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Factors
Affecting

PCB Fabrication Cost

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Factors Affecting PCB Fabrication Cost

This document provides a detailed breakdown of the key factors influencing the cost of printed circuit boards (PCBs). These factors are divided into **Quantifiable** and **Non Quantifiable Cost Drivers** to help you optimize your design while balancing performance and cost.

Quantifiable Cost Drivers

1. Size of PCB

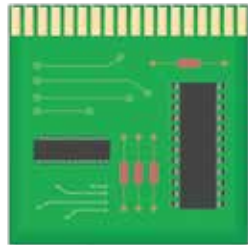
The size of your PCB directly impacts material usage and manufacturing costs. Larger PCBs consume more raw materials

Key Cost Drivers:

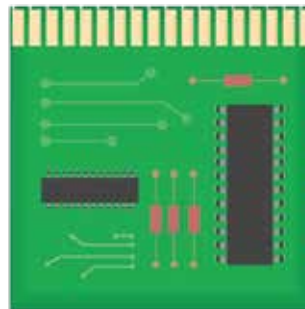
- **Material Usage:** Larger PCBs require more raw material.

Example:

A 150 mm x 150 mm board vs. a 200 mm x 200 mm board
- larger the size, the higher its cost.



Size: 150 x 150 mm



Size: 200 x 200 mm

2. Number of Layers

The number of layers impacts material, labor, and inspection costs. More layers mean more material and processing time.

Key Cost Drivers:

- **Material and Prepreg Layers:**
Each additional layer requires extra materials, including prepreg and core materials.
- **Non-Standard Core Materials for Inner Layers:**
Using specialized core materials for inner layers increases costs significantly.

Additional Processes:

Inner layers require preparation, automated optical inspection (AOI), bond film application, pin-less registration, book building, and bonding processes, all of which add to the cost.

Example:

A 6-layer PCB costs more than a 2-layer PCB due to additional materials, advanced processes like AOI inspection, and complex bonding requirements.

3. Build Complexity

The complexity of your PCB build significantly impacts its cost. Advanced designs with special stack-ups, impedance control, or specific material requirements increase the manufacturing effort and precision needed.

Key Cost Drivers:

- **Special Stack-Ups/Buildups:**

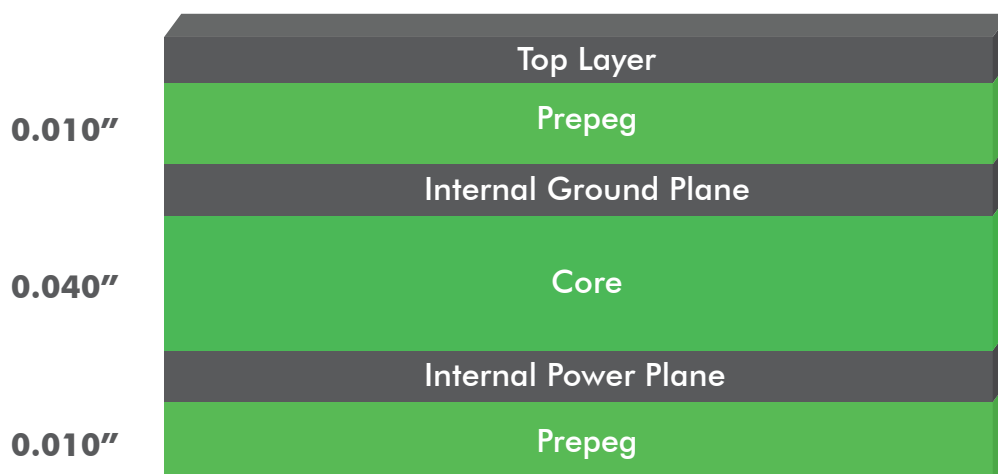
Designs requiring unique signal integrity or thermal management configurations demand precise material selection and additional processing steps like multi-stage lamination, extra thermal testing, etc.

