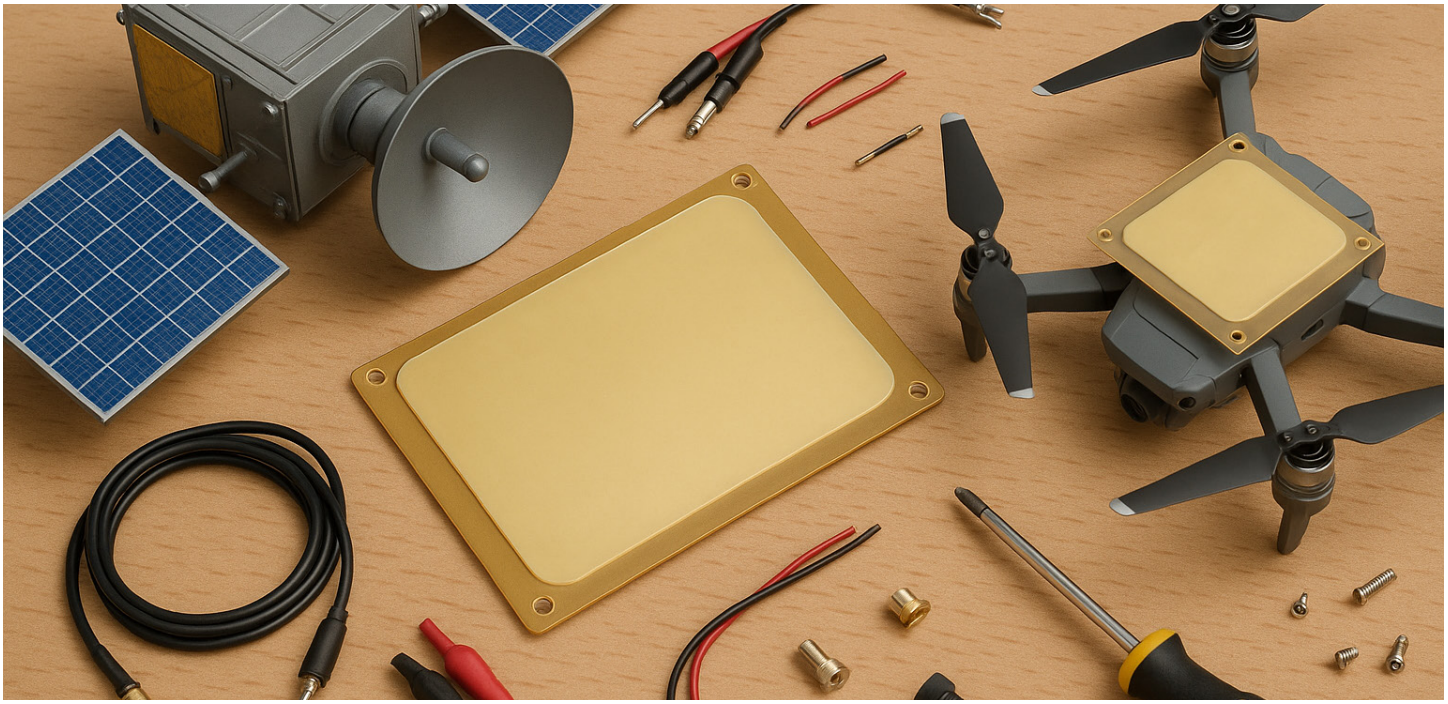
PhaseBlue® Series Circuit Materials

Design Guide

Table of Contents



PhaseBlue® use cases

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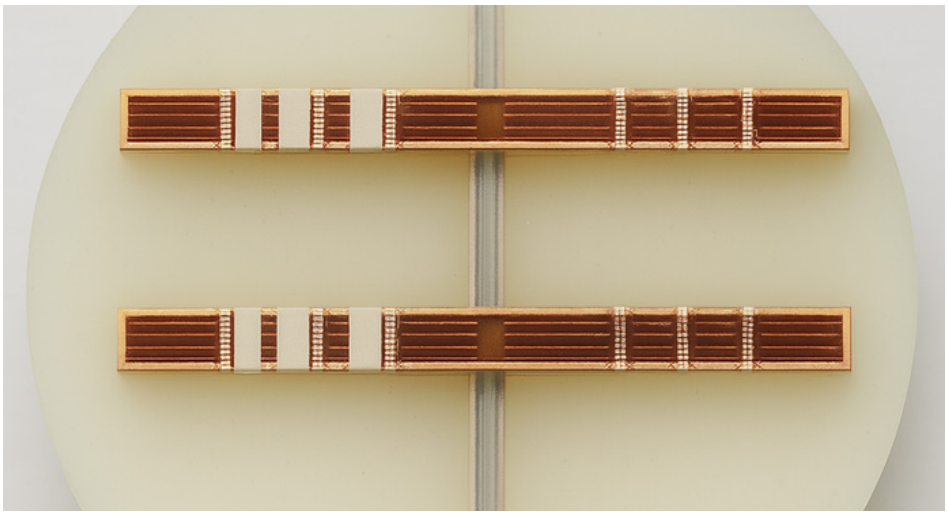
1. General

