Episode Book

EPISODE #5984

Reading a Mystery Adapter's Voltage Without a Label

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SYNOPSIS

Every technical person has the drawer of orphaned adapters. Daniel wrote in with the classic problem: a device with no spec, no label, and no memory of which adapter it took. He wants to know if a multimeter can find the voltage and polarity. The bad news is that an unpowered DC input is electrically silent — there's no number to measure. The good news is that polarity is partly readable, and the voltage question has a real answer, just not the one you'd expect. It lives in how much current the device pulls as you raise the voltage, and what that curve says about the regulator inside.

TRANSCRIPT



Corn

The drawer. Every technical person has the drawer, and it is a confession. Mine has a label on it that says "adapters" and it is lying, because half of what is in there belongs to a device I no longer own and the other half belongs to a device I own and cannot identify.



Herman

You have lived with that drawer since we moved in.



Corn

I have fed it. So has Daniel, apparently, and he's written in about it, because of course he has. He's got devices where the spec is gone, the label is gone, and the memory of which adapter they took is gone. The physical connector he can sort out, that's the easy part. What he wants to know is the voltage and the polarity, and whether a multimeter can get him there.



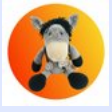
Herman

And whether the bench supply he's been meaning to buy can.



Corn

Right. His instinct is to start at five volts and creep up until the thing looks alive, and he's already spotted the hole in his own plan, which is that a device can look alive at the wrong voltage. He wants to know if there's anything you can actually see electrically when you've got the right number, assuming the draw normalizes.



Herman

That last phrase is the whole episode, Corn. He's already guessed the answer and he doesn't trust it.



Corn

So let's find out if he should.



Herman

Start with the thing he's going to want to hear first, which is the bad news. An unpowered DC input is electrically silent. There is no voltage present on those pins to measure. So the multimeter cannot read the required voltage off the jack. That is not a limitation of a cheap meter, that's true of every meter ever made. You can't measure a number that isn't there.



Corn

So what is it actually for?



Herman

Polarity, partly. And that matters a lot more than most people think. Reverse polarity is the primary way people kill a board. It's worse than instant death, because it can be subtle damage that shows up as a device that misbehaves sometimes and you never connect it back to the day you wired it backwards.



Corn

A slow death with no witnesses.



Herman

And the other direction is a coin flip you lose. Overvoltage is playing Russian Roulette, that's the line from the repair literature and it's the right one. Undervoltage is generally survivable. The device mostly won't die. It'll just be unreliable, or run hot, or drop out under load, and you'll never suspect the adapter because it turns on fine.



Corn

It turns on is a liar.



Herman

It turns on is the single most expensive sentence in electronics.



Corn

So to lay out the shape of this. The polarity problem is the dangerous one and the multimeter can help with it. The voltage problem is the harder one and the meter barely helps at all. And the answer to the voltage question is not in how the device behaves. It's in how much current it pulls.



Herman

That's the arc.



Corn

Then let's do the modems.



Herman

The modems are the perfect illustration of Daniel's exact failure mode. Two U.S. Robotics units, one wants nine volts AC, the other wants twenty, and the power jacks on both of them are identical and completely unmarked. Same connector, same chassis, twenty volts apart.



Corn

In AC, no less. So even the polarity trick is off the table, there's no polarity to find.



Herman

There is no polarity to find. And the documented behavior is exactly what Daniel is worried about. With too little voltage, the modem may appear to work but be unreliable. With too much, the smoke is released instantly. So one end of that range gives you a device that seems fine and is quietly failing you, and the other end gives you a dead modem in under a second.



Corn

So it's not a gradual thing where you'd creep up and feel it getting happier.



Herman

No. And that's the part people get wrong. The voltage isn't a dial where the device perks up as you approach the correct value and then you stop. Below the threshold it may look normal. At the threshold and above it until the tolerance runs out it works. Past the tolerance it's gone. There's no feedback gradient telling you where you are.



Corn

The device is not a witness. Okay. So what can the meter actually do for polarity?



Herman

It can do quite a lot, as long as you've got a ground reference on the device. If the device has any metal part, a chassis, a screw boss, an exposed ground, you put the meter in continuity mode and you beep from the center contact of the socket to that ground, and then from the outer contact to that ground. Whichever one beeps is the grounded one, and the grounded one is almost always negative.



Corn

Almost always.



Herman

Grounded contact to chassis reads zero ohms. That's the one that's tied to the ground plane on the board. The other one floats. So you've established the polarity of the socket without applying a single volt.



Corn

That only works if the jack isn't isolated from the chassis.



