Electrical Safety First

Powering change + saving lives.

LEADING THE CHARGE ON COUNTERFEITS

A STUDY INTO THE SAFETY OF 20W COUNTERFEIT AND LOOKALIKE APPLE CHARGERS

CONTENTS

“COUNTERFEIT TRADE MAKES UP APPROXIMATELY **2.5%** OF TOTAL WORLD TRADE.”

“FAKE CHARGERS CONTINUE TO PUT USERS AT **RISK OF ELECTRIC SHOCK** AND PUTS THEIR PROPERTY AND POSSESSIONS AT **RISK OF FIRE**.”

BACKGROUND AND EXECUTIVE SUMMARY

Counterfeit products are designed to trick consumers into thinking that they originate from a particular brand, when they do not. Research from the Organisation for Economic Co-operation and Development (OECD) and the EU Intellectual Property Office (EUIPO) has shown the massive and growing scale of the global trade in counterfeit products.

This research indicates that counterfeit trade makes up approximately 2.5% of total world trade and 6% of total imports into the EU, and that counterfeit consumer electronics goods is one of the categories of products most affected by counterfeiting. In addition to causing significant economic harm and discouraging innovation and investment, counterfeit products are typically produced as cheaply as possible by criminals who seek to maximise their profits by using substandard materials and production methods to the detriment of innocent consumers, and can represent considerable risk to consumer health and safely.

Counterfeit electrical products can pose a significant risk of fire and electric shock, which can be potentially fatal to the user and cause catastrophic damage to property. Electrical Safety First (ESF) has been studying the safety hazards caused by counterfeit electrical products for several years.

This report focuses on counterfeit and lookalike Apple chargers, and follows another ESF report from 2017, which found a 98% safety failure rate for the chargers tested, and a similar investigation carried out by Underwriters Laboratories in the USA in 2016, which found 99% of counterfeit Apple chargers tested also had safety failures (Figure 01).

Since these studies were published, the standard Apple charger for use with iPhones has evolved from 5W power output to 20W, but, unfortunately, the fake versions of these newer chargers are still unsafe. Fake chargers continue to put users at risk of electric shock and put their property and possessions at risk of fire.

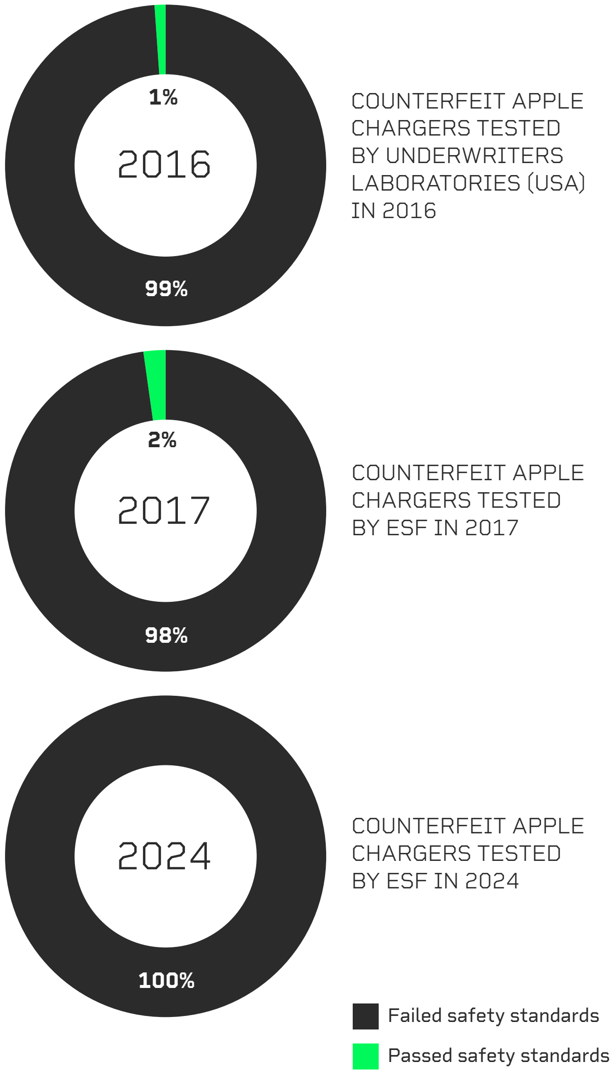
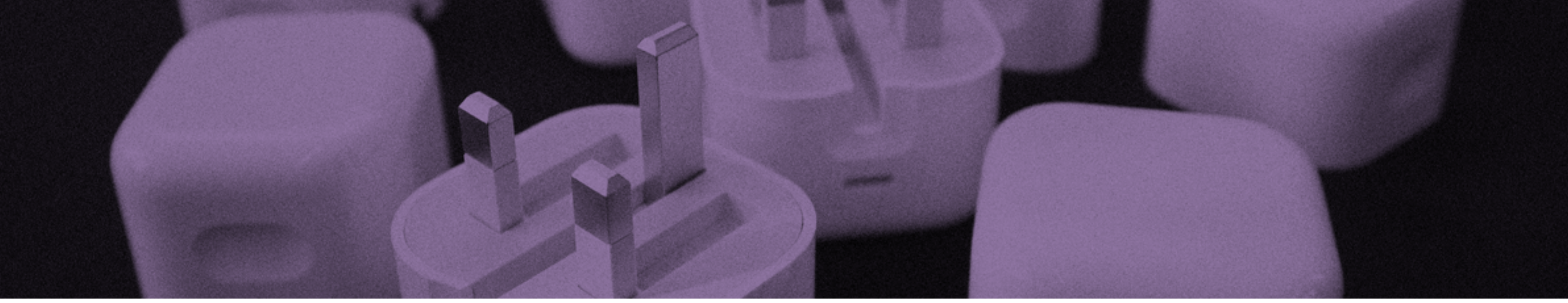


Figure 01: Counterfeit Apple chargers tested in 2016, 2017 & 2024.

> “WHEN **DESIGNED CORRECTLY** AND VERIFIED BY TESTING, PHONE CHARGERS ARE ONE OF THE **SAFEST** ELECTRICAL DEVICES IN OUR HOMES.”



1.0 THE COST AND IMPACT OF COUNTERFEIT CHARGERS

Figure 02: Raids on a counterfeit factory in Guangzhou, China (sourced from Apple).

Counterfeit mobile phone chargers are typically produced in illicit, underground factories in the far east, which do not observe applicable safety regulations. They are designed to appear outwardly identical to those of popular brands but are produced as cheaply as possible, to maximise profits. They are manufactured with poor quality materials or missing components and so fail to meet worldwide safety regulations. These chargers are not subject to proper quality control measures or safety checks. Examples of typical counterfeit charger factories are shown in Figure 02.

When designed correctly and verified by testing, phone chargers are one of the safest electrical devices in our homes. To protect users from electric shock, the output voltage is set to a level that is safe to touch and is isolated in such a way that, even if a fault occurs, additional layers of protection will keep you safe. To prevent fire and burns, the output current is limited and will shut down completely if a fault occurs. Unfortunately, consumers face the risk of fire, injury, and electric shock when charging their phone with a typical counterfeit charger. There are sadly all too frequent reports in the press about incidents involving counterfeit chargers that have resulted in fire, injury, or electric shock which could have been avoided by using a genuine charger that met applicable safety standards.

