EU Energy Label for iPhone and iPad:

An Explanation of Apple's Methodology

June 2025

Overview

The EU's new Energy Labelling regulation for smartphones and tablets prescribes several interim test methods that contain unclear language. As a result, some metrics on the energy label are influenced by the choices made by manufacturers and test labs interpreting the regulation. This paper's goal is to explain Apple's chosen test methodology and the resulting scores that were, in some cases, voluntarily lowered to account for potential differences of interpretation. We look forward to working alongside other stakeholders to address test method ambiguities in the future.

At Apple, we are deeply committed to making the world's best technology, while upholding our values and protecting the planet we call home. That means designing products that are built to last. We do that by building durable and energy-efficient hardware, maximizing our use of recycled materials, supplying ongoing software updates, and providing convenient access to repair services. We have a track record of making products that lead the industry in longevity. This benefits both our customers and the environment by reducing greenhouse gas emissions while minimizing the resources used to create our products.

We support regulations that spur innovation and action on longevity, energy efficiency, and the environment. As part of that, Apple is committed to complying with the Energy Labelling requirements for smartphones and tablets (energy label) under the new EU regulation 2023/1669, effective on June 20, 2025. The energy label is designed to provide metrics on energy efficiency, repairability, and durability.

To determine product scores, Apple developed its testing based on the methods detailed in the regulation. However, certain parts of the regulation contain language that is ambiguous, conflicting, or open to interpretation, which can lead to variations in the resulting energy label scores depending on the choices made during testing. While we expect to gain more clarity through the adoption of harmonized standards, in the interim, we chose to provide an explanation of our methodology. This paper details test method choices Apple made to arrive at its scores so that others can replicate our test results and understand our rationale.

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Apple’s focus on longevity

Designing products that last is part of Apple’s DNA. Our goal is to create the best experience for our customers while reducing our impact on the environment, which means we consider how to extend longevity at every stage of the product lifecycle. In 2024, we published Longevity, by Design, a comprehensive paper outlining our approach to product longevity centered around three pillars: building durable hardware, providing ongoing software updates, and improving repairability. We believe our approach is working, as demonstrated by the high residual value of secondhand Apple products, increasing product lifespans, and decreasing service rates.

For example, in many of our key markets, including in Europe, iPhone retains at least 40 percent more of its value compared to Android smartphones, with the valuation difference increasing for even older models of iPhone.[1] There are hundreds of millions of iPhones that have been in use for more than five years — and that number continues to grow. At the same time, the newest generations of Apple devices are much less likely to need repairs. For example, from 2015 to 2022, out-of-warranty repair rates across all Apple devices were down by 38 percent.

When it comes to building durable products, our drive is relentless. For every material used, part selected, and product assembled, our engineering teams continuously seek to improve durability. We do this by conducting extensive reliability testing throughout every stage of product development. Our tests are carried out over tens of thousands of devices every year and are designed to mimic real-world usage, which we believe is critical in providing our customers with products that stand the test of time.

The result of this rigorous commitment to durability is an improvement in our products year after year. For example, early generations of iPhone were susceptible to failure if accidentally exposed to liquids, so our teams iterated until they were able to achieve robust liquid ingress protection — which decreased repair rates by 75 percent.[2] And in 2024, we introduced the first iPad with liquid and dust ingress protection to provide our customers with even greater durability.

Connect the adhesive tabs to the 9V battery.

Hold the connection to debond the adhesive.

Lift the battery from the enclosure using a suction cup.

iPhone 16 uses an innovative adhesive technology that enables the battery to be debonded through a current from a household 9V battery

Another critical element to our products' longevity is Apple's proven track record of software support. We deliver long-lasting operating system (OS) updates that lead the industry in customer adoption and extend well beyond the historical industry norm. These releases provide optimized performance for every product they support, in addition to new features, critical security updates, and bug fixes. And even after an Apple product can no longer be updated with the newest OS, we strive to provide our customers with critical security updates. For example, in March 2025, we released an update to iOS 15 that covered products as far back as iPhone 6s, which was introduced in 2015.[3]

The durability of Apple products helps to minimize the need for maintenance or repair. However, sometimes repairs are unavoidable. That's why our teams are always working to maximize the repairability of our products, without sacrificing durability. For example, iPhone 16 is the most repairable iPhone ever with 12 modules that can be repaired. Its battery features an innovative adhesive technology that can be debonded by running a low voltage current — like a household 9V battery — without leaving adhesive residue or deforming the battery.

We've also continued to expand access to reliable, safe, and secure repairs by increasing the size of our industry-leading service and repair network, and expanding access beyond our network. We introduced Self Service Repair for iPhone and Mac in 2022, and have since extended it to iPad, giving our customers the option to conduct repairs themselves. We've streamlined our calibration processes for independent repairers and enabled calibration for used parts. And because our customers' safety, security, and privacy are paramount, we've introduced and strengthened measures to further safeguard every device so that personal data remains protected. That includes Parts and Service History, which alerts customers if key modules on their device have been repaired and whether its parts are made by Apple.

Our dedication to building products that last is rooted in our commitment to protecting the planet. Apple has set an ambitious goal to become carbon neutral for our entire carbon footprint by 2030. Our journey to 2030 is focused on first reducing our scope 1, 2, and 3 greenhouse gas emissions by 75 percent compared with 2015, and investing in high-quality carbon removal solutions for the remaining emissions. That means we're always looking for innovative ways to reduce our impact on the environment, the result of which is visible across all of our products.

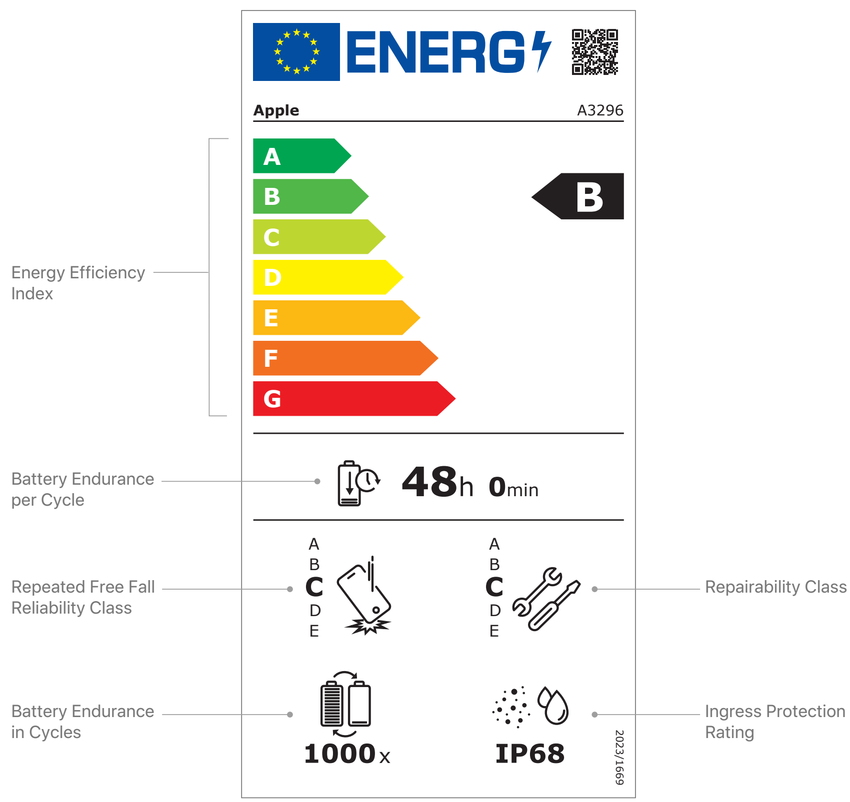
Since 2015, Apple has cut overall emissions by more than 60 percent. In fiscal year 2024, 24 percent of the materials we shipped in our products came from recycled sources. In fact, by the end of 2025, we plan to use 100 percent recycled cobalt in all Apple-designed batteries, 100 percent recycled tin soldering, 100 percent recycled gold plating in all Apple-designed rigid and flexible printed circuit boards, and 100 percent recycled rare earth elements in all magnets across new products.[4] To learn about Apple's progress, visit apple.com/environment.

Energy efficiency is also an important part of our environmental strategy, both for the production of our products and for the products themselves. A decade ago, we launched the Supplier Energy Efficiency Program to help our suppliers optimize their energy use and reduce emissions from manufacturing operations and facilities used to make our products. And year after year, Apple products are consistently rated by ENERGY STAR, which was established to set specifications that reflect the top 25 percent most energy-efficient devices on the market. In 2024, all eligible products received an ENERGY STAR rating for superior energy efficiency. And since its debut in 2010, Apple silicon has continued to advance new models of iPhone and iPad by accelerating performance while simultaneously improving energy efficiency and battery life.

EU Energy Label for Smartphones and Tablets

First introduced in 1994 for household appliances, the EU energy label is designed to provide information about the energy use of products. Since then, the label has expanded to cover more types of products and include other metrics on specific features unique to that product category.

Beginning in June 2025, EU regulation 2023/1669 requires smartphones and tablets to present six metrics on energy efficiency, durability, and repairability, as shown below.



Smartphone and tablet energy label example

The information provided on the label is derived from a series of tests prescribed by the EU.[5] In April 2025, the European Commission initiated a request for harmonized standards to be created to completely and precisely define the test methods.[6] However, as the harmonized standards are only in their early phases of development, the Commission issued interim or "transitional" test methods for certain metrics to be used until the harmonized standards are complete. This is common practice for new EU regulations.

Our goal is to transparently share the choices Apple made during testing to arrive at the scores on our energy labels so that others can replicate our results and understand our rationale.

In the interim period before harmonized standards are developed, the Commission requires manufacturers to upload any "parameters of the initial test procedure for the energy efficiency index, if not described sufficiently" to the European Product Registry for Energy Labelling (EPREL) database to enable market surveillance authorities to understand choices made by manufacturers for ambiguous parameters.[7] Apple fully complies with this requirement.[8]

Smartphone and tablet manufacturers must rely upon the transitional test methods and parameters defined by the regulation. As Apple prepared to implement the energy label for iPhone and iPad, we have found instances where those test methods have undefined, under-defined, or contradictory parameters. As a result, some of the metrics presented on the energy label are impacted by the parameter choices made by manufacturers or test laboratories interpreting the test method. This can lead to inconsistent results and misleading comparisons between products.

For example, we've found that various choices in testing — all consistent with the requirements of the regulation — can yield Energy Efficiency Index (EEI) and resistance to accidental drop results that vary by one, two, or even three letter grades.

