CARAPACE® - EMP110 DI

LIQUID PHOTOIMAGEABLE SOLDERMASK

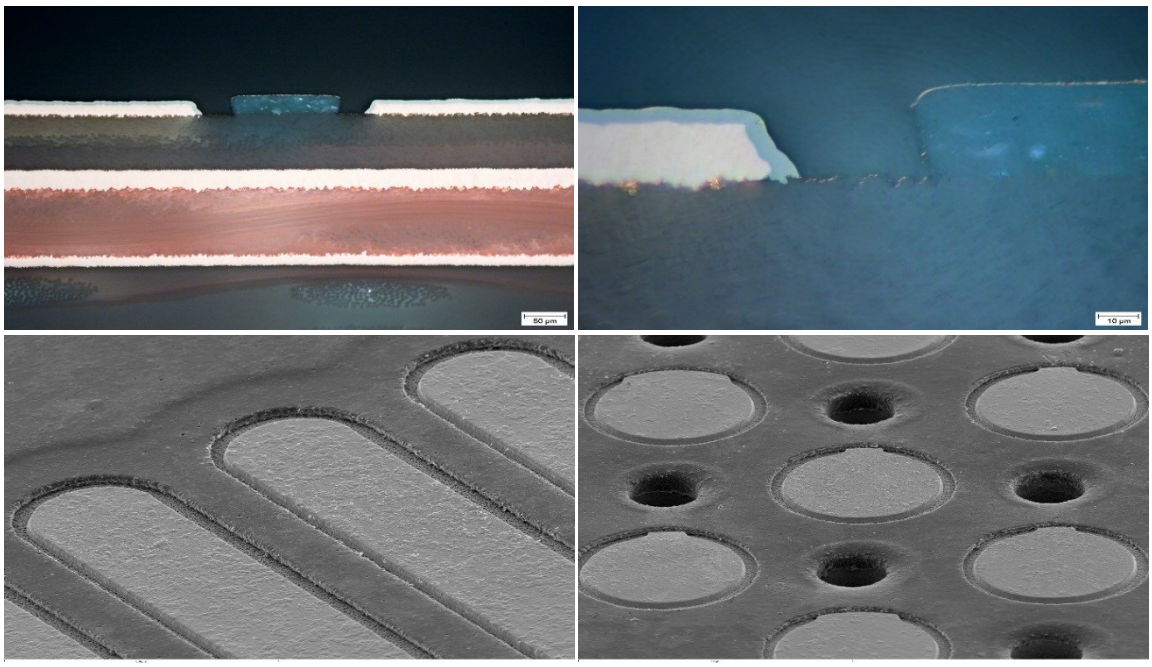
For Universal Direct Image

Product Description

Carapace® EMP110 DI is the next generation in Liquid Photoimageable Soldermask for Direct Imaging. Using two-component epoxy technology, EMP110 DI soldermask is ideally suited for high-reliability, HDI PCB production where ultimate resolution and registration is required.

The EMP110 DI formulation has been engineered to deliver straight sidewalls and fine solder-dam resolution over the wide range of coating thicknesses associated with screen-printed and sprayed PCBs.
Optimised radiation curing characteristics deliver high levels of through-cure at low energy levels without compromise in surface hardness or chemical resistance.

- Low exposure energy (100-250 $mJcm^{-2}$) to resolve small features sizes (light source wavelength dependant)
- No surface damage or erosion during developing
- Fine solder-dam resolution (50μm, 2mil)
- Suitable for DI (single, dual and multi-wavelength) and conventional exposure systems
- High Resistance to Pb-Free, ENIG & Sn Processes
- Meets ASTM-E-595 Soldermask Outgassing requirements.
- Halogen-free, RoHS and fully REACH compliant with no TGIC or other SVHC content.
- Available for screen-print and spray application methods
- Available in variety of colours (supplied as universal Part A and coloured Part B)



Carapace® EMP110 DI is available as standard in the following:

Screen-print: Transparent Matt, Transparent Gloss, Transparent eXtra Matt

Air-spray: Transparent Matt and Transparent semi-gloss

HARDENERS:

1) EMP110 PtB - The following hardeners is grouped into the EMP110 PtB class:

EMP110 Pt B (H5726 DI)

EMP110 Pt B (H5766 DI)

available in Green, Dark Green, Blue, Red, Black and Transparent

Other colours can be achieved using the transparent hardener and an additional colour concentrate. Please contact Electra for further details.

