



Top 5 Things to Keep in Mind When Designing Your 5G Product



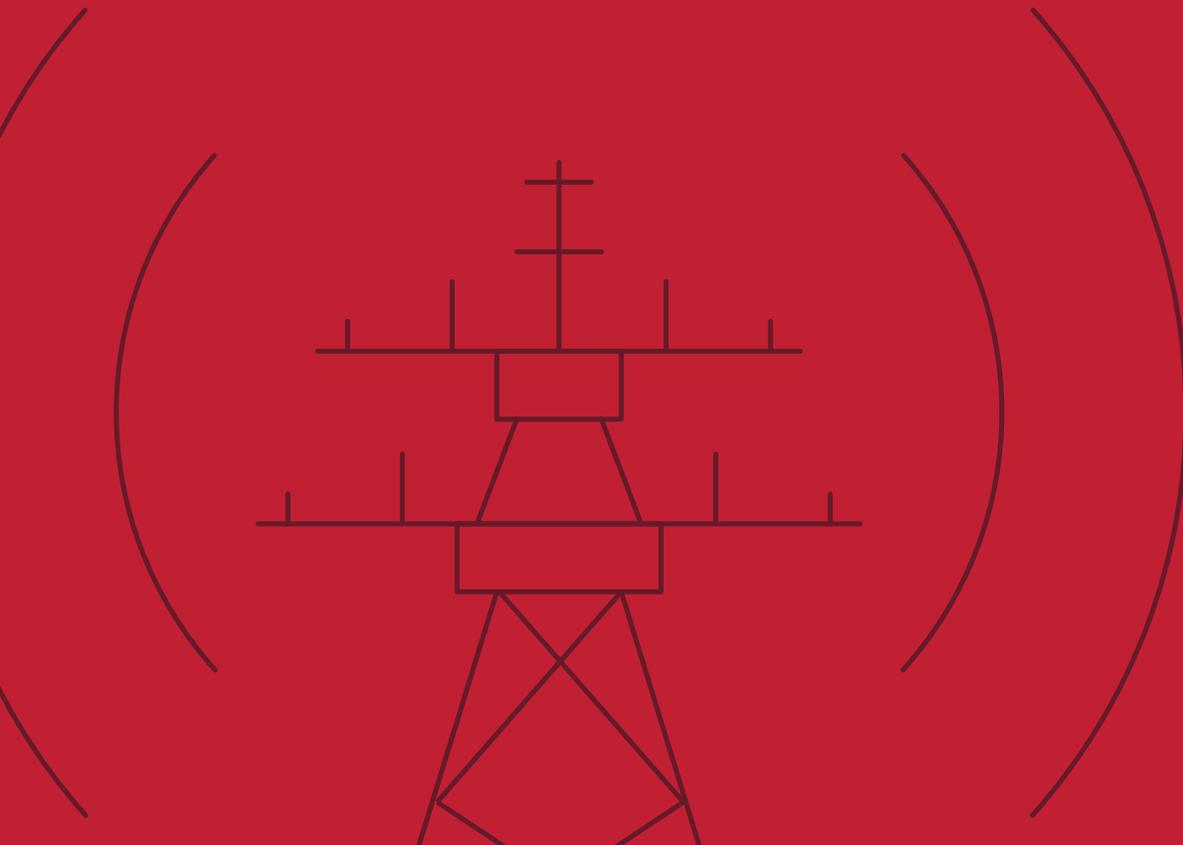
Empowering Trust[®]

When you are designing, or even planning to design, products with 5G, work with an expert partner to guard against recalls, bad reviews and noncompliance.

You may have already been learning about the fifth generation of mobile communications technology, 5G, for a few years. But now that you are designing, or planning to start designing, 5G products, you need to make sure you are ready to take advantage of all it has to offer, such as:

- Enhanced mobile broadband (eMBB)
 - High data rates for data-driven apps
 - Wide spectrum range
 - Wide area of application
- Massive machine-type communication (mMTC)
 - Scalable connectivity
 - Wide area coverage
 - Deep indoor penetration
- Ultra-reliable low-latency communication (URLLC)
 - Support mission-critical apps
 - Power apps in real time
 - Suitable for industrial control

But transitioning to 5G is much riskier than 4G. This is because 5G is not an incremental jump in technology but rather a leap. Therefore, potential points of failure are not always obvious, can be more complicated and potentially not as well defined as they were in the past. You need to be well prepared and informed of design and testing requirements to avoid common mistakes that could lead to recalls, bad reviews and penalties for noncompliance.





