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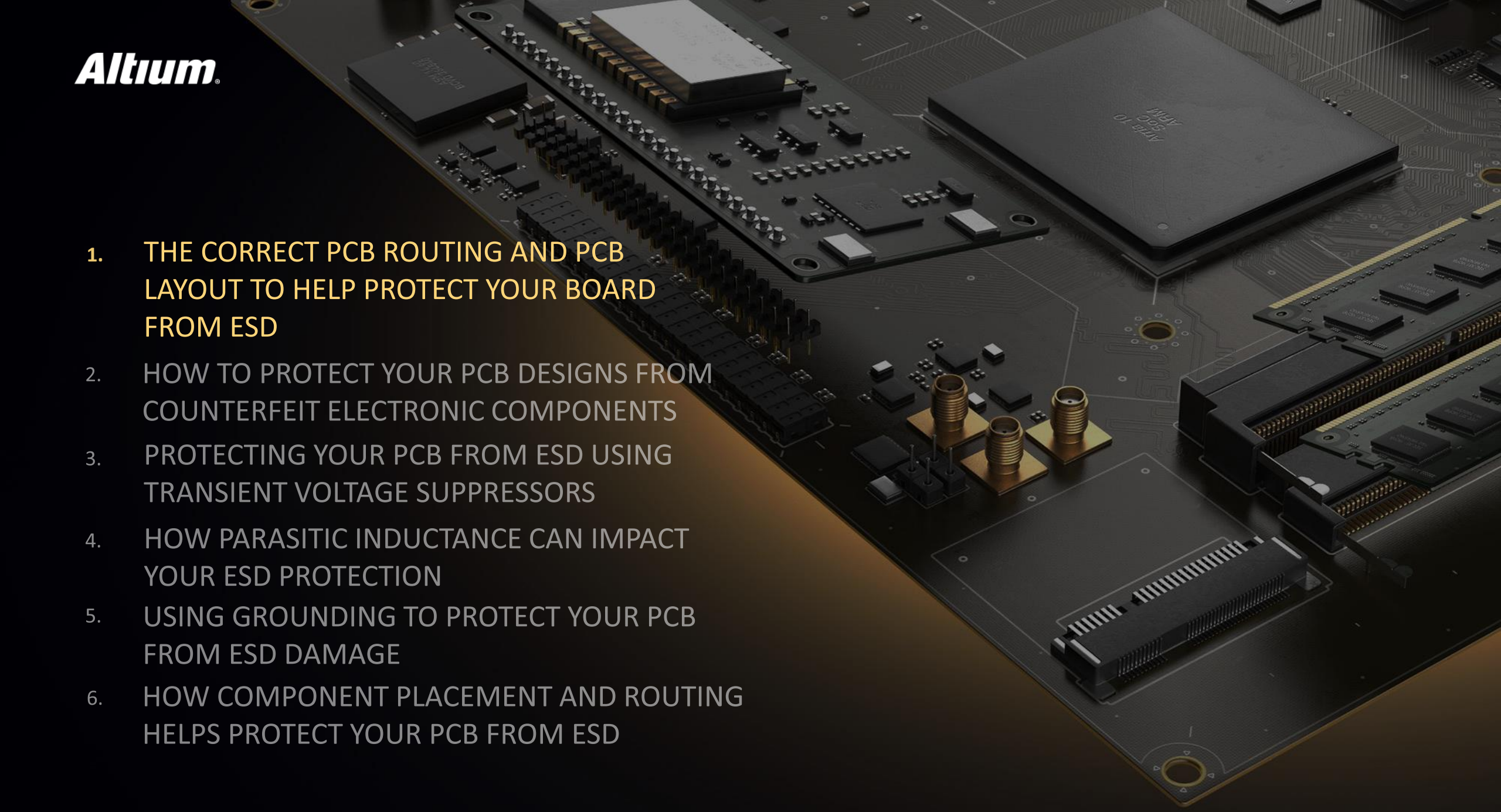
ESD PROTECTION FOR PCB DESIGN



1. THE CORRECT PCB ROUTING AND PCB LAYOUT TO HELP PROTECT YOUR BOARD FROM ESD
2. HOW TO PROTECT YOUR PCB DESIGNS FROM COUNTERFEIT ELECTRONIC COMPONENTS
3. PROTECTING YOUR PCB FROM ESD USING TRANSIENT VOLTAGE SUPPRESSORS
4. HOW PARASITIC INDUCTANCE CAN IMPACT YOUR ESD PROTECTION
5. USING GROUNDING TO PROTECT YOUR PCB FROM ESD DAMAGE
6. HOW COMPONENT PLACEMENT AND ROUTING HELPS PROTECT YOUR PCB FROM ESD

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1. THE CORRECT PCB ROUTING AND PCB LAYOUT TO HELP PROTECT YOUR BOARD FROM ESD

PCB Routing to Protect Board from ESD

- **Minimize circuit loops:** Minimizing circuit loops will reduce damage from ESD events propagating across your PCB. Loops that enclose a changing magnetic flux with experience induced current. While sometimes loops are unavoidable, do your best to minimize the loop's area
- **Use ground planes:** Multilayer PCBs should be designed using a ground plane. For designs that can't use a ground plane, you should instead use a grid pattern of vias to connect to power and ground, emulating a ground plane with traces
- **Optimize routing paths:** Try to eliminate traces that run parallel to each other, especially those between interconnected devices. If you can't avoid using a long signal trace, use a guard trace, even thought it runs parallel to a high speed signal
- **Transpose long trace length:** For high-speed applications, you should keep your traces short and avoid creating unintentional radiating antennas across your PCB. If there's no way around a long signal or power line, break the loops up by transposing the signal and ground line

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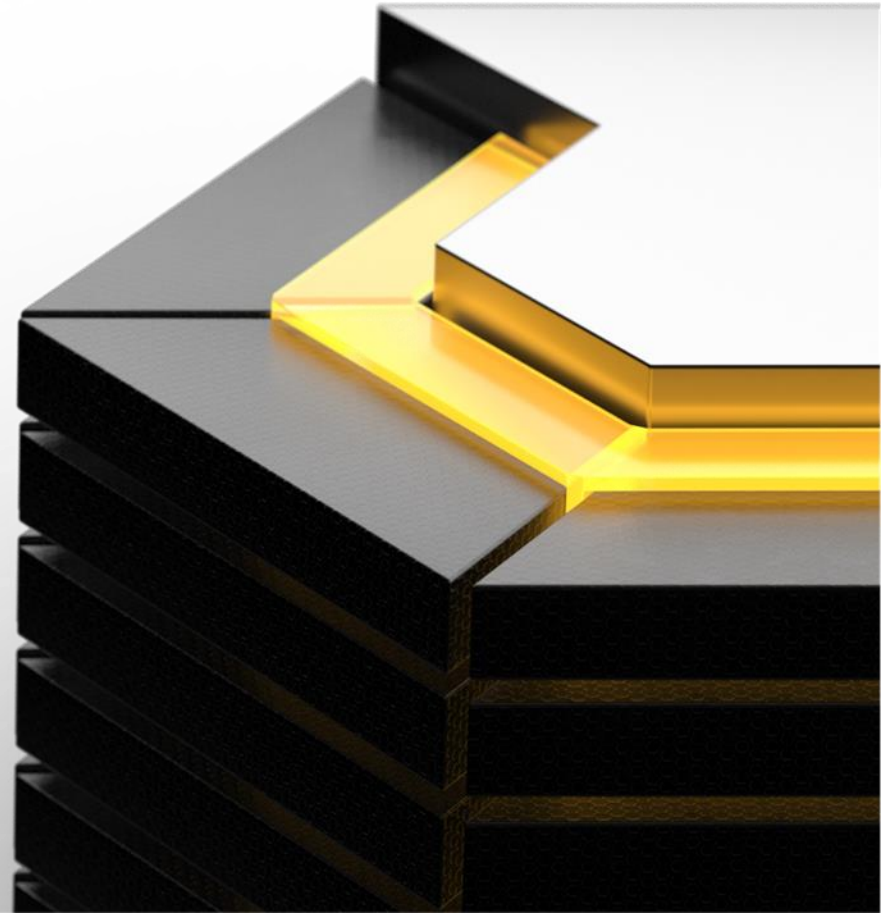

