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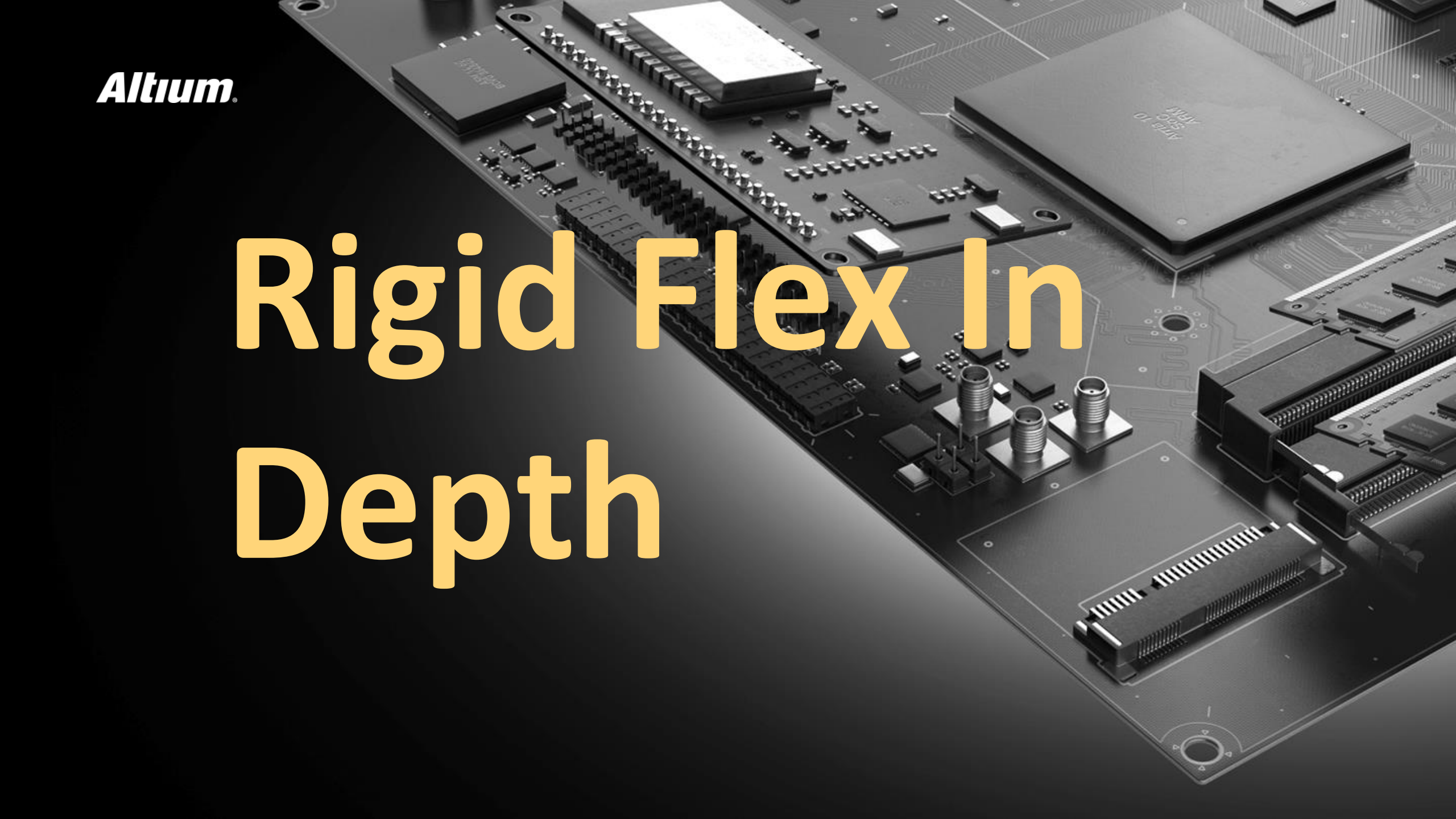
Rigid Flex In Depth



Understanding Rigid-Flex

Understanding how flex circuits and rigid-flex boards are made. Let us consider what basic materials go into these boards.

Flex-circuit materials:

•**Substrate and Coverlay Films -** The base material is typically fibreglass and epoxy resin. It's actually a fabric, and although we term these "rigid" if taken a single laminate layer they have a reasonable amount of elasticity. It's the cured epoxy which makes the board more rigid

•**Conductors –** Usually some kind of carbon film or silver based ink - copper is the most typical conductor of choice. Depending upon the application different forms of copper need to be considered.