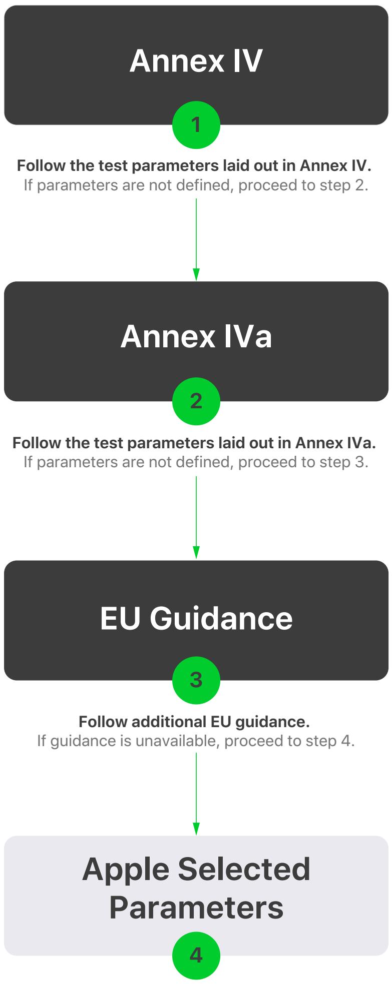
Our goal is to transparently share the choices Apple made during testing to arrive at the scores on our energy labels so that others can replicate our results and understand our rationale.

Guiding Principles for Apple Energy Label Testing

Apple was guided by two key principles when executing testing for the energy label.

1. Where the regulation explicitly and clearly referenced a test method or test parameter, Apple adopted that method or parameter completely and fully. When there were differing parameters in the EU regulation, Annex IV took precedent, followed by the transitional test methods in Annex IVa, and finally any subsequent instructions and resources issued by the Commission (e.g. Commission Frequently Asked Questions). While we do not agree with all the defined test methods and parameters, we abide by the EU's authority to prescribe test parameters in the regulation.

2. Where ambiguity exists in the transitional test method, we selected parameters that most closely represent real-world usage patterns to the best of our judgement. The EU notes the importance of "test methods that reflect real-world usage patterns" in the energy labelling framework directive.[9] We have also seen EU Court of Justice cases highlighting the importance of testing that reflects actual usage conditions of a product. We are in complete agreement that meaningful, real-world metrics are crucial for consumers to make informed purchasing decisions about the products they buy.



Guiding Principles for Apple Energy Label Testing. Where the regulation explicitly referenced a test method or parameter, Apple adopted that method or parameter according to the hierarchy presented above. As a last resort, if insufficient information was provided by the regulation or EU guidance, Apple selected parameters that best represent real-world usage.

As an additional cautionary measure, Apple went one step further and downgraded some of its scores to factor in test method ambiguities and variance. For example, Energy Efficiency Index scores for iPhone models on the EU market in June 2025 all qualified for the highest "A" grade, but Apple chose to voluntarily derate scores to a "B" grade to minimize the probability that a third-party tester interpreting the regulation differently would achieve a lower grade. We also downgraded scores for the Repeated Free Fall Reliability Class for the same reason.

This paper presents our choices transparently to enable European stakeholders — from our customers to enforcement authorities — to replicate our results while understanding our rationale. We encourage other consumer electronics manufacturers to also present their selected test parameters. We look forward to working to address these issues and develop harmonized standards.

Battery Endurance and the Energy Efficiency Index

The first two metrics on the energy label are related to energy efficiency. Battery Endurance per Cycle is a metric that represents the length of time a smartphone or tablet can execute a specific workload on a single battery charge. Energy Efficiency Index (EEI) normalizes the measured Battery Endurance per Cycle by the device's battery capacity to yield an energy efficiency score that is independent of the battery capacity.

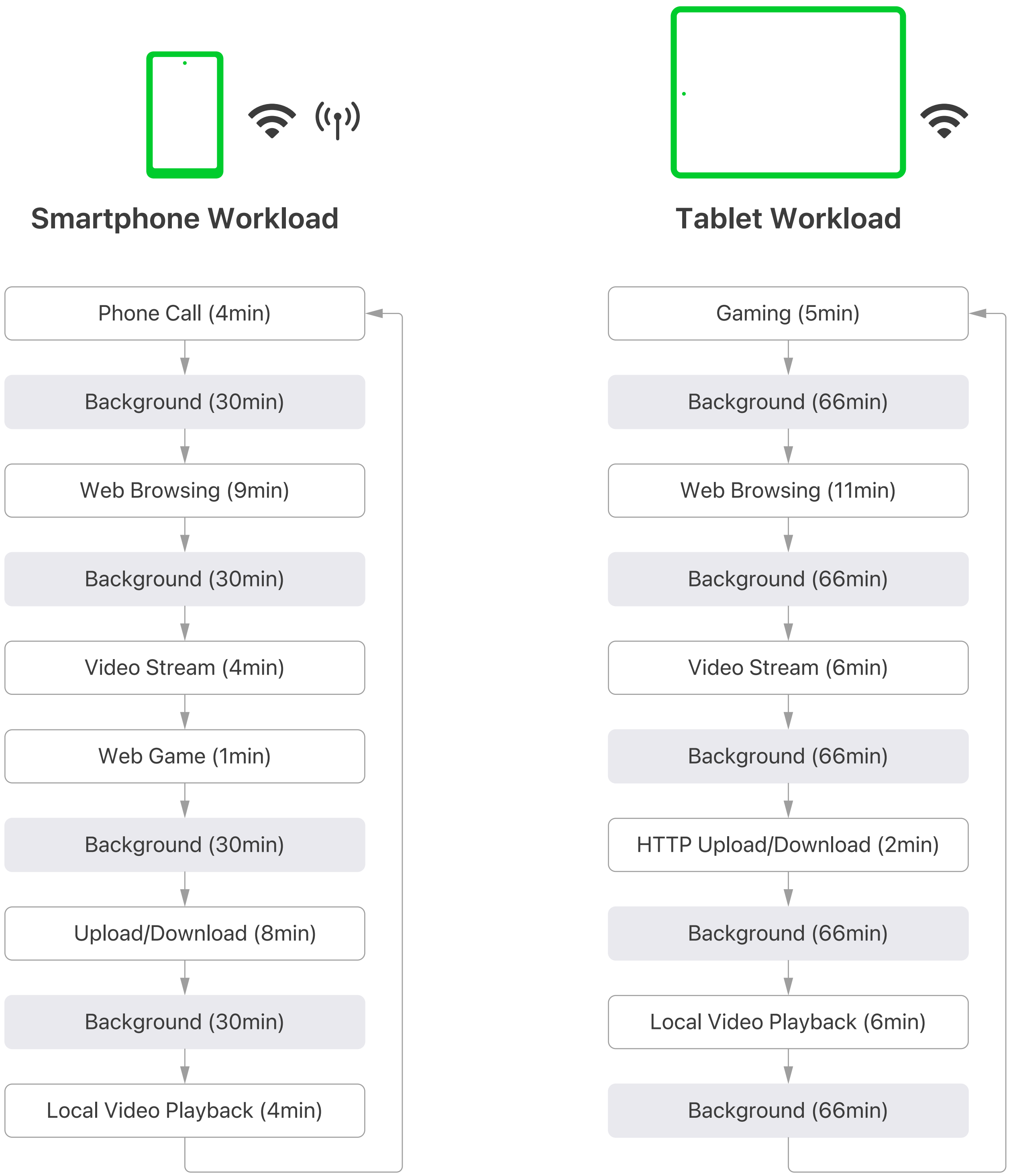
Energy efficiency testing methodologies

Battery Endurance per Cycle

Battery Endurance per Cycle is calculated by measuring the length of time a smartphone or tablet can repeatedly execute the standardized workload stipulated by the regulation until its fully charged battery is depleted (i.e. one complete battery cycle). The workload defined by the regulation involves a series of tasks, such as web browsing and video streaming, with idle periods of user inactivity in between most tasks.

Apple has historically presented its own metrics on battery endurance to customers on its website and in other advertisements. Apple's endurance metrics reflect a workload selected by Apple to represent customer use cases. However, the regulation's endurance results differ as the workloads and the conditions are not the same.

There are several differences between the smartphone and tablet workloads and duration of each task. For example, the smartphone workload includes a phone call while the tablet workload does not. Additionally, while the tablet workload requires only Wi-Fi connectivity, the smartphone workload requires both Wi-Fi and a cellular connection created through the use of a simulated 4G LTE cellular network. The specific set of tasks required for each workload is shown in the following figure. The workload is repeated until the battery is fully depleted, at which point the test stops and the endurance duration is recorded.



Workload for smartphone and tablet energy efficiency testing

Battery Endurance in Cycles

Energy Efficiency Index (EEI)

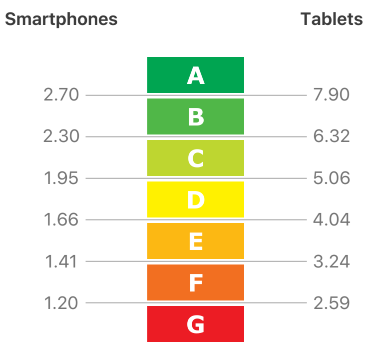
While the Battery Endurance per Cycle metric will be a function of the device's energy efficiency and battery capacity (i.e. larger batteries will lead to proportionally larger Battery Endurance per Cycle values), the EEI score is intended to present consumers with a normalized — and, therefore, comparable — metric on energy efficiency. The EEI score is represented as a grade from A (most efficient) to G (least efficient).

$$\textbf{EEI Score} = \frac{\text{Battery Endurance per Cycle (h)}}{\text{Battery Capacity (Wh)}}$$

EEI score calculation equation. The resulting value is then mapped to the scale shown below.

The EEI score is calculated by dividing the Battery Endurance per Cycle duration, in hours, by the battery capacity, in Watt-hours, as shown in the equation on the left.

The regulation defined scoring ranges that correspond to grades A through G, as shown on the left, with different scales for smartphones and tablets. The scoring ranges are universal for each product category, regardless of the performance characteristics of the product.