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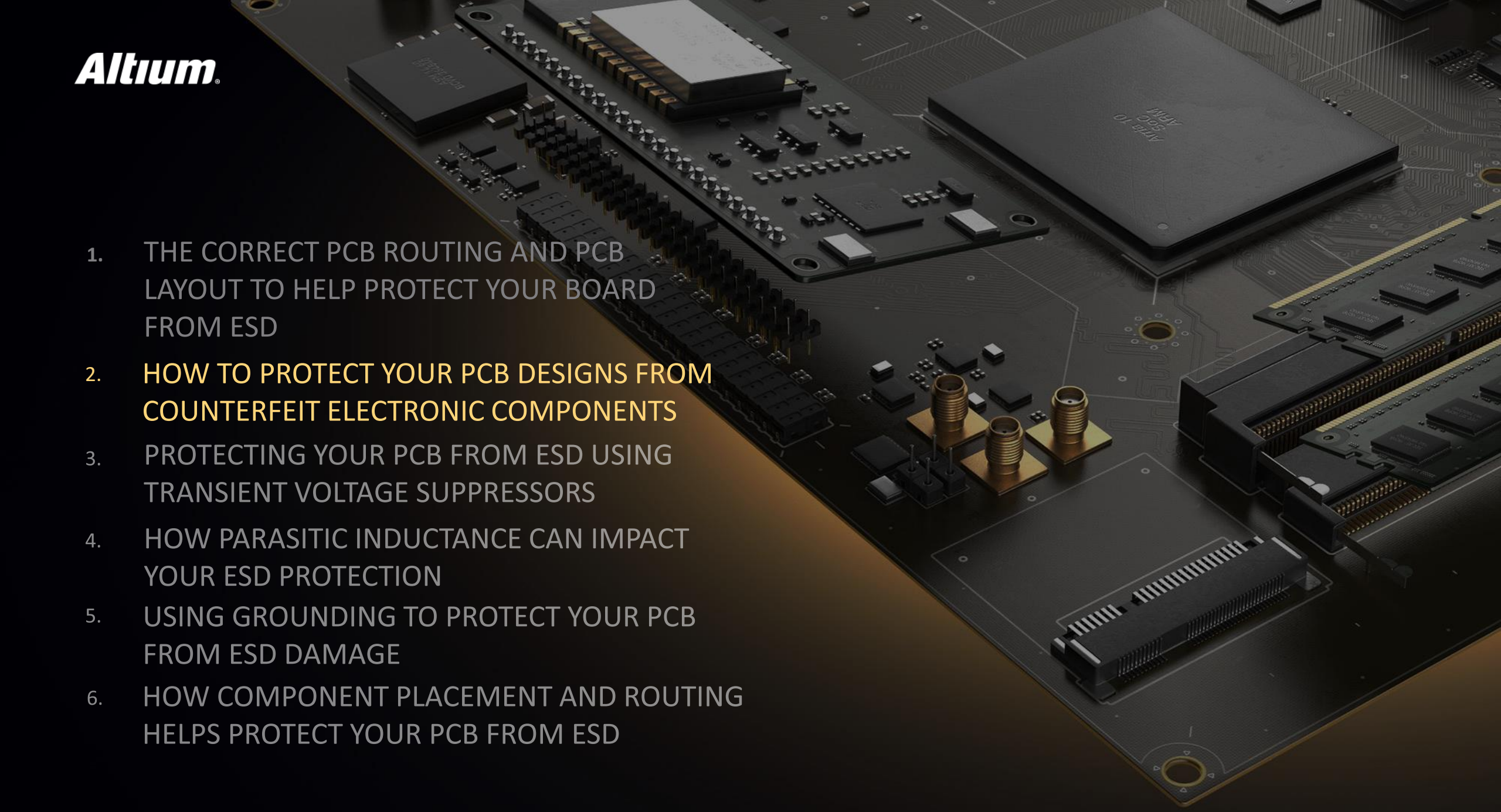

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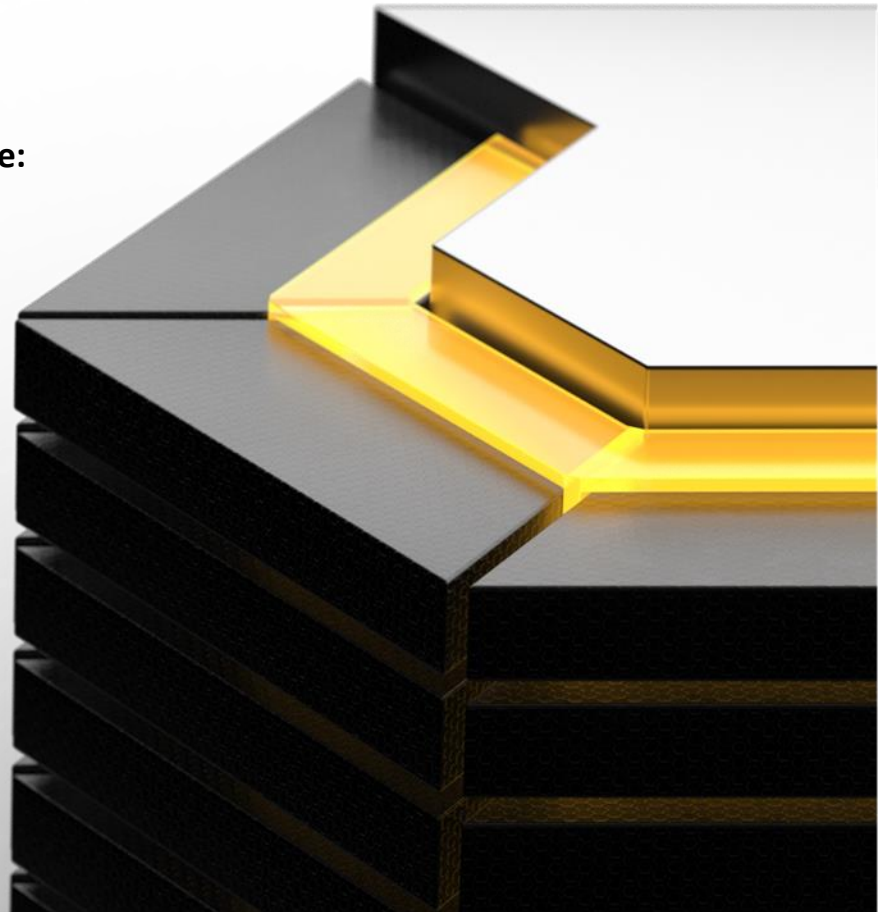
2. HOW TO PROTECT YOUR PCB DESIGNS FROM COUNTERFEIT ELECTRONIC COMPONENTS

What are counterfeit electronics?