2.0 FACTORS THAT COMPROMISE SAFETY

2.1 DESIGN AND SPECIFICATION

> Poor circuit design, component specification, and manufacturing are all major contributory factors when it comes to the dangers posed by counterfeit chargers.

At the heart of a charger, the transformer not only reduces the output voltage to a safe level, it provides an essential protective barrier between the mains electrical supply and the user (Figure 03). To cut costs and maximise profits, counterfeiters make a deliberate choice to substitute transformers for sub-standard alternatives or fewer components. Counterfeit chargers often incorporate cheaply made transformers and other components that cannot be relied on to maintain the protective barrier.

Plug pins manufactured with reduced brass content to save on costs are weak and brittle and may break when inserted or withdrawn from the socket-outlet. This can lead to a risk of electric shock from an exposed live pin.

Fewer components, smaller transformers, and lower-quality materials tend to result in counterfeits being lighter than the genuine article. This is a new phenomenon, which we did not observe in the 2017 study on counterfeit and lookalike 5W Apple chargers. This may be on account of the increased number and complexity of the components in the genuine 20W charger, and the relatively larger size of the 20W charger compared to the 5W charger. This means that the counterfeit and lookalike chargers would feel lighter and easier for consumers to identify as counterfeit.

As a result, unscrupulous manufacturers have taken to adding pieces of metal to offset the weight difference and make counterfeit and lookalike chargers more convincing. In many cases, the added metal weights themselves can compromise the protective barrier between the mains supply and the user, leading to a significantly increased risk of electric shock and fire.

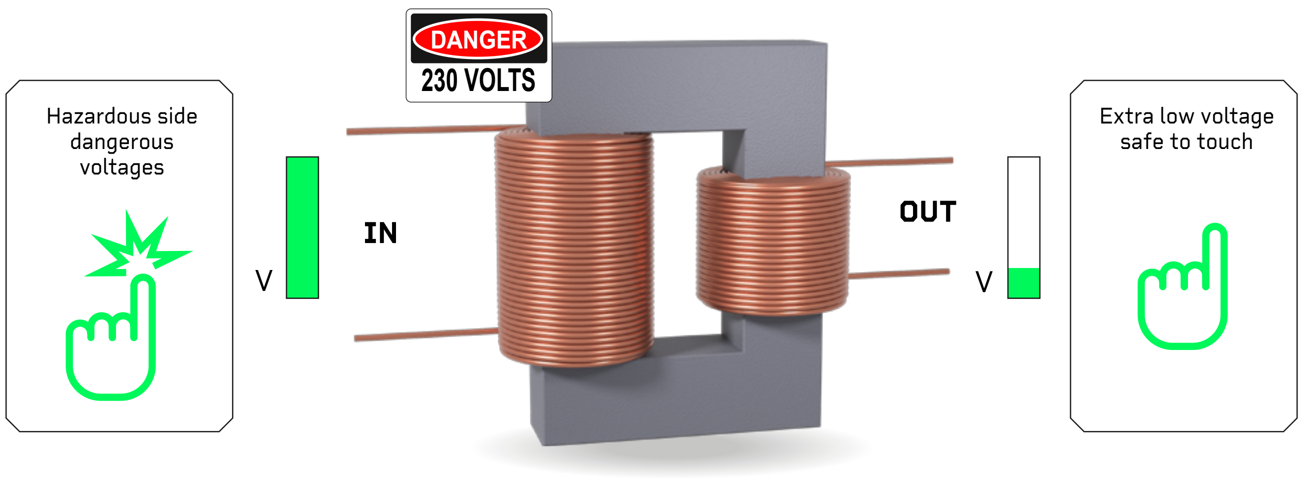
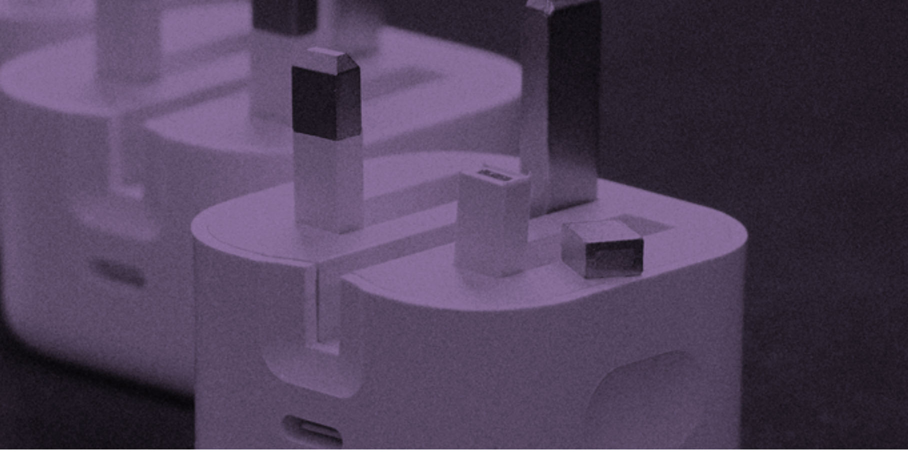


Figure 03: A transformer reduces the output voltage to a safe level providing an essential protective barrier.



> “EVEN AFTER PURCHASE, THE CONSUMER MAY NOT REALISE THAT THE CHARGER IS **COUNTERFEIT**.”

2.2 SUPPLY CHAINS

Every actor within the supply chain has responsibilities and obligations to ensure only safe products reach consumers. Reputable manufacturers of consumer electronics act responsibly and follow applicable safety standards. Unfortunately, illicit, underground manufacturers do not, especially when they are anonymous and pretend to be a different brand. In supplying sub-standard and counterfeit chargers, these manufacturers are either knowingly supplying potentially unsafe goods or are ignorant of their responsibilities. Online marketplace platforms that do not follow traditional supply chain models are often used as a ‘safe haven’ by unscrupulous third-party sellers, as the internet can provide a level of anonymity that reduces the risk and accountability of the seller.

2.3 RISK PERCEPTION

Some products, such as knives, are known for their potential danger as the hazard is clearly known or readily recognisable. But the user of a phone charger does not expect to be exposed to dangerous hazards and so, understandably, risk perception is relatively low.

This risk is even more pronounced with counterfeit products, which by their very nature are designed to deceive consumers. Consumers who purchase counterfeit or lookalike Apple chargers often do so because they are tricked into believing that they are purchasing a genuine Apple charger. This risk is particularly acute when purchasing from online marketplaces and websites, where everything can be made to look real, using Apple’s own images to market the products, and where the consumers are not able to inspect the products prior to purchase. Even after purchase, the consumer may not realise that the charger is counterfeit, as based on its outward appearance, it looks the same as the genuine product.

3.0 CHARGER UNBUNDLING

A growing trend in recent years is for major manufacturers to supply new mobile phones without chargers, known as 'unbundling'.

This solution is intended to improve consumer convenience and reduce environmental impact, because, by unbundling, the European Commission estimates the reduction in production and disposal of new chargers will reduce the amount of electronic waste by 980 tonnes annually.