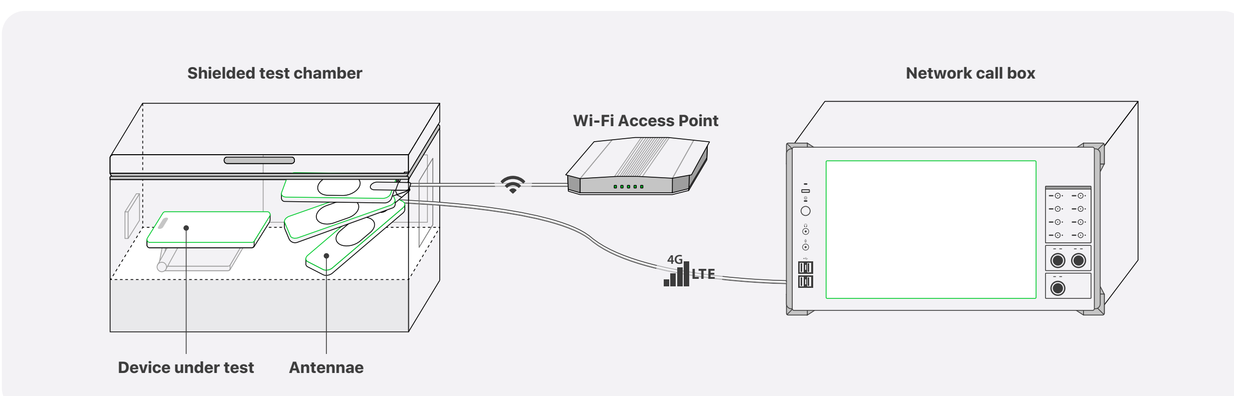
Smartphone and tablet Energy Efficiency Index (EEI) scoring scale.

Test set-up

The regulation stipulates several initial device and network settings prior to initiation of the test. Devices must be configured according to 37 different criteria, including display brightness, speaker volume, Wi-Fi signal strength, always-on display default conditions, and notification settings.

For portions of the iPhone test requiring the use of a cellular network, the regulation requires the use of a network simulator or call box, a test instrument that can simulate a 4G cellular network for mobile devices. The transitional test method includes many, but not all, parameters needed to define this network.

The energy efficiency test setup for smartphones is illustrated in the diagram below.



Energy efficiency test setup for smartphones. By conducting testing inside a shielded test chamber, only those Wi-Fi and cellular signals generated by the network call box or Wi-Fi access point are received by the device under test.

Apple's EEI workload app

The regulation defines a standardized set of tasks within the workload that must be used to evaluate the Battery Endurance per Cycle and EEI score, with precise timing associated with each task. However, the only practical means of completing the workload in a repeatable and precise manner is by automating it through an app. An app also ensures that testing continues uninterrupted as a single test takes multiple days to complete.

The European Commission recognized this challenge, and funded a pilot during the development of the regulation to create an Android and iOS app. However, this pilot test period expired and the Commission does not require the use of a specific app to conduct energy testing.[12] Apple developed its own test application as is permitted under the regulation to ensure repeatable results and precise adherence to the EEI workload.

To validate that Apple's test app meets the regulation's requirements, Apple commissioned SmartViser, the same third-party app developer used for the Commission pilot, to evaluate Apple's app. Apple provided SmartViser with access to its app and to the Apple engineering teams that developed the app. SmartViser concluded that Apple's app is consistent with the regulation and yields similar results.[13]

Apple's testing methodology

The following section details the rationale Apple used to resolve key ambiguities in the EEI testing parameters, focusing on Full Resource Allocation (FRA), speaker volume settings, and phone orientation and antenna selection. For a full list of testing parameters used by Apple, refer to Appendix A.

Full Resource Allocation (FRA)

In a 4G LTE network, when a smartphone needs to send or receive data, it will automatically transition from an Idle state to a Connected[14] state, as defined by the Radio Resource Control (RRC) protocol. Once in the Connected state, the device can proceed to download or upload data, as either requested by the user or sent by the network, and return to Idle once data is no longer needed by the device and a specified inactivity timer has elapsed.

Full Resource Allocation (FRA) is a network simulator setting that determines how available network resources, such as bandwidth, power, and transmission time, are allocated to Connected devices. If enabled, it overrides other applicable Connected power-saving network settings and forces the device to send and receive data continuously, regardless of whether data is needed or not, for as long as a device remains in the Connected state.

The EU regulation does not clearly stipulate whether FRA should be enabled. In fact, it does not even mention FRA, and there was no discussion on FRA during the stakeholder consultation process during the regulation's development. As the FRA setting has a significant impact on Battery Endurance per Cycle and EEI score, Apple had to decide whether to enable it or not.

Apple chose to turn off FRA for testing purposes for two key reasons:

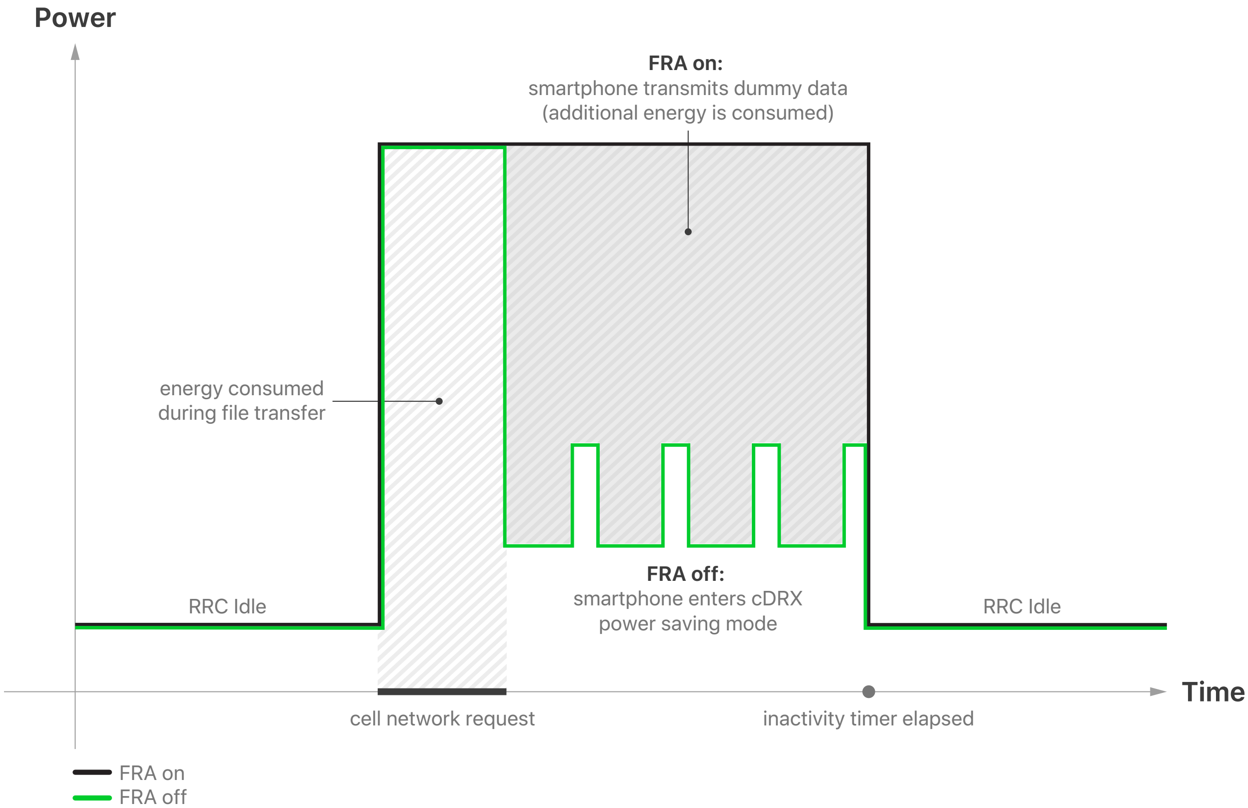
(i) Customers on cellular networks do not have the ability to activate FRA, so testing with it on is not realistic. The setting to activate FRA exists for test purposes only in network simulators to enable manufacturers to test data transfer speeds by forcing devices to send and receive as much data as possible.

(ii) Turning on FRA conflicts with two significant aspects of the regulation: cDRX power management and the Upload/Download test.

Annex IVa of the regulation specifies that the network simulator enable a power-saving mode called Connected-mode Discontinuous Reception (cDRX).[15] cDRX allows a smartphone to turn off its receiver while maintaining its connection to the network — reducing battery consumption when the device otherwise detects that it may not require network resources. Turning on FRA overrides cDRX by preventing a smartphone from turning off its receiver during periods of inactivity while in a Connected state.

Every smartphone builds in power-saving features like cDRX to extend battery life. There is widespread adoption of cDRX across cellular networks in Europe and around the world. The networking and telecommunications producer Ericsson, which operates in 180 countries, cites cDRX as "a key feature for device energy saving" and recommends it is enabled.[16] Apple's own guidance to cellular carriers around the world also details how to adjust network settings to maximize energy efficiency, and recommends cDRX is enabled. Apple believes a realistic test setup should allow cDRX to be enabled, which necessitates FRA to be off. Because the regulation stipulates that cDRX is enabled, we believe turning off FRA is consistent with the regulation's intent and real-world carrier networks.

Additionally, one of the tasks required for the EEI test involves uploading and downloading a file of a specific size. Turning on FRA makes the specific file size irrelevant because FRA forces the device to send additional data beyond the specified file size. This is illustrated by the following diagram.



Comparison of a smartphone's cellular power consumption with FRA off (green line) and FRA on (black line). In this example, power consumption rises once the cellular network initiates a file transfer. If FRA is off, following completion of network activity, power consumption lowers as the smartphone enters cDRX power saving mode. If FRA is on, however, network activity continues to the maximum extent possible, and overrides cDRX power savings. The additional energy consumed with FRA on is shown to illustrate its magnitude.

For these reasons, we followed our principle to use the most realistic conditions for testing where there is ambiguity in the regulation, and turned off FRA to allow iPhone to enter into a low-power state when network resources are not required.

We recognize that some third-party test labs are evaluating smartphones with FRA on. This will yield worse Battery Endurance per Cycle and EEI scores since power consumption will rise significantly. With FRA on, each time a smartphone connects to a cellular network, such as to download email, receive a push notification, or perform background activity involving the network, it is forced to unnecessarily continue transmitting more data than it otherwise would for as long as the Connected state persists. Over time, the energy expended during these periodic connections makes a significant difference to the overall efficiency of the smartphone and can impact scoring by approximately one letter grade.

Speaker volume settings

The EEI workload test performed by smartphones and tablets includes playing videos with audio. However, the video to be played, the speaker volume settings, and test setup are under-defined or conflicting in numerous ways, which could lead to significant variations in the EEI score.

For example, Annex IV requires a volume measurement of 75dBA at 20cm from the front screen of the device, with the room environment unspecified. In contradiction, Annex IVa stipulates the volume should be set at 60dBA at 40cm from the bottom edge of the device when placed flat on a table. These two procedures are not equivalent, and can lead to different results depending on varying device geometry and speaker layout.

