Episode Book

EPISODE #5609

IEC Cables: Terminate, Split, or Extend?

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SYNOPSIS

Daniel wrote in with four questions about IEC 60320 cables: can you terminate them yourself, do adapters matter, are splitters safe, and how long can a run actually be? The answers turn out to come from different places — a wiring standard, an ampacity table, and in at least one case, an honest "no source says that." Along the way: the odd/even naming rule that unlocks the whole connector family, why the cloverleaf really is called a Mickey Mouse connector, and the C15 trap where a cord fits perfectly and is still the wrong part.

TRANSCRIPT



Corn

Here's a question. You need to get power from a UPS on the floor to a workstation on the desk, and the run is awkward, and the UPS shipped with exactly three outlets, one of which is the input. What do you do?



Herman

Most people buy a plug strip and daisy-chain it, and then another one.



Corn

Right. Daniel wrote in with a whole thing about the alternative. He works mostly with C13 to C14, which in Israel everybody calls the Mickey Mouse cable, and he points out that nobody ever talks about these things even though they're everywhere in technical environments. His argument is that on the AC distribution side they're hugely useful, because they let you stop sprawling daisy-chained plug strips just because some AC-to-DC adapter happened to ship with a wall plug. The catch, as he puts it, is finding the parts and remembering which input connector you need, since there are several variants, including the little clover-shaped one.



Herman

He's not wrong about the clover one being a trap.



Corn

He's got four questions. First, is it viable to terminate these cables yourself, because you never know how long you need until you've got a coil of excess on the floor, and if the answer is yes, what is the cable actually called and what's its typical specification. Second, is there any practical difference between going direct from the UPS to a grounded device with an IEC cable, versus using one of those IEC-to-plug adapters, assuming the adapter carries the grounding pins. He says a C13 to Israeli plug adapter costs about a dollar. The purist in him wants one connection wired straight back to the IEC, and he's not sure there's any logic behind that. Third, splitters. One male to three female, safe as long as the total output stays inside the rated wattage? Fourth, and this is the one he's least sure about, how long can this cabling run. He's seen ten and twenty meter varieties and wants to know if there's a hard ceiling.



Herman

Four questions, and the answers don't all come from the same place.



Corn

Let's look at working with IEC cables in today's episode.



Herman

Start with what the standard actually is, because everything else follows from it. IEC 60320 is the appliance coupler standard. First published in 1970 as IEC 320, renumbered in 1994, and it covers non-locking connectors up to 250 volts AC and 16 amps. That's the whole scope. It is not a standard about cables. It's a standard about the interface where a cable meets a device.



Corn

Which is why the naming is so tidy once you know the rule.



Herman

Odd numbers are the female connector on the cord. The next even number up is the male inlet on the equipment. So a C13 cord plugs into a C14 inlet. That single rule unlocks the entire zoo. C13 and C14, the kettle cord, 10 amps under IEC, 15 under UL and CSA, 70 degree pin temperature, Class I, which means it's earthed. That's the one on desktops, monitors, UPSes, PDUs, servers, switches. It is the default.



Corn

Then the small ones.



Herman

C5 and C6, the cloverleaf. 2.5 amps, Class I, three conductors including earth. Laptop power bricks, projectors, some monitors. And here's the thing Daniel will enjoy, because Wikipedia and the vendor guides both list Mickey Mouse connector as a standard common name for C5/C6, right alongside cloverleaf. His slang isn't drift. It's in the



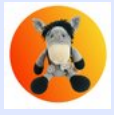
Herman (continued)

literature.



Corn

He'll be insufferable about that.



Herman

Then C7 and C8, the figure-8, or infinity, or shotgun. Two conductors, no earth, Class II, 2.5 amps. And this is the one people confuse with C5 constantly, because they look similar in a drawer. They are different shapes and not interchangeable. C5 has an earth. C7 doesn't.



Corn

And the big one.