- **Additional Features:**

Features like edge plating or differential pair routing add to the complexity and cost. For example: **Edge Plating** improves grounding and EMI shielding but requires extra plating processes.

Example:

A 4-layer PCB with controlled impedance for a telecom application requires specialized materials, precise layer alignment, and additional testing, increasing its cost.



4. Impedance

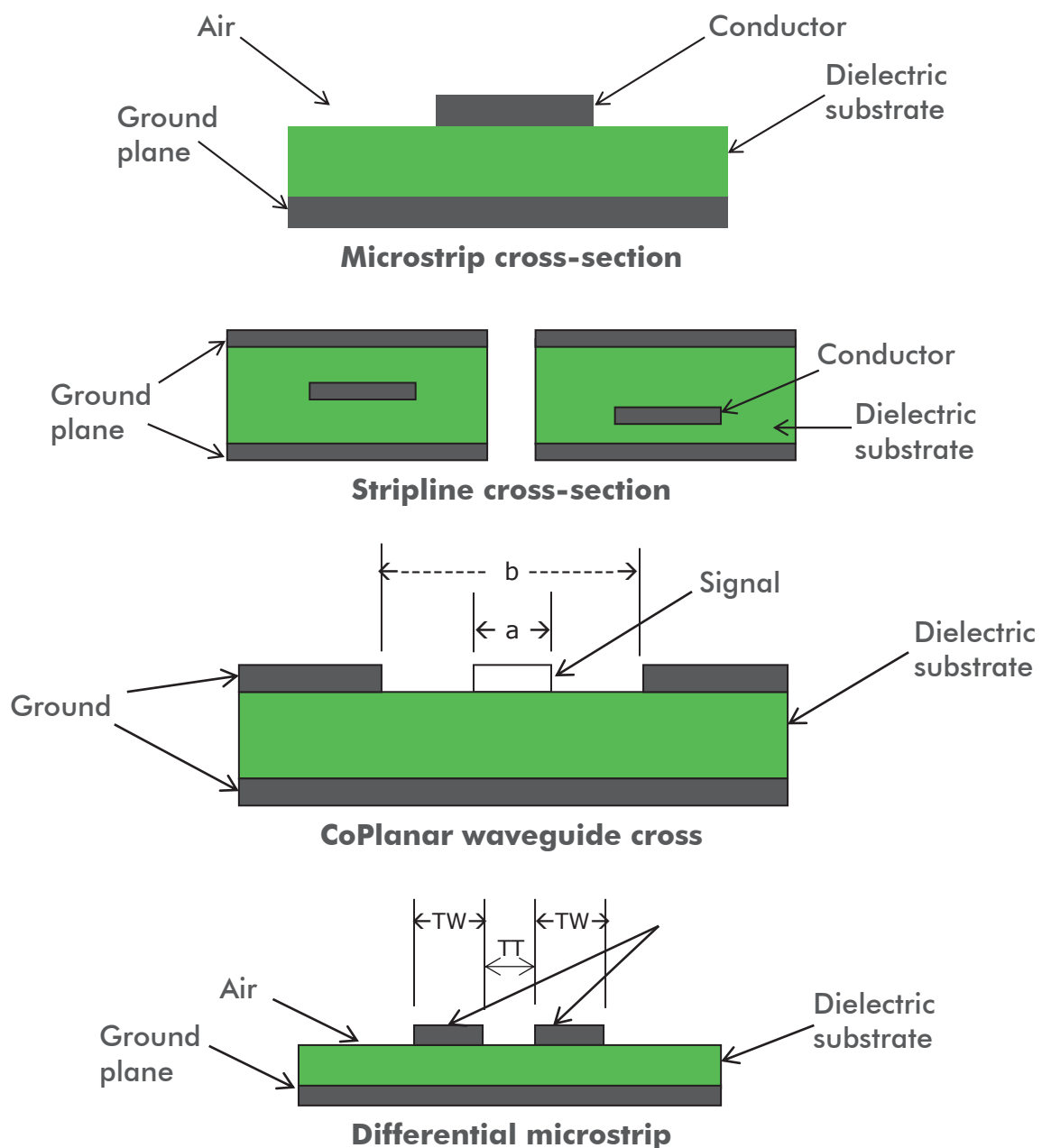
Controlled impedance requires precise stack-ups and tight tolerances, increasing costs.

