isola

DE104

Low Tg Laminate and Prepreg

Processing Guide

The processing guidelines contained in this document were developed through in-house testing and field experience. However, they should be considered to be starting points that will require further adjustment. Read the following review of processes for applicability to your particular Printed Wiring Board (PWB) fabrication environment. Remember that the suggestions contained herein can not account for all possible board designs or processing environments. Additional adjustments by the fabricator will be necessary. Isola can and will assist with this process, but the fabricator, not Isola, is ultimately responsible for their process and the end results. ***Fabricators should verify that PWBs made using these suggestions meet all applicable quality and performance requirements.***

Part 1: Prepreg Storage and Handling

Isola Group's prepreg bonding sheets for use in multilayer printed circuit board applications are manufactured to specifications that include physical and electrical properties and processing characteristics relative to the laminating application. Handling and storage factors have an important influence on the desired performance of the prepreg. Some parameters are affected by the environment in which prepregs are stored. They can also deteriorate over extended periods of storage. The prepreg received by the customer is a glass fabric that has been impregnated with a stated quantity of low volatile, partially polymerized resin. The resin is tack-free but somewhat brittle. Many lamination problems arise from resin loss off the fabric due to improper handling. The fabric used is based on the order and supplies the required thickness. In most cases the amount of resin carried by the fabric increases as the fabric thickness decreases.

Handling Suggestions

Handle all prepreg using clean gloves. Use sharp, precision equipment when cutting or paneling prepreg. Treat all prepreg as being very fragile. Use extreme care when handling very high resin content prepreg (glass fabrics 1080 and finer).

Storage Suggestions

Upon receipt, all prepreg should be immediately moved from the receiving area to a controlled environment. All prepreg should be used as soon as possible using a First-In-First-Out (FIFO) inventory management system. If not handled properly, DE104 prepreg will absorb moisture, which will lead to depressed Tg's and cure and affect flow in the press. If extended storage is required, separate facilities should be reserved with appropriate environmental control.

Prepreg should be stored at ≤ 23ºC and below 50% humidity. Prepreg packages should be allowed to equilibrate to layup room conditions before opening to prevent moisture condensation on the prepreg.

Stabilization time will depend on storage temperature. In cases where storage temperature is significantly below room temperature, keep prepreg in package or plastic wrapping during stabilization period to prevent moisture condensation. Once the original packaging is opened, the prepreg should be used immediately. Remaining prepreg should be resealed in the original packaging with fresh desiccant. Storage should be in the absence of catalytic environments such as high radiation levels or intense ultraviolet light.

Part 2: Innerlayer Preparation

Isola Group's DE104 laminates are fully cured and ready for processing. It has been the experience of most fabricators that stress relief bake cycles are not effective in reducing any movement of high performance laminates such as DE104. Therefore, it is suggested that the movement of unbaked laminate be characterized and the appropriate artwork compensation factors are used.

Dimensional Stability

The net dimensional movement of laminate after the etch, oxide and lamination processes is typically shrinkage. This shrinkage is due to the relaxation of stresses that were induced when the laminate was pressed as well as shrinkage contribution from the resin system. Most of the movement will be observed in the grain direction of the laminate.

There are situations that have been known to alter the proportion of shrinkage in grain versus fill direction in some board shops. These include autoclave pressing and cross-plying laminate grain direction to that of prepreg. While both of these practices have their advantages, material movement must be uniquely characterized.

Table 1: Initial Artwork Compensation Factors

Base Thickness	Configuration	Direction	Comp (in/in)
≤ 0.005″	Signal/Signal	Warp (grain)	0.0007-0.0009
"	"	Fill	0.0001-0.0003
"	Signal/Ground	Warp (grain)	0.0005-0.0007
"	"	Fill	0.0001-0.0003
"	Ground/Ground	Warp (grain)	0.0002-0.0004
"	"	Fill	0.0000-0.0002
0.006-0.009″	Signal/Signal	Warp (grain)	0.0005-0.0007
"	"	Fill	0.0001-0.0003
"	Signal/Ground	Warp (grain)	0.0003-0.0005
"	"	Fill	0.0000-0.0002
"	Ground/Ground	Warp (grain)	0.0000-0.0002
"	"	Fill	0.0000-0.0002
0.010-0.014″	Signal/Signal	Warp (grain)	0.0002-0.0004
"	"	Fill	0.0000-0.0002
"	Signal/Ground	Warp (grain)	0.0001-0.0003
"	"	Fill	0.0000-0.0002
"	Ground/Ground	Warp (grain)	0.0000-0.0002
"	"	Fill	0.0000-0.0002

Table 1 (for reference) illustrates the suggested approach to characterizing laminate movement and provides approximate artwork compensation factors for DE104 laminate when using a hydraulic press.