Additionally, Annex IV does not specify the content to be played during the test. This is important as different choices of content can result in significantly different measured sound levels. In addition, Annex IVa requires[17] the device to be measured while playing a "specified tone," yet no specific tone is provided. The Commission's Frequently Asked Questions website (FAQ) further complicates matters by suggesting[18] the use of "pink noise"[19] for calibration, but it also includes a test video with music to be played during the EEI test.[12] The music and noise signals differ so significantly that calibrating to 75dBA with pink noise can result in EEI test audio to be more than 10dB lower, depending on the device and manufacturer. This introduces uncertainty about whether the regulation intended calibration with the EEI test audio instead.

Finally, the regulation provides no guidance on whether testing must be conducted in a controlled environment such as an anechoic chamber, and it does not define the aforementioned table composition or size. Testing in an anechoic chamber is the most accurate and controlled way to conduct a test of this kind, and there will be a marked difference in volume levels compared to a test carried out in a different environment because the anechoic chamber walls absorb sound instead of reflecting it. Additionally, the choice of table shape and size will determine how much of a baffle effect[20] will result.

Each of the choices made by a test lab to interpret these conflicting or unspecified requirements would lead to different speaker volume, which in turn, materially impacts the power consumed during testing.

In accordance with the Guiding Principles for Apple Energy Label Testing, laid out in the beginning of this section, we followed a hierarchy to determine which settings to adopt. Based on this, Apple set the speaker volume at 75dBa at 20 cm from the front screen of the device because that is what was stipulated in Annex IV of the regulation. Annex IV did not mention how the device should be mounted, so we referred to Annex IVa, which requires resting the device on a table. Finally, we chose to conduct the test in an anechoic chamber because it produces more accurate, controlled, and repeatable results. These choices are summarized in the following table.

	Annex IV	Annex IVa	Commission FAQ	Apple Methodology
Volume Target	"75 dBa"	"60 dBa"	—	75 dBa
Microphone Distance	"20 cm"	"20 cm" and "40 cm"	—	20 cm
Microphone Position	"from the front (screen) of the device"	"on the same level as the phone, 40 cm from the bottom edge of the device"	—	From the front (screen) of the device
Device Mounting	—	"placed flat on the table"	—	Flat on table
Calibration Content	"all audio volumes (call and media) shall be set at 75 dBa at a defined distance..."	—	"calib.wav" (Pink Noise)	"calib.wav" (Pink Noise)
EEI Test Content	—	—	EEI media test content	EEI Media Test Content
Room Environment	—	—	—	Anechoic Chamber

Summary of conflicting speaker volume settings within Annex IV, Annex IVa, and the Commission FAQ. The resulting Apple methodology used to calculate Apple scores is shown in the column on the right.

Phone orientation and antenna selection

Most smartphones today include more than one antenna for cellular communication, with each having different efficiencies due to their individual electrical and mechanical design. The EEI test requires each smartphone to perform certain tasks on the cellular network, and so the energy efficiency of the antenna module becomes an important contributor to the EEI score. As part of this, the orientation of the smartphone during the test becomes important to define, as antenna selection is related to signal strength, which is impacted by distance and positioning of the smartphone relative to the source of the network signal.

However, the regulation's transitional EEI test method does not define the orientation of the smartphone in the network simulator, nor does it specify which antenna to use. Therefore, individual choices on orientation of the device will impact the EEI results, because different antennas have different energy efficiency levels.

The iPhone has four 4G antennas. For the EEI test, Apple chose the one that is most widely used in Europe to be consistent with our principle to represent real-life use patterns.

Reported Scores

To determine final reported Battery Endurance per Cycle and EEI values, we considered the impact of our testing decisions, as well as the potential for variability in results. We decided to factor in a safety margin to account for unit-to-unit variability, run-to-run variability, the potential impact of future security updates, and other factors. Our goal was to ensure that products already placed on the market will not require future scoring changes, which could result in customer confusion. This led us to take a conservative approach to reporting our product scores.

All models of iPhone, as of June 2025,[21] qualified for an EEI grade of "A". Once we downgraded the results to account for the safety margin, all models were still within the "A" range. However, in response to test method ambiguities, especially with regard to FRA and audio settings, we opted to be conservative and voluntarily downgrade our EEI results to the highest "B" grade. For battery endurance values, we used values corresponding to the highest "B" grade, rounded down to the nearest hour. We plan to revisit our approach to downgrading our scores each time new products are launched.

The regulation's EEI scale for tablets puts more advanced and capable devices at a clear disadvantage. This is because the scale does not account for display size, resolution, or display technology, nor does it reflect the tablet's intended use case or performance. For example, a 7-inch, low-resolution tablet primarily used for reading is graded on the same scale as a professionally oriented, 13-inch tablet with performance rivaling laptop computers.

iPad was designed as a new category of device, unique from smartphones and laptop computers alike. iPad uses advanced technology that can deliver pro-level features while preserving battery life and thin design. For example, iPad Pro uses a power-efficient tandem OLED display technology that is not used by any other tablet to provide users with best-in-class color accuracy, contrast, anti-reflectivity, and off-axis viewing, as well as 1000 nits full-screen brightness and 1600 nits peak brightness. Using custom Apple silicon also improves energy efficiency — the M4 chip in iPad Pro has the same performance as the M2 chip, but uses just half the power.

Despite our confidence in iPad's energy efficiency, Apple chose to downgrade our iPad results to account for the safety margin, with corresponding battery endurance values rounded down to the nearest hour. iPad scores either E or G, as of June 2025.[21]

Between the skewed EEI scale and our conservative approach, our reported EEI values differ from other reputable third-party ratings. Apple devices consistently rank among the high-performing products rated by ENERGY STAR, which was established to set specifications that typically reflect the 25 percent most energy-efficient devices on the market. In fact, iPad Pro consumes 63 percent less energy than the requirement for ENERGY STAR from 2025.

Repeated Free Fall Reliability Class

The energy label's Repeated Free Fall Reliability Class metric is a measure of durability. The grades assigned to each smartphone and tablet are intended to represent the resilience of those products in the case of an accidental drop.

Overview

At Apple, every product we make undergoes rigorous internal testing to ensure it meets our high standards of durability. Our processes are methodically designed to reflect real-world conditions, informed by a deep knowledge of consumer behavior and extensive data from the field. This gives us a very high degree of confidence in the durability of our products, which is one of many reasons that customers around the world choose Apple time and time again.

By contrast, we have some concerns about the whether the Repeated Free Fall Reliability Class metric set forth in the regulation is a reliable measure of a product's durability.

First, as we explain in the following section, there are key ambiguities in the prescribed tumble and drop tests that make the results unpredictable and difficult to replicate. As a consequence of these ambiguities, testers must make their own decisions regarding impact surface materials, test parameters, and criteria for product failure — all factors that can heavily influence the results. For example, the regulation calls for products to be dropped on a surface made with a "steel" plate backed by "hardwood". But it does not specify the grade of steel or type of hardwood even though both material types contain a multitude of options with widely varying properties. Additionally, the regulation does not specify how these materials should be adhered to each other or, for the tablet test, constructed as part of a larger testing apparatus.

Our second concern relates to sample size. To ensure the durability of our products, Apple's internal testing processes can involve hundreds or even thousands of test units. However, the regulation's transitional tumble and drop test methods calls for a sample size of only five units, which we believe is insufficient to produce repeatable results. In fact, our internal assessment of the repeatability of tumble test results, involving hundreds of units tested in tumble testers sourced from the same manufacturer, demonstrated that the spread of results necessitates a larger sample size to increase confidence in repeatability.

Moreover, standard engineering practice recommends a minimum sample size of 30 devices for new products or test procedures.

Third-party testing commissioned by Apple substantiates our concerns. After conducting the prescribed tumble tests for iPhone internally, we opted to have three third-party labs repeat the tests in an effort to validate the results.[22] We provided no specific guidance other than to follow the regulation, leaving decisions about how to resolve ambiguities at the labs' discretion. Predictably, the labs' individual results differed widely from Apple's results and each other. In one case, third-party lab results differed from each other by three letter grades.

Given this inconsistency, and out of an abundance of caution, Apple made the decision to voluntarily downgrade our results. We did this to minimize the probability that our scores would be higher than what an independent, third-party lab would report for our products. If the test methodology was more precisely defined and allowed a larger sample size, Apple would have considered reporting a higher score.

Test method concerns

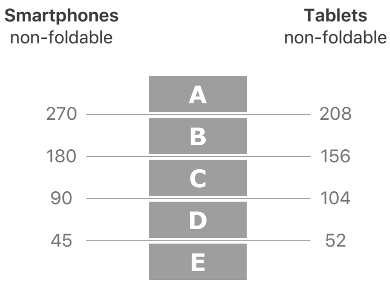
Even after accounting for ambiguities and sample size, we do not believe the prescribed durability testing is truly representative of real-world scenarios. For example, when Apple conducted the tumble test for iPhone, the most common specific failure mode we observed did not correlate with actual customer data from the field. This discrepancy can be partly explained by unintended biases in the test method prescribed by the regulation. To better understand the results, Apple recorded and analyzed high-speed video of our internal tumble testing. While the tumble test is intended to yield a random distribution of product orientations when impacting the drop surface, we found that it gives disproportionate weight to drops on the corner of iPhone at a rate that exceeds what we see in the field.

Compared to the test methods prescribed by the regulation, our data indicates that Apple’s robust internal durability testing is significantly more repeatable and more representative of real-world outcomes. Our internal testing is designed to mimic the full sphere of random impact angles, in line with what we observe in the field. We test from multiple heights and multiple surfaces our customers encounter in everyday life, such as granite, asphalt, and wood. By correlating our internal testing across thousands of units with devices dropped by our customers in the field, we’ve been able to develop models that very accurately predict how new devices will respond during accidental drops. This provides us with critical information to improve our designs and manufacturing technologies, which enable Apple devices to last and hold their value longer than competitors.

We do not expect regulations to replicate this level of rigor, as this would introduce significant burdens, especially for smaller manufacturers. We also empathize with the desire to have a simple test to provide consumers with a measure of impact resistance, since drop resistance meaningfully impacts device longevity. Nevertheless, our extensive experience indicates that the test methods prescribed by the regulation are simply inadequate as a measure of drop resistance.

Accordingly, we do not believe that our reported final scores from the EU-prescribed tests are indicative of the true durability of iPhone and iPad.