PhaseBlue® Series Circuit Materials are best suited where their low dielectric constant (Dk), low loss (Df), and formability deliver clear performance advantages. Considering these attributes during PCB layout improves both reliability and manufacturing yield.

Processing is optimized by applying thin-core or flexible-circuit design rules, using low bond strength materials, and minimizing thermal history. Proper material selection, feature geometry, and layout design enable repeatable, high-yield production.



PRINTED CIRCUIT BOARD AUTOMATED OPTICAL INSPECTION

2. Mechanical Performance Enhancements

Copper Types:

½ oz Rolled Annealed (RA) Copper is preferred for RF and formable circuits. Its higher tensile strength allows slight stretching without cracking, supporting tight-radius bends and compensating for thermal stress. RA copper also improves RF performance due to reduced granularity. ½ oz copper is typically chosen unless greater cross-sectional area of a trace is needed, possibly in current carrying or as a way to reduce impedance.

Electrodeposited (ED) Copper is lower cost but has poor elongation, making it more prone to cracking during forming.

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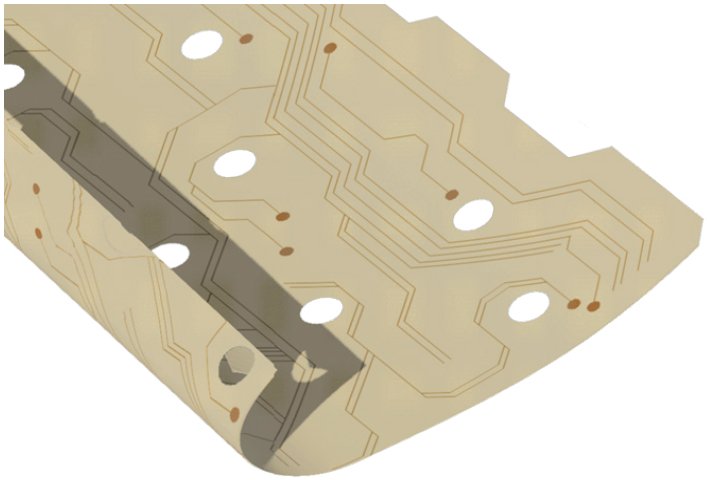
Trace Geometries:

A mismatch in coefficient of thermal expansion (CTE) between copper and the PhaseBlue® substrate can generate stress during processing, particularly at sharp corners in traces. These stress concentrations may cause copper to lift or crack. Careful trace design helps distribute stress and significantly improves reliability.

- Solder Pads – Avoid 90° trace-to-pad attachments. Use teardrop connections to reduce stress at the pad interface. Without teardrops, pads are more likely to crack under soldering temperatures.

- Trace Corners – Avoid 90° routing angles. Always use radiused bends to minimize stress concentrations. Sharp corners greatly increase the risk of copper lifting or cracking during DES processing and thermal cycling.



PhaseBlue® PCB Design

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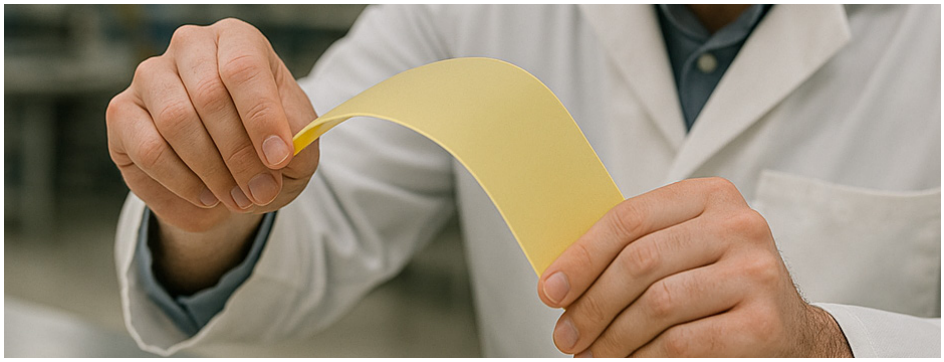
Central Access Design for Bending/Forming:

PhaseBlue® is a thin, polyimide-based laminate that offers excellent formability when designed correctly. In flexible circuit applications, two primary bend types are considered:

- **Dynamic bending** – continuous flexing (e.g., in hard disk drives, scanners, tape drives). PhaseBlue® is not recommended for these applications.
- **Bend-to-install** – limited bends during assembly. *PhaseBlue performs very well in this mode.*

Design guidelines for bend-to-install applications:

- Maintain a bend radius of at least 10× the total board thickness.
- Use larger bend radii and thinner substrates to further reduce stress on copper traces.
- Place copper layers as close as possible to the neutral axis (board centerline) to minimize strain during bending.