Counterfeit electronics are components that are fakes or relabeled as a higher quality product and sold to unwitting customers. The three main concerns regarding counterfeit electronics are:

- **Infringement:** Falsely representing a product is illegal, which applies to the counterfeiter and your company. You are liable for your product's legitimacy
- **Security:** Counterfeit products may have nefarious modifications, which give third parties unauthorized access to intellectual property, sensitive data, or other secure information. These can cause security ramifications and system malfunctions
- **Performance:** Counterfeits have lower quality and performance and sometimes don't work at all. Sometimes, they are even designed to fail intentionally



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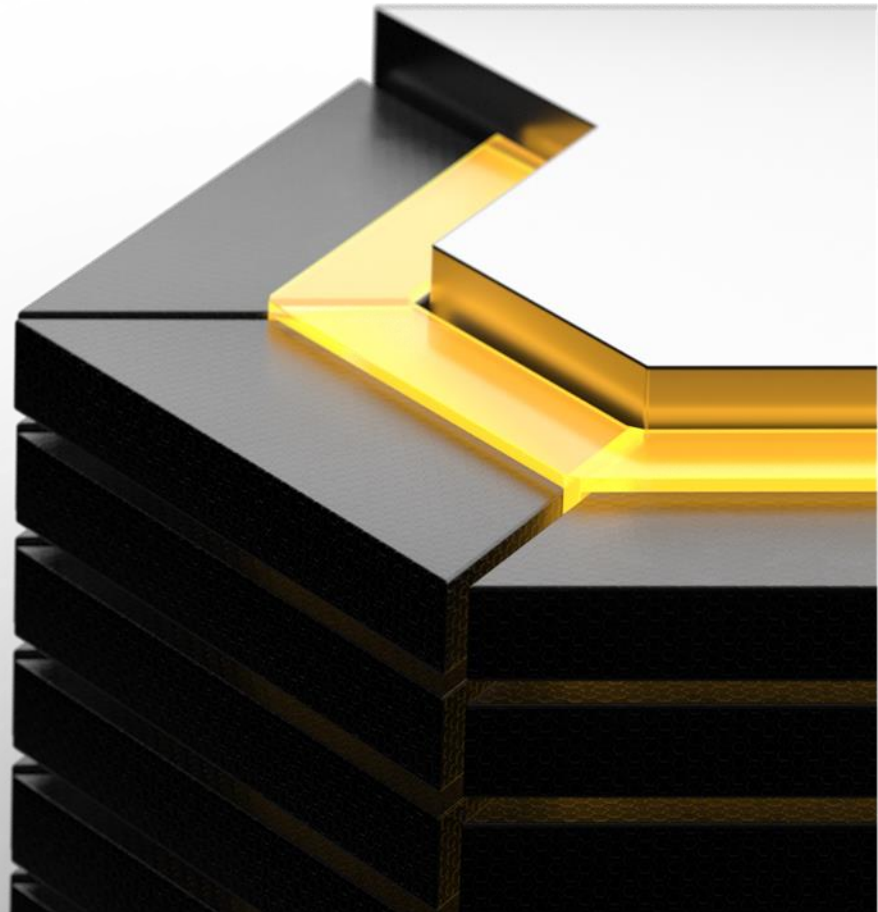
How do I protect my designs & products?

Where do you even start when trying to tackle the issue of counterfeit products? Here are some important tips:

- **Understand the supply chain.** Knowing where your components come from is important. The three main sources are:
  - **Original component manufacturers:** These are the companies that make the components. You can usually buy from these if you are buying wholesale or in huge batches
  - **Franchise distributers:** These companies have specific contracts to sell officially sourced parts from original components manufacturers and have solid documentation about sourcing
  - **Brokers, wholesalers, independent distributers:** These companies have a huge range of legitimacy and a higher chance of counterfeit.



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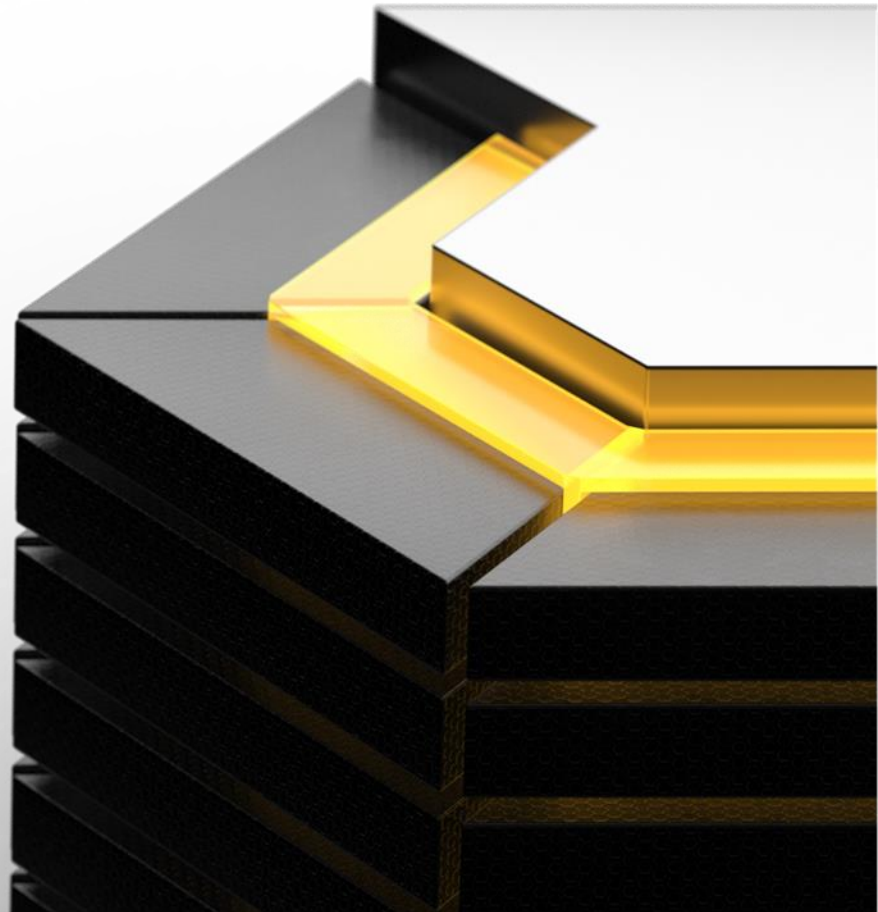
- **Learn how to inspect your components.** In order of cost and complexity:
  - **Visual:** Look for resurfacing, sanding, or refinishing where labels were removed and repainted
  - **Microscopic:** Check the surface of packaging and solder points for smoothness and consistency between parts
  - **Electrical testing:** Power a device up and make sure I-V characteristics match the manufacturer data sheet
  - **X-ray:** Here, you will compare seemingly identical components. Fakes usually have different wire bonding and internal variations
  - **X-ray spectroscopy:** This level of inspection may require local university materials science programs. Take a look for lead, as counterfeit parts rarely live up to ToHS compliance
  - **Advanced microscopy and marking:** These include obscure DNA-based dyes, scanning acoustic microscopy, and other techniques that identify counterfeit parts without destroying real ones