Herman

C19 and C20. 16 amps IEC, 20 under UL and CSA. Data centre connector. And it's deliberately not interchangeable with C13/C14, so you physically cannot put an under-rated cord on a high-current circuit. The standard does that on purpose.



Corn

So the family is legible. There's one more trap though, and it's the one that actually bites.



Herman

C15 and C16. Physically near-identical to C13 and C14, but rated 120 degrees instead of 70. There's a small notch. A C15 fits a C14 inlet, but a C13 will not fit a C16 inlet. That's deliberate safety keying. And the thing everyone calls a kettle plug is technically C15/C16, not C13/C14. The kettle is the hot one.



Corn

Which means Daniel's problem of remembering which input connector you need isn't just a convenience problem.



Herman

It has a safety dimension. We'll come back to that.



Corn

So with the family mapped out, let's start with Daniel's first question. Can you actually terminate these yourself?



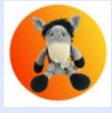
Herman

Yes. Unambiguously yes, and it's a standard, widely stocked part. Rewirable C13 connectors are sold to consumers. Kenable does a heavy duty rewireable C13 inline socket, 10 amp 250 volt, for somewhere between one sixty-eight and two pounds. A plain rewirable C13 socket is eighty-eight pence. RS PRO does one at about four pounds. And the Martin Kaiser 794 slash sw is rated 10 amp, 70 degrees, for nought point seven five to one point five square millimetre cable, ENEC and VDE approved. That's a proper part.



Corn

Eighty-eight pence.



Herman

And the standard explicitly permits it. IEC 60320 classifies connectors as rewirable or non-rewirable, and the C13/C14 row is marked rewirable connector allowed, yes. So it's not a grey area. It's a documented category.



Corn

How do they actually go together?



Herman

Screw or solder terminals, plus a cable strain-relief clamp. The clamp is the part people skip and it's the part that matters, because the clamp is what stops the flexing load from landing on the terminals. You strip the jacket back far enough that the clamp bites on the outer sheath, not on the individual conductors. That's the whole trick.



Corn

And the wire. He asked what the cable is actually called.



Herman

The classic IT cord is SJT, or SJTO, or SJTOW. Three conductor, 300 volt, PVC jacket, unshielded, with the black, white, green conductor colour code. And the gauge table is the useful part. Eighteen AWG is 10 amps. Sixteen AWG is 13. Fourteen is 15. Twelve is 20.



Corn

So for a C13, which is a 10 amp connector.



Herman

Eighteen gauge, three conductor, SJT. And that's not a guess, that's matched. Thomas Wilson, a professional engineer who writes about server power cables, puts it plainly. Eighteen three SJT wire matches the 10 amp capacity of the C14/C13 connector, so those assemblies are properly matched and can be UL labelled in that configuration. Sixteen three is allowed for C13 as well, but most assemblies ship eighteen three, because eighteen three is already correct.



Corn

So the answer to Daniel's first question is, buy a pound connector, buy eighteen three SJT, and the spec is fully determined.



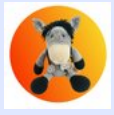
Herman

Fully determined. There's nothing to guess.



Corn

Except where you live.



Herman

Right, and this is the sharp bit. In the UK and the EU, rewirable IEC connectors are sold freely to consumers. You buy one for under a pound and you terminate it yourself, and nobody has a problem with that. In Australia, Access Communications states that modifying a mains-connected flexible cord by cutting and replacing the plug or any connector is electrical work under Australian law, must only be performed by a licensed electrician, and the modified cord loses its compliance certification. Same physical task. Opposite legal status.



Corn

So the identical act is a Saturday afternoon in Manchester and a call to a tradesman in Melbourne.



Herman

And the interesting thing is that neither jurisdiction is wrong on its own terms. The Australian position is about who is competent to make a permanent modification to a mains assembly. The British position is that a rewirable connector with a strain relief and a screw terminal is a consumer part, and always has been. Both are coherent. They just weight the risk differently.



