



Another EMC resource
from EMC Standards

CE + CE does not = CE - what to do instead for EMC

Helping you solve your EMC problems

emc9a v2.1 CCC

CE + CE

does not = CE !

– what to do instead for EMC



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(an engineering approach is required instead)
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Important note:
**CE + CE does not equal CE
for Safety compliance too**

- **The basic principles expressed in this course module, also apply to safety compliance...**
 - for example, I have a version of this course module which replaces ‘EMC’ with ‘safety’...
 - ◆ and replaces EMC standard numbers with safety standard numbers...
 - ◆ plus has a few other detailed changes, which do not affect the basic principles

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Selecting Commercial Off-the-Shelf (COTS) items for their EMC when integrating them into a new product

- **This course module is equally applicable to:**
 - systems and installations of any size or scale...
 - ◆ commercial, IT, industrial, residential, transportation, etc.
 - finished products...
 - ◆ machines, equipment, computers, vehicles, etc.
 - sub-assemblies and “components”
 - ◆ such as PLCs, power supplies, motor drives, pneumatic solenoids, valve islands, modules, assembled PCBs, etc.

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Why "CE+CE=CE" cannot achieve due diligence for EMC compliance

(an engineering approach is required instead)

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CE + CE = CE is a nice idea

- It would be nice if we could simply use CE-marked “parts” to build our final “product”
(whether the “parts” are components, modules, sub-assemblies, products, or even systems in their own right)
- But we need to have confidence that this would ensure actual EMC compliance for our “product”
– i.e. compliance with EMC Protection Requirements



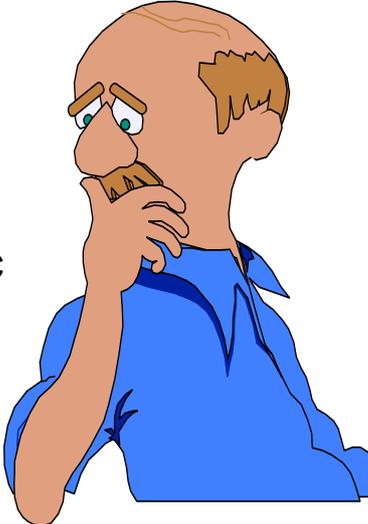
CE+CE+
CE+CE+
CE+CE+
= ???

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CE+CE is unreliable because:

- **Some suppliers lie, or don't try very hard, or get it wrong**
- **Test set-ups can differ from actual assembly or installation**
 - making nonsense of the part's EMC test data
- **Some test labs get it wrong**
- **Emissions can add up**

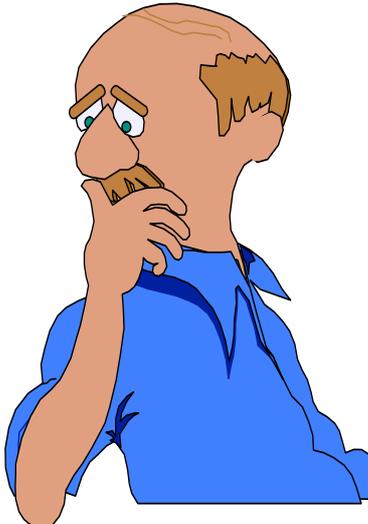


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CE+CE is unreliable continued...

- **Apparatus declared compliant by technical arguments instead of testing may never have been competently assessed...**
 - or assessor's recommendations or warnings ignored
- **When test purchases are made by enforcement authorities...**
 - they generally find between 25% and 50% do not comply with all relevant Directives...



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The Telegraph CCC

Non-compliant battery chargers have killed people

Woman in Australia killed by cheap phone charger
Australian authorities investigate after woman in her 20s found electrocuted



USB chargers seized by NSW Fair Trading from a Campsie store Photo: NSW Fair Trading