But although this move may support a reduction in e-waste, concerns have been raised that unbundling could increase demand for standalone chargers and exacerbate an already significant market for low quality and potentially dangerous counterfeit alternatives.

> "UNBUNDLING COULD EXACERBATE AN ALREADY SIGNIFICANT MARKET FOR **LOW QUALITY** AND POTENTIALLY **DANGEROUS** COUNTERFEIT ALTERNATIVES."

4.0 OVERVIEW OF STUDY

This report delivers findings from a safety screening investigation carried out on 56 UK and 60 EU plug-in 20W USB-C chargers. These were split into two sub-categories. Firstly, chargers identified as "counterfeit", meaning counterfeit chargers marked with Apple's trademarks intended to deceive customers, and falsely sold as genuine Apple chargers (Figure 04). Secondly, chargers identified as "lookalike", meaning chargers which are not marked with Apple's trademarks but which copy the design of a genuine Apple charger.

In the case of both counterfeit and lookalike chargers, these were marketed and sold for use with Apple-branded portable devices, such as iPhones and iPads.

Note: the design of the Apple charger is protected by registered designs owned by Apple.

The investigation was conducted by Electrical Safety First, working with an independent test laboratory, Eurofins E&E UK London, to perform the safety testing.

Of 116 chargers sourced and provided by Apple, 26 UK samples were identified as counterfeit and 30 as lookalike. Of the EU samples, 30 were identified as counterfeit and 30 as lookalike. The chargers were obtained from a variety of sources, including several independent online retailers, a variety of major online marketplaces that are highly popular with consumers, and discount high street retailers, in both the UK and mainland Europe.

Figure 04: Counterfeit EU Apple charger.

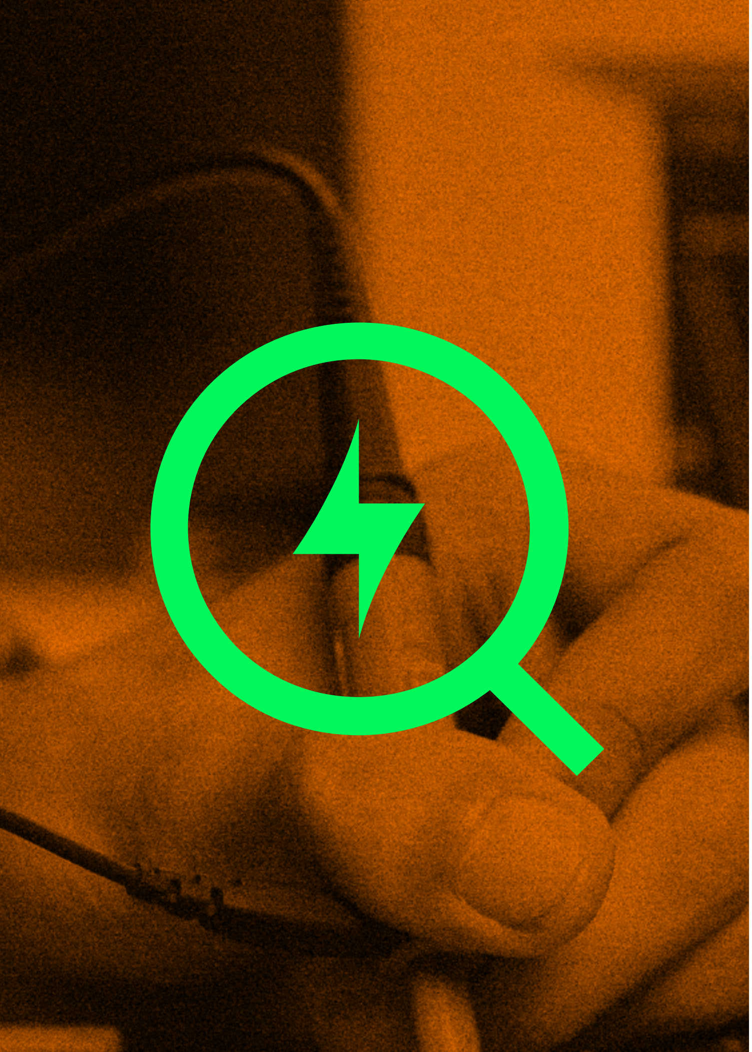
The chargers were subject to a bespoke test programme, designed by ESF and Eurofins E&E, incorporating a variety of different tests designed to identify potential safety issues – in particular, those that may increase the risk of fire or electric shock to the user. The test criteria were developed with reference to the latest applicable product safety standards and The Electrical Equipment (Safety) Regulations 2016.

Each sample was screened to meet basic safety criteria to progress to the next stage in the test schedule. In addition, a selection of samples that failed basic safety criteria were further scrutinised to identify the cause of the failure.

THE TEST SCHEDULE INCLUDED AN ASSESSMENT OF:

- Markings – 100% of samples checked.
- Plug pin gauging and mechanical strength – 100% of samples tested.
- Electric strength tests – 100% of samples tested.
- Deeper investigation on any chargers that passed electric strength tests – 9 samples (8%) tested.
- Deeper investigation on chargers that failed electric strength at <50% of the test voltage – 13 samples (11%) tested.

> 115 SAMPLES **(99.1%) FAILED** THE INTERNAL ELECTRONICS ELECTRICAL SAFETY TESTS.



4.1 HEADLINE FINDINGS

- All 116 samples (100%) failed the safety tests on either internal electronics or plug pins, or both.
- In addition to the safety tests, all samples (100%) failed the marking requirements set out in the applicable product safety standard.
- 115 samples (99.1%) failed the internal electronics electrical safety tests.
- 45 of the 56 UK samples (80%) failed the UK plug pin tests and 17 of the 60 (28%) EU samples failed the EU plug pin tests.

4.2 MARKING

All 116 of the samples tested failed the marking requirements of the standard. The highest numbers of marking failures across the four sample groups can be summarised as follows:

UK COUNTERFEIT	60% failed the legibility requirements
UK LOOKALIKE	44% were missing the vendor identification details
EU COUNTERFEIT	80% were missing the model number & 64% the vendor identification details
EU LOOKALIKE	88% were missing the model number (Figure 05)

Figure 05: Example of imitation charger sold with no markings.

4.3 SAFETY TESTING, GAUGING & MECHANICAL STRENGTH OF PLUG PINS

The plug pin gauging tests measure the dimensions of the plug pins and their respective positions to ensure the size, alignment, and position of the plug pins will not put undue stress on socket-outlets.

The plug pin gauging test (Figure 06) was applied to all 116 samples, before and after the plug pin mechanical strength tests.

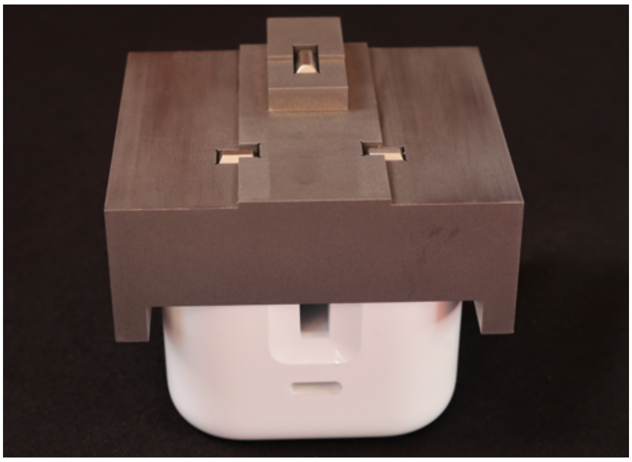


Figure 06: Example of genuine charger in a laboratory plug pin gauge from BS 1363-1 - Body shape and plug pin dimensions all within limits.