Herman

Which is the catch, and on a lot of consumer gear it is isolated, deliberately, usually for noise reasons. So the continuity trick is a strong signal when it works and tells you nothing when it doesn't. There's a softer version people use, which is that the center pin often reads a low resistance to the chassis, something like fifty ohms, and the outer barrel reads very high, three hundred kilohms sort of territory. Low on the center means the center is more likely the positive one. It's a heuristic, not a law.



Corn

Fifty ohms is not a measurement, that's a vibe with a decimal point.



Herman

It's a vibe with a decimal point, and I would not bet a device on it alone. There's one more clue you can get without opening anything, which is diode mode. A lot of inputs go through a diode for reverse protection, and you can sometimes see the junction with the meter in diode mode across the input pins, testing both directions. If you see the forward drop one way and nothing the other, you've found a protection diode and you've also learned which side is which.



Corn

And is that safe, poking a meter in diode mode into an unpowered device?



Herman

Usually. The meter only applies a small test voltage, a couple of volts, tiny current. Usually probing in both directions is safe, but there are exceptions, and if the input filters are unusual or there's a charged capacitor sitting there, all bets are briefly off. So: usually safe, not guaranteed safe.



Corn

That's the show's slogan.



Herman

And then you hit the wall, which one of the forum regulars put better than I can. You cannot get a multimeter to tell you the polarity if there is no power present, and to apply power without damaging the device you would have to already know the polarity.



Corn

That's a circle.



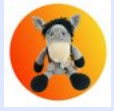
Herman

It's a closed loop, and the community answer to it is not clever. The community answer is: don't turn it on, take it apart. Open the case, follow the trace from the socket to the first component, and the polarity is right there in copper. Everything the meter can tell you from the outside is a guess. The board is not a guess.



Corn

That answer is going to annoy Daniel, because the whole point of having the meter was not having to open it.



Herman

It's going to annoy him, and it's still the right answer. There's one more thing worth saying about protection, because people treat reverse polarity protection as a safety net and it's more like a suggestion. A single series diode will protect you. In reverse it blocks, and the



Herman (continued)

circuit never sees the wrong polarity. The cost is about six tenths of a volt forward drop, or under three hundred millivolts if it's a Schottky. That's the honest version, a small tax for real protection.



Corn

And if the designer went cheap?



Herman

If the designer used a parallel diode instead, the diode shorts out the reversed supply. Which works, until it doesn't, because that diode may have failed shorted, especially if you used a high current adapter to feed it. And there's a cautionary tale in the same literature that is ugly. A Sony Discman, run off a car's twelve to fifteen volts with the polarity reversed, blew the DC to DC converter transistor clean in two, and that was a device with built in reverse voltage protection. It took out the microcontroller too.



Corn

So protection that existed and still lost the fight.



Herman

It existed, it engaged, and the energy was past the point where it could save anything. Which is why I keep coming back to the same place. You cannot know from the outside whether a device has protection, what kind, or whether that protection has already been used up by somebody else. The only way to know is to look.



Corn

So the meter answers polarity partially and the voltage question not at all.



Herman

Not at all. It cannot. There's nothing on those pins to measure.

L

Larry

Are you tired of squinting at tiny labels and guessing which wall wart belongs to which mystery box? Introducing the VoltGuesser three thousand, from the people who brought you the Bag of Adapters. The VoltGuesser three thousand connects to any device and instantly determines the correct voltage by reading the device's aura. Patented AuraSense technology detects the emotional state of your circuit board and selects the voltage it wants to be loved at. Compatible with all barrel jacks, all polarities, and all regrets. Results guaranteed or your device was probably fine anyway. Side effects include confidence, a faint smell of ozone, and the sudden ownership of nine extra adapters. Not available in stores, not available online, and not available.



Corn

I don't know who approved that.



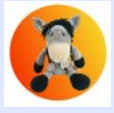
Herman

I don't know who Larry is.



Corn

We'll talk about it later, which means never. Where were we.



Herman

The voltage question, which the meter can't answer, which leaves the bench supply. And this is where Daniel's instinct gets its day, because starting low and creeping up is the community method. He's half right. He's just right for the wrong reason.



Corn

Explain the right reason.



Herman

The right reason is that you're not watching the device, you're watching the current. The bench supply has a voltmeter and an ammeter on the front, and the ammeter is the instrument that tells you what you're dealing with. There's a worked example in the repair forums that is almost exactly Daniel's case. A device rated somewhere in the thirteen to twenty-four volt band, and the question is what voltage do you actually feed it. The method is to apply an increasing voltage across that range and watch whether the current stays roughly constant or falls off.



Corn

And those two shapes mean different things.



Herman

They mean two different power architectures. If the current stays pretty constant as you raise the voltage, the device probably has a linear regulator inside. A linear regulator burns the excess as heat. So the current stays flat because the load downstream is the same, and the extra voltage is just being cooked off as warmth. In that case you want to run near the low end of the range, thirteen to fifteen volts, because the higher you go the hotter the regulator runs for no benefit at all.