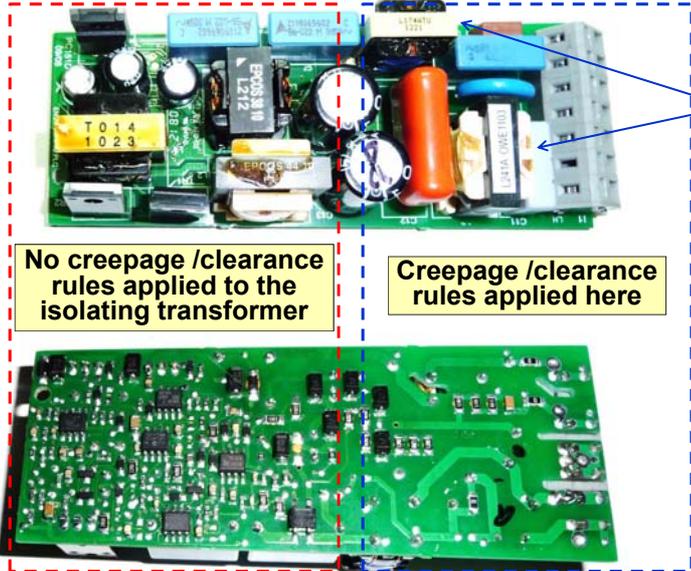
By AFP
6:25AM BST 27 Jun 2014

Australian authorities issued a warning about cheap, non-compliant USB-style chargers after a young woman died from apparent electrocution while using a laptop and possibly a smart phone.

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I see a lot of cheap battery-chargers and other mains-power converters with no creepage and clearance rules applied between input and output

CCC



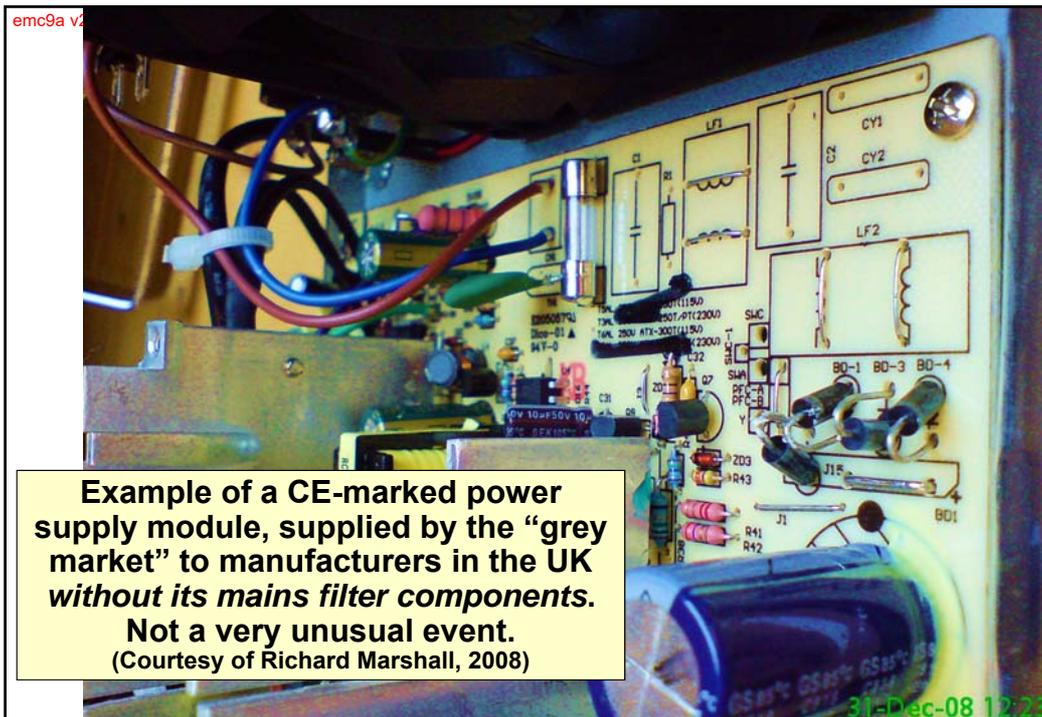
These are both filter chokes

No creepage /clearance rules applied to the isolating transformer

Creepage /clearance rules applied here

This lighting controller is CE-marked and labelled:
"SUITABLE FOR CLASS I AND CLASS II APPLICATIONS"

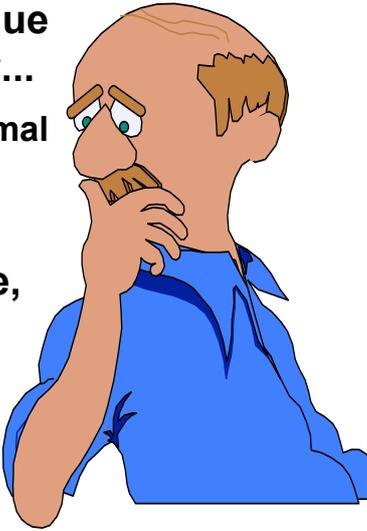
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CE+CE is unreliable continued... CCC