Ten of the UK samples (18%) and 17 of the EU samples (28%) failed the gauging tests before any other tests were performed (Figure 08). A further 60% of the UK samples failed gauging after the mechanical strength tests. A staggering 80% of samples with UK plug pins failed the gauging tests overall (see Figure 07).

> Incorrectly sized and misaligned plug pins can result in poor connection and undue wear and tear to socket contacts, which can cause overheating and risk of fire.

> “A STAGGERING **80%** OF SAMPLES WITH UK PLUG PINS **FAILED** THE GAUGING TESTS OVERALL.”

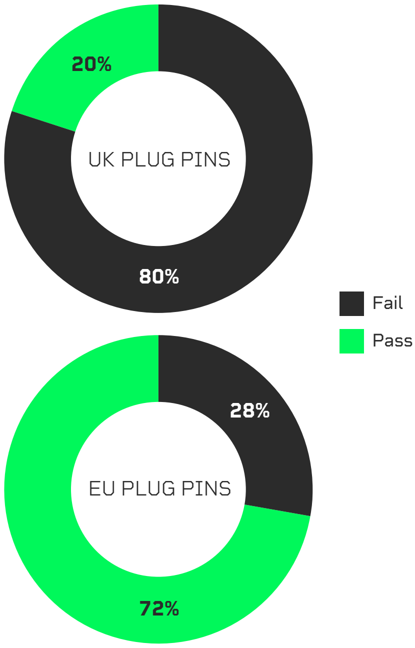


Figure 07: Overall results of the plug pin gauging tests.

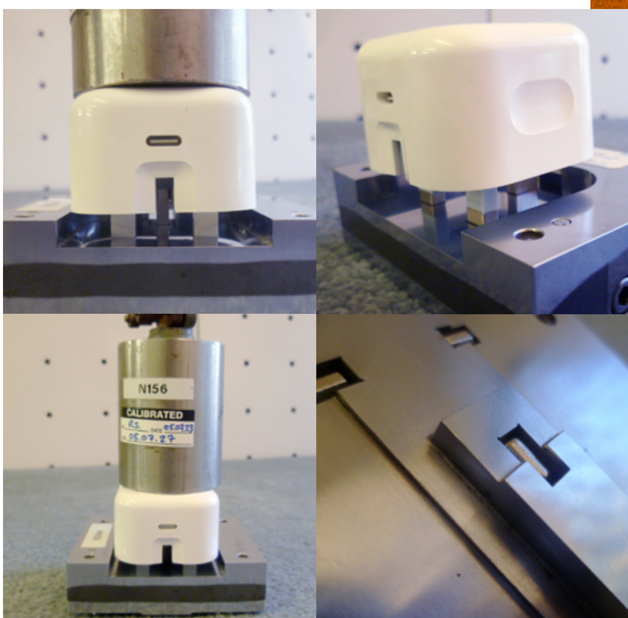


Figure 08: Examples of oversized bodies, short plug pins, and oversized plug pins found during the plug gauging tests.

4.4 MECHANICAL STRENGTH OF PLUG PINS

The mechanical strength test applies twisting and bending forces to plug pins to ensure they can withstand the stresses of normal use – such as inserting and withdrawing from a socket-outlet – and to ensure that they will not become distorted or break.

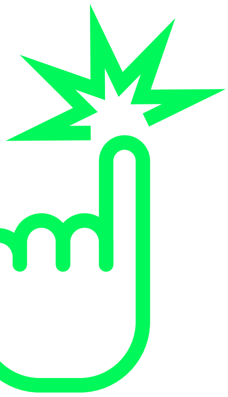
If a plug pin is not sufficiently strong, there is a danger it could break off inside a socket-outlet and present a risk of electric shock from an exposed live pin.

Figure 09: A counterfeit Apple charger that failed the mechanical strength test.

“71% **FAILED** THE MECHANICAL STRENGTH TEST.”

Of the 56 chargers with UK plug pins, 40 failed the mechanical strength test, which equates to a 71% failure rate. Of the 40 that failed, 38 resulted in snapped-off plug pins (Figure 09).

The EU samples fared much better in that only one sample out of the 60 tested (2%) failed the EU mechanical strength test. However, this may be due to the test for EU chargers being less onerous than the tests required for UK plug pins.



> “107 OUT OF THE **116** SAMPLES TESTED **FAILED** THIS CRITICAL SAFETY TEST.”

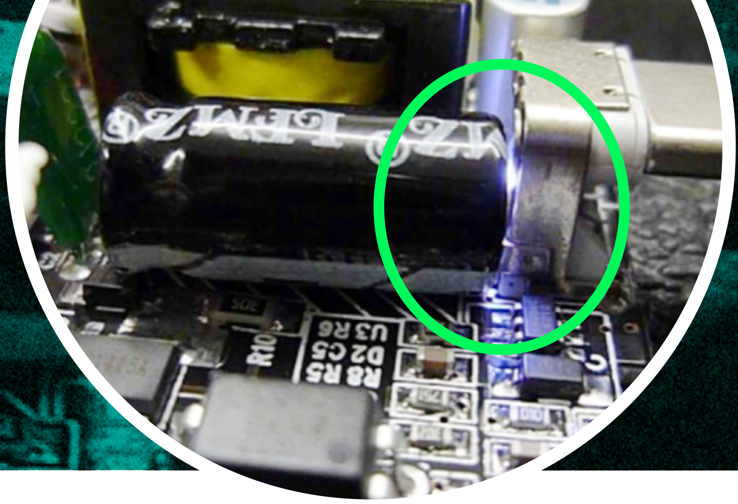


Figure 10: Example of flashover between a mains voltage component and the USB port during electric strength testing.

4.5 ELECTRIC STRENGTH

The electric strength test is carried out to ensure the electrical separation between the mains supply circuitry, and parts that the user can touch (the USB connector), is sufficient to prevent electric shock. 107 out of the 116 samples tested failed this critical safety test (Figure 10), which means 92% failed. A breakdown of the results across the four variants of chargers is illustrated in Figure 11.

Thirteen of the samples also failed at less than half the test voltage, which means they did not even meet the requirements for basic insulation. The equivalent of double or reinforced insulation is required for any extra low output voltage (30V AC RMS or 60V DC) that is accessible to the user, as required for a phone charger.