Key Cost Drivers:

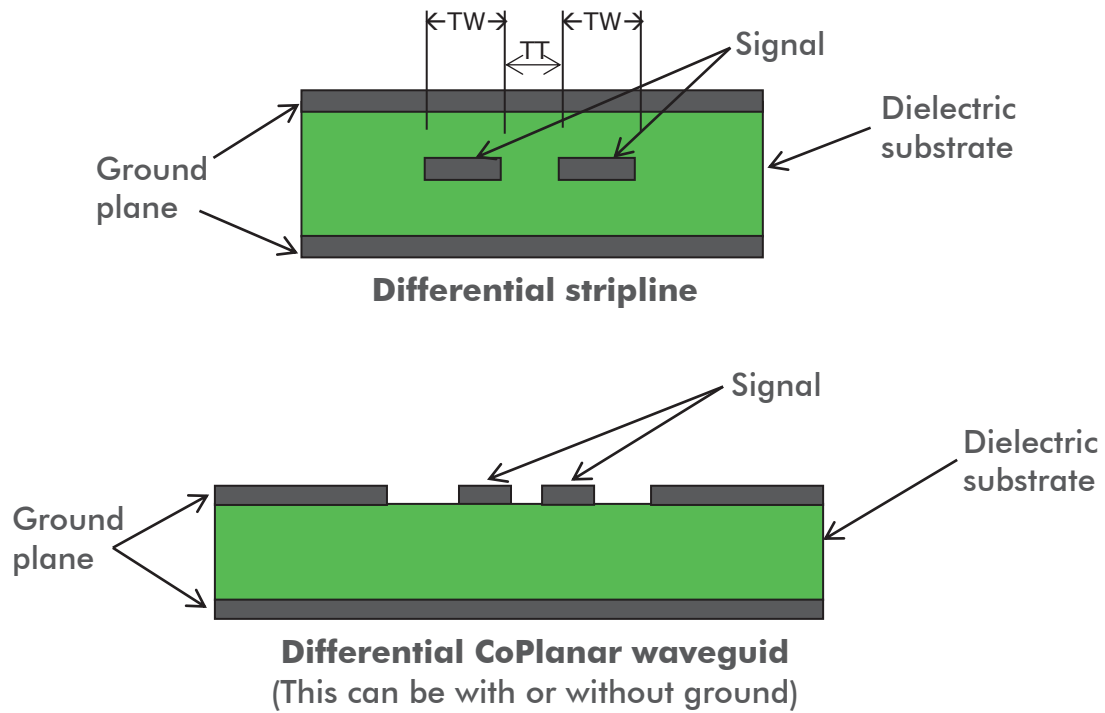
- Specialized materials for signal integrity.
- Maintaining controlled impedance for high-speed or high-frequency applications necessitates more expensive materials with specific dielectric properties, tight tolerances and careful stack-up planning.
- Additional testing and verification requires additional test coupons must be fabricated alongside the PCB, meaning the extra surface area on the manufacturing panel, increasing material usage and waste.

Example:

A controlled impedance PCB for high-frequency applications costs more.