Corn

Does Daniel's coil problem actually get solved by this? Because that was his real motivation. You gauge the length, you're wrong, now you're managing a coil.



Herman

That's the practical payoff. You can cut to length. You measure the run, you add a little slack, and you terminate. No coil. And a coil isn't neutral, by the way. A tightly coiled mains cable under load is a warm cable, because you've wrapped the heat path around itself.



Corn

Now the C15 trap, properly. Because Daniel said remembering the input connector is the trick, and we said that has a safety dimension.



Herman

A C13 cord physically fits a C16 inlet. It goes in. It clicks. It works. But the cord is rated 70 degrees and the inlet is rated 120. So in a hot aisle, in a rack, in a warm corner behind a desk, you have a cord operating above its rated temperature. World Cord Sets puts the principle exactly right. Physical fit does not mean correct specification. Always match the temperature and ampacity rating to the application.



Corn

That's a documented error in data centres, not a hypothetical.



Herman

It's a real one. And it's the purest version of what Daniel was describing, because the failure isn't a wrong shape. The shape is right. The rating is wrong, and nothing about the physical connection tells you that.



Corn

What about heat more generally? Because the derating numbers are worth having.



Herman

A C13/C14 drops from 10 amps at 25 degrees to 8.8 at 35, 8.2 at 40, and 7.5 at 45. So if the cable runs through a hot rack or a warm corner, the number on the connector is not the number you're actually working with. Ten amps is a 25 degree figure.



Corn

So termination is viable, the wire spec is clear, and the connector you choose is a rating decision, not just a shape decision. But Daniel's next three questions are about what happens once the cable is made. Adapters, splitters, and length.



Herman

Take the adapter question first, because it's the one where I have to be honest about what the evidence actually says.



Corn

Go on.



Herman

Daniel wants to know if there's a practical difference between going direct from the UPS to a grounded device with an IEC cable, versus using an IEC-to-plug adapter with grounding pins. And the honest answer is that I could not find a source that declares a grounded adapter electrically unsafe. Not one. The strongest position that exists is that adapters lack formal quality criteria. Wikipedia says adaptors between standards are not included in most standards, and as a result they have no formal quality criteria defined. It also notes that physical compatibility does not ensure the appliance and socket match in frequency or voltage, and that adaptors can cause excessive mechanical stress to wall-mounted sockets.



Corn

So his purist instinct is real, but it's not a safety rule.



Herman

It's a reliability preference. And it's a defensible one, on grounds that have nothing to do with a documented failure. The IEC 60320 standard defines the C13 connector as a proper appliance coupler with defined withdrawal forces, insertion cycles, and flexing tests. A direct C13-to-C14 connection is a specified, tested interface. An IEC-to-wall-plug adapter adds an extra mated interface that is not covered by the same standard sheet. So you're trading one tested interface for two interfaces, one of which has no formal specification.



Corn

It's not that the adapter is dangerous. It's that it's unspecified.



Herman

And I want to be clear, because this is where people manufacture a scare. There's no documented failure here. There's an absence of documentation. Those are different things, and the honest version of the answer is that Daniel's instinct is good engineering hygiene rather than a safety requirement.



Corn

And there's a mechanical argument too, which is the one that actually convinces me.



Herman

Which is?



Corn

An adapter is a lever. You've moved the plug further out from the wall, and now every accidental nudge on the cable is acting on a longer arm against a socket that was designed for a plug sitting flush in it. That's the excessive mechanical stress Wikipedia is describing. It's not an electrical failure mode at all. It's a mechanical one.



Herman

And it's the reason I'd avoid them in a rack, where cables get pulled, and be much more relaxed about one behind a desk that nobody touches.



Corn

Splitters next. One male to three female.