ELECTRIC STRENGTH TESTS

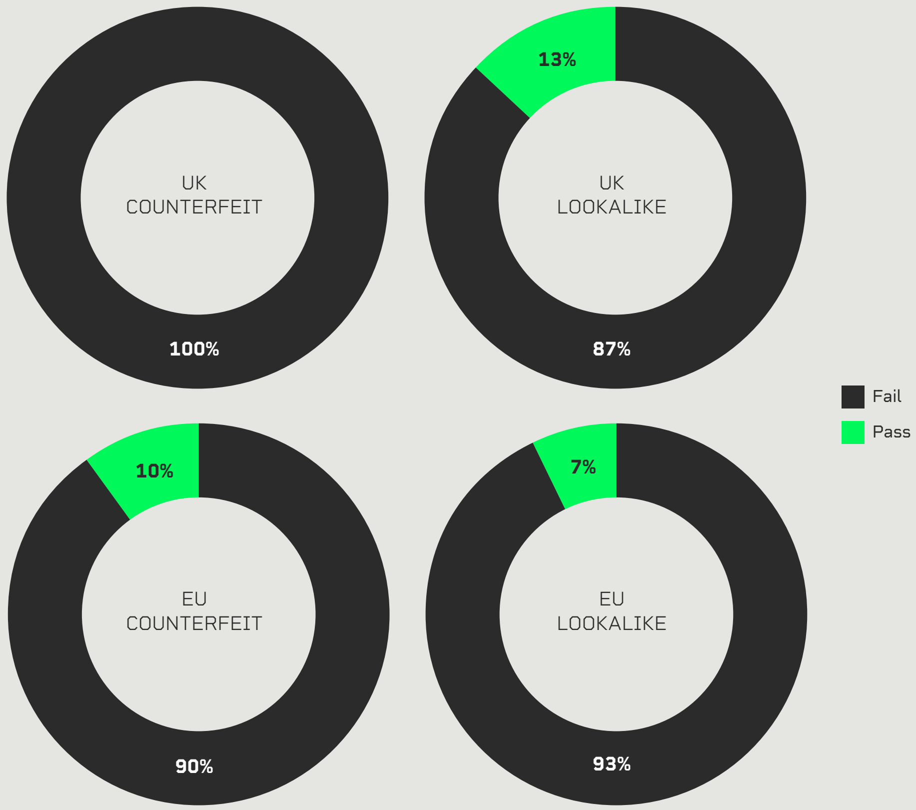


Figure 11: Overall results of the electric strength testing.

> “ THREE **FAILED** TO MEET THE **MINIMUM REQUIREMENTS** FOR TRANSFORMER CONSTRUCTION. ”

4.6 FURTHER INVESTIGATION

Further investigation was carried out on the nine samples that passed the electric strength test. This included an inspection of the internal circuity, wiring, and components that were likely to increase the risk of electric shock or fire to the user (Figure 12).

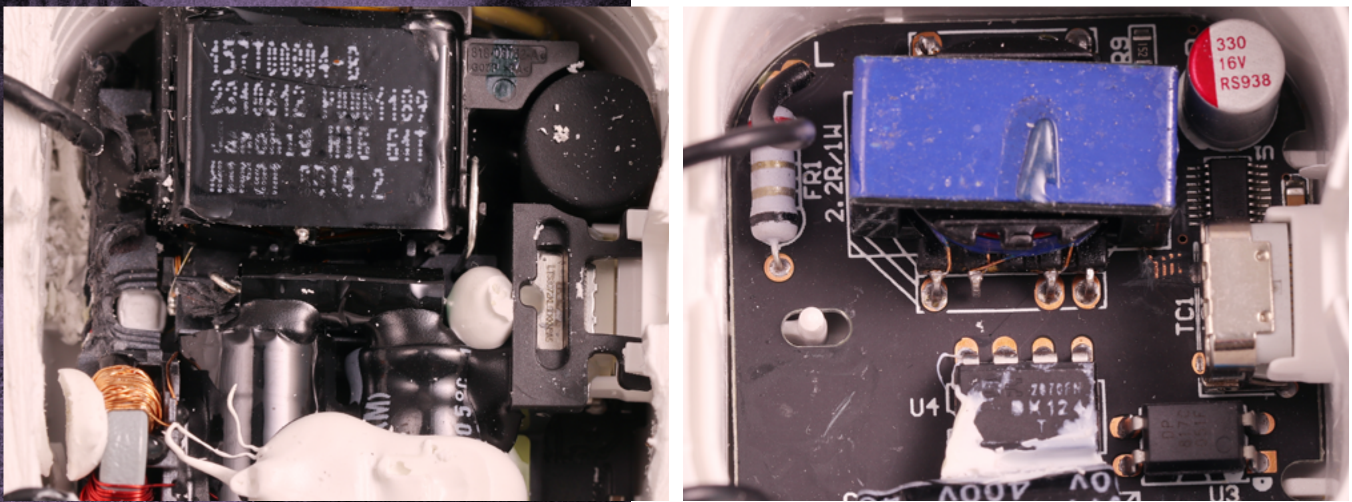


Figure 12: Genuine (left) vs Fake (right) Internal Components.

ALL NINE SAMPLES FAILED AT LEAST ONE OF THE CHECKS:

- Three failed to meet the minimum requirements for transformer construction, e.g. use of triple insulated wire in the secondary winding (see Figure 15).
- Four failed to maintain adequate creepage or clearance distances, which is the distance between the mains supply circuitry and the parts the user can touch.
- Two were fitted with sub-standard components (Figures 14).
- Three had insecure wiring.

> “THE ADDITION OF METAL WEIGHTS CLOSE TO INTERNAL COMPONENTS **SERIOUSLY COMPROMISED** THE ELECTRICAL SEPARATION.”

The thirteen samples that failed the electric strength test at less than half of the test voltage were also subjected to a deeper investigation to better understand why they failed so severely.

The investigation revealed issues similar to those found in the nine samples that passed the electric strength testing, including metal weights inserted into some of the chargers to replicate the exact weight of a genuine Apple charger (Figure 13).

The testing concluded that the addition of metal weights close to internal components seriously compromised the electrical separation between the mains voltage circuits and the USB output, meaning that there was a significant risk of a short-circuit occurring, resulting in electric shock and fire.

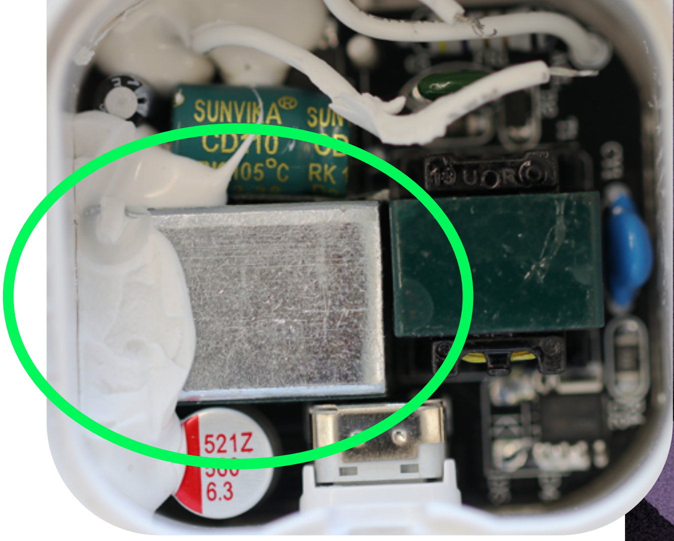


Figure 13: Sample #16 showing added weight compromising creepage and clearance distances.