- **Complying with the EMC Directive means not causing/suffering undue EM interference at any frequency...**
 - but merely passing tests to the normal emissions and immunity standards might not ensure this
- **The manufacturer is always liable, even where his supplier was at fault...**
 - buying “in good faith” is not a defence in the UK (and probably not in most other Member States either)



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There has never been any technical or legal justification for the CE+CE approach!

A quote from official EC Guide for the EMC Directive 2004/108/EC (8th February 2010)...

1.2.2 Combination of finished appliances (systems)

It should be noted that combining two or more CE marked finished appliances does not automatically produce a “compliant” system e.g.: a combination of CE marked Programmable Logic Controllers and motor drives may fail to meet the protection requirements.

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CE+CE is unreliable continued...

- **The EMC Directive *doesn't* apply to manufacturers who only supply “professional integrators”...**
 - so their product’s CE marking might be just for the LVD or Machinery or other Directives, and not cover EMC at all
- **So we need to adopt an engineering approach to electromagnetic (EM) compatibility performance**



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A proper engineering approach saves cost and time

- **Helps ensure that the product, system, etc:**
 - works first time
 - commissions quickly with fewer "gremlins"
 - is more reliable in operation
 - meets EMC Directive
- **Leading to:**
 - lower manufacturing and project costs
 - less risk of incurring penalty charges
 - fewer claims under warranty
 - better reputation, more repeat orders
 - less risk of being closed down by EMC enforcers

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Determining the purchasing specifications for EMC performance

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Determine the EM specification

- **Decide what the operational EM environment is...**
 - and whether there will be sensitive circuits or equipment nearby that could be interfered with...
 - preferably agree with your customer in the contract
- **Environmental assessment methods:**
 - expert assessment...
 - calculations using currents, powers, distances, etc...
 - instrumented site surveys...
 - including reasonable fault and low-occurrence events (e.g. use lightning incidence maps)

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Determine the EM specification continued...

- **A number of documents and guides are available to help assess EM environments and performance criteria...**
 - and hence write EM specifications for purchased parts...
 - e.g. our guide:
“*Assessing an Electromagnetic Environment*”
from the ‘Publications & Downloads’ page
at www.cherryclough.com

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Determine the EM specification continued...

- **Determine the performance criteria required for the various EM phenomena, e.g...**
 - safety/mission-critical systems mustn't degrade even during a single fault or a lightning surge...
 - warning sirens may be allowed to sound briefly during transient events, but not during continuous interference
- **It helps to relate the resulting EM specifications to EMC published standards....**
 - because test labs will already be equipped for them

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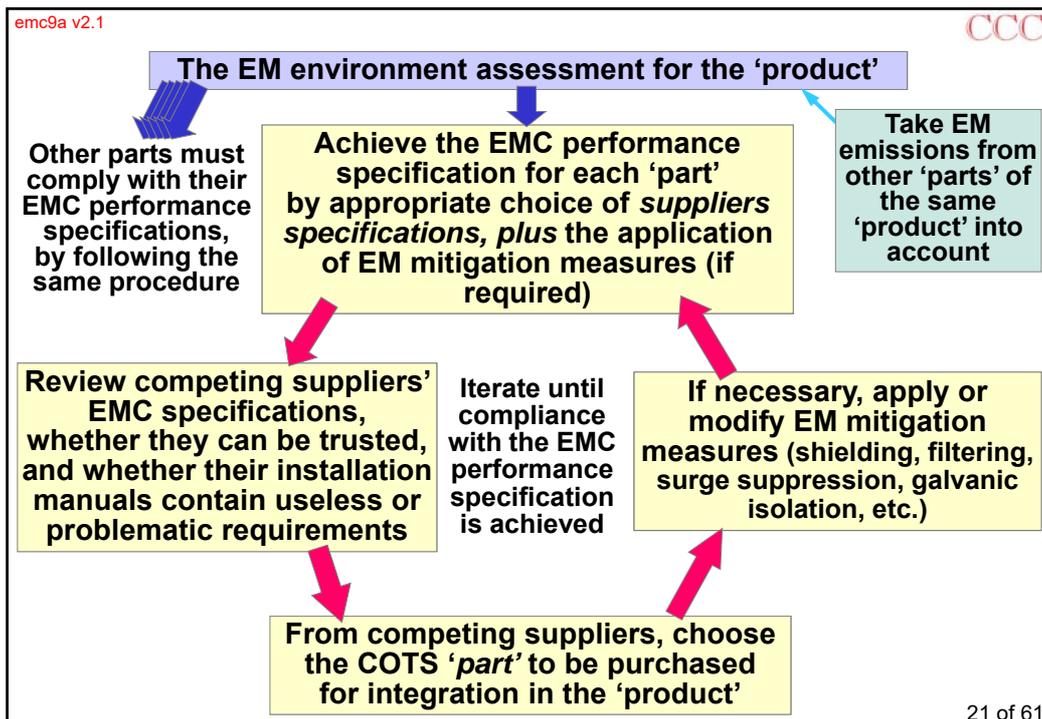
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Determine the EM specification continued...