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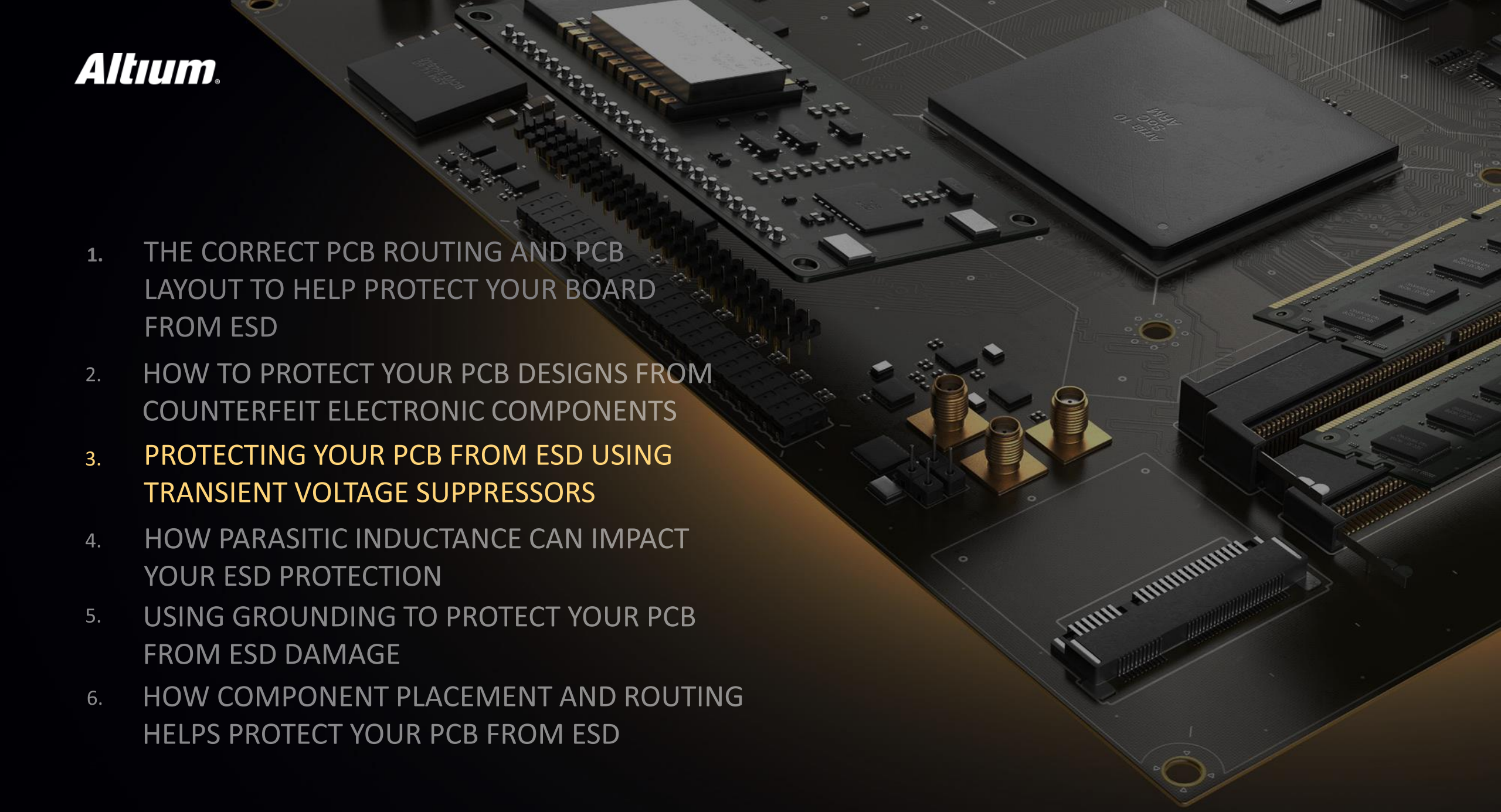

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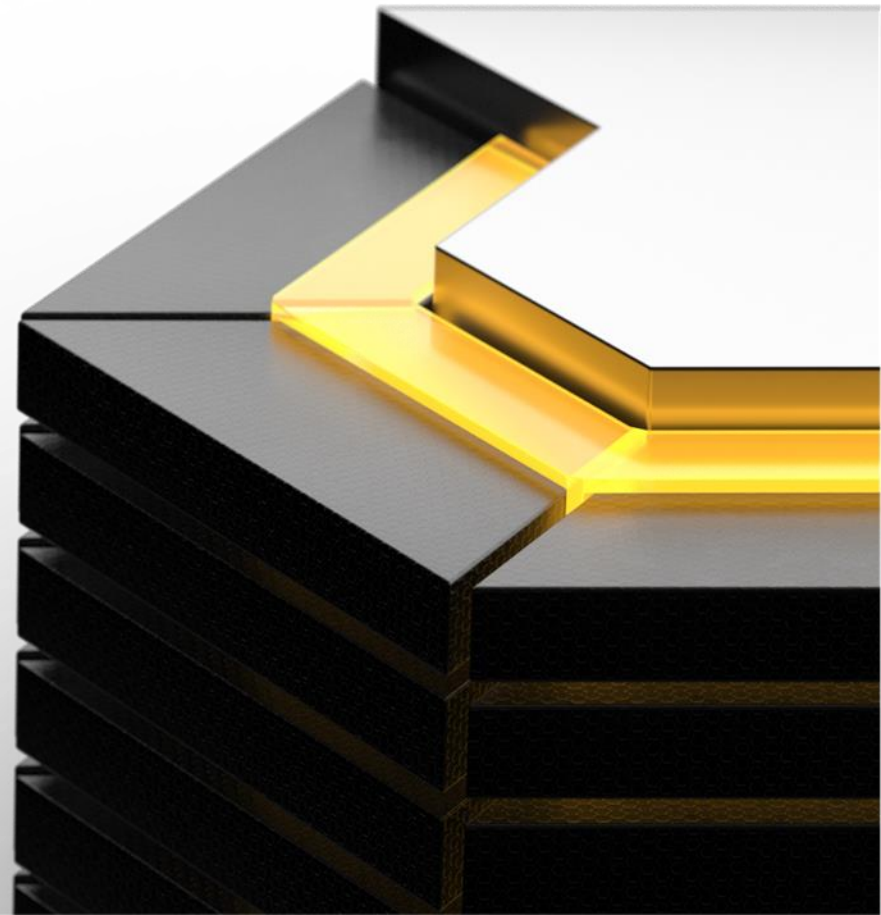
3. PROTECTING YOUR PCB FROM ESD USING TRANSIENT VOLTAGE SUPPRESSORS

Applying ESD Protection on Inputs

The first line of defense in ESD protection is to minimize the impendence of the path to ground. This minimizes the voltage that the board will experience during a discharge. Instead of shorting the path to the ground, you can …

- Add a protection circuit at the input in the form of a transient voltage suppressor
- Transient voltage suppressors (TVS) consist of two diodes combined with an avalanche diode and come as a single component, significantly reducing the chance of your components being damaged without significantly increasing the cost or complexity of your design
- The TVS subcircuit basically creates a current divider between the TVS and the IC or components you want to protect which presents a high input impedance to the input and doesn't interfere with normal operation



How to Use TVS Protection Effectively

When adding a TVS to your design, you want to smooth out your traces as much as possible to minimize any EMI generated at corners and propagating across the board.