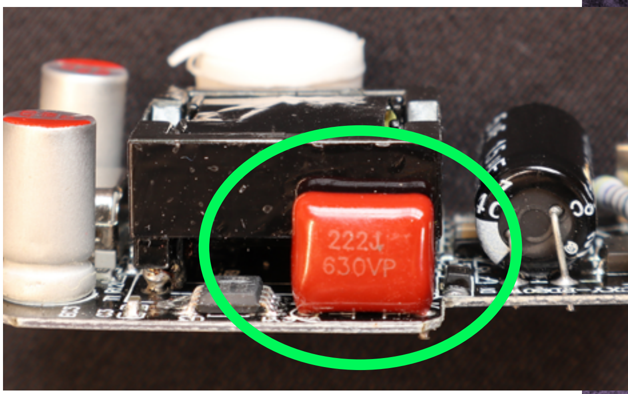


Figure 14: Sample #81 showing substandard capacitor used across the safety barrier.

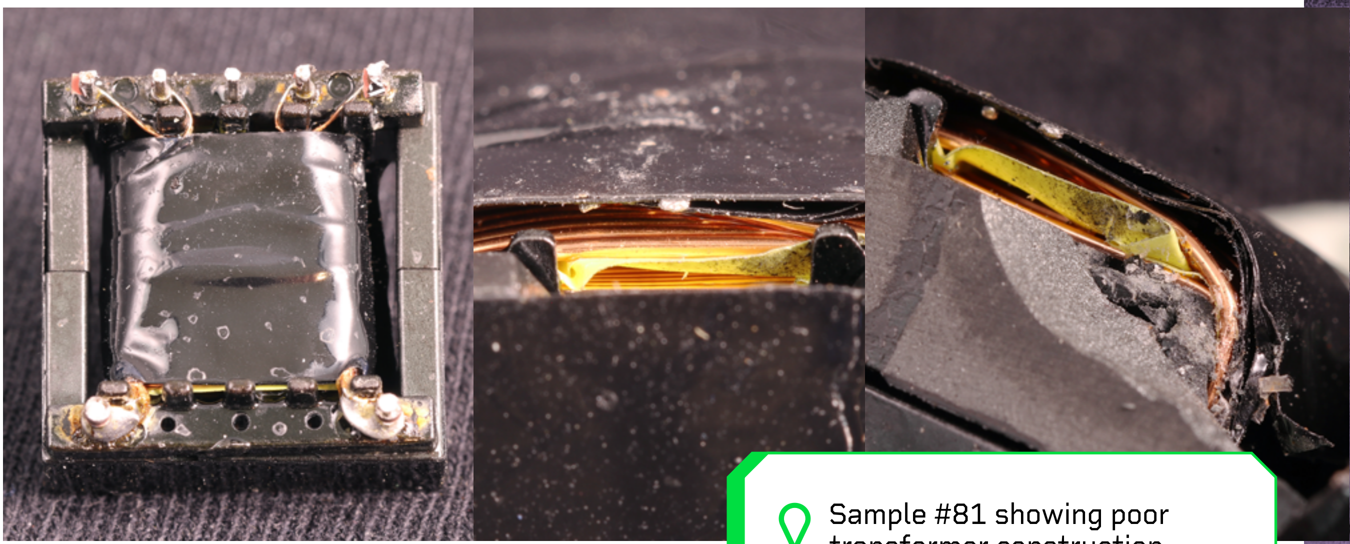
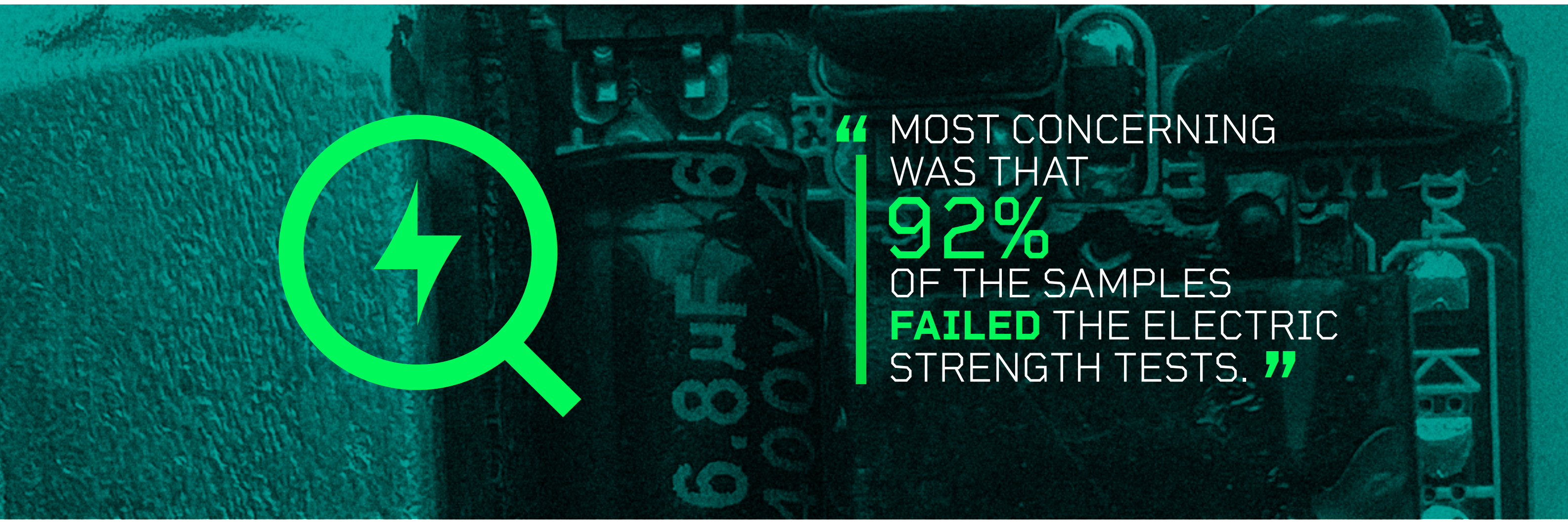


Figure 15: Sample #81 showing poor transformer construction.

Sample #81 showing poor transformer construction with only tape separating the mains voltage windings and the secondary windings, compromising creepage and clearance distances.

5.0 FAILURE ANALYSIS



> MOST CONCERNING WAS THAT **92%** OF THE SAMPLES **FAILED** THE ELECTRIC STRENGTH TESTS.

Most concerning was that 92% of the samples failed the electric strength tests, which tests the barrier between the mains input and the extra low voltage side (USB port and cable) of the charger that is accessible to touch and plugged into a phone or similar device. This represents an increase of 34% when compared to the results of the same test from the research carried out by Electrical Safety First in 2017.

Of the nine samples that passed this critical safety test, all nine still failed overall and had a combination of issues as detailed above.

The second most concerning issue was the discovery of weights being added to the counterfeit and lookalike chargers to compensate for the lack of components, and to align them more closely to the weight of genuine products.

Of the chargers subjected to further investigation, 68% had metal weights added compared to none found in the previous set of samples tested in 2017.

> OF THE CHARGERS SUBJECTED TO FURTHER INVESTIGATION, **68% HAD METAL WEIGHTS ADDED** COMPARED TO NONE FOUND IN THE PREVIOUS SET OF SAMPLES TESTED IN 2017.