- **Immunity: specify the EM environment the parts have to function in (phenomena and levels)...**
 - specify the levels of performance degradation that are acceptable for *each* of the significant EM phenomena
- **Emissions: specify the EM emissions the parts are allowed (frequency ranges, transients, and levels)...**
 - remembering that continuous emissions can add up...
 - ◆ and always do when two or more identical 'parts' are used in one 'product'

*I can provide a spreadsheet that does
"Root Sum Square" (RSS) emissions summations*

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Determine the EM specification continued...

- **Include the EMC specifications with the purchasing contracts for the 'parts'...**
 - and also include the verification and validation you require before accepting the 'parts' into your company...
 - having previously made sure their suppliers understand them...
 - ◆ and have the ability to deal with them...
 - ◆ and have charged an appropriate price...
 - it doesn't help if your supplier can't *actually* do what you need, or if you help drive him out of business

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Determine the EM specification continued...

- **Most suppliers at present are very poor at knowing what their part's EM performance is and describing it (they think passing the EMC tests is enough)...**
 - but some are becoming quite good
- **Be prepared to negotiate with 'parts' suppliers**
- **May need to use filtering or shielding to achieve target EM performance using COTS 'parts'...**
 - usually costs more overall...
 - but at least the problems are identified in advance, not when the product fails in the field and fixes are costly

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Judging suppliers' evidence of EMC performance

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How to check that suppliers have achieved adequate EMC performance

- It is always best to use 'parts' (whether they are modules, products, sub-assemblies or even systems) with **known good EMC...**
 - make your suppliers take care of EMC for you...
 - ◆ may have to pay more, but has the least cost/risk overall...
 - be sure to follow their installation and use instructions
- **Known good:**
 - means that you have got the evidence of compliance...
 - and have checked that you can trust it...
 - and have checked it meets your EMC requirements

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Don't rely on CE marking !

Obtain Declarations of Conformity *and* the evidence for them *and* all manuals (installation and user)

Check, confirm, and document:

Check manufacturer has QC which ensures continuing EMC compliance of serial production

Does the EMC performance at least equal your EMC specification?

Were the test set-ups used in the evidence typical of your intended use?

Are the EMC requirements in the manuals problematic?

Purchasing contracts should specify

1. The functions required and performance to be achieved
2. The electromagnetic environment they are to be achieved in

Beware: some suppliers fix CE marks illegally
– or don't use the due diligence that you require

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Checking Declarations of Conformity

- **Do they list the same EMC standards and levels that you have specified for that part?**
 - it may be difficult to judge whether parts are suitable if they have been tested to different standards...
 - some EMC standards are of little help to the integrator
 - ◆ especially EN 61800-3 (motor drives) and EN 61131-2 (PLCs)
- **Is the Declaration clearly signed and dated?**
 - and does it include any inappropriate warnings or limitations or attempts at disclaimers?