This table assumes that laminate and prepreg grain directions are oriented along the same dimension. Each shop must characterize material behavior given their particular lamination cycles, border designs and grain orientation of laminate to prepreg. It is also suggested that specific laminate constructions be specified and adhered to so that dimensional variations due to changes in construction are avoided.
The table assumes also that signal layers are either half or 1 ounce copper and ground layers are either 1 or 2 ounce copper.

Imaging and Etching
DE104 laminates are imaged using standard aqueous dry films and are compatible with both cupric chloride and ammoniacal etchants.

Bond Enhancement
Both reduced oxides and oxide alternative chemistries have been used successfully in fabricating DE104 multilayer boards to date. Users should make sure the oxide or oxide replacement coating exhibits a consistent and uniformly dark color.

If reduced oxides are used, consult the chemical supplier for post oxide baking considerations as excessive baking may lead to lower pink ring resistance. It is generally suggested that post-oxide baking be performed vertically, in racks. Suggest mild bake of oxided innerlayers (15-30 minutes @ 80-100°C).

Slightly longer baking cycles may be advisable under certain **conditions, but should not exceed 60 minutes. Baked layers should be used immediately. If this is not possible, store layers at or below 20°C (68°F) and below 50% RH. Layers should not be stored for longer than 24 hours after coating.**

For conveyorized oxide replacements, an efficient dryer at the end of a conveyorized oxide replacement line should remove all moisture from the innerlayer surface. ***However, drying of layers for 30 minutes minimum @ 100°C or higher is considered a "best practice", especially for boards to be subjected to "lead-free" processes. Drying in racks is preferred.***

The use of DSTFoil™ will typically increase the bond strength by approximately 1 to 1.5 lbs. as compared to non-DSTFoil copper foil. If immersion tin adhesion treatments are used, the fabricator should test the coating to verify adequate bond strength develops with DE104 prepregs.

Part 3: Lamination

Standard Lamination

Vacuum assist lamination processes are recommended. Non-vacuum lamination processes should be reviewed by Isola technical service engineers prior to production implementation.

Sequential Lamination

Use a 50 minute cure for sub-assemblies depending on thickness and ***a 60 minute cure for the final assembly.*** This suggestion assumes a final assembly thickness ≥ 0.125″ (3.2 mm). Removal of DE104 flash should be performed by routing rather than shearing to minimize crazing along the panel edges.

Table 2: DE104 Lamination Pressure

Lamination Method	Suggested Pressure Range
Hydraulic Pressing (without vacuum assist)	300-400 PSI 21.1-28.1 Kg/cm^2
Hydraulic Pressing (vacuum assisted)	275-350 PSI 19.3-24.6 Kg/cm^2
Autoclave Pressing	150-175 PSI 10.6-12.3 Kg/cm^2

Table 2 outlines general suggestions for lamination pressure based on press type used. Note that these are guidelines only and the board design may require that these suggestions be modified. Consult Isola Technical Service for assistance.

Single-Stage Press Cycle Lamination

The following page outlines the suggested lamination parameters for the single-stage lamination cycle. The lamination cycle selected will be a function of board stackup, complexity and thickness as well as the lamination presses capability. Note that the following graphs are for reference purposes only and may require adjustment depending on the board size, thickness and complexity.
Thicker boards may require additional dwell time at curing temperature to achieve full cure.

While use of both the pressure drop cycle and cooling well below Tg in the "hot" press are strongly suggested, these steps are considered to be "optional" and the PCB fabricator may have equipment or capacity limitations which prevent following these suggestions.

