

# X-ray inspection of consumer electronic components

How fully inspected, quality electronic components ensure safe mobile phones, laptops and tablets whilst protecting profits



# Executive summary

Millions of people across the globe begin and end every day with the glow of a mobile device upon them. The lure of connectivity, convenience and capability of mobile phones and computers is a powerful one. Within our global population of circa 7.7 billion, an **estimated 5 billion people** have mobile phones that, in many cases, are inextricably intertwined into their everyday activities. One **2019 study** revealed that, on average, individuals check their smartphones 63 times in one day. Today, we expect our devices will be always on, always working.

Our growing use and dependence on consumer electronics that are always on, always working, simultaneously creates a manufacturer's mandate for tight quality control to ensure the devices do in fact keep working properly. By continuously evolving quality to the highest possible standards, manufacturers keep our devices operational, reliable and safe whilst also protecting business from financially devastating events involving device failures.

Consumer electronics' operation relies on micro-sized components, such as semiconductors, printed circuit board assemblies and lithium-ion batteries. Thus, it is component level quality and reliability that largely determine device functionality. Components then, must be fully tested prior to use in electronic consumer devices, where failure can have escalating consequences.

In electronic components, the juxtaposition of increasing sophistication with decreasing size heightens the challenge of achieving comprehensive quality assurance. Additionally, non-visible or hidden areas must be inspected via full-component, high resolution, non-destructive testing. The only options capable of this type of testing are state-of-the-art X-ray inspection solutions.

Given our increasing global dependence on personal or consumer electronics, we need strong manufacturing protection. Such behind-the-scenes protection will help ensure connectivity, convenience and game-changing capabilities that the world has come depend upon, while helping electronics manufacturers safeguard people, jobs and manufacturing profitability. Innovative manufacturers that place a high priority on ensuring electronics quality, safety and reliability will have a greater positive impact worldwide, allowing users to begin and end each day without worrying about the functionality of their devices.

# Table of contents

Executive summary ..... 2



1. The state of consumer electronics ..... 4



2. Electronic componentry and quality requirements..... 5



3. What matters to consumer device manufacturers? ..... 7

Summary ..... 8



# The state of consumer electronics (especially smartphones)

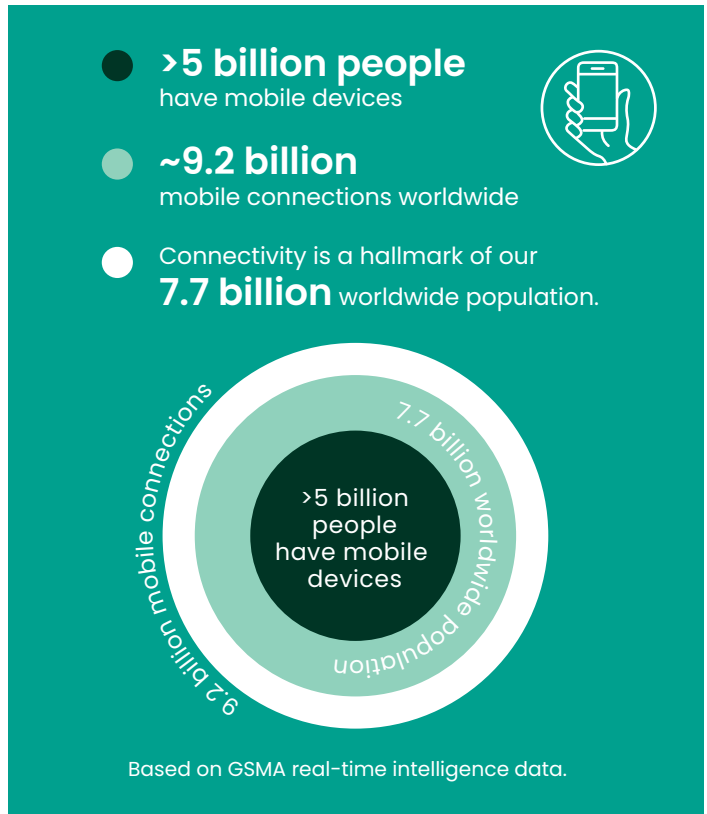
With **over 5 billion people** who have mobile devices and an estimated 9.2 billion mobile connections worldwide, (based on GSMA real-time intelligence data), connectivity is a hallmark of our 7.7 billion worldwide population.