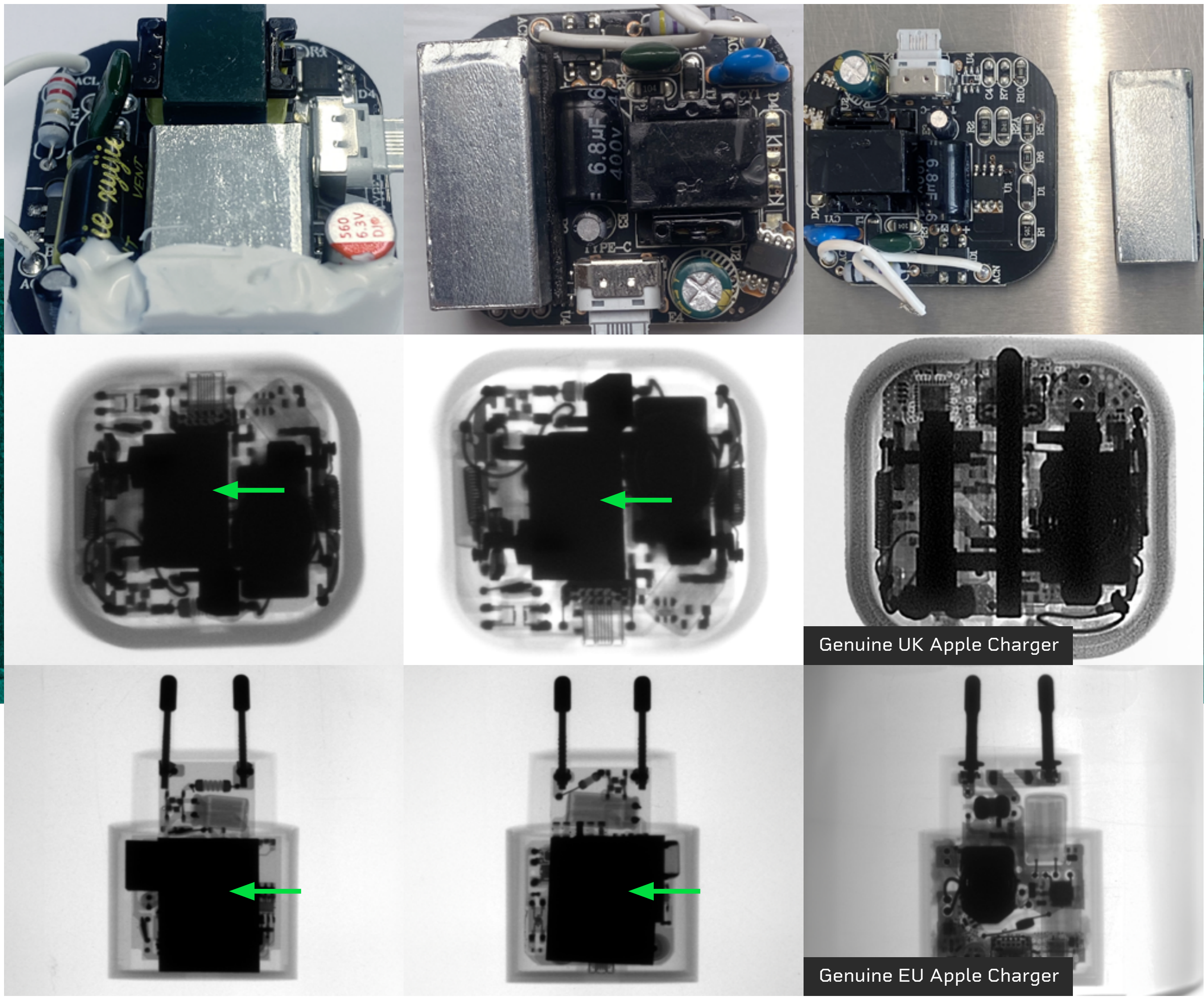


Figure 16: Showing examples of samples with weights added and x-ray images compared to a genuine Apple charger.

The position of the metal weights and their proximity to live parts across the transformer, which provides the separation between the mains voltage and the USB output, is also a major cause of the increased number of failures of the protective barrier within this sample set. Furthermore, the metal weights are very poorly secured next to circuit components, typically using only a small amount of silicon or glue (see Figure 16). Should a metal weight break free, there is a high probability it will cause an internal short-circuit and potentially a fire. Compromising the protective barrier also poses a serious risk of electric shock.

The mechanical failure rate of the UK plug pins saw a significant increase since the tests of 2017 from **68%** to **80%**. Furthermore, the mechanical strength tests that resulted in snapped-off plug pins increased by 63% compared to the findings in 2017.

6.0 CONCLUSION

The findings of this research reveal that the failure rate is now even higher than it was in 2017, with 100% of the samples failing the safety tests, even though this study involved around double the number of samples that were tested in 2017.

Just as concerning is the increase in the failure rate of the essential protective barrier designed to protect the user and any connected equipment. For the duration of the product's life, users must be shielded from potentially hazardous voltages and currents by adequate insulation, clearances, and creepage distances.

For most counterfeit and sub-standard lookalike chargers in the study, deficiencies in the insulating barrier which could cause the USB output voltage to rise to mains voltage level (about 240 Volts) present a real and needless risk of fire and electric shock to users, and the potential destruction of connected equipment.

Many samples displayed the CE mark and other third-party certification marks despite not meeting the requirements of legislation or safety standards, misleading the authorities and consumers into believing the product is safe (Figure 17).

> “THE **FAILURE RATE** IS NOW EVEN HIGHER THAN IT WAS IN 2017, WITH 100% OF THE SAMPLES **FAILING THE SAFETY TESTS**.”

Figure 17: Example of manufacturers placing the CE mark on an unsafe charger that does not meet the requirements of the European Low Voltage Directive and marking the product with certification marks to suggest that it has been tested and approved by a third-party test house (Sample 65).

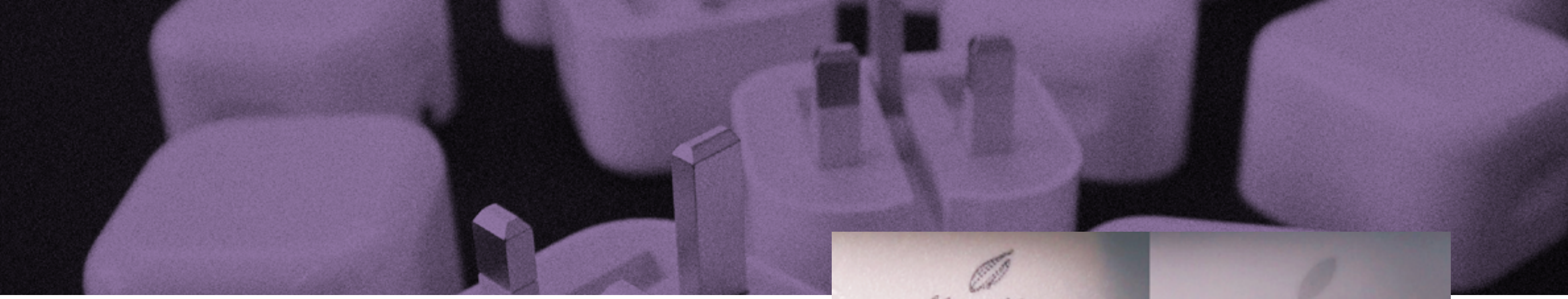
> “ THIS MEANS THAT **WEIGHT** IS NO LONGER A RELIABLE INDICATOR THAT THE CHARGERS ARE **COUNTERFEIT**. ”

7.0 IDENTIFYING COUNTERFEIT APPLE CHARGERS

As the authorities and consumers become more aware of the differences between genuine and counterfeit goods, the methods the counterfeiters are adopting to maintain the deception are becoming increasingly sophisticated.