Where TW = Track/conductor width
 TT = Track - track spacing



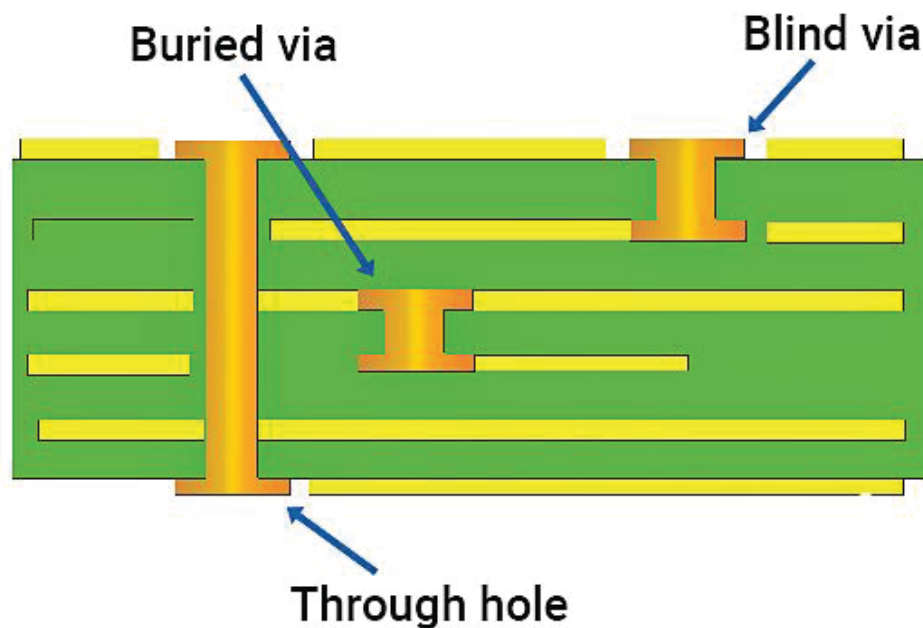
5. Vias

The type and quantity of vias impact costs. Blind, buried, require additional steps.

Key Cost Drivers:

- **Blind and Buried Vias:**

These require additional drilling and lamination processes since they connect only specific layers instead of spanning the entire stack. Multiple lamination cycles are often necessary, increasing manufacturing effort and time.



6. Track and Gap

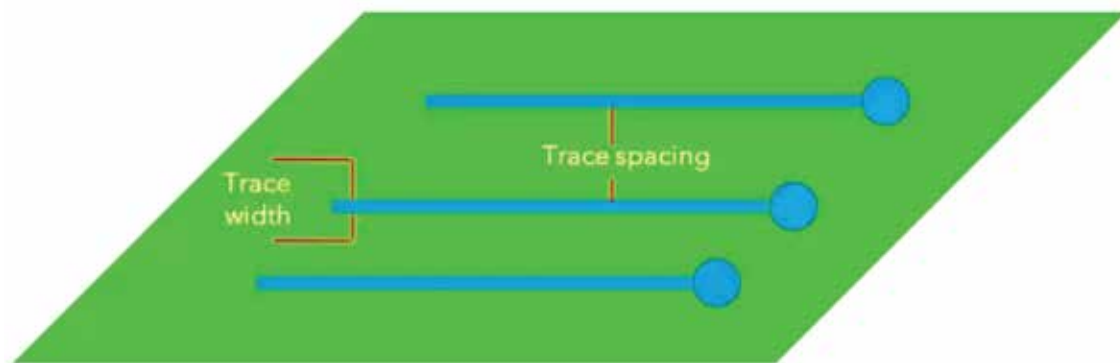
Finer tracks and gaps increase processing time and require higher precision, raising costs.

Key Cost Drivers:

- Widths <5 mil more difficult to etch reliably.
- High-density designs require advanced tools.

Example:

A 4-mil track and gap for IoT boards can add to the cost.

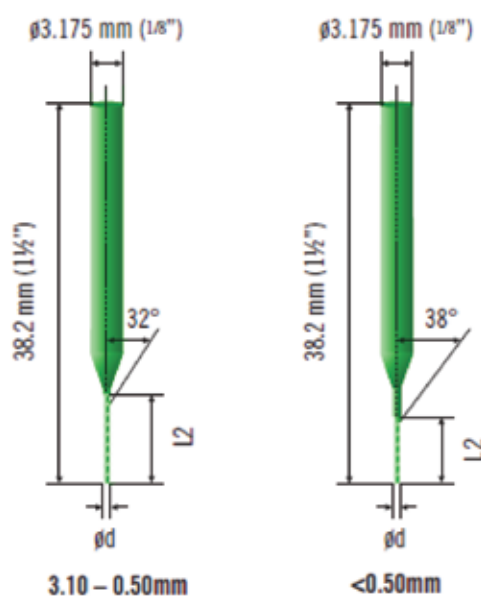


7. Hole (Size & Quantity)

The number and size of holes directly affect drilling time and tooling costs.

