measured with RS 600, C 20/1°, D = 100 s^{-1};
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 silicone thick film lacquers of the series **ELPEGUARD® DSL 1706 FLZ** are distinguished by the following properties:

6.1 General properties

- do 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
- suitable for thick film application; typical layer thicknesses are up to 300 µm (see also Item 7 "Processing")
- on account of its high viscosity **ELPEGUARD® DSL 1706 HV-FLZ** can also be spot-applied to protect, for instance, solder pads and pins

- short processing times due to fast cross-linking at room temperature
- good adhesion to many substrates even without additional adhesive agents (self-priming)
- condensation cross-linking, low cross-linking shrinkage
- highly elastic, thus suitable to cover stress-sensitive components
- also suitable for flexible circuits
- on account of its fluorescent adjustment (Index FLZ) the coating can be easily controlled under UV light (black light with a UV-A impulse at 350-375 nm); thus even an inadvertent coating/lacquer displacement is securely detected
- highly protective effect against high moisture stress and other aggressive environmental conditions over a broad temperature range (-55 °C up to +200 °C [-67 °F up to 392 °F] (see also Item 2 "Application")
- high continuous temperature resistance (thermal class H = 180 °C [356 °F], DIN IEC 60 085)
- very good chemical and hydrolytic stability even in case of high temperatures and extreme moisture stress (tropical climates)
- meet requirements of IPC-CC-830B
- excellent insulation properties
- excellent dielectric properties
- stress-compensating in case of thermal shock and vibration
- resistant against weathering influences and UV radiation
- water repellent
- no decomposition on account of ozone
- correspond to the best flame class V-0 according to UL 94
- free of halogenated flame retardants
- can be easily removed mechanically or soldered through for repair purposes. After completion of the repair work the lacquers of the series **ELPEGUARD® DSL 1706 FLZ** can be reapplied to the previously cleaned substrate.

Since the lacquers of the series ELPEGUARD® DSL 1706 FLZ are condensation cross-linking systems they should not be used encapsulated since, among others, in case of high temperature stress a reversion of the material may occur.
The additive cross-linking silicone thick film lacquer ELPEGUARD® DSL 1705 FLZ is suitable for use in encapsulated environments. A special technical report on this product is available upon request. In our report manual this technical data sheet is filed under group 1. On our report manual CD, technical reports can be accessed in the ”Products” section.

6.2 Physical and mechanical properties

These values are achieved at a coating thickness of 125 µm after 24 hours‘ storage at room temperature.

Property	Test method	DSL 1706 FLZ DSL 1706 NV-FLZ DSL 1706 HV-FLZ
Solvent/cleaning agent resistance	based on IPC-SM-840 C, 3.6.1 Isopropanol Isopropanol : water (75 : 25) deionized water	 passed passed passed
Flexibility	IPC-CC-830B, 3.5.5	passed

6.3 Electrical properties

These values are achieved at a coating thickness of 125 µm after 24 hours' storage at room temperature.

Property	Test method	DSL 1706 FLZ	DSL 1706 NV-FLZ	DSL 1706 HV-FLZ
Dielectric strength	IPC-TM-650, 2.5.6.1 DIN EN 60243-1	63 kV/mm		
Dielectric strength	IPC-CC-830B, 3.6.1	passed		
Specific volume resistivity	VDE 0303, part 30 DIN IEC 60093	6.3×10^{15} Ohm x cm		
Surface resistance	VDE 0303, part 30 DIN IEC 60093	2×10^{14} Ohm		
Moisture/insulation resistance	IPC-CC-830B, 3.7.1 (65 °C [149 °F]/90 % r.h.)	4.5×10^{10} Ohm class A and B		
Moisture and insulation resistance	85/85-test; ramp formed storage at high air moisture and high temperature, amongst others 3 days at 85 °C [185 °F] and 85 % r. h.	6.3×10^{9} Ohm		
Thermal shock	IPC-CC-830B, 3.7.2	class 3 passed		
Hydrolytic stability	IPC-CC-830B, 3.7.3	passed		
Comparative tracking Index (CTI, Tracking resistance)	DIN EN 60112 on base material with CTI 275	CTI > 600		
Resistance to condensation	based on ISO 6270-2 (BIAS 12 V, 40 °C [104 °F], 100% r. h.)	2.0×10^{10} Ohm		
Thermal class	based on DIN IEC 60 085	H = 180 °C [356 °F]		
Dielectric constant ε_r	based on ASTM D 150 at 100 Hz at 100 kHz	 2.5 2.5	 2.5 2.5	 2.1 2.1
Dissipation factor tan δ	based on ASTM D 150 at 100 Hz at 100 kHz	 0.0007 < 0.0002	 0.001 < 0.0002	 0.0013 < 0.0002

7. Processing

The silicone thick film lacquers **ELPEGUARD® DSL 1706 FLZ** and **DSL 1706 NV-FLZ** are generally suitable for an application by means of brushing, spraying or automatic selective coating units.

On account of their high viscosity the silicone thick film lacquers **ELPEGUARD® DSL 1706 HV-FLZ** can only be applied by means of a dispenser or similar.

Ensure an even and bubble-free coating by adjusting suitable application parameters.

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.

On account of their moisture sensitivity stainless steel working tools and, if necessary, Teflon-coated hoses are especially recommended. for the processing of the lacquers of the series **ELPEGUARD® DSL 1706 FLZ**.