Corn

It's a space heater with a job.



Herman

It's a space heater that got the job. And if instead the current drops as you raise the voltage, and he cites it nearly halving over that range, the device probably has a switching DC to DC converter inside. A switching converter trades voltage for current, so as the input voltage rises the input current falls to deliver the same power. In that case any voltage in the range works, it's regulating, and he favors the high end.



Corn

So the current curve is telling you which kind of regulator you're feeding.



Herman

It's telling you which kind of regulator you're feeding. Which is not quite the same as telling you the correct voltage. And I want to be honest about that, because it's Daniel's actual question and the honest answer is unsatisfying. The current signature tells you the regulator type. It does not hand you a magic number that says nine point four volts exactly. It tells you the range that's safe and how the device behaves within it. That's the electrical thing you can see. That's as close as it gets.



Corn

To Daniel's question about seeing it electrically, the draw normalizing is real, it just doesn't mean what he hopes it means.



Herman

Right. Normalizing tells you the device is regulating, not that you've found the one true voltage. There's no one true voltage for most of these devices. There's a band, and inside the band the device does its job, and the margin you're spending is heat.



Corn

Okay. Now the part that actually keeps the board alive, because everything so far has been about measuring and this is about not destroying things.



Herman

The current limit. And this is the single most important operational thing in the episode. The current limit is the safety mechanism, and it's a limit, not a setting, which people get backwards constantly. The voltage control says what voltage you want. The current control says the maximum current you'll allow before the supply stops cooperating. If the load tries to draw more than the limit, the supply doesn't deliver more, it drops the voltage instead to hold the current at the limit.



Corn

So the current knob protects the device even though the device is what's asking for too much.



Herman

The protocol is: set the voltage with the output off. Set a low current limit. Connect the leads. Then switch on and watch the current. If the supply jumps straight to its current limit, something on the board is drawing too much, and you switch off and go looking for a short before you raise anything. And the reason the limit matters is that your test setup should be for what could happen, not what should. A board that ought to draw a hundred milliamps might have a hidden fault that wants five amps, and if your limit is five amps it will take five amps and destroy itself. If your limit is two hundred milliamps, it tells you there's a problem and nothing dies.



Corn

Less smoke.



Herman

In two words, less smoke. That's the actual phrase people use.



Corn

And reading the display, that's the diagnostic.



Herman

The display is the readout, and the mode it's in is the message. Constant voltage with the current settling below the limit is normal, that's a healthy board taking what it needs. Constant current the instant you switch on with the voltage near zero means a short on the rail, the board is a wire right now. Constant current with the voltage partly sagged means an overload or a partial short, it's pulling more than you allowed but not a dead short. Constant voltage with zero current means nothing is happening at all, which is a broken connection, a blown fuse, or the device is switched off.



Corn

So the meter on the bench supply is more informative than the multimeter in your hand.



Herman

For this job, yes, because it's applying power and reporting back, which the multimeter can't do on a dead circuit. And Daniel's instinct is half right in the way we said. Starting at five and creeping up is the method. The half he's wrong about is the half he's relying on, which is the device looking like it works. It can look like it works at nine volts and need twelve. The current is what knows.



Corn

Does he want it at twelve because the label said twelve, or because the device actually needs it?



Herman

That's the honest hole in the whole method, and it's worth sitting with. If you don't know the spec, the current signature tells you the regulator type and not the setpoint. The setpoint came from a label that's gone, or a manual that's gone, or a person who is gone. What you're doing with the sweep is bounding the problem and avoiding the two fatal directions, not recovering the original number.



Corn

So there's no protocol. There's a set of heuristics that a lot of people independently arrived at.



Herman

That's the negative finding, and it's real. Nobody sat down and wrote the standard. What exists is community practice. Continuity to chassis for polarity. Voltage sweep with current observation for voltage. The CV and CC and current-limit workflow from the repair guides is the closest thing to a formal method, and it's a workflow, not a standard. But there are numbers worth carrying around. Most consumer DC devices live between five and twenty volts. If you measure an adapter's unloaded output, five to ten percent above the label is normal. Unregulated transformer bricks routinely read ten to twenty-five percent high with nothing attached, which is not a fault, that's just how they work.



Corn

And the caution threshold?



Herman

If your unloaded reading is more than twenty-five to thirty percent above the marked value, be cautious. That's the point where you start to suspect the adapter is wrong for the job, or something inside it has drifted. And that's a useful number because it applies to the adapter you've already got, which is often the only one whose provenance you know.



Corn

A drawer of adapters with no devices, and a pile of devices with no adapters. It's a puzzle with no solution.



Herman

The good news is the drawer tends toward equilibrium.



Hilbert

You're both right and you missed the funniest part.