•**Adhesives -** Traditionally, adhesives are required for bonding the copper foil to PI (or other) films, because unlike a typical FR-4 rigid board, there's less "tooth" in the annealed copper, and heat & pressure alone are not enough to form a reliable bond.

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Types of Fabrication Processes

Flex & Rigid-Flex Fabrication Processes

Flex build-ups - A typical flex, or rigid-flex board, looks straightforward. However the nature of these requires several additional steps in the build-up process. The beginning of any rigid flex board is always the single or double-sided flex layers.

Lamination and Routing -We now have a flex circuit that needs to be laminated in between the rigid sections. This is the same as an individual drilled, plated and etched core layer pair, only much thinner and more flexible due to the lack of glass fibre.

Laminated Stackups - The flex circuit is laminated into the panel along with the rigid and any other flexible sections, with additional adhesive, heat and pressure.

The Fabrication Process

1. Adhesive/Seed coating applied -Either an epoxy or acrylic adhesive is applied, or sputtering is used to create a thin copper layer for a plating key.

2. Copper foil added -Either by RA/ED copper foil lamination to the adhesive (the more mainstream approach) or chemical plating onto the seed layer.

3. Drilling - Multiple plated flex substrates can be drilled simultaneously by combining them from multiple reels, drilling between work plates, then rolling out to separate reels on the other side of the drilling machine.

4. Through-hole plating -Once the holes are made, copper is deposited and chemically plated in the same way as rigid board cores.

The Fabrication Process

5. Etch-resist printing - Photosensitive etch resist is coated onto the film surfaces, and the desired mask pattern is used to expose and develop the resist prior to chemical etching of the copper.

6. Etching and stripping -After exposed copper is etched, the etch resist is chemically stripped from the flex circuit.

7. Coverlay - Top and bottom areas of the flex circuit are protected by coverlay which is cut to shape.

8. Cutting out the flex - This is often referred to as “blanking”. The high-volume cost-effective approach to blanking is by using a hydraulic punch and die set, which involves reasonably high tooling costs.

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Understanding Physical Constraints of Rigid-Flex

•**Multiple Flex Sub-Stacks -** While it's possible to build just about any stackup with rigid and flex sections, it can get ridiculously expensive if not careful to consider the production steps and the material properties involved.

•**Adhesive Beads -** Adding a bead of epoxy, acrylic or hot-melt will help improve the longevity of the assembly.

•**Stiffeners & Terminations -** Extreme ends of flex circuits typically terminate to a connector if not to the main rigid board assembly.

•**The Panel -** The rigid flex circuit stays together in it's panel for the assembly process, so components can be placed and soldered on to the rigid terminations.

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Understanding Documentation for Rigid-Flex

Fab documentation for flex circuits and rigid-flex boards.

Documentation - It could boil down to a few golden rules:

- Make sure the fabricator is capable of building rigid-flex design.
- Make sure they collaborate on designing the layer stack to fit their particular processes.
- Use IPC-2223 as point of reference for design, making sure the fabricator uses the same & related IPC standards - ensure consistent terminology.
- Involve them as early as possible in the process.

Output Data Set - Many designers still present Gerber files to the board house. However ODB++ v7.0 or later is preferred, since it has specific layer types added to the job matrix that enable clear flex-circuit documentation for GenFlex® and similar CAM tools.

Define the stack by area using a table - The most important documentation provided to fabricator is arguably the layer stack design. Along with this, for rigid-flex, also provide different stacks for different areas, and somehow mark those very clearly.

Understanding Documentation for Rigid-Flex

Conveying the PCB design intent - Generate a 3D image showing flexible and rigid areas this will help the fabricator understand the intent more clearly **.** Many people do this currently with the MCAD software, after having imported the STEP model from the PCB design.

Parts Placement – Rigid-flex designs imply that components might exist in layers other than top and bottom. This is a bit tricky in the PCB design software, because normally components must exist on top or bottom.