- You should avoid using a VIA to connect the ESD source to the TVS if it is at all possible. Stick to traces for the TVS, since VIAs can really complicate ESD protection
- You should also include a buffer resistor in your protection circuit. This is added in series between the possible ESD source and the IC you're trying to protect. This helps decrease the peak current that will reach the IC from the current divider you've added at the input
- Choosing the right TVS for your application requires careful consideration of the inductance on your board and the voltage range you need to protect against

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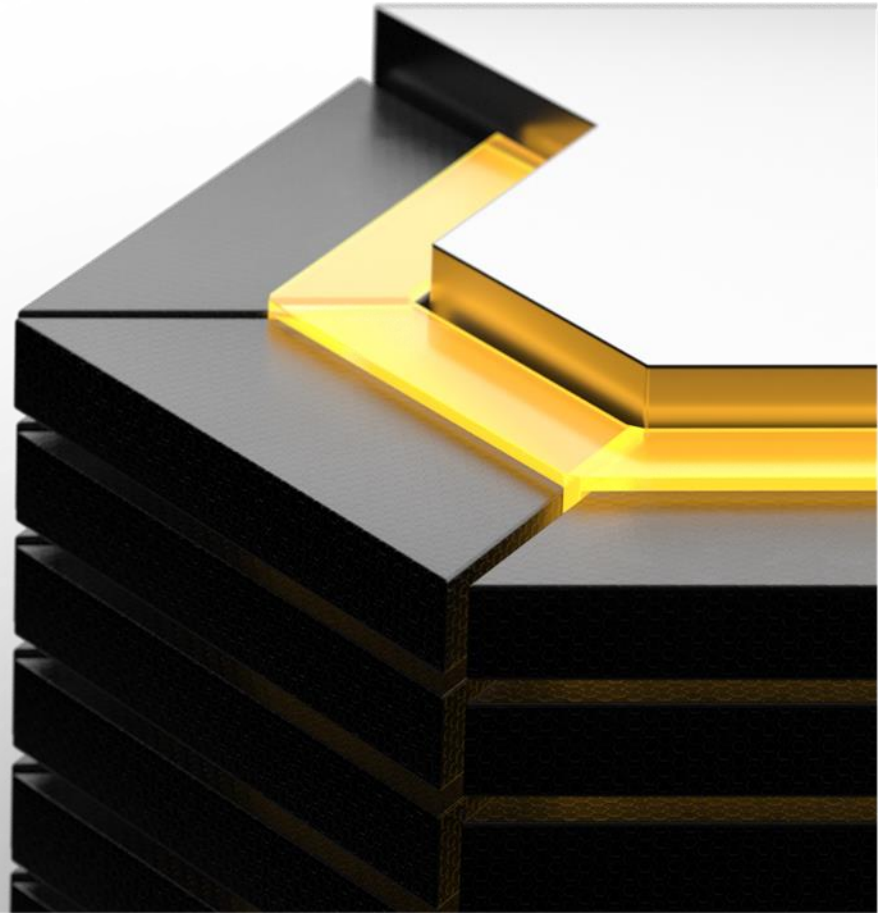

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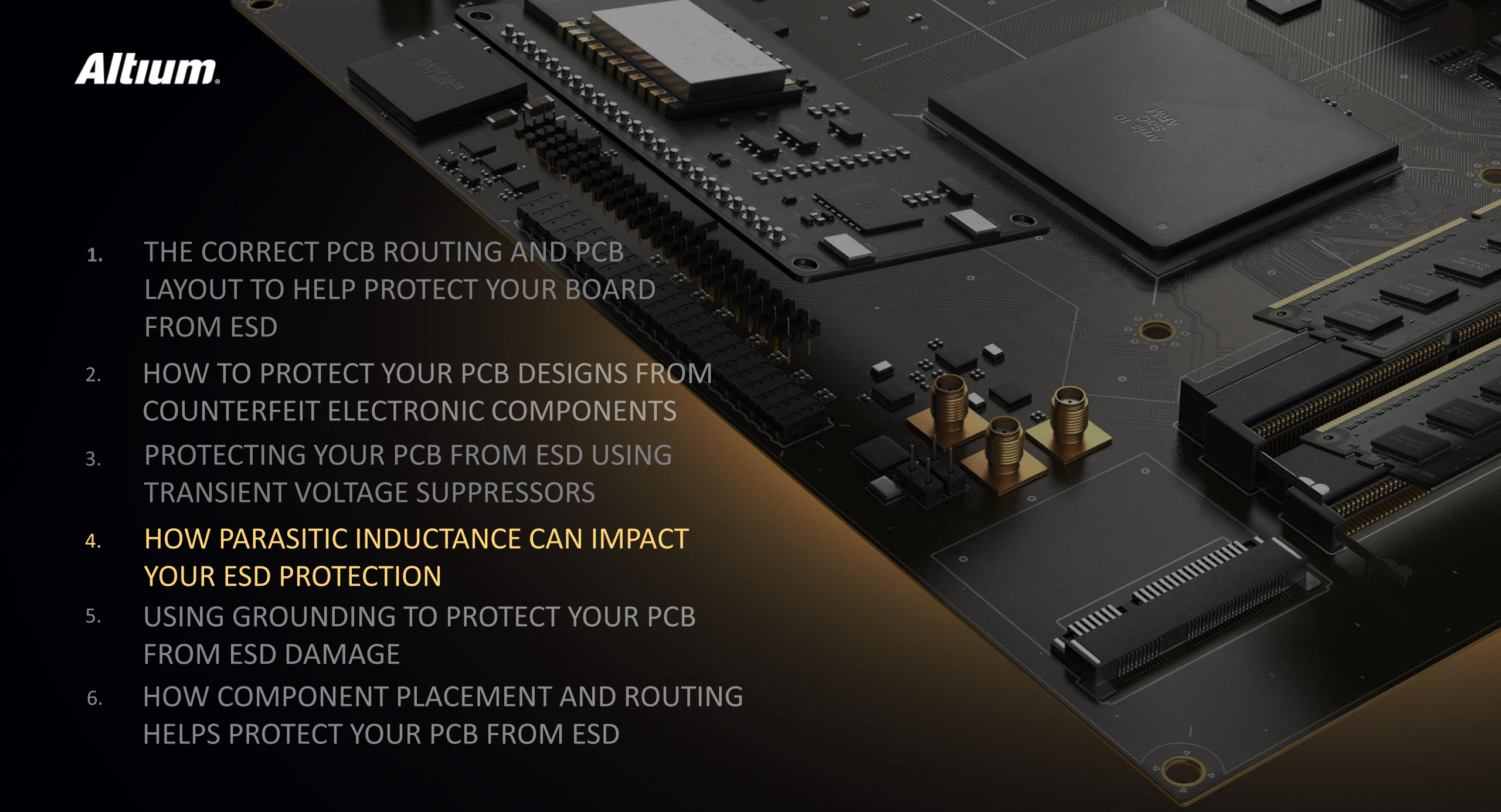