Board surface preparation

Mechanical pre-cleaning:

Brush
320 to 400 grit silicon carbide brushes with a recommended footprint on the copper of 10-15mm. (0.4-0.6 inches).
Brushes should be regularly checked and dressed to ensure optimum preclean is retained.

Pumice Slurry Scrub
Pumice concentration between 18 - 22% (v/v) is recommended (3F or 4F virgin grade).
Slurry should be changed between 500-1000 panels

Aluminium Oxide Slurry Scrub
Aluminium oxide concentration between 18 - 22% (v/v) is recommended (400 grit).
Slurry should be changed between at least 20,000-30,000 panels

Aluminium Oxide Jet Slurry Spray
Aluminium oxide concentration between 18 - 22% (v/v) is recommended (220 grit virgin grade).
Jet spray pressure 20-24 PSI ensuring the jet nozzle patterns fully overlap
Slurry should be changed between at least 10,000-20,000 panels

Panels must be fully rinsed such that any slurry particles are completely removed. Failure to remove particles can result in poor cosmetics and adhesion loss.

If panels are heavily oxidised and tarnished then a micro-etch prior to mechanical pre-cleaning is strongly recommended. Panels must be thoroughly rinsed prior to mechanical cleaning stage.

Recommended Surface roughness figures are Ra 0.2-0.4µm.

Chemical pre-cleaning:

High Roughness, Deep-Etching Clean
Due to the excellent mechanical bond achieved between the copper surface and soldermask, proprietary deep-etch chemistries are the preferred method of pre-clean.
For a list of recommended and approved chemistries, please contact your Electra representative.

Microtech Clean
Simple microtech solutions such as sodium persulphate are not recommended as the sole method of preclean.

In all cases panels must be thoroughly rinsed and dried such that no tarnish is present and no water moisture remains in the holes or between closely spaced tracks.

It is recommended that all freshly cleaned panels are coated within 2-4 hours. The actual maximum time will vary depending upon ambient temperature and humidity. Panels left longer than 4 hours should be re-cleaned prior to coating.

Mixing:

Carapace® EMP110 DI is supplied as standard in pre-weighed 1kg or 3kg packs for screen print and 2.2kg or 11kg packs for air-spray.

The resist is supplied in pre-weighed packages of paste + hardener. The original supplied mix ratio must be used if mixing smaller amounts than the standard pack-size.

Incomplete mixing can cause poor developing, stickiness during exposure and impaired final properties

Viscosity reduction:

Screen Print:

EMP110 DI is supplied screen ready. Viscosity adjustment is not recommended as this may result in thin deposits on track edges and/or prolonged drying times.

Spray:

It is advisable to use a slow speed mechanical mixer when mixing in solvent. Care should be taken to avoid incorporating air into the resist during mixing. Resist should be allowed to stand for 2 hours after mixing to allow air to escape.

EMP110 DI AS soldermasks using EMP110 Pt B (H-5726 DI) should be reduced with **Electrareducer ER6.**

Where **ER6** is not available, an equivalent from an approved source may be used. The use of non-approved solvents is not recommended as they can cause contamination and other processing problems.

Solvent addition	20-30% Gloss 25-35% Matt
Filter	Use 43-62T (110-196) screen mesh

Due to the fast viscosity readings using a Zahn$_3$ cup, air inclusion can give erratic readings. It is therefore recommended to use the Ford Nº4 or a cup giving similar values (e.g. Frikmar Nº4).

Mixed pot-life: Screen-print 2 – 3 days Spray (fully reduced) 5 – 7 days

Screen-printing process settings:

Manual Screen printing parameters

Screen-mesh	38 - 43T (98 - 110 mesh) Polyester (½ - 1 oz base copper) 32 -36 T (83 - -92) Polyester (>1oz base copper)
Screen Tension	22-25 Newtons
Squeegee	Sharp edge 60-70 Shore (Durometer)
Snap-Off (Off-contact)	3.0 mm (¼") minimum
Print cycle	Flood /Print /Print (Pushed stroke)
Wet weight	59 – 75 gram sq. m (5.5 – 7.0 gram sq.ft.)
Wet Thickness	30 – 45 microns (wheel gauge)