Single-Stage Lamination (No "Kiss" Cycle)

Step 1:

Load/center the package as quickly as possible. ***Pull vacuum for 20 minutes on lifters.***

Step 2:

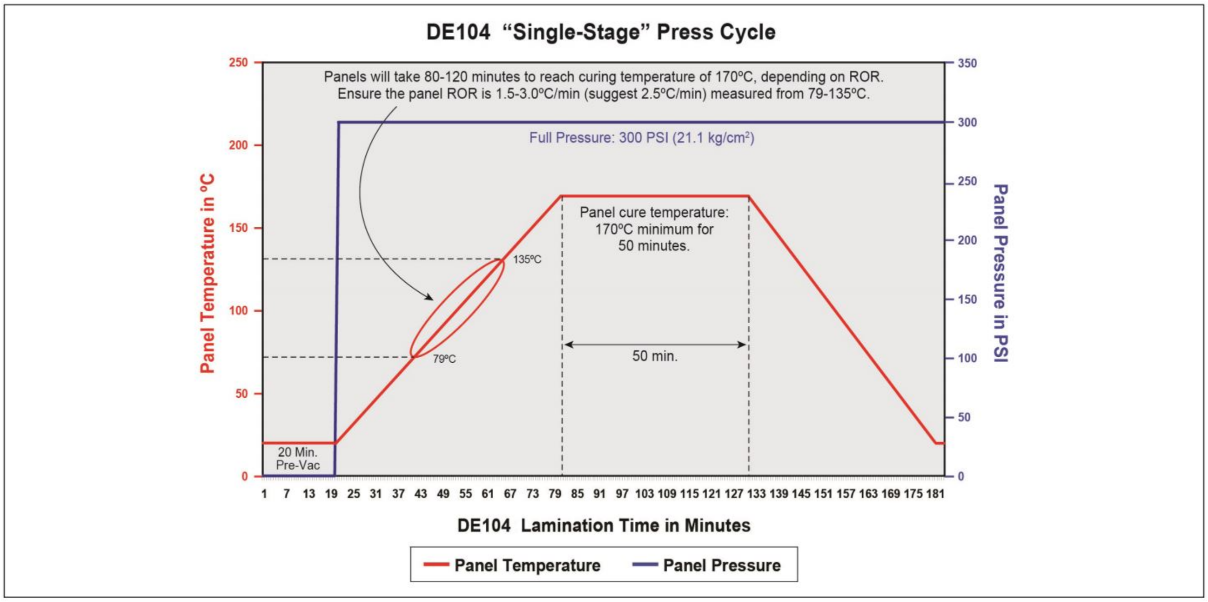
Apply full pressure of 275-400 PSI (19.3-28.1 kg/cm^2) on the panels. Suggest 300 PSI (21.1 kg/cm^2) for initial pressure setting. **See Graph**.

Step 3:
Adjust heat rise to ~1.5-3.0°C/min (2.7-5.4°F/min), as measured between 79-135°C (175-275°F) by controlling the platen ramp rate and/or by using the appropriate amount of pressure padding. ***Suggest 2.5°C/min (4.5°F/min).***
NOTE: Some board designs may require adjustments to ROR and/or pressure for better results.

Step 4:
Cure for a minimum of 50 minutes @ 180°C (356°F)
NOTE: A 60 minute cure may be appropriate for high layer count boards or thicker boards.

Step 5:
Cool material as slowly as possible or at 2.8°C/min (5°F/min) down from 170°C (340°F) through 135°C (275°F).

Suggested DE104 Single-Stage Pressure-Temperature Profile
Please note: This is not a press control program! The graph represents the preferred pressure/temperature profile panels are subjected to during the lamination program cycle. ***Note that the actual high pressure setting chosen may differ from the 300 PSI suggested in this graph. Press pressure and cure duration selected may depend upon board design as well as other factors.***



Part 4: Drill

DE104 materials exhibit greater modulus properties as a result of the increased thermal stability of the resin system. During drilling, the debris formation with DE104 is different from the standard FR406 materials. Due to the increased thermal decomposition properties of the resin system, the DE104 drill debris remains as free particles and will not impact the drill flute relief volumes.
To assure effective removal of the resin debris during drilling, undercut drill geometries and high helix tools are suggested. On high layer count technologies and thicker overall board thicknesses, peck drilling parameters may be necessary. Suggested parameters are outlined below for typical multilayer designs.