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4. HOW PARASITIC INDUCTANCE CAN IMPACT YOUR ESD PROTECTION

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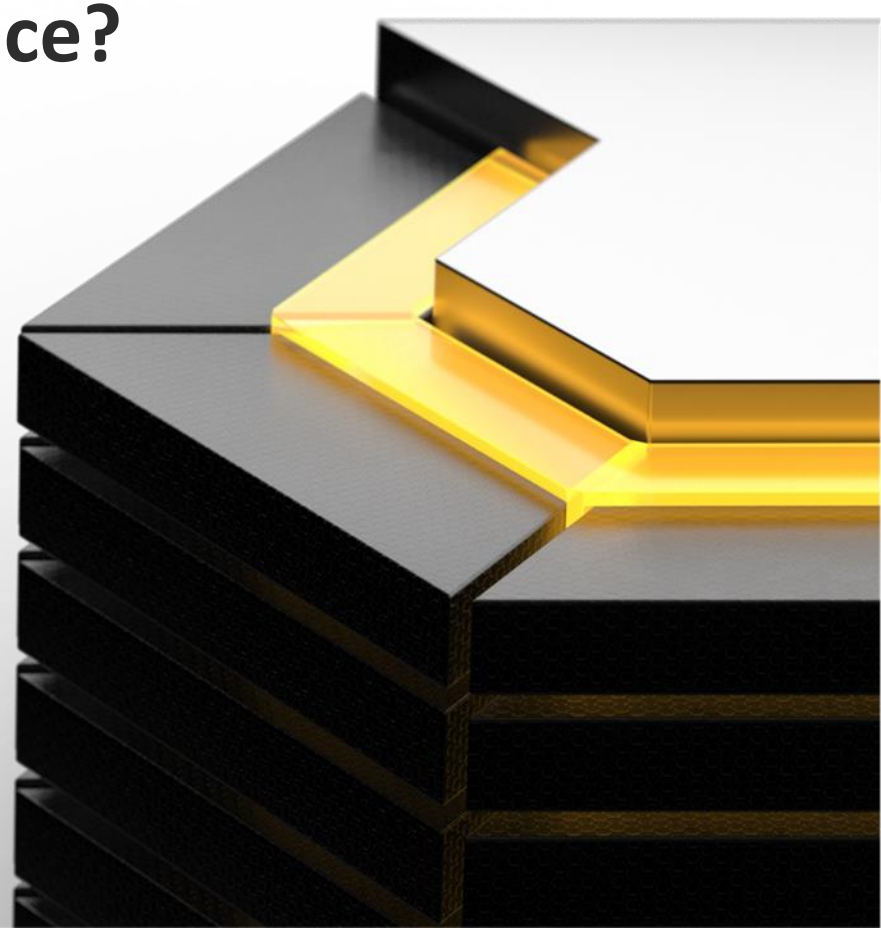
How do I Minimize my Parasitic Inductance?

Parasitic inductance can have a significant impact on how effective your ESD protection is. Managing your interfaces and using transient voltage suppressors at your inputs are critical first steps. However, if you don't minimize parasitic inductance, all that work can go to waste. Some tips for minimizing this parasitic inductance include:

- Keeping the trace short and using direct routing. Don't use a stub or via to connect to the ground plane so there's no additional path length or material
- Keeping the TVS short without using vias or stubs
- Keeping the TVS close to the input connector, which helps prevent transient coupling of the ESD pulse into neighboring traces



Positioning Sensitive Components

- Keep the sensitive components that you are protecting further away from the TVS
- By putting your sensitive components further away from the input and the TVS protection, you can get some of your parasitic resistance to work for you by decreasing the voltage spike of the ESD pulse that your components experience
- If you are using similar protection methodologies in multiple products, you can design your circuits once and use modular designs to make re-use easy. PCB software, like Altium Designer, makes modular designs simple to implement and helps you protect your PCBs

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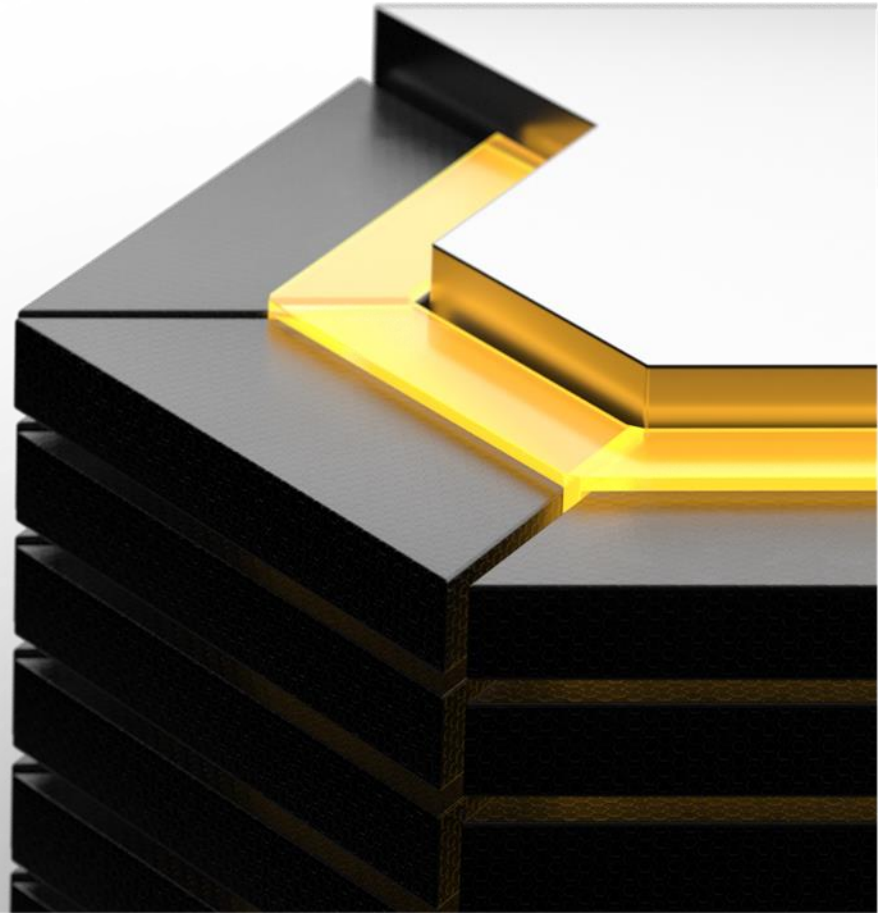