Horizontal semi-automatic printing parameters

Screen	38 - 43T (98 - 110 mesh) Polyester (½ - 1 oz base copper) 32 -36 T (83 - -92) Polyester (>1oz base copper)
Screen Tension	22-25 Newtons
Squeegee	Sharp edge 60-70 Shore
Snap-Off (Off-contact)	3.0 mm (¼") minimum
Print cycle	Flood /Print /Print (Pushed stroke)
Wet weight	59 – 75 gram sq. m (5.5 – 7.0 gram sq.ft.)
Wet Thickness	30 – 45 microns (wheel gauge)
Squeegee angle	15 - 25° from horizontal
Flood pressure	30 - 40 psi
Flood / Print speed	2.0 - 3.0 fpm (0.6 – 0.91 $mmin^{-1}$)
	Check planarity of squeegee and flood bar

The board outline image may be made on the screen using conventional stencil material or masking tape and screen filler. To prevent a build up of ink on the reverse of the screen that may block holes, it is advisable to shift alternate boards along the x- or y-axis before printing. Alternatively, a rudimentary stencil, such as an expanded drill mask, can be used on the screen to prevent ink going into the holes.

Do not utilise the vacuum bed, as this will suck an exaggerated amount of ink into the holes.

Vertical semi-automatic / automatic printing parameters (Circuit Automation)

Screen	38 - 43T (98 - 110 mesh) Polyester (½ - 1 oz base copper) 32 -36 T (83 - -92) Polyester (>1oz base copper)
Mesh bias	22.5° to frame
Screen Tension	22 - 25 Newtons (stretch and glue frames) 28 – 32 Newtons (*Shur-Loc E-Z* frames)
Squeegee	Sharp edge 60-70 Shore
Squeegee angle	27 - 30° (ideally measured with digital gauge)
Squeegee pressures	60 – 90 psi (machine dependant)
Flood pressure	20 – 30 psi
Flood speed	4.5 – 7 inch /sec. (11.4 – 17.8cm/sec)
Print cycle	Flood / Print / Print
Print speed	1) 4.5 – 6 inch /sec. (11.4 – 15.2cm/sec) 2) 4.5 – 6 inch /sec. (11.4 – 15.2cm/sec) *A faster print on 2nd cycle will increase the thickness*
Wet weight	59 – 75 gram sq. m (5.5 – 7.0 gram sq.ft.)
Wet Thickness	30 – 45 microns (wheel gauge)
Jog	0150 – 0250
Shuffle	ON
Skew	50-80psi (left and/or right). Typically used for heavy copper
Peel-off	70-80psi. Only used for thin panels (<1mm (.039”)
Lower clamp	Only used for thin panels (<1mm (.039”)
Panel Tension	45-60psi Used for thin (<1mm (.039”) panels or if panels are bowed
ISO-Print squeegee	V-shape 70-75 Shore
ISO-Print pressure	20 – 60psi (machine dependant)

ISO-print can be used to remove build-up of soldermask on screen between panel prints. This can be useful if production has large holes or slots.

Where available it is recommended to utilise the ISO facility on double-sided print equipment.

Screens should be left flooded during any down-time and cleared with a dummy print before production re-starts.

Spray process settings:

Argus equipment

Temperature	Gun 75-90°C (90°C preferred) Atomisation air 75-90°C (90°C preferred) Stand-by air 50°C
Spray pitch	0.8 – 1" (20 – 25mm)
Conveyor speed	3.0 – 4.0 fpm (0.9 – 1.2mmin^{-1})
Reservoir pressure	set to achieve required thickness
Atomisation pressure	30-50 psi (typically 40 psi) Conveyor speed and air pressures determine the sprayed wet thickness
Wet thickness	60-75µm (2.5-3.0 mils) depending on copper height

Eco-Spray equipment

Index:	0.6 – 0.8 inch (15 – 20mm)
Scan:	300 - 750
AutoClose:	300 - 600
Tank pressure:	set to achieve required thickness
Fan pressure:	30 – 40 psi
Gun temp.:	70°C (158°F)
Gun opening:	15 – 25 clicks (depending on heating)
Wet thickness:	60-75µm (2.5-3.0 mils) depending on copper height

Atomising pressure should be set to give minimal mottling.

Shaping air is to be adjusted to give an even spray pattern.

Lower atomising pressures will lead to increased mottling.

Tack-dry:
The aim of the tack-drying stage is to solely remove the solvents. It is important for the drying chamber (static or conveyorised) to have good air circulation with air supply and extraction facilities.

Convection dry

Hardener	Recommended temperature	Recommended/Max time (mins)	Max hold-time* after optimum tack-dry before developing
DI specific hardeners	75°C (167°F)	40-60	72 hours

* it is recommended that boards are held in an air-conditioned, UV safe-light area.