1

Complicated 5G radio frequency testing compliance

New technologies generally evolve faster than rules and regulations. The overall process to cope with this is straightforward. At first, a new technology must be evaluated on a case-by-case basis. As the technology evolves and matures, the regulatory bodies gain a more comprehensive understanding of the factors that impact compliance. The goal is to help ensure a high level of consistency for compliance review among different products, enable a design-to-compliance approach for manufacturers, and shorten the time to market.

Some topics will be developed and lead to final guidance, while others will only be interim guidance to be phased out. An example of the latter is a specific antenna tuning inquiry for which a communication test set was not yet available for the new radio (NR) band in question, and the factory test mode did not have antenna tuning test capability. Special procedures were developed to cope with this situation. When a call box covering the NR band becomes available, the United States Federal Communications Commission (FCC) intends to no longer allow the interim procedure. To illustrate the case-by-case nature of guidance provided during this phase, a second device, even if subject to the same overall conditions, might receive different specific test guidance due to differences in the factory test mode capabilities for that second device. Because the requirements can change over time, it's important to work with a trusted testing, inspection and certification (TIC) organization to stay up to date on the latest compliance rules and testing plans. Listening to TIC webinars and having gap analysis reviews can help you know you are designing a product to the latest 5G release specifications.

Inconsistent adoption by various countries of various frequency bands for 5G also can affect your product design choices. At the Telecommunication Certification Body (TCB) Council workshop held in October 2020, discussion centered around updates from the FCC and Canada's Innovation, Science and Economic Development (ISED) regarding changes to radio regulations, measurement procedures and application requirements for the United States and Canada, respectively. Harmonization between the requirements of these two bodies is extensive, but not 100 percent. As a result, many manufacturers of products intended for both markets submit simultaneous applications to both countries. UL's Global Market Access experts stay abreast of changing regulations for 5G in more than 150 countries as well as the local languages and cultures and the paper needed to get your product quickly through customs.

5G is complex. But you don't need to know everything about potential pitfalls if you engage with a knowledgeable partner like UL to help guide you through the compliance requirements and performance testing during the product life cycle.

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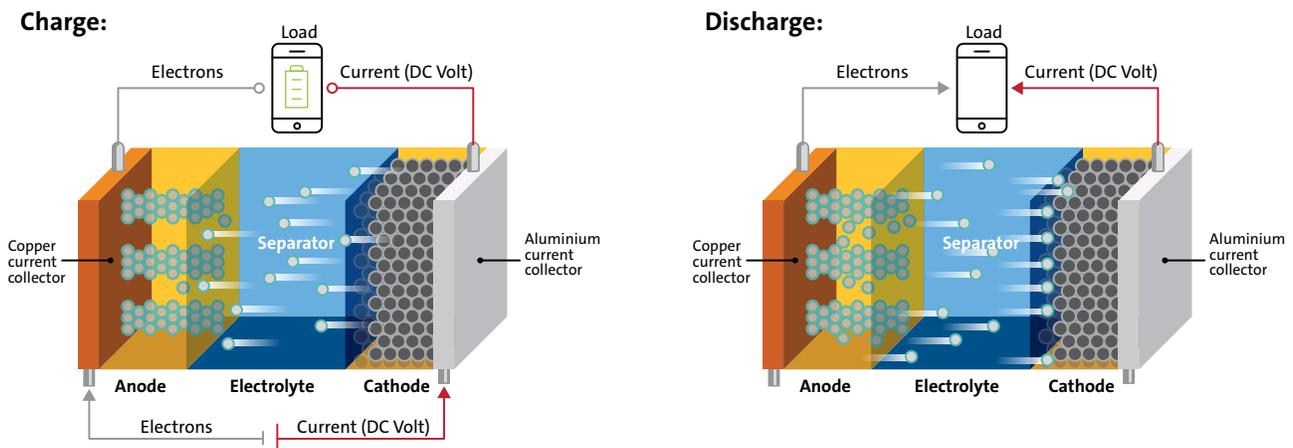
Countering 5G's effects on battery life

5G products operate differently than 3G and 4G products, which can impact battery requirements. For example, products using 5G channels, including mmWave, will initially require multiple transmitters operating simultaneously in different bands, which increases the need for power. While faster data transfer with 5G means less time spent transmitting, some 5G devices are designed to operate more often or use more computer processing power to handle real-time, high-volume data transfer. These advances can impact battery life and power requirements.

On top of that, 5G enables more applications where the risk of battery failure increases the chance of injury or death, such as uses in medical devices and autonomous vehicles. Structural battery issues can cause a short circuit and damage the device they were powering, resulting in severe consequences including the product bursting into flames. As a matter of fact, in 2006, 10 million laptops were recalled due to battery issues.¹ Ten years later, 2.5 million cellphones were recalled due to flaws in the battery that caused them to catch fire.² The estimated direct cost of this recall was \$5.3 billion (USD).

