

Advanced Printed Circuit Requirements for a New 5G-Enabled World

Mission-critical 5G components can benefit from transparent and early-design assessments from an independent, trusted source of expertise in advanced PCB performance evaluations.

5G technology and its global rollout is the most dramatic and positive disruptive technology since the introduction of the personal computer in 1975. 5G and beyond will drive a global revolution by transforming how consumers in every market segment communicate with everyone and everything else.

But we can only realize the promise of 5G if we avoid network and component failures. The next generation of highly advanced printed circuit boards (PCBs) plays a pivotal role in enabling 5G technology to roll out across critical infrastructure building blocks such as carrier networks, servers, base stations, etc. This fundamental framework depends on complex and high-performance PC designs for robust and seamless zero-failure data management and transmission. Reliability and customizable design are essential to support various everyday applications, including life-saving medical applications, global travel with autonomous vehicles, “smart” utility grids and mission-critical industrial robotics.

UL Solutions’ advanced testing capabilities can help original equipment manufacturers (OEMs) navigate this new standard of PCB reliability.

*What’s different about 5G PCB performance demands compared to conventional 4G? **Everything.***

5G has higher speeds, lower latency response time and zero-failure reliability compared to 4G. It also enables continuous high-speed processing of big data, supporting billions of connected devices. While reliance on the 5G millimeter wave spectrum (mmWave) will challenge printed circuit board design, construction viability is a cost-effective and reliable solution for component-long life. As a result, PCBs are in the midst of a similar step-change revolution in their design, construction and testing to support the 5G revolution.

New high-speed printed circuit materials supporting highly complex integrated circuit designs will, by default, become the building blocks to enable advanced PCB reliability and functionality for critical applications and networks. 5G (and beyond) viability, however, will not come without significant new challenges to PCB design and manufacturing.

Mass-market, one-size-fits-all PCB products will no longer be viable in the new 5G era. The growing demand for high-speed PCBs will require design customization to meet critical performance specifications. This includes the primary variables of substrate types, circuit design complexity and other critical variables that combine to deliver the necessary PCB performance and robust application design life.

To differentiate end products and services in the new 5G landscape, PCB manufacturing partners must deliver customer value and reliability through customized solutions and design innovation.



A broad view of evolving high-speed market segment applications

5G networks reach remarkable speeds that allow new ways to connect and interact. OEMs in every market segment and industry now have an opportunity to reinvent their products and services to include the latest PCB designs, differentiating themselves in the market and enabling future game-changing technologies. Industry-specific innovations include:

- **Automotive**
The automotive industry may be the closest market segment demanding an actual zero-failure network. Fully autonomous vehicles will require a high-speed 5G connection for hundreds of thousands of cars simultaneously. 5G cellular networks will enable additional applications such as autonomous driving, vehicle-to-vehicle (V2V), vehicle-to-infrastructure (V2I), vehicle-to-network (V2N) and vehicle-to-pedestrian (V2P) communications. Reliability is critical for autonomous vehicles in steering and navigation, with no room for failure.
- **Medical**
New technology will allow surgeons to perform remote procedures on patients from another location where surgical instructions must be relayed to the medical device instantly, with no lag or signal failure. Other applications include ambulances or medical aircraft doing onboard patient diagnostics in emergencies for inbound wireless hospital data transmissions or just-in-time medical diagnostic scans and treatment needs.
- **Industry 4.0**
Industrial robots and smart factories will rely on seamless wireless network performance and extensive data communications with corresponding Internet of Things (IoT) components.
- **Defense**
Satellite and defense industries must design for extreme environmental operating conditions to provide long-term service and reliability, communicating flawlessly with increased volumes of data over vast distances and antenna configurations. Design failures after launch make troubleshooting and repair a costly proposition. Before launch, PCB and device failures must be comprehensively tested and vetted for performance needs, as in-flight failures are not an option.

Each of these market segments will rely on PCB reliability and zero-fail network performance with new antennas that are compact and reliable for an average of 5-10 years from installation to manage massive (multiple-input, multiple-output) MIMO data requirements. These devices include advanced PCB components that will demand application-critical network reliability and ultra-low latency with zero margins for error and failure. This performance demand for OEMs supplying network components or new 5G market technology also translates into viable economic business strategies for brand differentiation, growth opportunity and market success. Pre-compliance testing is essential before launch in order for manufacturers to detect and resolve potential design flaws early in the process to reduce design costs and accelerate market launch.

UL Solutions printed circuit reliability capabilities

Mission-critical PCB design performance across all market segments drives the growing focus on long-term PCB reliability. The cost of downstream failures, scrap and lost productivity have become critical considerations in board design and manufacturing of 5G printed circuits.

Early detection of design or fabrication flaws in PCB components is a new financial benchmark for scrap reduction. Back-end repair of failed components is no longer a viable logistical option for components installed in complex environments like onboard orbiting satellites. Repairs are costly and virtually impossible to execute in many situations.

Incorporating reliability evaluations into early life cycle designs and environmental PCB performance testing protocols can stimulate and analyze complex signal integrity, high frequency and impedance circuitry for predictive failure risks. This provides the OEM with a data-driven assessment of the probability of long-term technical and financial success.

The UL for 5G testing offerings can provide transparent and early-design assessments from an independent, trusted source of expertise in advanced PCB performance evaluations.

Learn how UL Solutions can help bring confidence to your innovations at [UL.com/PCB](https://www.ul.com/PCB).



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