Key Cost Drivers:

- Holes <0.3mm require smaller tools with shorter flute length. The shorter flute length results in fewer panels being drilled at a time reducing the drilling efficiency.
- Excessive hole density increases cost, due to longer drill cycles.



8. Hard Gold Tabs

Hard or tab gold finishes enhance durability but increase costs due to additional gold requirements

Key Cost Drivers:

- **Electroplating Process:**

Requires nickel underplating and precise gold plating, adding complexity and time.

- **Material Costs:**

Gold's premium price significantly raises costs.

- **Selective Plating:**

Specialized masking and handling for connector tabs or edge contacts add extra labor and precision steps.

Example:

Gold-plated edge connectors for applications like gaming consoles or industrial equipment require hard gold finishes for durability, significantly increasing costs compared to standard finishes.



9. Tolerances

Tighter manufacturing tolerances require advanced equipment and additional inspections, increasing overall cost.

Key Cost Drivers:

- Tolerances below industry standard (PCB size tolerance less than ± 0.2 mm).
- Track width and spacing tolerance less than 20%.

Example:

High-precision PCBs for medical devices may demand PCB size tolerances of ± 0.05 mm, increasing costs substantially.

10. Copper Foil Weights

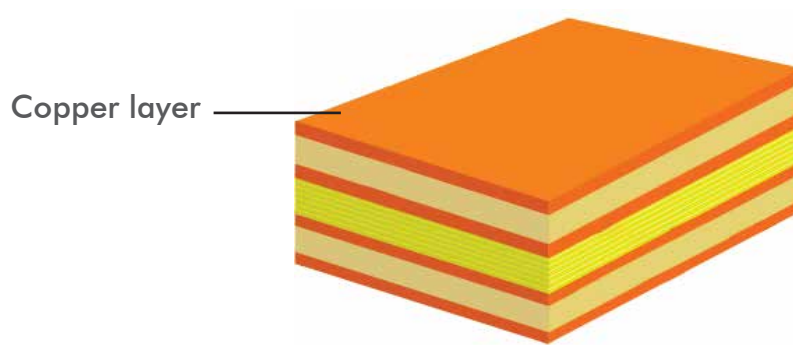
Thicker copper foils enhance current-carrying capacity but increase material cost and challenges in etching, raising overall cost.

Key Cost Drivers:

- Copper thickness above 1 oz/sq ft.
- Specialized etching for heavy copper designs.

Example:

Heavy copper PCBs for power distribution systems can add to the base cost.



11. Soldermask, Legend/Silkscreen, Carbon Print

Custom colors of soldermask, thick carbon layers, or silkscreen other than white raise costs due to material and setup.

Key Cost Drivers:

- Non-standard solder mask colors other than Green (e.g., black, blue).
- Thick carbon layers for keypad contacts.

Example:

A PCB with a black solder mask and thick carbon print for automotive applications increases the costs.



12. Surface Finishes

The type of surface finish impacts durability, performance, and cost.

Key Cost Drivers:

- ENIG for extended shelf life.
- HASL for cost efficiency.
- OSP for budget-friendly options.

Example:

A PCB with ENIG for aerospace applications costs more than one with HASL.

13. Base Materials

High-performance materials for specific applications increase costs significantly.

Key Cost Drivers:

- FR4 for general applications (base cost).
- Rogers/Teflon for RF and microwave designs.

Example:

A PCB made with Rogers material for 5G applications can cost much more than standard FR4.

Non-Quantifiable Cost Drivers

14. Under Specification

Failing to specify critical requirements can lead to delays and added costs due to redesigns.