Repeated Free Fall Reliability Class



Number of drops required to survive for each Repeated Free Fall Reliability Class for non-foldable smartphones and tablets

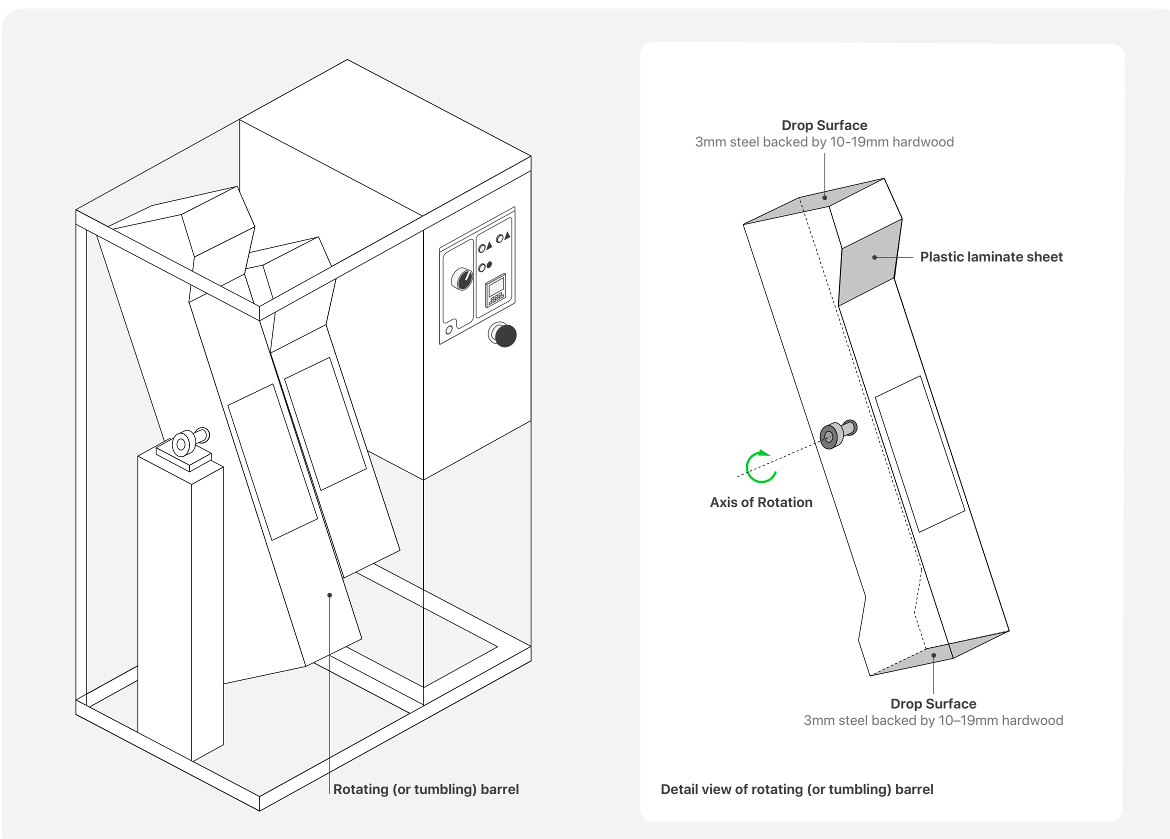
Repeated Free Fall Reliability Class testing methodologies

The Repeated Free Fall Reliability Class metric is represented as a grade from A (most drop resistant) to E (least drop resistant), as shown in the figure on the left, and is determined by measuring the number of drops that a smartphone or tablet can endure without inducing a defect. The greater the number of drops before a defect is induced, the higher the grade.

To calculate scores, the regulation references separate test methodologies for smartphones and tablets. Five units of each product must undergo the prescribed tests and are checked for full functionality at pre-defined intervals that correspond to the next letter grade. At least four of the five units tested must maintain full functionality to continue testing until the next interval.

Test set-up

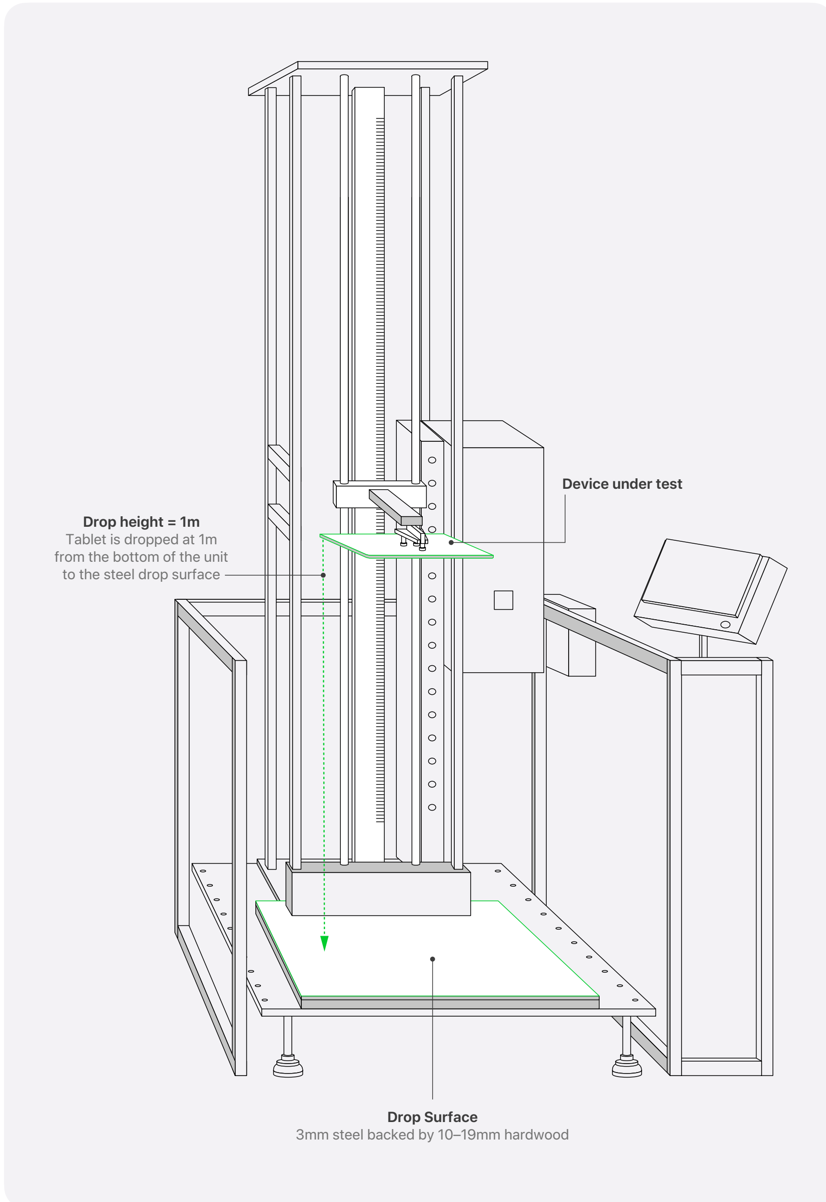
For smartphones, the EU stipulates the usage of a tumble tester as defined by international standard IEC 60068-2-31, illustrated in the following figure. The tumble tester is required to be a rotating rectangular barrel comprised of 3mm steel and backed by 10-19mm thick wood at each flat end. The smartphone to be tested is placed at one end of the tumbler, and then rotated to induce a drop at a random orientation. Each smartphone is required to be checked for functionality at 45, 90, 180, and 270 drops. Four out of five units must pass an interval check to continue testing to the next interval.



Tumble tester used to measure Repeated Free Fall Reliability Class for smartphones

Neither the regulation or the standard specify the manufacturer of the tumblers. The only requirement is to comply with the specification outlined in the IEC standard.

For tablets, the regulation requires that the drop test is conducted without the use of a tumbler. Instead, the tablet is to be dropped from a height of 1m onto 3mm of steel plate backed by 10-19mm of hardwood. Each tablet is required to be dropped 26 times, each with a prescribed orientation, in a specific sequence, until the device fails during one of the determined interval checks. Tablets are checked at 52, 104, 156, and 208 drops. During each interval, each device will be dropped twice at each of the 26 prescribed orientations. Four out of five units must pass an interval check to continue with testing. The following figure illustrates the apparatus used to conduct tablet drop testing.



Drop tester used to measure Repeated Free Fall Reliability Class for tablets

Apple’s testing methodology

The following section details the rationale Apple used to resolve key ambiguities in the Repeated Free Fall Reliability Class testing parameters, focusing on drop surface materials, test procedure, and how functional failure is defined. For a full list of testing parameters used by Apple, refer to Appendix B.

Test apparatus materials

One ambiguous aspect of the reliability tests concerns the materials used to create the drop surface for both the tumble and drop tests. The regulation stipulates that the drop surface should be a steel plate backed by hardwood, and the thicknesses of those materials are specified. However, the materials themselves are under-defined and this ambiguity will lead to wildly differing results depending on the materials selected.

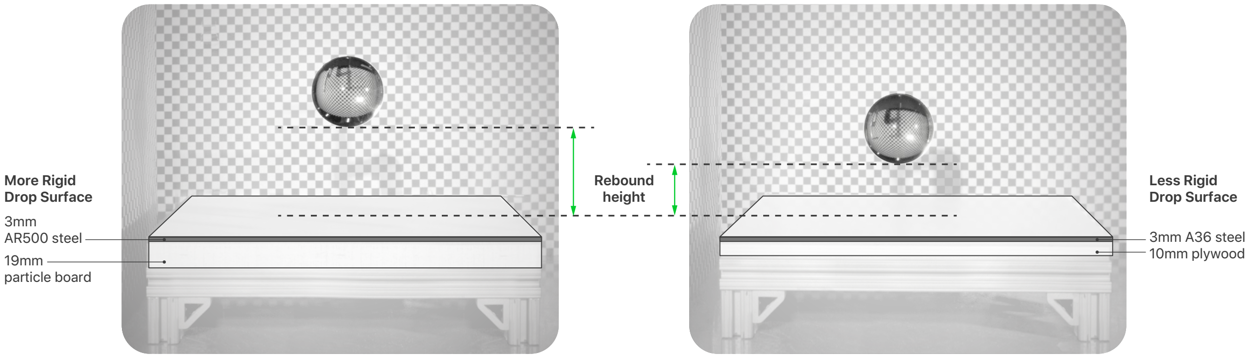
For example, balsa wood, with its characteristic low density and softness, and ipe wood, with its high density and strength, are both classified as hardwoods, despite dramatically different shock absorption properties. Similarly, there are thousands of grades of steel with varying material properties. Additionally, if the steel alloy selected is magnetic, magnets embedded within a smartphone could alter the device’s behavior within the tumble tester, leading to different results. Therefore, the selection of both the wood and steel in the testing apparatus will have a significant impact on the number of drops a device can withstand before a defect is induced.