Herman

Mainstream, UL-listed product. CableChum does a C14 to three times C13 in sixteen gauge SJT. Infinite Cables does a NEMA 5-15P to three times C13, sixteen gauge, 13 amp 125 volt. StarTech does a C14 to two times C13 at 13 amp 250 volt. Tripp Lite does the P004-18N-4XC13, which is a C14 to four times C13, 10 amp, eighteen gauge. These are not grey-market parts. Prices are around six dollars for a one metre C14 to three times C13, and about fifteen for a thirty centimetre version.



Corn

So the product category is fine. The question is the loading rule.



Herman

And the loading rule is the bit people get wrong, because they count sockets. The rating is the maximum total load regardless of the number of sockets used. That's the governing sentence. A 16 amp 250 volt adapter with four sockets is fine carrying four devices at 2 amps each. It is not fine carrying two devices at 10 amps each, because that's 20 amps into a 16 amp adapter. The socket count is irrelevant. The total is everything.



Corn

So Daniel's instinct is right. Stay inside the rated wattage and you're fine.



Herman

With one refinement, which is the one that turns within rated wattage into a slightly more conservative number. The 80 percent continuous-load rule. Continuous loads, meaning three hours or more, should not exceed 80 percent of ampacity. So a 10 amp C13 cord should carry no more than about 8 amps continuously.



Corn

And a workstation plus a monitor plus a dock is a continuous load. It's on all day.



Herman

So the number to design against is 8, not 10. And there's a second thing worth knowing, which is that splitter blocks and cables are usually un-fused. The exception is C13 cords on British BS 1363 plugs, which are always fused, because the plug itself is fused. Everywhere else, the fuse protection is upstream, in the UPS or the breaker. The splitter is not protecting anything.



Corn

Which matters, because the splitter is the thing a person adds last, when the UPS is already full.



Herman

It's the last thing added and the first thing that should be counted. But to be fair to the product, if you buy a Tripp Lite C14 to four times C13 at 10 amps and eighteen gauge, that splitter's rating exactly matches the C13 cord's own rating. So you're not degrading the circuit by adding it. You're just distributing the same 10 amps across four outlets instead of one.



Corn

Length. Daniel's seen ten and twenty metre varieties.



Herman

And there's no hard ceiling. I looked for one. There is no maximum cord length in IEC 60320, and no vendor documentation states one. The limit is voltage drop, and voltage drop is a function of current and conductor gauge. It is not a function of the connector standard at all.



Corn

Which is why twenty metre cords exist and get used.



Herman

Because at mains voltage, the current is tiny relative to the power. At 230 volts, for a given wattage, the current is roughly twenty times lower than it would be at 12 volts. Resistive loss scales with current squared, so dropping the current by a factor of twenty drops the loss by a factor of four hundred. That's the whole reason long mains runs work and long low-voltage DC runs don't.



Corn

Give the contrast, because it's the clearest way to see it.



Herman

A five metre, sixteen foot USB cable at 24 gauge will lose 38.5 percent of its power to line losses at 5 volts and 2.5 amps. That's a real number from a Hacker News discussion about low-voltage DC wall sockets. The commenter's conclusion was that low DC voltages are not practical for power runs over about two metres. Same physics, opposite outcome, because of the voltage.



Corn

The honest answer to Daniel is that the ceiling is set by acceptable voltage drop and heat, not by the connector.



Herman

If you want the conductor-sizing intuition, it's the usual one. Six square millimetres is about 30 amps, ten is about 40, sixteen is about 55. Longer runs and higher currents want fatter copper. For a twenty metre IEC cord at 10 amps on eighteen gauge, the drop is small but it isn't zero. You just don't need to care about it at these lengths and these currents.



Corn

The connector doesn't set the limit. Physics and upstream protection do.



Herman

That's the through-line for all three of those questions, actually. The adapter, the splitter, the length. In every case the connector standard is silent and something else is doing the work. Standards for the adapter, arithmetic for the splitter, physics for the length.



Hilbert

Fourteen pounds ninety-nine.



Corn

Sorry?