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What Not to do with Copper

Dos and Don’ts of Flex circuit copper

Do Keep Flex Flexible - Decide just how much flex is needed up front.
Don’t Bend at Corners - It is generally best to keep copper traces at right-angles to a flex-circuit bend
Do Use Curved Traces - It’s best to avoid abrupt hard right-angle trackwork, and even better than using 45° hard corners, route the tracks with arc corner modes.
Don’t Abruptly Change Widths - Whenever there is a track entering a pad, particularly when there is an aligned row of them as in a flex-circuit terminator this will form a weak spot where the copper will be fatigued over time.
Do use Hatched Polygons - Sometimes it’s necessary to carry a power or ground plane on a flex circuit..
Do Add Support for Pads - Copper on a flex circuit is more likely to detach from a polyimide substrate, due to the repeated stresses involved in bending as well as the lower adhesion.
Double-Sided Flex - For dynamic double-sided flex circuits, try to avoid laying traces over each other on the same direction.

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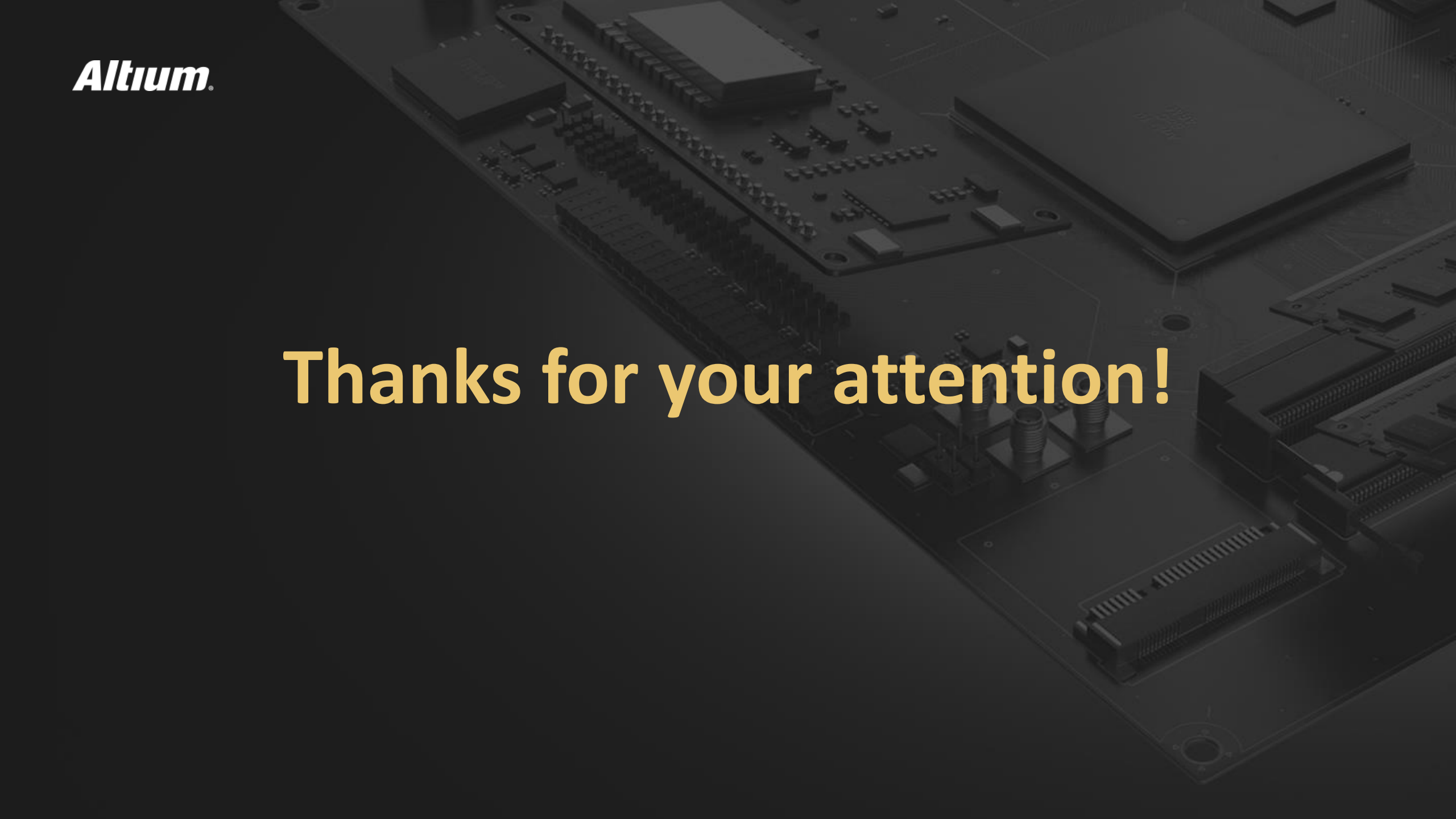

Thanks for your attention!