The severity of damage that batteries can cause shows the importance of having safety standards and certification for batteries.

For 5G consumer products, the two most important battery performance parameters are capacity and cycle life. A higher capacity enables the device to operate for a longer time between recharges. A higher cycle life indicates that the battery will last longer under many typical usage characteristics. The battery and product design, construction and chemistry influence these parameters.



UL's Battery Safety Testing services are extensive, broad and lead the industry. We do more than test and certify batteries. We contribute to the development and international harmonization of industry safety and performance standards, focusing on better performance as well as safety to deliver trust and acceptance in global markets for our customers.

1. <https://www.engadget.com/2006-10-19-sony-battery-recall-approaches-10-million-costs-mounting.html>
 2. <https://www.nytimes.com/2016/09/16/business/samsung-galaxy-note-recall.html#:~:text=Sept.%2015%2C%202016%20SEOUL%2C%20South%20Korea%20-%20it,some%20customers%20said%20their%20phones%20had%20caught%20fire.>

3

5G requires more attention to the design of printed circuits and printed circuit boards

Printed circuit (PC) and printed circuit board (PCB) design has always involved electrical, mechanical, environmental, thermal and manufacturing process factors. These factors become more critical and challenging for 5G products due to data rates in the gigabit range and operating frequencies in the mmWave bands.

PCB considerations for 5G compared to 4G include:

- RF front end will continue to be integrated directly on the PC.
- PC must be designed to manage higher speed and higher frequency signals.
- Overall PCB laminate materials requirements include low dielectric constant (Dk) and low dissipation factor (Df).
- Induced polarization of a dielectric material by an external electric field.

Today's PC products are extremely sensitive to manufacturing variations, manufacturing temperatures and precise copper thickness uniformity. So, the cost of design failure and reliability is a critical factor across all major market segments requiring 5G compatibility. Scrap and field failures have always been an issue; but they are more critical now that PCs are so important for 5G equipment as it becomes increasingly more difficult to make repairs by hand.

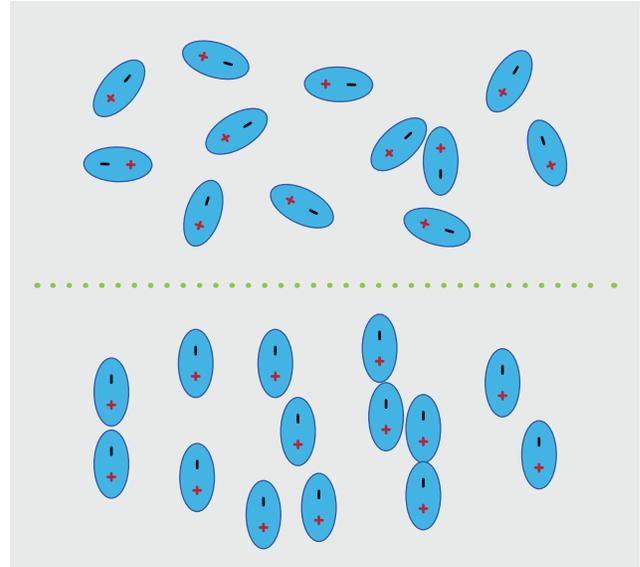
Proven and widely accepted reliability evaluations can and should be proactively incorporated into the early design to accommodate environmental performance demands of PCs. Among others, these include electrical, mechanical and thermal tests. PC safety certification is needed primarily to mitigate electric shock and flammability hazards.

Some of the tests performed include:

- Dielectric strength
- Breakdown voltage
- High voltage arc-tracking rate
- Impact
- Bending properties
- Material distortion under load
- Bond strength of laminates and adhesives
- Flammability tests (resistance to ignition and burn rate)

UL offers a proprietary performance and reliability qualification to test for the unique demands put on PCs by 5G technology. This qualification gives wireless carriers, end-product manufacturers and consumers confidence in the safety, performance and reliability of the PC.

We are the only certification body to develop safety standards and test bare PCs, i.e., boards without components. UL Recognized, safety certified PCs are accepted in lieu of bare board testing requirements in most end product standards across the world.



Induced polarization of a dielectric material by an external electric field.

4

Specific absorption rate and power density testing

Specific absorption rate (SAR) is a measurement of energy absorbed within a person. Power density (PD) is a measurement of an applied field outside a person. The challenge for 5G radio frequency exposure evaluations is how to combine SAR below 6 GHz with PD above 24 GHz.