The silicone thick film lacquers of the series ELPEGUARD® DSL 1706 FLZ cure under the influence of moisture. Ensure the inks are protected from moisture during processing, e.g. by using inert gas (nitrogen).
Containers must be tightly closed after use, partially filled containers should be filled up with nitrogen.
When silicone based and silicone-free inks are used at the same time problems, such as dewettings, may occur during the processing of the silicone-free lacquers.
Therefore, keep work places/tools separate to avoid the different ink systems coming into contact with each other, as for instance through contaminated working tools.

The higher the viscosity of the ink the thicker the ink layers can be achieved. Typical layer thicknesses are up to 300 µm.

→ Please bear in mind that curing will take considerably longer the thicker the ink layer is applied since the moisture that is required for curing has to diffuse through the whole ink layer first.

→ Evacuate the silicone thick film lacquers before and/or immediately after application to remove any air that may have merged with the lacquer.

This is especially recommended in case of applications with layer thicknesses of approx. 300 µm as well as in case of application by means of compressed-air.

→ Do not expose the silicone thick film lacquer directly and/or permanently with compressed-air as otherwise it merges with the lacquer and forms bubbles after application.

Thus a second coating after complete curing of the first layer is recommended for the application of thicker ink layers.

→ Ensure that the surface to be coated is clean, grease-free and dry.

→ Observe that any form of (ionic) contamination affects the adhesion as well as the electrical properties, especially under extreme climatic conditions. Poor adhesion enables the deposit of water between pcb and conformal coating and thus may lead to corrosion/defects. Therefore, clean the assembly of fluxing agents and other contaminations or ensure that the properties you desire are achieved by performing corresponding tests.

→ Ensure you check the assembly that has been manufactured under your series conditions after coating and curing in the subsequent operating environment.

7.1 Adjustment of viscosity

The silicone thick film lacquers of the series **ELPEGUARD® DSL 1706 FLZ** must be processed in the condition supplied. The various adjustments can be mixed with each other, so that – according to the desired layer thickness or if required by the process – another viscosity can be adjusted.

Do not add any solvents or thinners to reduce the viscosity.

7.2 Auxiliary products

- **Cleaning agent R 5817**
  For cleaning work place and tools we recommend our cleaning agent **R 5817**.

Do not use the cleaning agent to clean hands.
Solvents extract the natural grease from the skin.

- **Peelable protective skin EH 13.150 AQ-T**
  blue transparent, solvent-free, water-borne 1-pack system for the protection of smooth surfaces, e.g. of lacquer coating machines and scales, against soiling from ink splashes or other contaminations. After drying, a highly elastic and tear resistant film results that can be peeled-off and renewed as required.

Special technical reports on these products are available upon request. In our report manual these technical reports are filed under group 5 and 13. On our report manual CD, technical reports can be accessed in the ”Products” section.

7.3 Manual processing

The silicone thick film lacquers of the series **ELPEGUARD® DSL 1706 FLZ** can be applied by means of brushing. This process is especially suitable for repair work and small series' as the ink can be applied selectively. But in this case uneven layer thicknesses may result.

7.4 Mechanical processing

7.4.1 Compressed-air spraying

Spraying pressure, spraying angle and distance have to be adjusted according to the object's geometries.

When applying the lacquer by means of compressed-air spraying the safety precautions of national regulations must be observed, as for example Chapter 2.29 "Processing of Coating Materials" of the German Trade Association Regulation BGR 500 "Operation of Work Equipment" (formerly VDG 23 and BGV D 25), in particular Section 3 ”Operation” as well as in the explosion protection rules (BGR 104).
Moreover, obey the operating and maintenance instructions of the spraying cabin and filter mat manufacturers.

7.4.2 Automatic selective coating

The use of automatic selective coating units makes it possible to coat defined areas of the assembly with a uniform ink film.

Optimum equipment parameters depend upon the assembly geometry, the required final properties etc. and thus should be determined in co-operation with the corresponding unit manufacturer, Lackwerke Peters GmbH + Co KG as well as the end user.

Upon request, we will provide you with contact addresses of high-performance manufacturers of such units as well as contract coating companies.

8. Drying/Curing

The silicone thick film lacquers of the series **ELPEGUARD® DSL 1706 FLZ** cure very fast at room temperature under the influence of moisture to a clear transparent coating. For final curing a relative humidity of at least 5 – 10 % is required. Curing can be accelerated by means of a higher humidity (50% relative humidity is ideal) or by means of heat addition (max. 60 °C [140 °F]).

Thicker layers require a longer curing time. The following values shall serve as guidelines:

	at room temperature (approx. 23 °C [73.4 °F]), 50% relative humidity wet layer thickness approx. 125 µm
tack-free	< 15 min
dry	45 min

Dependent upon the substrate and humidity full adhesion is achieved after 24 h or longer.

→ Do not encapsulate/pack the coated components prior to complete curing as the silicone thick film lacquers of the series **ELPEGUARD® DSL 1706 FLZ** need atmospheric humidity to cure.

→ Please consider that in case of too high atmospheric humidity (approx. 70% relative humidity upwards) during curing, especially in case of higher layers, bubbles may form because the cross-linking reaction progresses too fast.

A relative humidity of 50% is optimal.

9. Standard packaging

The silicone thick film lacquers of the series **ELPEGUARD® DSL 1706 FLZ** are packed for delivery as follows:

10 plastic bottles of 1 kg = 10 kg = 1 selling unit

Partial lots of a selling unit can 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.

Any questions?

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

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