PhaseBlue®

Pads Only Plating:

- Rolled Annealed (RA) copper offers finer grain structure and superior formability compared to Electro-Deposited (ED) copper.
- Challenge: Traditional panel plating applies ED copper across the entire panel, which decreases flexibility and can create issues in bend regions.
- Solution: Pads-only plating deposits copper exclusively on via pads, leaving bend areas thinner and composed of RA copper only.
- Trade-off: This method significantly improves formability but introduces additional cost and processing steps.

Soldermask:

- PhaseBlue is compatible with most soldermask systems.
- Preferred option: Low-temperature curing soldermasks.
- Application methods: Curtain coating, screening, or nip lamination.

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3. High Frequency Performance Enhancements

Substrate Compression:
PhaseBlue® is a processable laminate from a reticulated nanostructure (85% air and 15% polyimide). While mechanically strong, the cells can collapse under:

- High temperature (approaching T_g), or
- High pressure (>150 psi).

Such collapse reduces dielectric thickness, increases dielectric constant, and changes electrical performance.

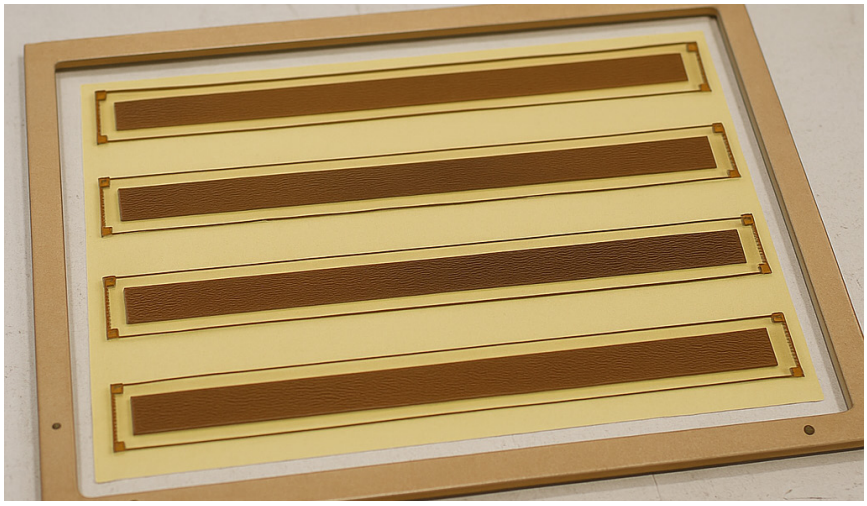
Design recommendations:

- Use materials and processes that operate at lower temperatures and pressures.
- Include microstrip or stripline test coupons on each panel to verify impedance and confirm no structural damage during processing.

Dielectric Constant of Mixed Substrates:

Circuit laminates often include adhesive layers for copper bonding or for combining different dielectric materials. The effective dielectric constant (Dk) of the stackup is the thickness-weighted average of each layer's Dk value.

Design recommendation: Always include all layers, adhesives as well as dielectrics, when calculating the overall Dk for accurate impedance control.



PhaseBlue® in a protective frame

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Dielectric Layering:

Adjusting dielectric thickness changes the spacing between a trace and its reference ground plane. Combined with modifying the trace cross-sectional area, this allows designers to fine-tune impedance.

Design recommendation:

- Use dielectric layering to create tighter-tolerance feedlines that are easier to manufacture and more precisely matched to target impedance.

4. Summary

PhaseBlue® Series Circuit Materials are an excellent solution for formable, high-frequency circuits. Their unique properties require design practices that follow flexible circuit principles and place careful emphasis on dielectric constant (Dk) control.

For best results, use this Design Guide in combination with the PhaseBlue Processing Guide. Blueshift's technical team is available to provide expert support and help ensure the success of your designs.

We encourage you to leverage this innovative material in applications that demand both mechanical flexibility and high-speed performance.

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Please reach out to the Blueshift team with any questions!

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