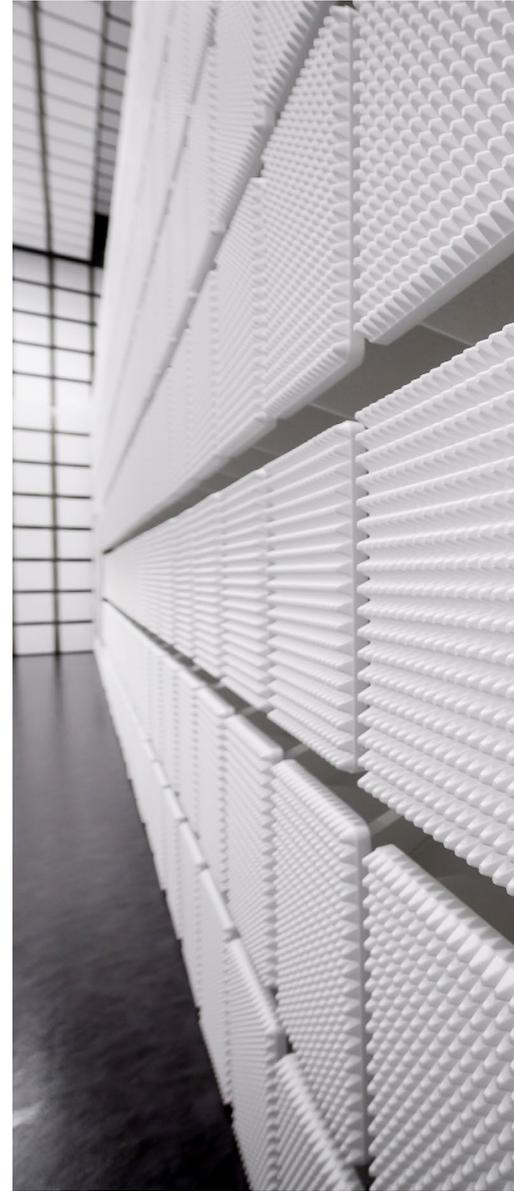
Different units specify SAR and PD parameters, and the corresponding measurements are made at physically different locations. Upon calculating each measurement's ratio to the corresponding limit for that measurement, these dimensionless ratios are added to yield the total exposure ratio. The next step is to confirm that this sum is less than one.

This SAR equation provides a pragmatic and sensible way to combine these disparate measurements. As no update was presented for this configuration, existing guidance continues to be applicable for 5G.

UL has more than 20 years' experience in SAR testing, so you can rely on our industry-leading expertise to help you meet the requirements needed to launch your 5G products quickly and efficiently while mitigating the risk of a costly recall.

We offer:

- Global reach — testing and certification in all markets
- Full-service SAR laboratories — accredited by numerous regulatory agencies, major market governments and Vodafone
- Tailored testing solutions — enhanced process efficiency and streamlined testing cycles designed around your requirements
- Leading engineers — practical advice and support to help ensure you get the test results you need to launch on time



5

Cybersecurity

Cybersecurity risks, and their associated activities, fall into a variety of categories. No matter how the various activities are categorized, they can all do damage. Nevertheless, various forms of categorization are useful to identify both common and unique features and to help develop strategies to cope with each risk.

With 5G, the overall network will have significantly more nodes, more data will be communicated, and more data will be shared. Also, some portions of the 5G ecosystem will depend on low latency. For users of these devices, any denial of service disruptions can have severe consequences. The result is that cybersecurity will become more important as 5G networks and devices are deployed.

Cybersecurity risks include:

- Risk of control loss
 - Interception of network communications
 - Access to systems on the network
 - Distributed denial of service (DDoS) attacks
- Risk to sensitive communications
 - Eavesdropping
 - Providing abusive responses
 - Intercepting livestreaming
- Risk to sensitive data
 - Theft of personal/health data
 - Extortion of user
 - Negative user experience

UL’s approach encompasses training, advisory and testing services. Specific elements include Security by Design, Security Development Life Cycle (or SDL) Gap Analysis, Penetration Testing and Security Framework Assessments.

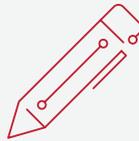
UL’s end-to-end approach

Understand risk



Developing security standards and frameworks
Advising clients on technology and cybersecurity strategy

Establish security levels



Securing IoT ecosystem programs
Supporting roadmap execution

Manage risks



Validating and maintaining security
Functional and interoperability testing of IAA functionality (identification, Authentication, Authorization)



**For more information about 5G Compliance Testing
or to contact a UL expert, please visit [UL.com/
services/5g-compliance-testing](https://www.ul.com/services/5g-compliance-testing).**

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