Hilbert

That's what the C5 cords cost. Fourteen pounds ninety-nine, from the AV supplier, and the university bought forty of them one year because the originals kept disappearing. I was doing installs for a lecture capture system. Projectors, document cameras, the little control panels on the podium. Every projector brick took a C5, the Mickey Mouse one, and every one of those cords went missing inside a term.



Herman

Where did they go?



Hilbert

Into the C7 pile. Well-meaning staff would unplug a projector, take the cord, and it would end up in the box with the figure-8 cables, because they look the same in a drawer and nobody reads the label. Then the next install you'd reach into the box and pull out a C7, and it wouldn't fit, and you'd spend twenty minutes finding a C5. We started cable-tying them to the brick.



Corn

Which is the worst possible place to tie them.



Hilbert

It is. Because then instead of unplugging the cord from the brick, people yank the cord out of the wall, and the strain relief takes it. Every one of those cords came back with the relief chewed through. The contacts were fine. The connector was fine. The relief was gone, because somebody pulled the wrong end.



Herman

The failure pattern in the field isn't the contact at all.



Hilbert

It never is. It's the relief, and it's the confusion between C5 and C7, and it's the fact that the two look identical to anyone who isn't the person who bought them. I can tell them apart by feel in the dark, if you want.



Corn

We do want.



Hilbert

The C5 has a wider pin spacing and a flat top. The C7 is two parallel rectangles with a notch. Your thumb finds the notch. It's not a skill, it's just forty of them.



Corn

The adapters. You agree with Daniel.



Hilbert

I agree with him, but not for the reason you gave. You said adapters have no formal quality criteria. Fine. My reason is that every adapter I ever found in a lecture hall was the thing that got left behind. The rack gets pulled out for a service, the adapter stays in the wall, and the C13 end is the one that survives, because the C13 end is attached to the equipment. I've got a box of orphaned adapters somewhere. I don't have a box of orphaned C13 cords.



Herman

That's a good argument. The adapter is the part that decouples.



Hilbert

The splitters. I found one behind a podium, one male to three female, daisy-chained three deep. Feeding a projector, a document camera, and a laptop dock. All of it on one 10 amp cord.



Corn

Three deep.



Hilbert

The total load was fine, honestly, it was maybe four amps. But nobody had counted it. It had just grown.



Corn

The field version of the loading rule is that the number is fine and the counting never happens.



Hilbert

The counting never happens. Somebody adds one thing, and then somebody adds another thing, and the person who owns the circuit is not in the room.



Corn

That field texture is a good place to land, because it points at the two things the research couldn't fully answer.



Herman

The first is length. There is no published maximum IEC cord length. Not in the standard, not in vendor documentation. The limit is voltage drop and heat, which means the answer to how long can I run this is it depends on the current and the gauge, and nobody will give you a number.



Corn

Which is unsatisfying for a field that loves numbers.



Herman

It's very unsatisfying. And it's the honest answer, because a standard that specifies withdrawal forces and insertion cycles has no business specifying length. Length isn't its problem.



Corn

The second is the adapter. No documented safety failure, only an absence of formal quality criteria.



Herman

Which means Daniel's purist instinct is a reliability preference dressed up as a safety rule. And that's a pattern worth noticing, because a lot of engineering folk wisdom is exactly that. It's not wrong. It's just wearing the wrong label.



Corn

The interesting thing about all of this is where it's heading. The C13/C14 ecosystem was built for data centres and offices, and it's quietly becoming the home lab's power distribution standard. Smaller UPSes, desktop users running home servers and networking



Corn (continued)

gear on battery backup, and now the same questions about termination, adapters, splitters and length that a data centre answered years ago are being asked in living rooms.



Herman

With less margin and fewer people to ask.



Corn

Thanks to Hilbert Flumingtop for producing. This has been My Weird Prompts. If you want to send us a prompt, email us at show at my weird prompts dot com.



Herman

We'll be back soon.