Via phones and computers, electronic consumer devices add tremendous capability, convenience and connectedness to our world every day. Their popularity simultaneously creates a significant need for safe, reliable and predictable operation. Consumer electronics rely on their micro-sized components, such as semiconductors, lithium-ion batteries and printed circuit board assemblies (pcba's) for power and proper functionality. Therefore, component quality is at the root of consumer electronics' safety and is paramount to protecting people and profits.

The accelerated rate of innovation, features and functionality in consumer electronics is driving adoption and proliferation – and increased use of electronic components. Growth, specifically in artificial intelligence, smart apps and devices, is just getting started. Other recent developments include biometrics, location tracking, mobile artificial intelligence (AI) and wearable technologies. What does all this mean? From home management and security, golf gear, televisions to smart baby sleepers and cribs, the integration of electronic components into ordinary, everyday items—to make them 'smart'—and routine behaviors is becoming ubiquitous, expanding the definition of "consumer electronics" exponentially. The nexus of all this communication and connection is the smartphone, an increasingly vital element in our daily lives.

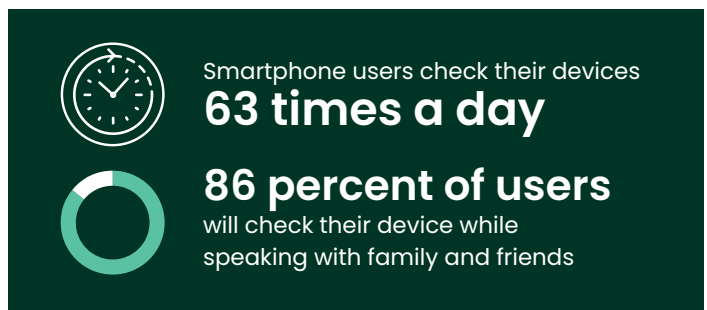
*"The integration of electronic components into ordinary, every day items—to make them 'smart'—and routine behaviors is becoming ubiquitous, expanding the definition of 'consumer electronics' exponentially."*

Consumer electronic devices, with smartphones at the forefront, are an integral and highly visible part of our world. To a large extent, safe and reliable operations are in the hands of the electronic component manufacturers that produce semiconductors, pcba's and lithium-ion batteries. Device incidents, while low in frequency, can spur viral mega-headline news events worldwide, doing disproportionate brand damage with negative financial consequences. In consumer electronics manufacturing—components and devices—safety and profit protection go hand-in-hand.



While the forecasts have repeatedly predicted the replacement of computers by smartphones, it has not happened. Smartphone growth and global usage, however, is impressive and positions smartphones as the leading consumer electronic device. According to **Pew Research**, an estimated 5 billion people have mobile devices, half of these being smartphones. The adoption is skewed higher in advanced economies with 76% of people having smartphones compared to 45% in emerging economies.

Smartphone significance goes well beyond adoption percentages. Smartphones have become, well, an obsession. A 2019 survey shows that, **on average**, smartphone users check their devices 63 times a day and 86 percent of users will check their device while speaking with family and friends.







# Electronic componentry and quality requirements

The sheer market size and increasing proliferation of consumer devices, together with the microlevel and often “non-visible area” quality requirements, creates an ever-evolving challenge for electronic component manufacturers. Additionally, consumers prefer sleeker, thinner electronic devices that are concurrently more powerful (i.e., thinner phones with higher battery capacity), thus escalating the pressure on electronic components from a design, capability and quality standpoint. As consumer device electronic components shrink in size, they simultaneously increase in functionality and variety – with unique measurements, shapes and stress points on micro-levels. In other words, complexity increases as size decreases. Thus, the challenge for ensuring electronic component safety intensifies further.

To put this challenge in perspective, one very small irregularity, typically 5X smaller than a human hair, can cause electronic device failure. And, component irregularities are frequently on non-visible areas, such as a wire-bonds or joint cracks in semiconductors. Finding flaws in electronic components prior to installation into consumer devices, provides proper assurance and proactive protection.