Cutting Speed and Chipload
The parameters in **Table 3** and **Table 4** provide moderate initial starting ranges for typical board designs. Thick boards with heavy copper or special cladding such as invar will require more conservative drill parameters. Boards with numerous 2 oz. copper innerlayers or boards with coarse glass weave may require more conservative parameters. Peck drilling techniques are suggested for boards with thickness > 0.100″ (2.5 mm).

Stack Hight and Hit Count
Stack heights and hit counts will vary with construction and overall thickness of the boards being drilled. For thicker boards (above 75

mils or 1.91 mm overall) with high layer counts, drill one high. Aluminum entry and lubricated backing help create good quality hole walls but are not essential in all applications. Do not exceed 1,000 hits for bits below 0.020″ (0.508 mm) diameter and 1,500 hits for bits above 0.020″ (0.508 mm) .

Table 3: Suggested Drilling Parameters For Initial DE104 Setup with Undercut Bits

Drill Size		Spindle Speed	Surface Speed Per Minute		Infeed		Chipload	
inch	mm	rpm	SFPM	SMPM	in/min	m/min	mil/rev	mm/rev
0.010	0.25	90,000	235	71	65	1.65	0.70	0.018
0.015	0.40	80,000	315	96	80	2.03	1.00	0.025
0.020	0.50	60,000	315	96	90	2.29	1.50	0.038
0.025	0.65	54,000	350	107	80	2.03	1.50	0.038
0.030	0.80	48,000	375	114	85	2.16	1.80	0.046
0.035	0.90	44,000	400	123	88	2.24	2.00	0.051
0.040	1.00	43,000	450	137	107	2.72	2.50	0.064
0.050	1.30	34,000	450	137	85	2.16	2.50	0.064
0.060	1.50	29,000	450	137	72	1.83	2.50	0.064
0.080	2.00	21,000	450	137	55	1.40	2.50	0.064

Table 4: Suggested Alternate Drilling Parameters For Initial DE104 Setup with Undercut Bits and High-Speed Spindles

Drill Size		Spindle Speed	Surface Speed Per Minute		Infeed		Chipload	
inch	mm	rpm	SFPM	SMPM	in/min	m/min	mil/rev	mm/rev
0.004	0.10	180,000	186	57	43	1.10	0.24	0.006
0.010	0.25	180,000	464	141	134	3.40	0.74	0.019
0.020	0.50	95,000	490	149	138	3.50	1.45	0.037
0.040	1.00	48,000	495	151	161	4.10	3.36	0.085
0.060	1.50	32,000	495	151	114	2.90	3.57	0.091

Part 5: Hole Wall Preparation

General

Good desmear and electroless copper deposition performance are more easily achieved when the drilled hole quality is good. The generation of smooth, debris free hole walls is influenced by the degree of resin cure, drilling conditions and board design considerations. The elimination of 7628 or similar heavy glasses (whenever possible), coupled with properly adjusted drill parameters on fully cured boards has been shown to improve overall drilled hole quality. This helps reduce smear generation, which improves desmear performance and can ultimately help to
reduce copper wicking.

Factors which influence chemical desmear rates, and therefore the suggestions in this document, include: resin type, chemistry type, bath dwell times, bath temperatures, chemical concentrations in each bath and the amount of solution transfer through the holes.
Factors which influence the amount of solution transfer through the holes include: hole size, panel thickness, work bar stroke length, panel separation in the rack and the use of solution agitation, rack vibration and rack “bumping” to remove air bubbles.

Chemical Desmear

Dwell times and temperatures typically used for most high performance materials should be satisfactory. Extended dwells or doublepasses through permanganate will increase resin removal. Cyclic amine chemistry tends to produce more consistent results than permanganate sensitizer baths based on glycol ether. Consult the chemical supplier for suggested conditions.

Plasma Desmear

If available, plasma can be used with or without a single permanganate pass (to be determined by each fabricator). Standard plasma gas mixtures and cycles are satisfactory. ***Care must be exercised to avoid excessive resin removal if both plasma and permanganate are employed together.***

3-Point Etchback

True 3-point "Etchback" exposes the innerlayer "post" on all three sides for subsequent plating processes. This will require a more robust approach compared to simple desmear, which is designed only to remove resin smear from the vertical surface of the innerlayer interconnect "posts". Plasma will readily etch back DE104 resin. Standard plasma gas mixtures and process cycles designed for conventional FR-4 epoxy are satisfactory and are suggested for use as initial starting parameters for etchback of DE104. The practice of following the plasma process with a chemical process is suggested rather than plasma alone to increase hole wall texture and remove plasma ash residues.