The influence of drop surface materials can be illustrated by closely observing impact. In the following experiment conducted by Apple, an acrylic ball was dropped from the same height on to two different impact surfaces:

(i) AR500 steel backed by 19mm of particleboard hardwood — representing materials that are more rigid (e.g. AR500 is often selected for impact resistance, such as armor applications)

(ii) A36 steel backed by 10mm of plywood hardwood — representing materials and dimensions that yield a less rigid surface (e.g. A36 is more ductile and softer than AR500, plywood is less dense than particleboard, and the thinner hardwood provides less rigidity)

Apple used high-speed video to capture the impact event. The following figure captures the rebound height, which is the maximum height of the ball following impact. The more rigid drop surface transferred more kinetic energy back to the ball, causing it to bounce higher (left). The less rigid drop surface absorbed more kinetic energy at impact, leading to a shallower bounce (right). Both drop surfaces conform to the regulation, yet the response in the object being tested is substantially different. In the case of a smartphone, the more rigid surface could induce greater internal stresses and damage as a result of the higher kinetic energy transferred during impact. This demonstrates that the drop surface specified by the regulation is not sufficiently defined to yield repeatable results.



Rebound height of an acrylic ball following impact between a more rigid surface (left, 3mm AR500 steel backed by 19mm particle board) and a less rigid surface (right, 3mm A36 steel backed by 10mm plywood). Both drop surfaces conform to the regulation. The substantial difference in rebound height demonstrates that regulation under-defines the drop surface materials.

The method to adjoin the hardwood and steel, which is not stipulated by the regulation, also influences drop resistance. If an adhesive is used, it could significantly alter the results by providing a buffer layer for the test or by making the wood not uniformly flat. Conversely, using screws or a clamp to join the two layers could create a surface that is bowed. Even slight variations in the flatness of the drop surface can significantly impact the test results.

The standard and regulation also do not define a specific material for the plastic laminate sheet in the tumbler for smartphone testing. A smartphone is initially placed on the laminate sheet, and the laminate sheet's properties, such as its roughness, will impact the initial velocity of the smartphone when it begins free fall.

There are numerous manufacturers of tumblers in compliance with the specification outlined in the IEC standard. Apple chose the vendor Heina, as it produces one of the most common tumble testers on the market. In testing Apple commissioned with third-party labs, it was found that different tumble tester constructions led to different test results.

For the drop test for tablets, Apple made the decision to select birch for the hardwood because it is used widely as a plywood in Europe,[23] and is the same wood found in the Heina tumble tester. We selected SUS304 for the material of the steel plate because it's one of the most common types of stainless steel and is often found in household items and appliances. And finally, we elected to clamp the corners of the wood and steel together with a vice-grip because it resulted in the most consistent results as compared to using an adhesive.

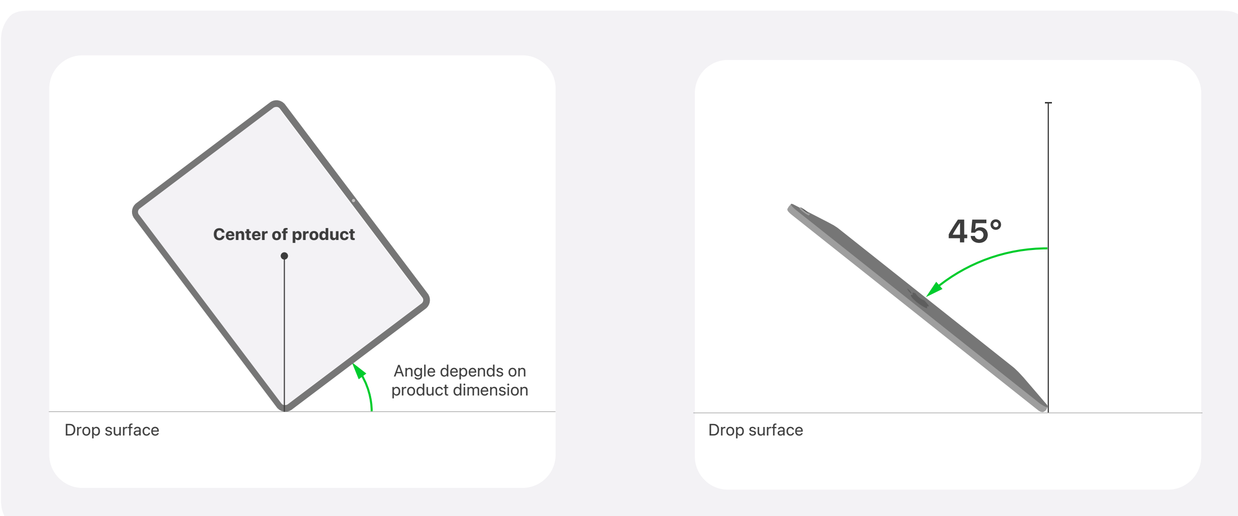
Additionally, wear and tear on an apparatus, as well as its level of maintenance, can influence test scores. To guard against this, when the materials were brand new, Apple measured the coefficient of restitution (COR), which is a metric of how much kinetic energy is lost when two objects collide. We periodically checked this measurement, and when we observed a five percent variance in the COR due to wear, we replaced the wood and/or steel.

Testing procedure

The regulation defined some of the requirements for carrying out the test, but many parameters were ambiguous.

For the tumble test, Apple ran individual tests on each model to determine the tumble tester speed required to impact the center of the drop surface while ensuring that the device did not hit the front or back walls of the tumbler.

For the drop test, the regulation specifies 26 distinct orientations the tablet needs to be positioned at impact, but the angles of these orientations are not defined. For example, the regulation lists drop orientations such as “lower right edge” and “lower left front corner” but leaves the exact orientation ambiguous, thereby creating room for varying results. For corner drop orientations where the iPad display is perpendicular to the drop surface (e.g. “lower right edge”), Apple selected a drop angle that would align the center of the iPad (i.e. geometric center) with the impacted corner, as this represents the worst-case angle. For edge or corner drop orientations where the iPad display is intended to be angled toward to the drop surface (e.g. “lower left front corner”), Apple chose a 45-degree orientation relative to the drop surface because it is the midpoint between 0 and 90 degrees.



Drop orientations for “lower right edge” (left) and “lower right front corner” (right).

Defining functional failure

The regulation sets out a list of functions that need to be maintained in order for the device being tested to pass inspection. If the device is found to be defective in any of the areas specified during a prescribed interval check, it fails the function test and is assigned the last grade successfully completed. For example, a smartphone that fails between 46 and 89 falls would be assigned the letter grade D.

Moreover, the specific threshold for a functional failure is often vague in the regulation. For example, the regulation cites "integrity of screen" as a measure of functionality. Nowhere does it fully define this terminology, nor does it affix a quantifiable measurement to the damage that would compromise the screen's integrity and result in a fail. The regulation goes on to further specify that "cracks of the touchscreen or any other cover layers of a display shall not be considered a defect" as long as the unit retains "full functionality and safe use." However, nowhere does the regulation define "safe use" for the purposes of this test.

As a result, we selected more precisely defined failure criteria that best represented real-world scenarios. For example, we defined functionality to mean that the touch screen still worked provided no glass had separated from the device. We deemed the test a failure if glass separated from the device, as this could pose a hazard that, in practice, motivates many users to seek repair.

Determining how to measure failure is a critical aspect of any reliability test. Without specific definitions and quantifiable results, failure is subjective. The functionalities laid out by the regulation are either undefined or under-defined, and as a result, wide discrepancies are possible.

Repairability Class

Apple’s approach to repairability

Repairability is an important component of designing products that last. Apple strives to improve the longevity of our devices by following a set of design principles that help resolve tensions between repairability and durability.[24] They include impact to the environment; preserving the safety, security, and privacy of our customers; enabling transparency in repair; and expanding access to repair services.

Around the world, our customers have access to numerous repair options including Apple Store locations, Apple Authorized Service Providers, participating Independent Repair Providers, mail-in repair centers, onsite service, and Self Service Repair. In fact, 85 percent of the U.S. population is within a 30-minute drive of an Apple Store, Apple Authorized Service Provider (AASP) location, or Independent Repair Provider (IRP). In the United Kingdom, that’s true for 82 percent of the population, and in Italy and Germany, it’s 89 percent.

In 2022, we were the first manufacturer to launch a Self Service Repair program — to provide anyone with relevant experience repairing electronic devices access to the manuals, genuine Apple parts, and tools used at Apple Store and Apple Authorized Service Provider locations. We’ve since launched a new diagnostic tool that gives users more transparency and autonomy to troubleshoot issues. In 2025, we introduced iPhone display repair videos geared toward novice repairers.[25] Self Service Repair now supports dozens of products including iPhone and iPad in over 30 European countries, including Belgium, France, Germany, Italy, Poland, Spain, and the Netherlands.

We’ve also made our products more repairable over time through technological solutions that improve repairability without sacrificing durability. iPhone 16 is the most repairable iPhone ever and includes a groundbreaking new process for battery removal. By running a low-voltage electrical current — which can come from a household 9V battery — through the new ionic liquid battery adhesive, the battery will release from the iPhone enclosure. It’s a faster and safer battery removal process than using stretch release adhesives and it’s just one of the many ways we’re harnessing the power of innovation to make our customers’ devices last longer.

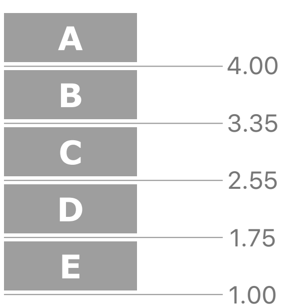
In 2024, Apple Diagnostics for Self Service Repair became available in Europe following its introduction to the U.S. in 2023. Apple Diagnostics troubleshooting sessions give customers the same ability as Apple Authorized Service Providers and Independent Repair Providers to test devices for optimal part functionality and performance, as well as to identify parts that may need repair. With this expansion, Apple Diagnostics for Self Service Repair now supports iPhone, iPad, Mac, and Studio Display models in 33 countries and 24 languages. In addition, iOS 18 and iPadOS 18 introduced Repair Assistant, a powerful tool that helps customers and repair professionals complete repairs after a part has been replaced in iPhone or iPad. Repair Assistant installs calibration data to pair recently installed parts and validate that they're working as expected and calibrated correctly.

Repairability testing methodologies

The regulation evaluates the following six categories to assess the repairability of smartphones and tablets:

1. Disassembly depth,
2. Fasteners,
3. Tools,
4. Spare parts,
5. Duration of OS updates, and
6. Repair information.

Each of these categories is worth 15 percent of the total score, except disassembly depth, which is worth 25 percent.