Infra Red dry
IR drying is dependent on coating application method, IR wave-length and IR intensity.

Please contact Electra Technical Support Department for recommendations regarding specific equipment types and manufacturers.

Direct Imaging

Ensure panels are at room temperature before the exposure stage.
It is recommended to pass panels through a contact dust removal system prior to placing in the DI unit.

Equipment / Light Source	Typical energy requirement $mJcm^{-2}$ or setting as otherwise indicated	Stouffer Step (clear copper)
Altix ADIX (377/387 nm LED)	100 - 250	8 - 11
ChimeBall Technologies (Maskless Lithography) (Hg lamp, single or multi-wave LED)	Dose setting 200 - 300	8 - 11
First EIE EDI500 (high pressure mercury UV lamp)	50 - 100	8 - 11
Limata UV-R (375/395/405nm Laser)	100 - 250	8 - 11
Miva **26xx** series (375/395nm LED) **2000** series (365/375/395/405nm LED) **2000L Trio** 25µm (360/375/390/405nm LED)	*(depending on configuration) PB 300 – 1600* PB 400 – 1600* PB 200 - 400	8 - 11
Orbotech Paragon™ (355nm laser)	100 – 250	8 - 11
Orbotech Nuvogo™ (365/405nm Laser)	100 - 200	8 - 11
Print Process Apollon DI A11 (375/390nm LED)	100 - 250	8 - 11
Schmoll MDI (365/375/395/405nm LED)	100 - 200	8 - 11
Ucamco Ledia SD-53 (365/385/405nm LED)	100 - 200	8 - 11

The exact energy requirement will be determined by copper height, soldermask thickness and resolution requirements.

Determination of the correct imaging energy should be carried out after setting the developing speed.
Above energy requirement is based on the standard green version, other colours may require higher energy levels.
It is strongly recommended to blank out vacuum holes except for those around the perimeter of the panel. This can be done using a sheet of mylar or a bespoke plate from the imaging equipment supplier.

Conventional Imaging

If required it is also possible to image EMP110 DI using conventional UV exposure units.
Step wedge: 9 - 11 clear (Stouffer 21 step)

Developing

Developer: 1% soln sodium or potassium carbonate.
Spray pressure: 1.5-2.5 $kgcm^{-2}$, 20-40 psi.
Spray time: 30-90s in carbonate chamber(s) (dependent on quantity of ink in holes).
Temperature: 35°C (95°F)

Boards should be well rinsed with fresh water and fully dried after developing.
Do not final cure boards when wet.

The optimum developing speed is set when an unexposed board develops off completely, 25-30% of the way through the machine. This speed should be ascertained by preliminary tests prior to making exposure tests.
Developing speed and break-point settings will be determined by the amount of ink deposited in the holes during coating.

Final Cure

Convection oven: 60 mins at 150°C (300°F) Time at board temperature

UV bumping

It is recommended that all boards are processed with a UV bump.

Before final-cure: 1000 – 2000 $mJcm^{-2}$
or

Post-final-cure: min. 3000 $mJcm^{-2}$.

UV bumping before final curing can reduce volatiles extracted during curing.

If the soldermask is not UV bumped then occasionally white staining can be seen at final finish.
If staining does occur it is easily and permanently removed by a short bake cycle of 10-15 mins @ 120-150°C (248 - 300°F).

Safelight

It is recommended to process Carapace®EMP110 DI under safelight conditions. Between drying/exposing and exposing/developing, boards should be kept in yellow light. Boards should, in any case, be kept out of direct sunlight until completely processed.

Notation/marking inks

UV, thermal curing and Inkjet notation inks are suitable for use with Carapace®EMP110 DI. Thermal curing inks may be applied before or after final cure. If UV curing notation inks are used they should be applied before final

cure and before UV bump. In this case UV curing the notation ink should serve as the bump for the soldermask, depending on cure energy.

Flux residues / staining

Occasionally flux residues or staining can be seen on boards, particularly when using very acidic or aggressive fluxes. Washing boards (post HASL or wave-solder) when still hot causes this and can be exaggerated by using hot water rinse. Boards must be allowed to cool after soldering before rinsing and it is recommended all rinse solutions be below 40°C (104°F).