If plasma is not available, chemical etchback for 3-point connections can usually be accomplished using a double-pass through the permanganate line. Care must be taken when using a double-pass to minimize copper wicking. Consult the chemical supplier for suggested conditions.

Part 6: Secondary Drilling, Routing and Scoring

Secondary Drilling

As common with most high Tg epoxy materials with increased modulus properties, the use of entry and backer material may be necessary during the secondary drilling of larger hole sizes to avoid crazing/fracturing at the hole perimeter. Additionally, sharper plunge point angle geometries may be necessary to avoid crazing around secondary drilled hole perimeters.

Routing and Scoring

Table 5: Suggested Routing Parameters for Initial DE104 Setup

Tool Diameter		Spindle Speed	Spindle Travel Speed	
inch	mm	rpm	in/min	m/min
0.060	1.50	45,000	20	0.50
0.100	2.50	35,000	40	1.00
0.125	3.20	25,000	50	1.27

Due to the greater modulus properties of the DE104 materials, modifications of the final PWB rout fabrication process may be necessary. **Table 5** lists initial starting parameters using chip breaker or diamond cut tool designs. ***Note that parameters listed may require further adjustment.*** Chip breaker or diamond cut tool designs are recommended.

For PWB designs requiring scored geometries, the testing of various Tg's and resin content materials has determined that adjustments to the process will be necessary. As the modulus strength of materials increases, the maximum resultant web thickness (dependent on the scored edge depth) must be decreased to avoid excessive fracturing upon breaking away the scored materials.

Individual board designs/stack-ups may require adjustment of score depth geometries. ***Thinner web thicknesses are typically required.*** This is influenced by layer count, glass types and retained copper in the design. ***The customer should contact the scoring equipment and/or bit supplier for application specific suggestions for use with DE104 materials.*** Your Isola Technical Account Manager may also be able to provide some initial suggestions, but these should be validated through testing by the individual PWB fabricator.

Part 7: Packaging and Storage

DE104 finished boards have low moisture sensitivity and good shelf life. However, Isola recommends using best practices in storage and packaging, as noted below, to reduce risk during assembly. Printed boards made from DE104, which require a long shelf life, the best protection is provided using a Moisture Barrier Bag (MBB) with a Humidity Indicator Card (HIC) and adequate drying desiccant inside the MBB to prevent moisture absorption during shipment and long-term storage. Upon opening the MBB, the boards should be processed within 168 hours when maximum shop floor conditions are at < 30°C (85°F)/60% RH. MBB bags that are opened for inspection should be resealed immediately to protect the boards from moisture uptake.

Part 8: Health and Safety

Always handle laminate with care. Laminate edges are typically sharp and can cause cuts and scratches if not handled properly. Handling and machining of prepreg and laminate can create dust (see DE104 Material Safety Data Sheet). Appropriate ventilation is necessary in machining/punching areas. The use of protective masks is suggested to avoid inhaling dust. Gloves, aprons and/or safety glasses are suggested if individuals have frequent or prolonged skin or eye contact with dust. Isola Group does not use polybromidebiphenyls or polybromidebiphenyloxides as flame retardants in any product. Material Safety Data Sheets are available upon request.

Part 9: Ordering Information

Contact your local sales representative or visit: **www.isola-group.com** for further information.

Or contact us at: **info@isola-group.com**

Isola Group North America
6565 West Frye Road
Chandler, AZ 85226
Phone: 480-893-6527
Fax: 480-893-1409

Isola Asia Pacific (Hong Kong) Ltd.
12/F, Kin Sang Commercial Centre
49 King Yip Street, Kwun Tong
Kowloon, Hong Kong
Phone: 852-2418-1318
Fax: 852-2418-1533

Isola GmbH
Isola Strasse 2
D-52348 Düren, Germany
Phone: 49-2421-8080
Fax: 49-2421-808164

Learn More

https://www.isola-group.com/products/all-printed-circuit-materials/DE104

NOTES

The data contained in this document, while believed to be accurate and based on both field testing and analytical methods considered to be reliable, is for information purposes only. Any sales of these products will be governed by the terms and conditions of the agreement under which they are sold.