*“One very small irregularity, typically 5X smaller than a human hair, can cause electronic device failure.”*

Fortunately, inspection to ensure full electronic component quality has evolved to match these rapid increases in capability and complexity manifested in smaller and sleeker electronic components. With micro and nano-focus X-ray and CT (Computed Tomography, a special type of 3D X-ray technology) inspection solutions, the three essential electronics inspection characteristics provided are:

1. High resolution imagery
2. Inspection of both visible and non-visible areas
3. Non-destructive testing

Only X-ray solutions enable the detection of latent micro-imperfections within consumer electronic components on both visible and non-visible areas without destroying the part, making them the must-have equipment to help enable full quality inspection of electronics. Most importantly, component inspection detects flaws much earlier in the component and final electronic device manufacturing processes to significantly minimize corrective costs and avert in-use failures and safety hazards.

Other non-destructive inspection techniques, such as optical testing and electrical testing, provide partial protection. These alternative techniques cannot offer 3D inspection of non-visible features and can create a false positive. Undetected flaws can lead to bigger issues. For example, in lithium-ion batteries used for mobile phones, unobserved component flaws can escalate into thermal runaway, resulting in fires and potential explosions. Vulnerabilities can heighten quickly, creating safety, financial and legal consequences. Mitigating potential vulnerabilities and risks is the preventative action required to avoid a negative domino effect, and mitigation must start early in the component manufacturing process. Therefore, to ensure quality, manufacturers of electronic components for consumer devices must produce fully inspected, high quality parts because public trust and safety, as well as business results, are highly dependent on component quality.

Although lithium-ion batteries have a **failure rate** of less than one in a million, when failure occurs, the consequences are extraordinarily high from a financial, legal and brand damage perspective. Since lithium-ion batteries utilize the same fundamental design across device types, they pose identical risks regardless of manufacturer or device. Although the risks are the same for each manufacturer at the component level, the potential ramifications of a device failure escalate disproportionately based on device type, incident impact, visibility, etc. One does not have to cast their mind back too far to recall certain incidents where manufacturers have suffered significant safety, financial and brand equity damages due to faults on these types of components. Simultaneously, these lithium-ion component failures have fortified inspection processes and, as a result, have further enhanced the quality of lithium-ion batteries today.









# What matters to consumer device manufacturers?

Now integral to our daily lives, consumer devices are important, visible and widely used, making them high-stakes manufacturing products. As a result, keen focus on component quality and reliability is the new norm, spurring the development of global industry standards and process requirements by the Association Connecting Electronics Industries, known as the IPC\*. The consumer electronics supply chain is governed by IPC compliance, most pointedly for electronics standards.

IPC creates both standards and classifications that are globally recognized for ensuring electronics safety and reliability.



## IPC Classifications

IPC classifications define the degree of inspection and the level of acceptance required for compliant inspection. For the vast majority of consumer electronics, manufacturers require Class 2 for their components. In very simple consumer electronics applications, such as remote controls, Class 1 is sufficient.

**Class 1.** For electronics with shorter life cycles and simpler end-use applications

**Class 2.** For electronics with extended life cycles and mid-level complexity

**Class 3.** For electronics with high performance and/or on-demand performance requirements and harsher end-use environments