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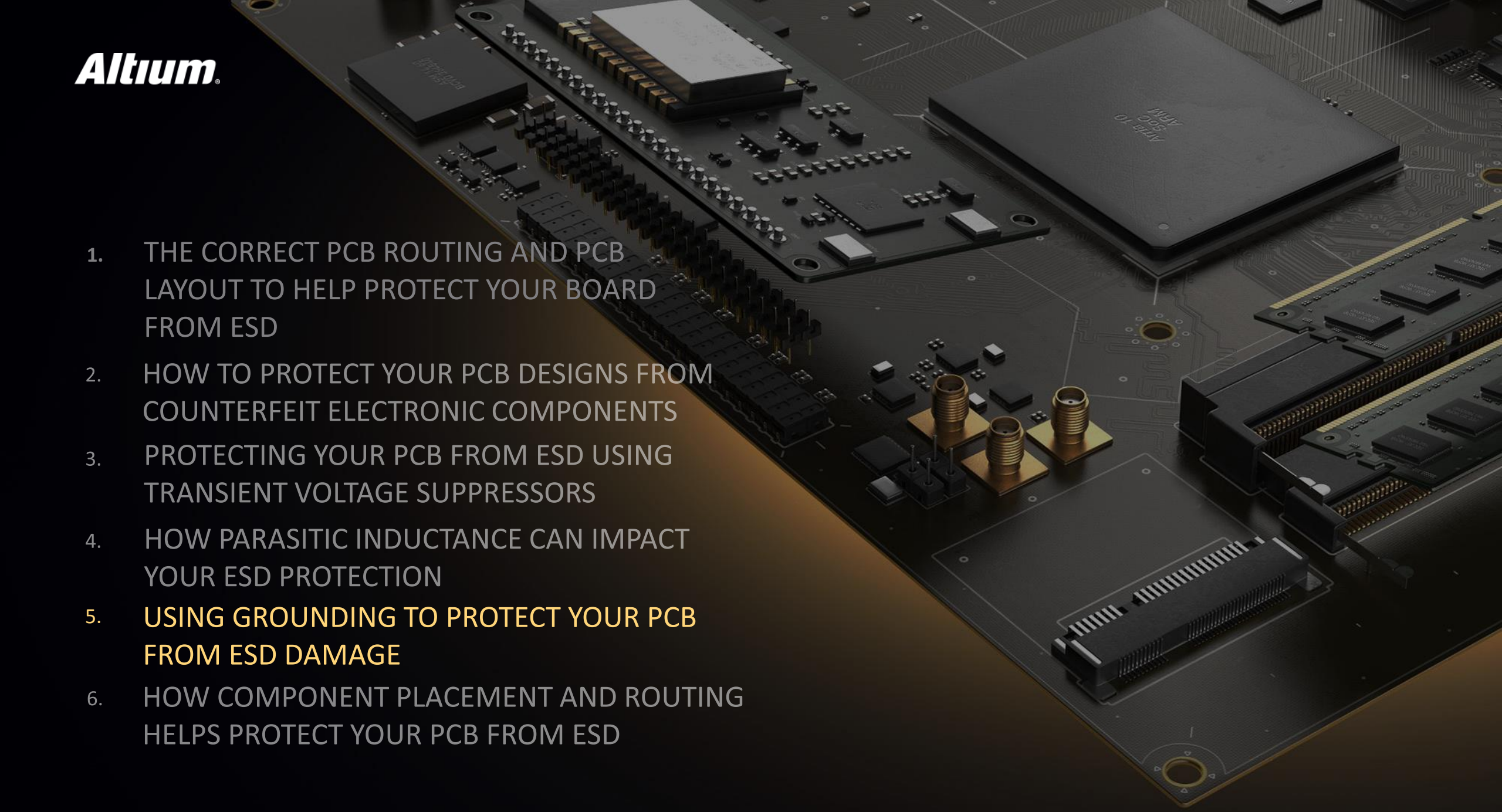

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5. USING GROUNDING TO PROTECT YOUR PCB FROM ESD DAMAGE

Grounding to Protect PCB from ESD Damage

Using grounding to protect from ESD is necessary at many stages in your product development. Good practice includes using an ESD mat and grounding yourself. You can also provide grounding protection for your products by designing them properly. When doing so, you should …

- **Use ground planes:** this gives you another way to reduce the area of circuit loops in power to ground traces. This decreases the total EMI induced within the loop area, decreasing the corresponding current that can flow where it shouldn't
- **Protect your ground planes:** You should use TVS circuits between the power and ground on sensitive components to divert the induced currents. You can also use high-frequency bypass capacitors between power and ground on sensitive components or a copper land when attaching connectors to your PCB
- **Use a chassis ground:** By allowing your board and chassis to share a ground, you can improve the grounding of the entire system. One of the easiest ways to do this is by using a chassis screw, which connects the ground plane to the chassis

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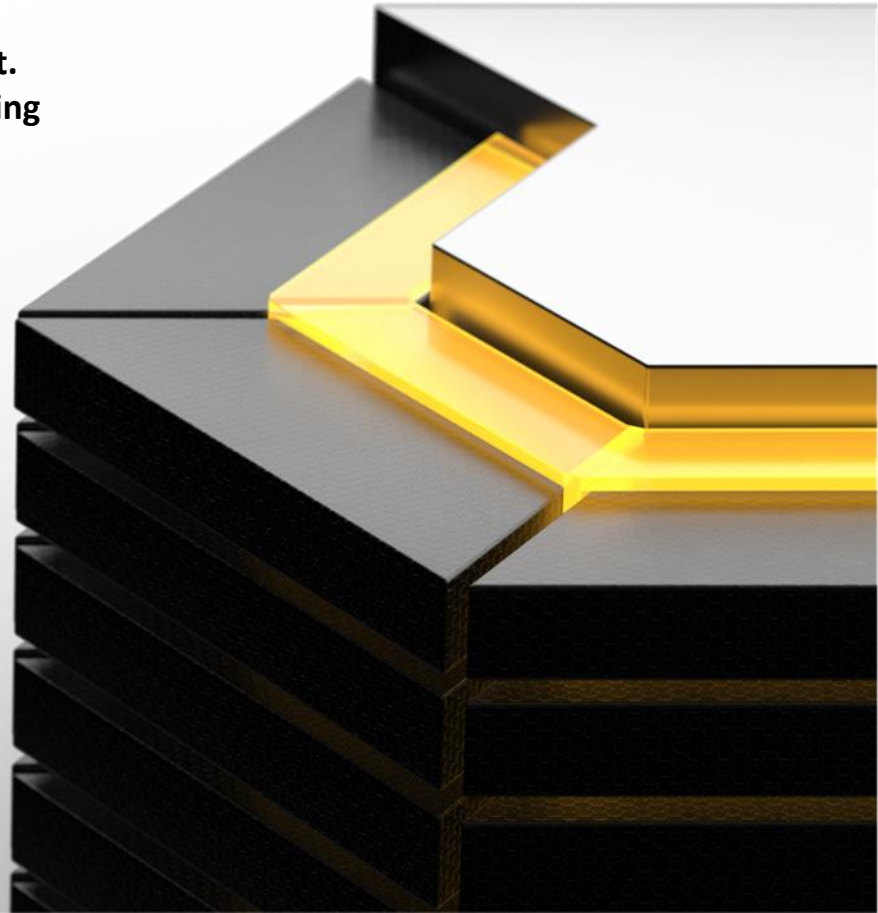