If staining does occur it can be removed by post baking boards, after soldering, for 10-15 mins @ 120-150°C (248 - 300°F)

Stripping

After developing, any reject boards may be stripped of soldermask using a 5% NaOH solution at 40-50°C (104 - 122°F)
After curing, soldermask can be stripped using a proprietary soldermask stripper such as **ES108H/4000.**

Cleaning

Equipment should be cleaned of residual soldermask using **SW200 or Dowanol PMA.**

Shelf-life

12 months from date of manufacture when stored in cool, dry, recommended conditions.
Storage should be between 10 and 25°C (50 - 77°F) and must be away from sources of heat and direct sunlight.

Final Properties

TEST	METHOD	RESULT	CLASSIFICATION
Hardness (pencil)	SM-840E	6H	Pass, class H
Adhesion (Rigid)	SM-840E	Copper: 0% removal Base laminate: 0% removal	Pass, class H
Chemical resistance Isopropanol (min.120s) Isopropanol/H_20 (75/25) D-Limonene 10% Alkaline detergent Monoethanolamine Deionised water	SM-840E Room temp. 120s 46 (± 2)°C 15 min Room temp. 120s 57 (± 2)°C 120s 57 (± 2)°C 120s 60 (± 2)°C 5 min	No surface roughness No blisters No delamination No swelling No colour change No cracking	Pass, class H
Methylene chloride	Internal testing:- Room temp. 60s		Pass

TEST	METHOD	RESULT	CLASSIFICATION
Hydrolytic stability	SM-840E	No evidence of reversion	Pass, class H
Insulation resistance	SM-840E	Before solder: 2.8E+12 Ω (avg.) After SnPB: 6.7E+11 Ω (avg.) After SAC305: 3.8E+11 Ω (avg.)	Pass, class H min req. 500MΩ (5.0E+08Ω)
Moisture & insulation	SM-840E	No blistering, separation, degradation. No solder: Initial 2.8E+12 (Ω) (avg.); During 1.5E+09 (Ω) (avg.); After 1.5E+13 (Ω) (avg.) SnPB: Initial 6.7E+11 (Ω) (avg.); During 2.3E+09 (Ω) (avg.); After 1.4E+12 (Ω) (avg.) SAC305: Initial 3.8E+12 (Ω) (avg.); During 1.6E+09 (Ω) (avg.); After 3.2E+11 (Ω) (avg.)	Pass, class H min req. 500MΩ (5.0E+08Ω)
Electrochemical Migration	SM-840E	Resistance ≥ 2 MΩ No dendritic growth	Pass, class H
Resistance to Lead-Free Solder	SM-840E	No adherence of solder to the soldermask surface	Pass, class H
Simulation of Lead-Free Reflow	SM-840E	No adherence of solder to the soldermask surface	Pass, class H
Adhesion to other soldermask materials	SM-840E	0% removal	Pass, class H
Wave-solder resistance 10 (± 1)s at 260 (± 5)°C	SM-840E	No loss of adhesion or solder pick-up.	Pass, class H
Hot-air-solder-level	N/A	Minimum 5 cycles	Pass
Thermal shock	SM840 E	No cracks, delamination, crazing or blistering	Pass , class H
Dielectric strength	SM840 E		Pass , class H
	IEC60243-1 and IEC60464-2	134 KV/mm (3417 V / mil)	
Dielectric constant		4 (1 MHz)	
Insulation resistance	SM-840E	Before solder: 9.1E+13 Ω (avg.) After solder (@ 260°C): 7.1E+13 Ω (avg.)	Pass, class T min req. 500MΩ (5.0E+08Ω)
Moisture & insulation	SM-840E	No blistering, separation, degradation. No solder: Initial 9.1E+13 (Ω) (avg.); During 5.7E+9 (Ω) (avg.); After 8.1E+13 (Ω) (avg.) After solder (@260°C): Initial 7.0E+13 (Ω) (avg.); During 4.8E+9 (Ω) (avg.); After 4.1E+13 (Ω) (avg.)	Pass, class T min req. 500MΩ (5.0E+08Ω)
Electrochemical Migration	SM-840E	< 1 decade drop in resistance No dendritic growth	Pass, class T
Oxygen Index	SM-840 E ASTM 2863	≥ 28%	Pass, class T

Soldermask Outgassing

	Total Mass Loss (TML)	Collected Volatile Condensable Material (CVCM)	Water Vapour Recovered (WVR)
ASTM-E-595 requirement	Max. 1.0%	Max. 0.10%	Report
EMP110 DI With min. 3000mJcm^{-2} UV bump (post-final cure)	**0.69%**	**<0.01%**	**0.73%**

UL File e95722 94 V-0

For further information, contact:

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