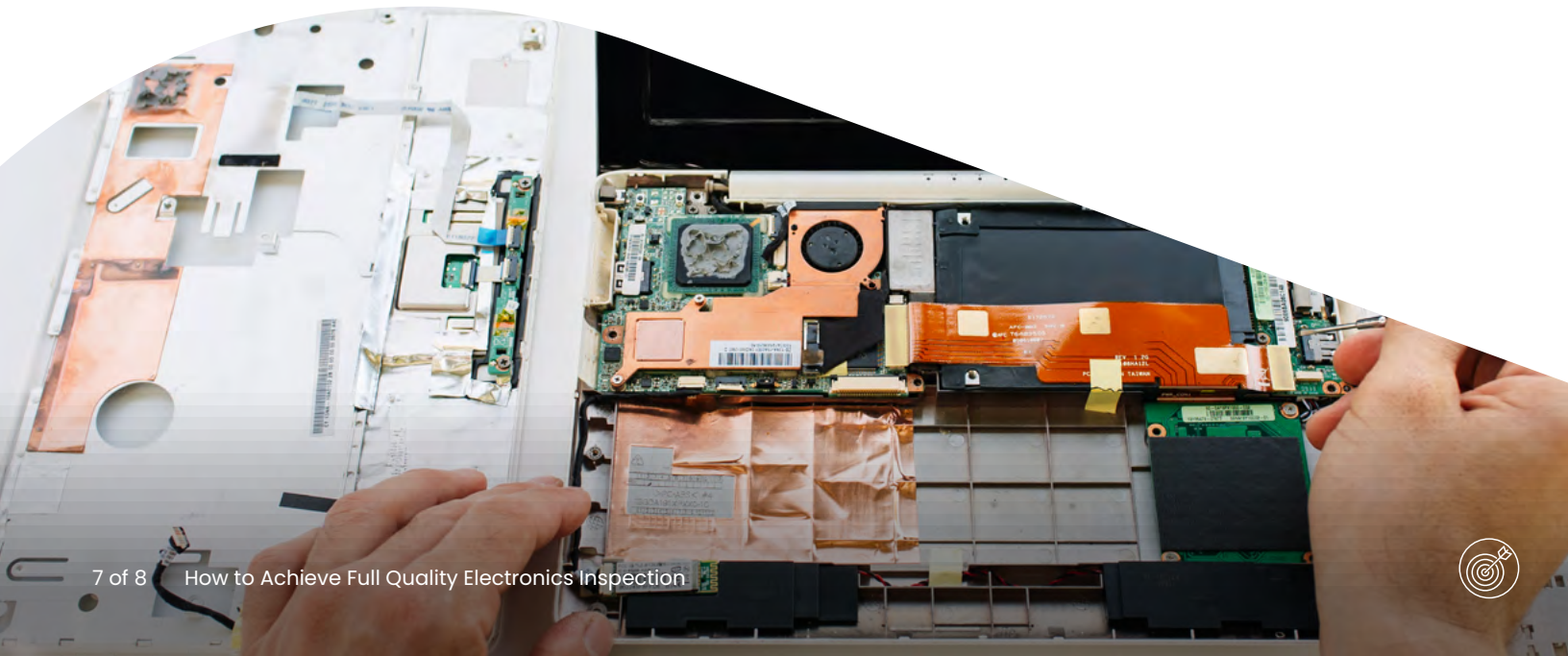


## IPC Standards

Most commonly used in electronic assemblies for consumer electronics is **IPC-A- 610**, the acceptability standard for solder, component damage, etc. Additional IPC standards that direct electronics quality requirements include:

- IPC-7095D for ball grid arrays (BGA)
- IPC-A-610G for electronics assemblies
- IPC J-STD-001 for soldered electrical and electronics assemblies
- IPC/WHMA-A-620 for cable and wire harness assemblies

For consumer electronics, the manufacturing financial stakes are high thus IPC compliance is an important and valuable competitive differentiator. X-ray inspection is the sole solution that can provide proper assurance of IPC compliance via high resolution, non-destructive examination of visible and non-visible areas. Finding an industrially minded partner with deep expertise in X-ray inspection technologies facilitates the required levels of compliance.



# Summary

Mobile phones and computers are used extensively around the world today. Their safe and reliable operation—while challenging to manufacturers and often assumed by individual users—is of paramount importance. Fortunately, innovative X-ray inspection solutions deliver strong protection and value for consumer electronic component manufacturers and help ensure mobile phone and computer safety, protect people and sustain manufacturing profitability. In a world where we don't think about, and don't want to think about, the quality and reliability of our personal electronics, it is innovative manufacturers who obsess about that quality that are making a positive difference in our world.

For more information, feel free to  
contact us here: [BakerHughesDS.com/contact](https://www.bakerhughes.com/contact)

*\*The images/information are Copyright 2019 by IPC International, Inc. and are used with IPC's permission. This image/information may not be altered or further reproduced without the prior written consent of IPC.*

Copyright 2020 Baker Hughes Company. All rights reserved.

BHCS34361A (04/2020)

**Baker Hughes** ™