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Supplier's quality control

- **Having passed an EMC test once upon a time proves nothing at all about the EM performance or compliance of the parts they supply to you...**
 - unless the manufacturer has a Quality Control system in place that actually maintains specified EM performance in serial manufacture
- **Such a QA system will involve:**
 - control of all changes as regards their EMC impact...
 - sample-based testing to prevent EMC performance drift (and nasty surprises due to IC “die shrinks”)...
 - a list of “approved suppliers” that your own QA people visit and check up on, on an unscheduled basis

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3rd-Party Approvals

- **Some independent “Safety Approvals Bodies” (e.g. UL, TUV, ETL-Semko, Intertek, etc.) also provide EMC Approvals for parts...**
 - and some independent EMC test labs offer a similar service (e.g. EMC Technologies Pty Ltd, Australia)
- **They should take care of all the “continuing EMC compliance”, EMC QA, and change control issues...**
 - including factory inspections every 6 months or so....
 - but carefully check whether what they do is what you need (don’t just simply take their word for it)

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Supplier’s quality control continued...

- **For example, the Turkish cable manufacturer Atlas Kablo was revealed in late 2010 to have been supplying batches of cables without sufficient copper cross-sectional area (CSA), since 2009...**
 - this has been not-uncommon practice for far-eastern cable manufacturers for many years, who seem to prefer to substitute cheaper PVC for copper...
 - obviously causing fire and shock hazards, because overcurrent protection assumes the correct copper CSA

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“Conditions of Acceptability”

- **Independent ‘3rd-Party EMC Approvals’ can include “Conditions of Acceptability”...**
 - ◆ e.g. “The product must be mounted in a shielded and filtered enclosure with the following specifications....”
- **So always get copies of all 3rd-Party Approval documents (not just their Certificates)....**
 - and always read them through very carefully from start to finish...
 - and *if you decide to purchase the part* – always follow any Conditions of Acceptability for the use of those ‘parts’ in your ‘product’

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Checking EMC standards: the Generics

- **There are two sets of two generic EMC standards:**
 - EN 61000-6-1 immunity for residential, commercial, and light industrial, not as tough as EN 61000-6-2
 - EN 61000-6-2: the toughest immunity standard, for (heavy) industry environments
 - EN 61000-6-3: the tightest emissions standard, for residential, commercial and light industrial environments (= EN 55022-B, VDE 0891, CISPR 22-B, similar to FCC Part 15)
 - EN 61000-6-4: emissions for (heavy) industry, not as tough as EN 61000-6-3, approx = EN 55022 Class A

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Checking the generics continued...

- **The best parts are those that meet the toughest standards for emissions and immunity:
EN 61000-6-3 and EN 61000-6-2**
- **Such parts are suitable for use in a very wide range of environments: residential to heavy industrial**
- **Standardising on such parts makes the selection of parts and integration of custom equipment much easier**

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Checking the generics continued...

- **Parts declared to the (heavy) industrial generics are often sold for use in products intended for light industrial and commercial environments**
 - but they would require extra EMC work and testing to reduce their emissions to suit such environments
- **Parts declared to the residential, commercial, and light industrial standards are often sold for use in products intended for industrial environments**
 - but they would require extra EMC work and testing to increase their immunity to suit such environments

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Checking the generics continued...

- **Some parts are declared to EN 61000-6-1 and EN 61000-6-4, the easiest of all the four generics:**
 - they are too noisy for residential, commercial, or light industrial environments
 - and not immune enough for heavy industrial environments
- **So they are not suitable for anywhere!**
 - such sales are almost certainly illegal!
 - these parts can ruin the compliance of the final product, without expensive additional EMC testing and rework

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Watch out for EN 55022 (= CISPR 22)

- **These standards are only for IT or telecomm's, e.g. computers, modems, printers, VDUs**
 - and allow Class A emissions (similar to EN 61000-6-4) for commercial and light industrial environments
- **Almost all other standards require tighter limits for commercial and light industrial environments (equivalent to EN 55022 Class B)...**
 - so when integrated into a non-IT final product, such parts can cause excessive emissions...
 - a common problem when integrating computers in industrial control systems, or printers in anything

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	Generic emissions	EN 55022 (for information technology only)
Residential environment	EN 61000-6-3 = EN 55022 Class B	Class B = EN 61000-6-3
Commercial environment		Class A = EN 61000-6-4
Light industrial environment		
Industrial (heavy) environment	EN 61000-6-4 = EN 55022 Class A	

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Watch out for EN 55011 (and CISPR 11)