Key Cost Drivers:

- Missing layer stack-up details.
- Incomplete drill hole data.

Example:

An under-specified PCB may require 2-3 design iterations, increasing overall costs and lead time.

15. Over Specification

Unnecessary high-end features add costs without improving functionality.

Key Cost Drivers:

- Over-specifying tolerances or surface finishes.
- Using advanced materials for non-critical applications.

Example:

Specifying Rogers material for a low-frequency application increases the costs unnecessarily.

16. Reliability

Higher reliability demands stricter testing, premium materials, and rigorous inspections.

Key Cost Drivers:

- Extended thermal cycling tests.
- Use of high-reliability standards, IPC class-3 increases the cost than IPC class-2

Example:

PCBs for medical devices require advanced testing, increasing the costs.

17. Lead Times

Shorter lead times require expedited processes and premium pricing.

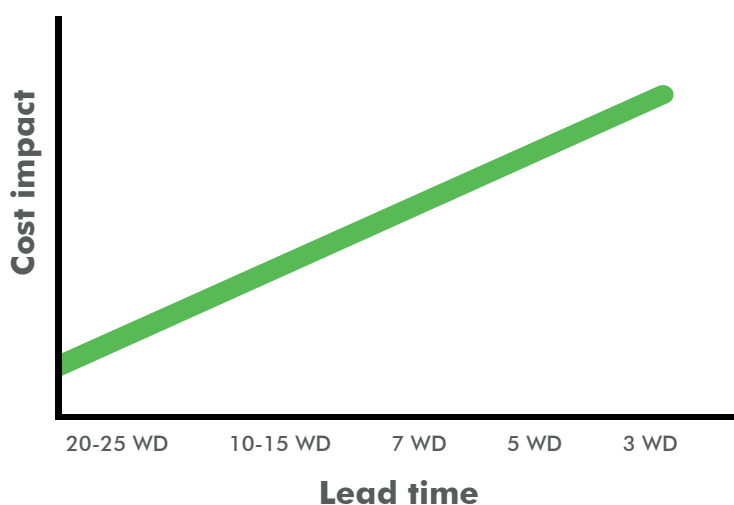
Key Cost Drivers:

- Overtime for quick turnarounds.
- Prioritizing production over standard schedules.

Example:

An expedited 3-day PCB service can cost more than a standard 7-day service.

Lead time influence on cost



18. Lack of Knowledge, Communication, Willingness

Miscommunication, insufficient knowledge about PCB manufacturing, or lack of collaboration between stakeholders can lead to costly mistakes, delays, and redesigns.

Key Cost Drivers:

- **Incomplete Information:**

Missing design files or unclear specifications lead to production errors or delay in product to market.

- **Poor Collaboration:**

Misaligned goals between designers and manufacturers increase costs.

- **Resistance to Adaptation:**

Unwillingness to revise designs or adapt to manufacturing constraints can lead to inefficiencies.

Example:

- A designer failing to include impedance control details may require a production halt and rework, increasing the cost.

Optimization Tips:

- Maintain open communication between design and manufacturing teams.
 - Provide complete and accurate design files.
 - Be flexible and receptive to feedback from manufacturers.
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Conclusion