Herman

Which part.



Hilbert

The part where you don't need any of it. My cousin runs a stall on Jaffa Road, sells refurbished printers, and every one of them comes with a brick that has a sticker on it with the printer's model number on it. He has a shoebox. You walk in with a mystery machine, you tell him what it is, he hands you the brick that matches, six shekels. He's been doing it for twenty years.



Corn

You're telling us to go to a printer stall instead of buying a bench supply.



Hilbert

I'm telling you what people actually do. He has a label maker. The label maker cost him forty shekels in the year two thousand and something and it still works. Every brick that comes through the door gets a sticker with the model it came off. That's the whole system. No meter, no sweep, no diode mode. A shoebox and a label maker.



Herman

And what happens when the brick dies?



Hilbert

He puts the sticker on the next one and checks it with the printer. If the printer prints, the brick was right. That's his test. He prints one page.



Corn

So the electrical signature has been solved commercially by one man on Jaffa Road.



Hilbert

He's not solving anything, he's just been doing it long enough that he doesn't get it wrong. And he'll tell you the one you actually want is the old heavy one, because the old heavy ones don't die. He keeps the light ones in a separate box for the people who come back.



Corn

They come back. So there's a box.



Hilbert

It's a shoebox. The good box is a shoebox too, it's just older. I've rung him twice about the label maker, by the way. He won't sell it.



Herman

Did you ask how much.



Hilbert

Four hundred shekels. That was the second call. He went up.



Herman

You asked twice.



Hilbert

The first one I lowballed. People who won't sell a thing find out what it's worth when you ask them properly. Anyway, the printer stall closes at two. If you go at one he'll let you look in the box.



Corn

Where the device shows it's working but it's under-volted, the stall is the thing that tells you the truth because it's already been told.



Hilbert

That's what a label does. It's not clever, it just doesn't lie.



Corn

The shoebox is the answer and it's a shoebox.



Herman

It's a shoebox and a label maker, and the label maker is forty shekels.



Corn

Okay, so put the whole thing together for Daniel. The meter can tell him polarity if the jack is grounded to the chassis, and it's guessing after that. The meter cannot tell him the voltage at all, because the input is silent. The meter can, if he opens the device, read the polarity right off the trace and that's the only version of the answer that isn't a guess. The bench supply can tell him which kind of regulator he's feeding by watching the current, and the current limit is what keeps the board alive while he finds out.



Herman

And the honest limit of all of it is that none of it recovers the number that was on the label. If the label is gone, you bound the problem and you stay inside the safe band, and you accept that the device might really want twelve and you're giving it nine and it'll run until it doesn't.



Corn

Which is Daniel's way it goes wrong exactly. It turns on.



Herman

It turns on, and it turns on at nine, and it turns on at twelve, and the only way you ever knew it wanted twelve was that it started misbehaving last Tuesday.



Corn

That's the thing I keep coming back to.



Herman

Say the thing.



Corn

That the device is not a witness. It will not tell you it's unhappy at the voltage you gave it, and it cannot tell you what it wants, because it doesn't have a mouth and the pins are dead until you feed them. You're not measuring anything. You're inferring everything, and the metering is just a way to keep the inference from being fatal.



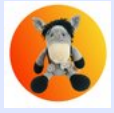
Herman

That's the honest version of the whole episode.



Corn

Then the cutting room floor, because there's a fact in here that didn't earn a place in the discussion and I want to use it. The forward drop. Six tenths of a volt on a standard protection diode, under three hundred millivolts on a Schottky. That number is the whole reason Schottky diodes exist in the parts catalog, and it's the exact tax between guessing and protecting. Nobody in this drawer is paying it, because the drawer is full of devices that didn't come with protection and the adapters that came with them.



Herman

The diode costs less than the sticker on it.



Corn

It usually does. So to Daniel: half his instinct is right, the half he trusts is the half that's wrong, and the only evidence that's real is the current.



Herman

The bench supply answers the voltage question by inference. The multimeter answers the polarity question partially. And the device looking fine is the trap, every time.



Corn

Which takes us to the close. Hilbert, thank you for producing, and thank you for the printer stall, which we are going to end up going to.



Herman

We are going to end up going to it, and he's going to be closed.



Corn

If you want to send us your own prompt, you can do it on Telegram at t dot me slash MWP listener bot. And if you've got a drawer of orphaned adapters, leave us a review and tell us what's in it, because we want to feel better about ours.



Herman

You want to feel better about the drawer.



Corn

I want the validation.



Herman

For more along these lines, there's episode four, If Your Voice Ages, Does Your Fine-Tune Become Useless; episode sixteen, On Deepfakes, SynthID, And AI Watermarking; and episode eleven, How Does Fine Tuning Work Anyway. This has been My Weird Prompts. We'll be back soon.

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