- These standards are for 'ISM' equipment, which use EM energy for their main functions
 - dielectric heaters, induction heaters, electric welders, spark erosion, magnetic stirrers, wood dryers and gluers, plastic bag sealers, diathermy equipment, etc.
- They allow unlimited levels of emissions at specified 'ISM' frequencies (e.g. 27MHz, 2.45GHz...)
 - ◆ which can cause great problems for other equipment, and serious health hazards for their operators...
 - when integrated into a non-ISM final 'product' their ISM emissions can easily cause emissions tests to be failed

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Checking the supplier's instructions

- **Always insist in writing for full EMC information on:**
 - assembly materials and methods....
 - installation materials and methods...
 - any limitations to use...
 - make it clear that supplier may be held legally liable for withholding anything with any EMC relevance
- **Some suppliers know their 'parts' have problems**
 - but don't want to "worry their customers"...
 - this has even happened on safety-critical equipment!

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Assembly / installation instructions continued...

- **Do they specify inappropriate or vague limitations?**
 - e.g. *"Do not use this product if it causes interference"*
 - e.g. *"If interference occurs, fit product in shielded box"*
 - e.g. *"May require manual reset after interference"*
- **Do they specify expensive or hard-to-get cables or connectors, or additional filters or shielding?**
 - can significantly affect overall project costs and times unless ordered well in advance...
 - may only be available in huge minimum quantities

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Checking assembly / installation instructions

- **If EMC instructions not provided...**
 - the ‘part’ probably has poor EMC (and its supply in the EU without EMC instructions is illegal anyway)
- **Are the instructions useless?**
 - e.g. *"use screened cable"*
 - e.g. *"fit a supply filter"*
 - e.g. *"install in a shielded enclosure"*
- **Some suppliers warn that EMC is bad / unknown...**
 - avoid them like the plague!

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Checking limitations to use

- **Does the product information include any limitations to use? e.g...**
 - *"Do not use a mobile radiotelephone within 3 metres"*
 - *"Not to be used near sensitive apparatus"*
 - these are quite acceptable, having been carried forward from the limitations to use assumed by test standards (although it would be helpful if they specified ‘near’ and ‘sensitive’ in practical detail)
 - harmonised EMC test standards all assume some limitations to use...
 - ◆ but suppliers usually don't tell their customers what they are (Marketing people hate providing any negative information at all)

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Checking EMC test results

- **Full test results on accredited tests are best..**
 - accredited means the test accuracy and implementation is regularly checked by a National Accreditation Body...
 - ◆ a number of test labs outside the EU have been assessed by EU Accreditation Bodies and / or experts
- **Results from non-accredited labs can be as good...**
 - but EMC testing is tricky to get right and errors of $\pm 20\text{dB}$ are not uncommon (that's a range from 1% to 100 times)
- **Also, check directly with the issuing laboratory that any test certificates or reports are not forgeries!**

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Full test results should include:

- exact identification of the model tested (and its hardware and software versions)...
- sketches/photographs detailing the *actual* test set-ups...
- lists of the test equipment used (and, if not an accredited lab, their calibration dates)
- emissions graphs showing they are under the limit lines (preferably by *at least* 6dB)
- the precise functional performance criteria for the immunity tests (% , ppm, etc.)

- **And should be signed by both the test engineer *and* the test lab manager (or else they are meaningless)**

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Checking the test set-ups

- **Test set-ups should be checked:**
 - are they the same as the EMC installation instructions provided by the supplier?
- **Take special care over Far Eastern test reports...**
 - test labs that have been favourably assessed by UK, German or Australian National Assessment Bodies should be OK
- **How do the test set-ups used relate to how you intend to use the part?**
 - we can have more confidence in set-ups that are more similar

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Checking test set-ups continued...

- **Check especially for:**
 - lack of external cables (cables usually are biggest problems for EMC)...
 - special types of cables or connectors, and/or additional: ferrite clips, filters, “earthing” or “grounding” straps, etc.
- **Were emissions maximised by operation and set-up?**
 - and was immunity minimised by operation and set-up?
- **Did the test set-up allow degraded performance criteria to be correctly measured?**

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Checking Technical Documentation Files

- **Will the supplier let you see his full TDF?**
 - if not, why not? What has he got to hide?
- **Competent assessments of TDFs (not mandatory under 2004/108/EC or 2014/30/EU) often contain warnings and recommendations, and even warnings of non-compliance, e.g...**
 - *“The supplier should make clear to the customer certain installation requirements and limitations to use.....”*
 - has the supplier implemented these?