Repairability class scale

These category scores are totaled and represented on the energy label as a grade from A (most repairable) to E (least repairable) as shown in the figure on the left.

The full calculation methodology is available in Annex IV point 5 of the regulation.

Apple's testing methodology

To determine its energy label repairability scores, Apple followed the transitional test methods set out by the regulation.

Apple does not believe that the resulting repairability scores are indicative of the repairability of its devices. This is because, in some cases, the regulation rewards prescribed ways of repairing a device, without accounting for innovative methodologies that may be faster, safer, or more repeatable (e.g. adhesives that can be debonded through an electrical current). This approach leads to artificially lowered scores for certain devices that are repairable in practice.

Battery Endurance in Cycles

Apple’s approach to Battery Endurance

Apple uses state-of-the-art battery technology, which works in tandem with Apple silicon and iOS or iPadOS, to deliver maximum battery longevity for users. Nevertheless, batteries experience wear over time that primarily correlates with how many times a battery is charged and discharged, and the environment in which it is used.

To further increase the battery performance of its devices, Apple has introduced software innovations like optimized battery charging, which slows the battery aging process, maximizing battery endurance and product performance.

Battery Endurance testing methodology

To assess battery endurance, the EU has set forth testing and reporting requirements on how many charge cycles a battery can endure while maintaining a specific level of performance. One charge cycle is defined as a battery going from a fully charged to fully discharged state. The energy label requires disclosure of the number of charge cycles a device’s battery can withstand until its usable capacity has reached 80 percent of its rated capacity, in multiples of 100.[26]

For more information on Apple’s claim, refer to www.apple.com/batteries.

Apple’s testing methodology

To determine its energy label battery endurance scores, Apple followed the test methods set out by the regulation, which were well-defined and unambiguous.

Ingress Protection

Apple's approach to Ingress Protection

At Apple, we are constantly looking for ways to improve our products, and that includes providing liquid and dust ingress protection. As an example, early generations[27] of iPhone were susceptible to failure if accidentally exposed to liquids. So, our design teams iterated until they were able to achieve robust liquid ingress protection, which decreased repair rates by 75 percent with iPhone 7 and iPhone 7 Plus. The reliability of our hardware will always be our top priority when seeking to maximize the lifespan of products, and ingress protection is just one way we deliver on that commitment to our customers.

To ensure that every product is resistant to dust and liquids, we conduct rigorous ingress protection (IP) testing. We also go further than standard IP testing, and expose our products to liquids and foods, harsh chemicals, skincare products, intense UV light, and abrasive materials, which are designed to mimic real-world usage.

Ingress Protection testing methodology

To assess how resistant a product is to solid foreign objects like dust, as well as water and other liquids getting inside and potentially harming functionality and safety, the EU leverages existing IP protocols. Those protocols are set forth by International Electrotechnical Commission (IEC) under the international standard IEC 60529, and detail a rating scale for how resistant an enclosure is to ingress of dust and water, as shown in the following table. The IP XY rating has two numbers: X detailing solid foreign objects resistance and Y detailing water resistance.

Rating Level	Ingress of solid foreign objects	Ingress of water with harmful effects
0	no protection	no protection
1	≥ 50mm	vertical water dripping
2	protected from touch by fingers and ≥ 12mm	water spray less than 15º from vertical
3	≥ 2.5mm	water spray less than 60º from vertical
4	≥ 1mm	splashing of water
5	dust protected	jetting of water
6	dust tight	powerful jetting of water
7	N/A	temporary immersion, 1m depth
8	N/A	continuous immersion, ≥ 1m depth

Ingress protection ratings. The procedure for conducting these tests is described in IEC standard 60529.

Apple’s testing methodology

To determine its energy label IP scores, Apple followed the test methods set out by the regulation, which were well-defined and unambiguous.

Apple labs test products under IP standards protocol and the results are verified by the Canadian Standards Association (CSA).

Looking forward

At Apple, we are committed to building the best products in the world for our customers. That means designing products that stand the test of time to make the most of the resources used to create them. We also support regulations that encourage environmentally conscious practices across the wider industry, like the new EU Energy Labelling regulation for smartphones and tablets.

At the same time, it is critically important that regulations are clear and consistent so there is a uniform standard of adherence. The EU Energy Labelling regulation has a number of significant ambiguities in the prescribed transitional test methods. In the absence of harmonized standards, the different choices that manufacturers make to fill in the gaps of those ambiguities result in wide variations in energy label test scores and potential customer confusion.

This paper lays out the choices that Apple made in those testing cases and how we arrived at our product scores. We hope it serves as both a clarifying tool for consumers and a catalyst for further dialogue with the European Commission, member states, and industry stakeholders. Apple will continue to support policies that aid consumers, drive industry-wide innovation, and address global environmental challenges.

Appendix A

The following table describes the full list of parameters Apple used in Battery Endurance per Cycle and Energy Efficiency Index testing.

Parameters defined[28] in the EEI Transitional Test method linked in Annex IVa, under the network tab

Parameter		Value
1	Technology	FDD LTE
2	LTE Category	CAT 3
3	RF Band	Band 3 FDD
4	DL EARFCN	1575
5	UL EARFCN	19575
6	RSRP	-90 dBm
7	RSRQ	-10 dB
8	Tx Power	10 dBm
9	DL Modulation	64 QAM
10	UL Modulation	16 QAM
11	Bandwidth	20 Mhz
12	MIMO	MiMO 2 x 2
13	Audio Codec[29]	AMR WB-12.65
14	Audio Mode	Loopback
15	Connected DRX	Manual
16	Connected DRX On Duration timer	psf6
17	DRX Inactivity Timer	psf1920
18	DRX Retransmission Timer	psf16
19	Long DRX Cycle	sf1280
20	Long DRX Cycle StartOffset	0
21	Short DRX	Disabled
22	UL Dynamic Scheduling	Off (Static scheduling)
23	Neighbour Cells	band1 / EARFCN 500 / - 110 dBm band3 / EARFCN 1700 / - 110 dBm band7 / EARFCN 3200 / - 110 dBm band20 / EARFCN 6300 / - 110 dBm
24	Default Paging Cycle	1280ms
25	Extended Idle Mode DRX	Disabled
26	RRC Status Change	Enabled Status Change Timer = 30s
27	CDRX On Duration Timer[30]	psf6

Undefined[28] parameters (i.e. not defined in Annex IVa)

Parameter		Value
28	CFI	Best effort
29	UL-DL Configuration	N/A
30	Special Subframe Configuration	N/A
31	AttachType	Depend on UE
32	TA Update Type	Depend on UE
33	Packet Scheduling Mode	Static
34	TBS Pattern (full resource allocation)[31]	Off
35	Packet Rate	Manual
36	MCS DL	20
37	MCS UL	20
38	RB DL	52
39	RB UL	54
40	TDD ACK NACK Feedback Mode	Bundling
41	AS Integrity Algorithm	Auto
42	NAS Integrity Algorithm	Auto
43	EPRE/AWGN	Disabled
44	Periodic Update Timer	60 minutes
45	Attach T3402	deactivate
46	E-UTRAN Deactivate ISR Timer	deactivate
47	Extended Service Request T3442	deactivate
48	EPS Network Feature support	Enable
49	CS-LCS	no information
50	EPC-LCS	not supported
51	EMC BS	supported
52	Additional Update Result	Disable
53	Power Saving Mode T3324 Timer	Disable
54	Default Paging Cycle	1280 ms

Parameter		Value
55	nB	T
56	Extended Idle Mode DRX	Disable
57	Paging Time Window Length	1.28s
58	E-UTRAN eDRX Cycle Length	10.24s
59	Time Alignment Timer	Infinity
60	TimingAdvanceCycle	Same as Time Alignment Timer
61	HARQ Max Number of Transm.	n5
62	TTI Bundling	Disable
63	Semi Persistent Scheduling	Disable
64	Tx Burst Pattern	Disable
65	Q-RxLevMin	-55 (-110 dBm)
66	Q-RxLevMinOffset	Disable
67	Q-Hyst	0dB
68	Q-OffsetCell	3dB
69	Q-OffsetFreq	3dB
70	S-IntraSearch	Enable, 8
71	S-NonIntraSearch	Enable, 8
72	Q-QualMin	Disable
73	Q-QualMinOffset	N/A
74	T-ReselectionEUTRA	0
75	T-ReselectionUTRA	0
76	T-ReselectionGERAN	0
77	Cell Reselection Priority	4
78	ThreshServingLow	8
78	ThreshX-High	2
80	ThreshX-Low	1
81	ThreshServingLowQ	Disable
82	ThreshX-Q	Disable

Parameter		Value
83	UL TPC Pattern	All 1
84	P-Max	10
85	Reference Signal Power	18
86	P0-Nominal PUSCH	-85
87	Alpha	0.8
88	Scheduling Request Configuration Index	30
89	Scheduling Request Periodicity	20
90	Scheduling Request Subframe Offset	15
91	Carrier Aggregation Pcell	Infinity
92	Carrier Aggregation PCell/Scell Deactivation Timer	Infinity
93	DL Mac Padding	Enabled
94	Internet Connection Shared by Network Simulator	yes

Appendix B

The following table describes the full list of parameters Apple used in Repeated Free Fall Reliability Class testing for iPad.