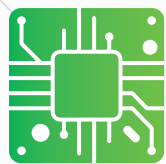
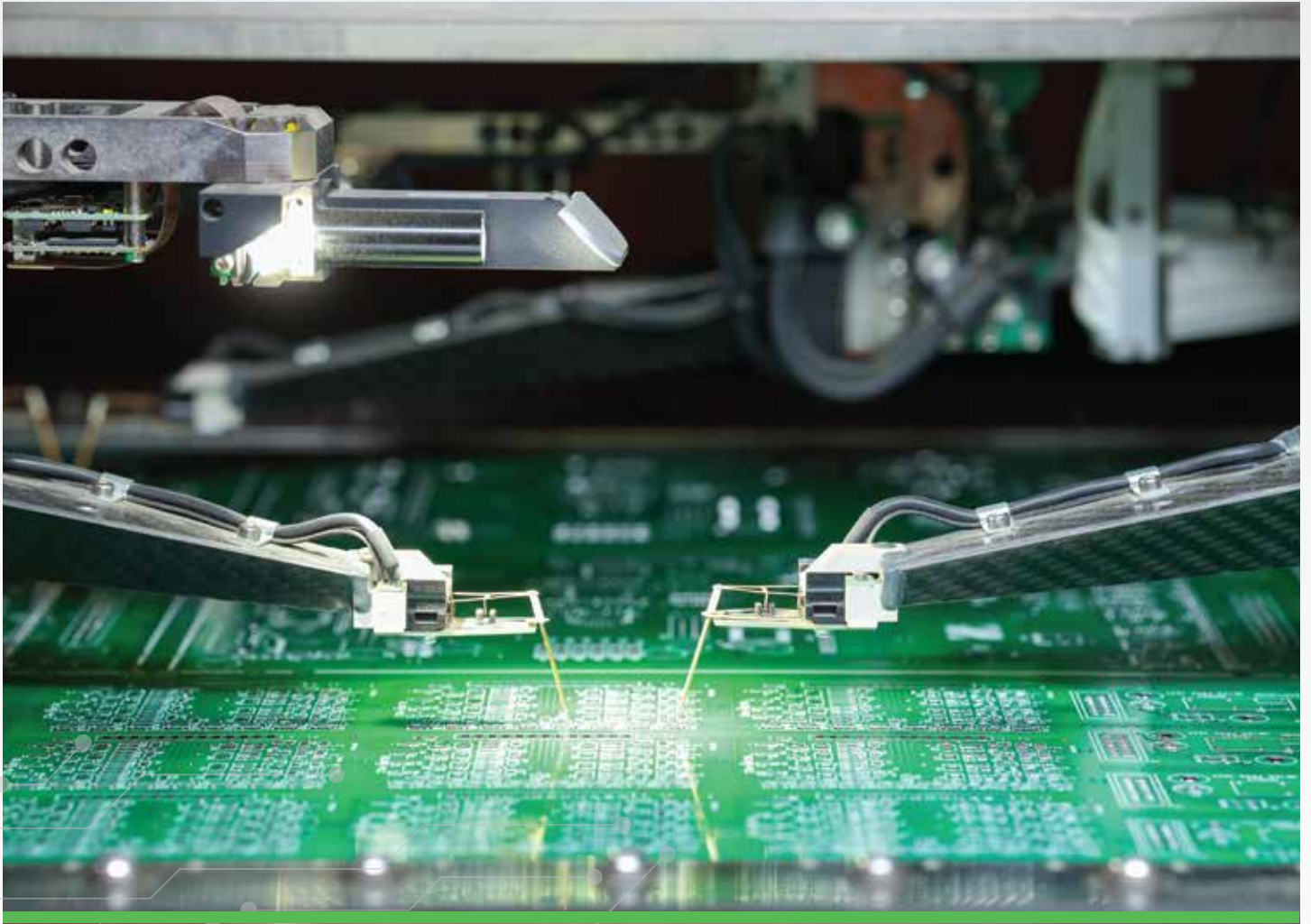
Understanding the factors influencing PCB costs is critical for optimizing your design and budget. By carefully considering quantifiable and non-quantifiable cost drivers, you can make informed decisions that balance performance, reliability, and affordability. Whether choosing the right materials, specifying tolerances, or improving communication with your manufacturing partner, every detail plays a role in determining the final cost.

At PCB Power, we strive to help you achieve cost-effective, high-quality PCB solutions. With our expertise and customer-focused approach, we can guide you through the design and production process to ensure your project is successful from start to finish. If you have questions or need assistance, our team is always here to help you navigate these factors and deliver the best value for your investment.

By proactively addressing these factors, you can avoid unexpected expenses, reduce production delays, and ensure your PCBs meet the highest quality and functionality standards. Let's work together to build the foundation for your next successful project!

Want to calculate your PCB costs instantly?

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