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Getting the evidence (GTFE)

- **If suppliers can't or won't provide the evidence, what are they hiding?**
 - ◆ most are hiding the fact that they haven't any evidence...
 - If they claim design secrecy, point out that you can find out anyway simply by buying a unit and testing it...
 - if they still won't help, ask for a 'trusted third party' review (e.g. by an Accredited EMC test Lab), which answers your questions without revealing their 'secrets'
- **Salesmen always say everything is perfectly OK...**
 - don't believe anything they say, if they can't supply *hard, factual, trustable* evidence to back it up

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Second sources, counterfeits, and controlling Purchasing

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Using alternative 'parts' (and second sources)

- **Alternative 'parts' can have very different EMC performances, especially ICs (e.g. even 74HCxx)...**
 - so it is important to specify *exactly* which 'parts' are permitted to be used to assemble the 'product'
- **I also recommend checking the product's EMC characteristics when it has been assembled using the permitted alternative 'parts'...**
 - can use 'quick tests' to compare it with the 'reference' unit that passed all of its EMC tests...
 - e.g. by using close-field probing techniques
see our course module and demonstrations

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Controlling purchasing and suppliers

- **The Purchasing (Buying) department must not be permitted to change any 'parts' or suppliers...**
 - without approval from the company's EMC expert on the EMC implications (may need some EMC checks or tests)
- **Where possible: suppliers of sub-assemblies, modules, and complete units (hardware or software) must not be permitted to change *their* parts or suppliers either...**
 - without approval from the company's EMC expert ...
 - otherwise check the EMC characteristics of each batch delivered are as required (e.g. using close-field probes)

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Counterfeits

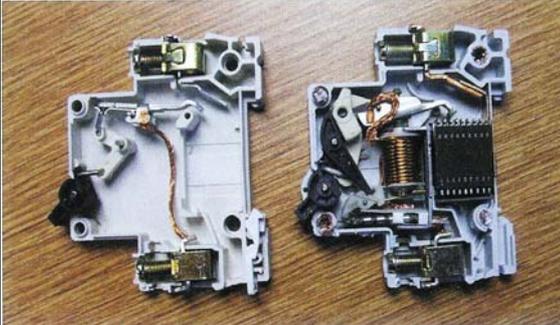
- **Recent years have seen an exponential rise in the proportion of counterfeit electronic components...**
 - from high-end ICs to low-cost parts such as capacitors
- **To try to minimise the problem, only purchase from manufacturers' approved agents...**
 - and subscribe to databases that list counterfeits and describe their distinguishing characteristics (*see later*)
- **All 'parts' should always be inspected and batch-tested when received...**
 - *before being accepted into Stores and suppliers paid*

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Examples of counterfeit circuit breakers

Source: Beama Counterfeit Working Group



Counterfeit and genuine circuit breakers – the difference is potentially fatal

The most obvious difference between the real and the fake was its weight, but these days they add small pieces of metal or concrete so they weigh the same

“This distributor in China displays row upon row of Miniature Circuit Breakers (MCBs). All of them are counterfeit, illegal and highly dangerous.”

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Can you tell which i-Phone charger is the counterfeit?