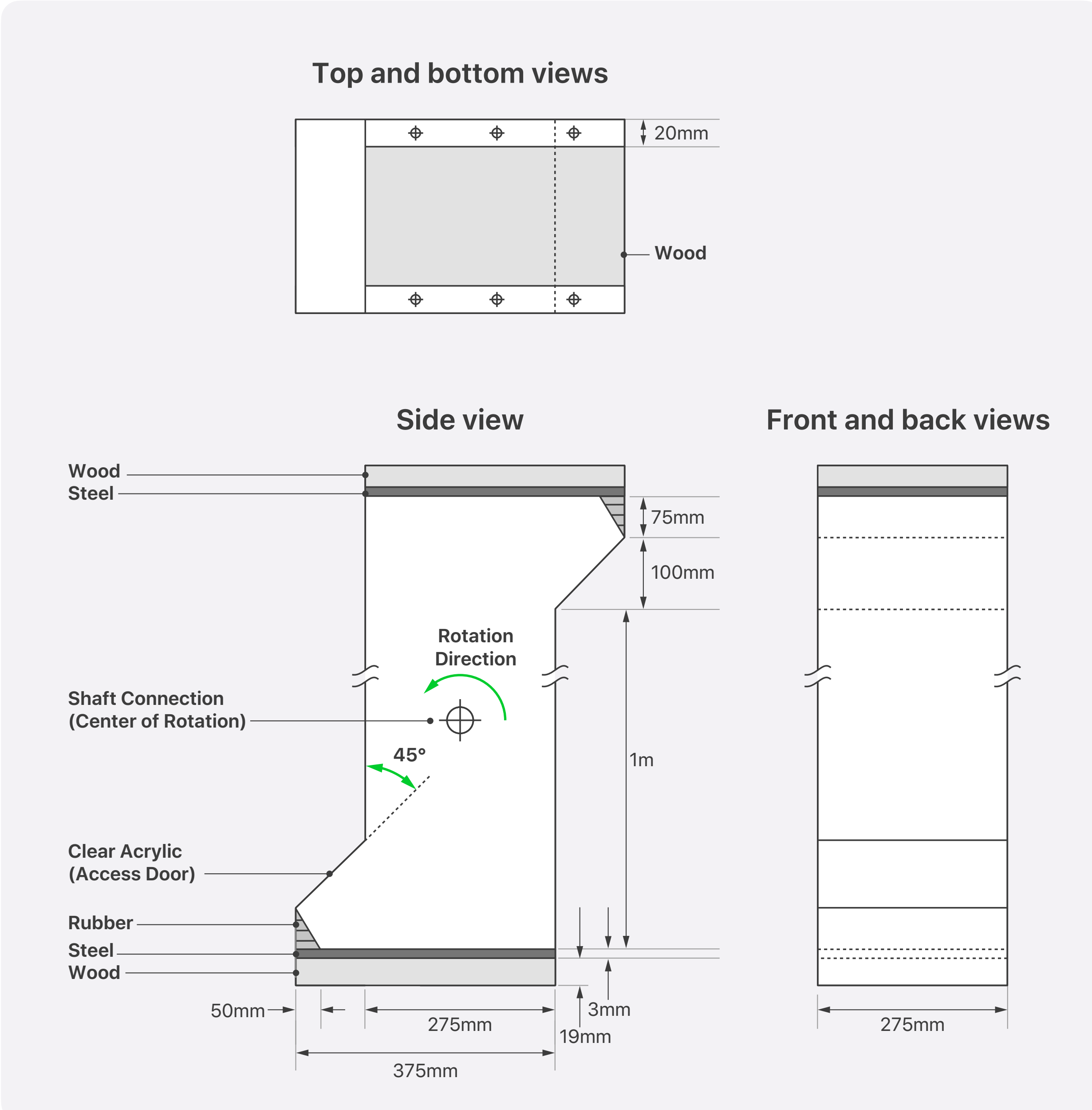
Parameter		Specification
Drop Surface	Steel Grade	SUS304 Stainless Steel
	Steel Thickness	3mm
	Hardwood Type	Birch
	Hardwood Thickness	19mm
	Steel - Hardwood Bonding	Stack on top with corners clamped; no use of adhesive
Drop Tester	Testing Apparatus	Free Fall Tester
Drop Height		1 meter (from unit bottom to the drop surface)
Drop Orientations and Sequence		1. Display Face 2. Lower Left Front Corner 3. Lower Backside Edge 4. Front Right Edge 5. Left Face 6. Lower Right Backside Corner 7. Lower Right Front Corner 8. Bottom Face 9. Backside Face 10. Front Left Edge 11. Top Left Backside Corner 12. Backside Right Edge 13. Top Right Front Corner 14. Lower Left Edge 15. Top Right Edge 16. Top Left Front Corner 17. Lower Right Edge 18. Top Face 19. Front Lower Edge 20. Lower Left Backside Corner 21. Top Left Edge 22. Front Top Edge 23. Top Right Backside Corner 24. Backside Left Edge 25. Right Face 26. Top Backside Edge

Parameter	Specification
Drop Orientation Details	iPad is positioned at the desired impact orientation before drop. It is dropped held to a clamp that prevents it from rotating. iPad is released 10-20cm away from the drop surface. In-plane edge drops (top left / right edge, bottom left / right edge) are defined such that a line connecting the geometric center of the tablet and the impact edge is perpendicular to the drop surface. Other edge drops (for example, lower backside edge) and corner drop orientations, are defined at 45° from the impact surface.
Functional Test Check Cadence	Every 52 drops
Failure Criteria	• Glass damage beyond bezel causing loss of functionality, or any glass damage impacting safety of handling • Display failure (up to 10 pixel defects) • All cameras tested for still and video • Mobile communication (if applicable) • Bluetooth connectivity • Wi-Fi connectivity • Battery charging (wired and wireless) • Touch screen failure • Button functionality • Vibration failure (if applicable) • Microphone failure • Speaker functionality • Headset audio • Unsafe for continued usage • System rattle (e.g. battery detach) • Device cannot power on, or display does not function • Other functional failure modes

Cross section of drop surface

The following table describes the full list of parameters Apple used in Repeated Free Fall Reliability Class testing for iPhone.

Parameter		Specification
Drop Surface	Steel Grade	Steel AISI 316L
	Wooden Plate	Birch plywood
	Steel Thickness	3mm
	Connection Method	Screw
	Plywood Thickness	19mm
Drop Tester	Testing Apparatus	Heina Tumble Tester II TT2-1000/1000
Drop Parameters	Tester Speed Setting	Speed was selected that enables the device under test to free fall within the barrel, and impact the center of the drop surface. For iPhone models on the EU market in June 2025, the speed setting was between 9.0-12.5 drops per minute. The speed was adjusted in increments of 0.5 drops per minute until the desired behavior was observed.
	Drop Height	1 meter (barrel height, slope area excluded)
Drop Orientation Details		• For the first time a device is loaded, the unit under test was placed with the cover glass facing down • When re-loading devices following a checkpoint, the device was placed back in the center of the drop surface at the same orientation when the device was unloaded
Failure Criteria		• Glass damage beyond bezel causing loss of functionality, or any glass damage impacting safety of handling • Display failure (up to 10 pixel defects) • All cameras tested for still and video • Mobile communication • Bluetooth connectivity • Wi-Fi connectivity • Battery charging (wired and wireless) • Touch screen failure • Button functionality • Haptics failure • Microphone failure • Speaker functionality • System rattle (e.g. battery detach) • Device cannot power on, or display does not function • Battery functionality • Other functional failure modes



Tumble tester schematic

Endnotes

1. Longevity, by Design, Apple, 2024, support.apple.com/content/dam/edam/applecare/images/en_US/otherassets/programs/Longevity_by_Design.pdf
2. Introduced with iPhone 7 and iPhone 7 Plus, which achieved an ingress protection rating of IP67 under IEC standard 60529.
3. support.apple.com/en-us/100100
4. apple.com/environment/pdf/Apple_Environmental_Progress_Report_2025.pdf
5. See Annex IV, Measurement and calculation methods, and Annex IVa Transitional Test Methods in EU Regulation 2023/1669. Annex IV provides methodologies for the energy label, which includes some definitions and test setup parameters to be used while conducting the test. Annex IVa provides a reference to IEC 60068-2-31 for resistance to accidental drop. Annex IVa also provides a link that contains multiple tables of parameters relevant for the EEI test.
6. The regulation generally requires use of "harmonized standards" for testing. Where no harmonized standards exist, for example, for testing energy efficiency or resistance to accidental drop, EU Regulation 2023/1669 notes that, "[I]n the absence of relevant standards and until the publication of the references of the relevant harmonized standards in the Official Journal of the European Union, the transitional testing methods set out in Annex IVa, or other reliable, accurate and reproducible methods, which take into account the generally recognized state-of-the-art methods, shall be used."
7. See Annex VI(1), point (h), and Article 3(1), point (d), of EU Regulation 2023/1669.
8. Apple's submission to the EPREL database will be visible as of June 20, 2025.
9. energy-efficient-products.ec.europa.eu/ecodesign-and-energy-label/legislative-framework_en
10. ec.europa.eu/docsroom/documents/52518
11. See Annex IV(1.2) of EU Regulation 2023/1669.
12. energy-efficient-products.ec.europa.eu/faqs/product-faqs/smartphones-and-tablets-faqs_en
13. Tested on a prerelease version of iOS 18.5 and iPadOS 18.5 with Apple EEI scoring app version 1.0.31 b50.
14. The Radio Resource Control Protocol is governed in in 3GPP TS 36.331. Connected refers to the RRC Connected State. This state enables the exchange of both control and user data.
15. See Annex IVa, EEI, network tab, ec.europa.eu/docsroom/documents/52518
16. ericsson.com/en/blog/2020/2/mobile-devices-and-energy-efficiency
17. Annex IVa, EEI, device tab, https://ec.europa.eu/docsroom/documents/50214
18. The FAQ includes a file by the name of "calib.wav," which we have interpreted to mean that it is the file that should be used for calibration of the audio settings.
19. Pink noise is a type of sound that contains all audible frequencies, but with more power in the lower frequencies. Pink noise has a frequency spectrum where the power per frequency interval is inversely proportional to the frequency.

20. The “baffle effect” describes the ability of hard, reflecting surfaces near a loudspeaker to redirect sound toward a listening position, boosting the measured sound level.
21. Tested on a prerelease version of iOS 18.5 or iPadOS 18.5.
22. Testing conducted at TUV (Fareham, UK), EAG (Eindhoven, Netherlands), APP+ (Barcelona, Spain).
23. forest.jrc.ec.europa.eu/media/atlas/Betula_spp.pdf; https://propopulus.eu/en/in-search-of-an-alternative-to-russian-birch/
24. For example, the addition of adhesives, seals and gaskets to make iPhone water resistant made repairs more complex but the improvements to product longevity justified an increase in repair complexity. For more information, refer to Longevity, by Design.
25. support.apple.com/en-us/122308
26. As detailed in Annex I of the regulation, rated battery capacity is “the amount of electricity declared by the manufacturer that a battery can deliver during a 5-hour period when measured under specified conditions, expressed in milliampere-hours.”
27. Generations prior to iPhone 7.
28. Defined parameters are those in the EEI Transitional Test Method linked in Annex IVa of regulation 2023/1669. Undefined parameters are those cell parameters required to be defined within the "SmartStudio" software for the AnritsuMD8475B cellular network box.
29. AMR WB 12.2 is not a valid setting, despite what the regulation stipulates. Apple changed this parameter to AMR WB-12.65 to complete the testing.
30. Parameter 29 states “psf4” in Annex IVa. However, this conflicts with Parameter 16 which appears first in the Annex. For this reason, the value in Parameter 16 was used.
31. The TBS Pattern set to "OFF" means that Full Resource Allocation was not used.