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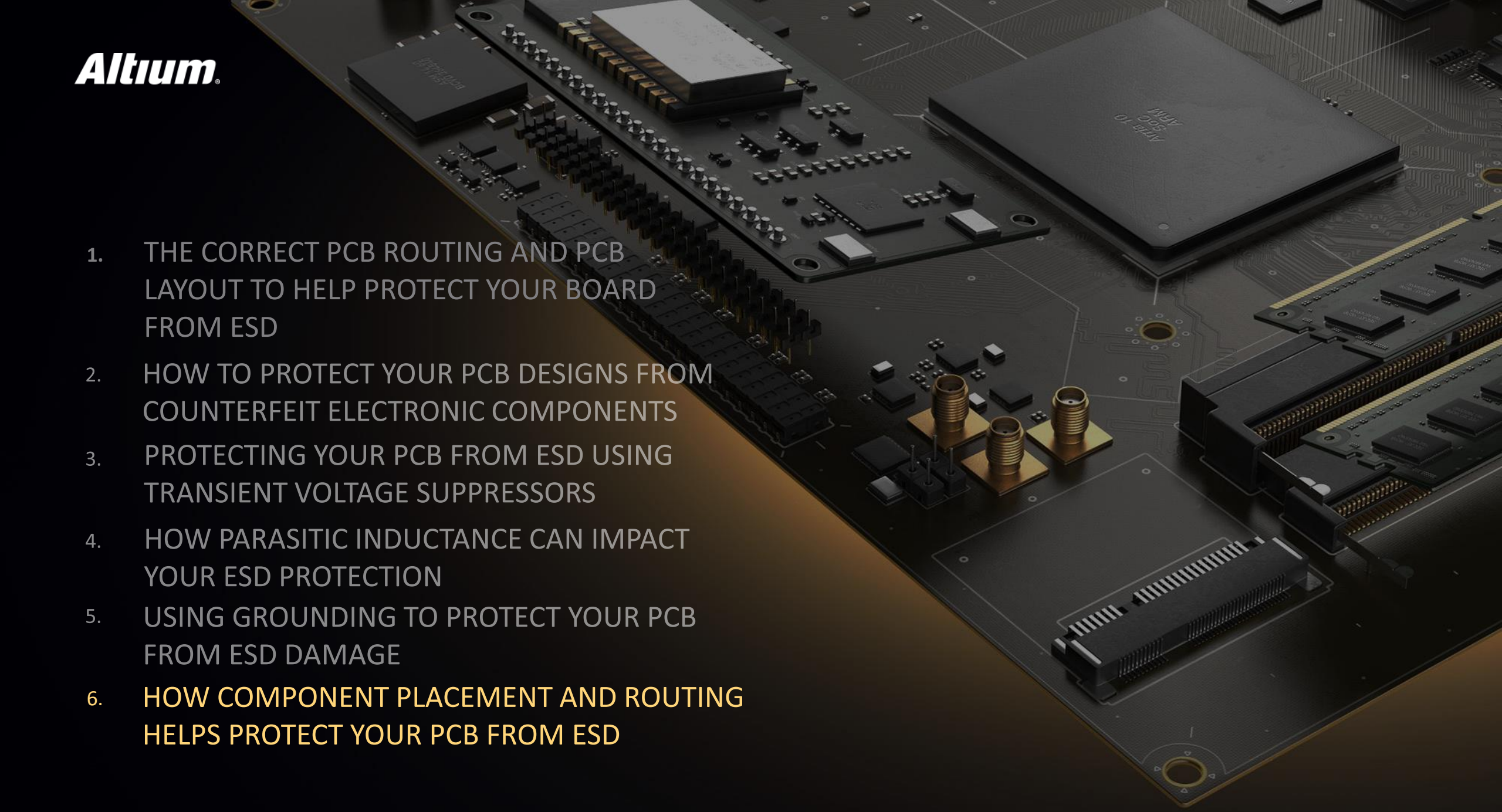

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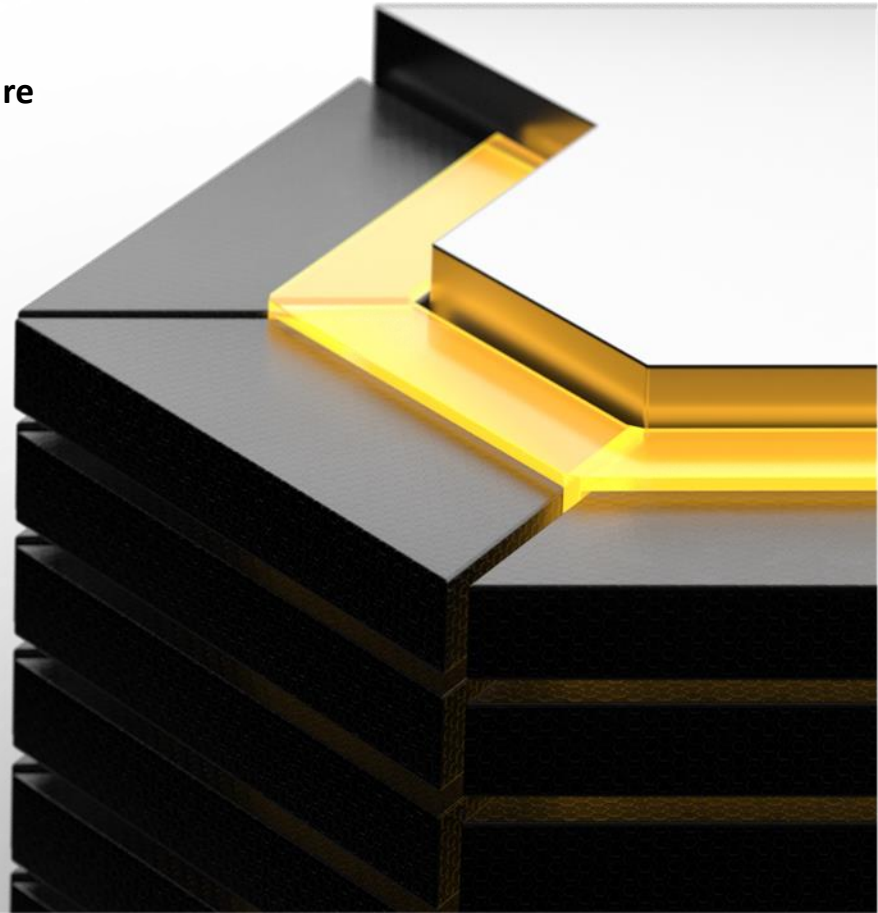
Component Placement

Good component placement affects routing on your board, which determines how any ESD effects will be spread across PCB and into your sensitive or unprotected components. Here are some basic guidelines for improving your routing to best protect your PCB and sensitive ICs:

- **Place components in the safest place possible:** Keep unprotected circuits away from the traces between a TVS protection circuit and a connector input, or any other location where ESD is anticipated. Sensitive components that are on a protected line should be placed closer to the center of the board to balance parasitic inductance
- **Minimize the length of your lines:** Place all components with lots of interconnects close to each other to minimize length and the number of interconnecting lines. Additionally, you should minimize circuit loops
- **Mind your edges:** Don’t run sensitive tracks along the edge of the board, especially for supply tracks. You want to minimize radiation from these tracks as well as their exposure to crosstalk from other tracks



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Thanks for your attention!