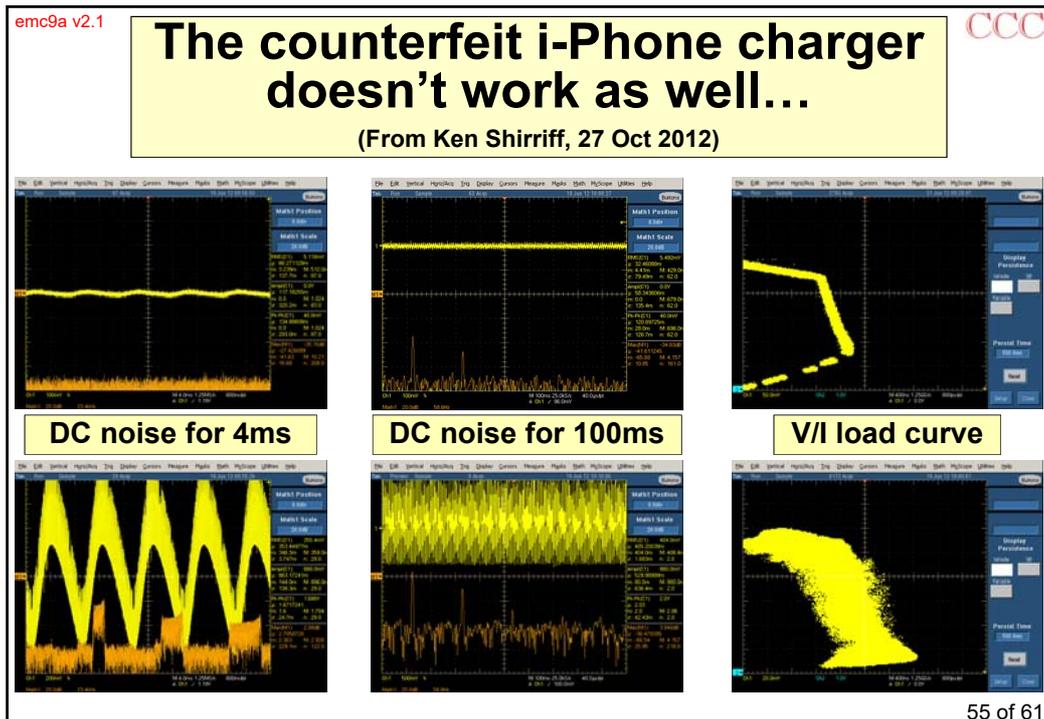
(From Ken Shirriff, 27 Oct 2012)



Apple's price \$29

Sold on eBay for \$2 as: 'Original Genuine Apple charger'

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Counterfeit HRC mains fuse (no silica sand inside) failing a short-circuit test



Two frames from a video posted at:
www.youtube.com/watch?v=KVJVswLbqaA

Also see: www.esc.org.uk/public/guides-and-advice/checking-a-plug/testing-sub-standard-plugs

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Counterfeit products, parts, etc.

- **Worldwide: 10% of technology products are counterfeit** (www.agmaglobal.org) including...
 - ◆ complete products...
 - ◆ electrical components (fuses, circuit-breakers, etc.) and electronic parts (capacitors, ICs, etc.), including military
 - ◆ and many correctly-branded products carry counterfeit safety approval marks (TUV, VDE, UL, etc.)...
- **If your product causes injury or damage due to a counterfeit component...**
 - your company will probably be held liable, as well as other suppliers in the supply chain...
 - ◆ and it is possible that *you personally* could be liable too

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Detecting counterfeits

- a) **Keep up to date with sources of information**
(e.g. www.anticounterfeiting.org.uk, www.beama.org.uk,
www.counterfeit-kills.com)
- b) **Subscribe to counterfeiting databases**
(e.g. www.eiema.org.uk, www.anticounterfeitingforum.org.uk)
- c) **Check for variations in appearance, markings, packaging and assembly**
- d) **Randomly sample/test from each batch**
before accepting a shipment into your company
- e) **Only purchase from official agents or distributors**
(not from the 'grey market') – *who you always pay on time!*
- f) **Purchasing contracts should require suppliers to warn of any counterfeiting that they even suspect**

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Some anti-counterfeiting standards

- SAE has published many anti-counterfeiting standards, see www.anticounterfeitingforum.org.uk/best_practice.aspx
- US Department Of Defense, DFARS, “Final Rule on the Detection and Avoidance of Counterfeit Electronic Parts”, effective 6th May 2014
- DEF STAN 05-135: Fraudulent and Counterfeit Materiel Avoidance
- IEC/TS 62668-1 Ed.2: Process management for avionics - Counterfeiting prevention - Part 1
- IEC/TS 62668-2 Ed. 1.0: Process management for avionics - Counterfeit prevention - Part 2: Managing electronic components from non-franchised sources
- ISO 12931:2012 Performance criteria for authentication solutions for anti-counterfeiting in the field of material goods
- ISO/DIS 16678 - Guidelines for interoperable object identification and related authentication systems to deter counterfeiting and illicit trade
- IECQ, the IEC's Counterfeit Avoidance Programme Quality assessment system

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CE + CE does not = CE
– what to do instead for EMC

the end



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Member