In this investigation, we have seen many examples of unsafe counterfeit and lookalike chargers with metal weights being added to compensate for the use of lighter substandard materials, a lack of safety-critical components, and to replicate the weight of a genuine charger. This means that weight is no longer a reliable indicator that the chargers are counterfeit.

The best way to ensure getting a genuine charger is to buy from a reputable source. However, there are quick and simple checks that can be carried out to indicate a charger is a genuine 20W Apple product without dismantling the product. It is also helpful if the person checking is familiar with the genuine product or has one available to compare.



7.1 TEXT AND MARKINGS

Look out for poor-quality markings and spelling mistakes. Genuine Apple chargers have a solid Apple logo and well-defined wording. Genuine Apple markings are clean and legible (Figure 18). Many of the counterfeit and lookalike models inspected had poor or ill-defined logos and markings – from merged wording and spelling mistakes, to logos generated and printed with dots or diagonal, horizontal or vertical lines, as shown in Figures 19, 20 and 21.

Figure 18: Examples of genuine EU and UK Apple charger markings.

Figure 19: Side by side markings comparison for counterfeit (left) and genuine (right).

Figure 20: Examples of merged markings and spelling mistakes on counterfeit Apple chargers.

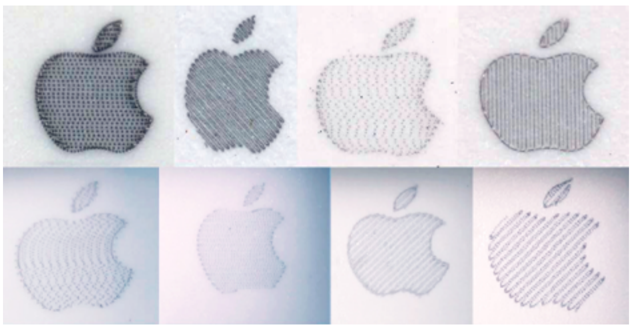


Figure 21: Examples of counterfeit Apple logos on EU and UK chargers.

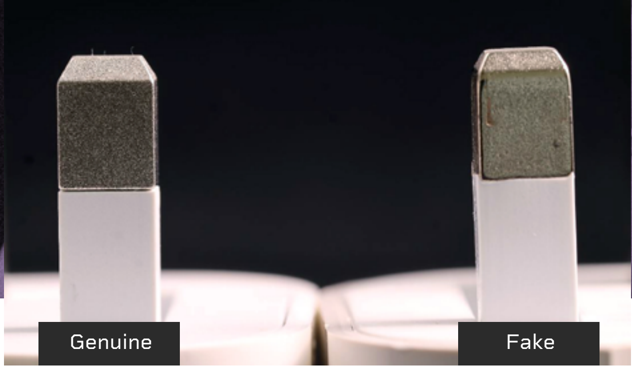


Figure 22: Genuine vs fake plug pins.

7.2 PLUG PINS

Plug pin finish and its material is another obvious indicator that the product is either counterfeit or substandard. The finish on the plug pins on a genuine charger is high quality, matt, and uniform. On counterfeit chargers, the finish is usually glossy or shiny with surface imperfections. The angled profile on the ends of the plug pins also tends to be less well-defined and lacks sharpness compared to genuine chargers. See Figure 22.

7.3 DIMENSIONS

Plug pin dimensions and positioning on counterfeit chargers can vary significantly. The dimensions can be harder to check, but it is relatively straightforward using the Electrical Safety First plug checker (Figure 23).

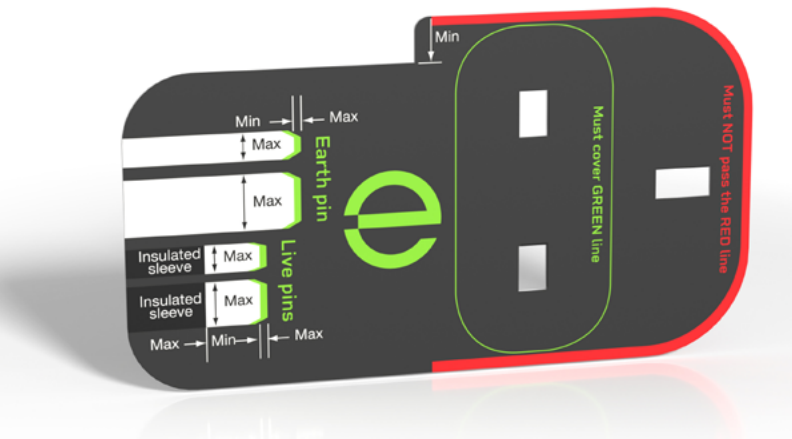


Figure 23: Electrical Safety First plug checker.

The new 2024 version 2.0 of the plug checker can be ordered from the Electrical Safety First website at: https://www.electricalsafetyfirst.org.uk/plug-checker/

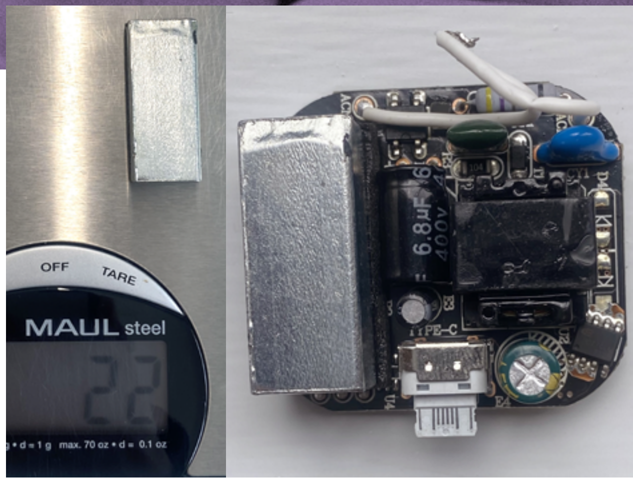


Figure 24: Example of a 22g metal weight fixed inside a counterfeit charger, making up more than 25% of the charger's overall weight.

7.4 WEIGHT

Genuine Apple 20W UK chargers weigh around 86g, and the EU variant weighs around 53g.

This investigation found metal weights fixed to circuit boards to compensate for the lack of quality materials and components. In many cases, the metal weights made up more than 25% of the total weight of the charger (Figure 24). The overall weight of chargers in this investigation varied significantly, as can be seen from the table below.

	Maximum	Minimum
UK Counterfeit	85g	68g
UK Lookalike	87g	61g
EU Counterfeit	58g	49g
EU Lookalike	60g	31g

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Registered Charity (England and Wales) No. 257376
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Title: “Leading the Charge on Counterfeits”
Version 1.9 © Issued November 2024

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