

# Mains Adapters

## The case of the treacherous LED...

Dr. Thomas Scherer

I notice on the cover of an old copy of Elektor in large print it states: 'Equipment is only as good as its power supply'. Even though that particular edition is now more than thirty years old the statement is as true today as it was then.

### Relations

Fourteen days ago I took a call from my wife's cousin Tina; she was having trouble connecting to the internet. I pictured their network setup which I had installed a few years ago: an internet router with Ethernet connection to an access point providing WLAN coverage for all the family's laptops. It appeared that none of the lights were lit on the access point. The usual suspects had already been ruled out: the mains adapter had not been accidentally pulled out and power was definitely available at the wall socket. On the face of it this was almost certainly a hardware failure, either a mains adapter or one of the pieces of equipment or maybe both; it was difficult to be more specific over the phone.

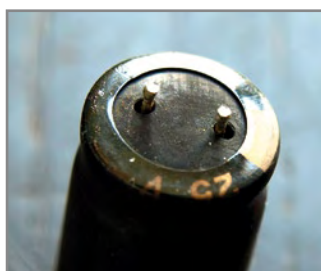
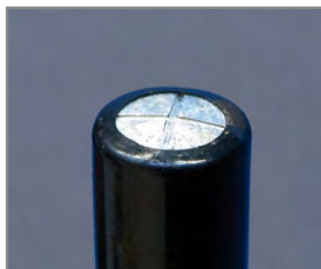
The next time they visited they had the access point and mains adapter with them so I was able to run some tests. Firstly plug in the mains adapter, check the output voltage... nothing; this was going to be easier than I had thought. A rummage through my drawers did not produce a suitable replacement adapter capable of supplying 5 V at 2 A so for testing I rigged up a bench supply with the output set accordingly. The access point sprang into life and I could connect to it using my laptop. The diagnosis was clear; access point OK, mains adapter dead (makes a change, it's usually the expensive part that breaks first!). This adapter was totally encapsulated so it could not be fixed. I identified several suitable replacements advertised on the website of a local electronics store; this was the quickest and cheapest solution to the problem. It was now only necessary to carry out an on-site reconnection of the equipment with the new adapter before harmony (and internet access) could again be restored to the family.

### Two weeks later

It's 10 pm on a Sunday evening and after a busy weekend it's usually a good time to sit down, check my inbox and look for any interesting new posts in the forum on the Elektor website. To the left of the screen next to the list of E-mail accounts I notice an unwelcome icon indicating that the last attempt to access the mail server was unsuccessful. A click on 'receive' does not clear the problem and while attempting to surf, the browser confirms that there is indeed no internet connection.

### Watson, Bring my spy glass

What's going on? Maybe the router had somehow reset to its factory settings? Using the browser to access the router's setup page indicates that the problem is more serious; it is not possible to view this page.



I looked behind the monitor where my eight-way Gbit-hub is hidden and see that the power LED is lit but all of the other port LEDs are off.

Perhaps the hub firmware has crashed? Disconnect the mains plug, wait a few minutes then plug in again... still only the power LED was lit.

It was time to disconnect the equipment and take a closer look on the bench. It didn't look as if we had the same problem as Tina, the power LED indicated clearly that the adapter was supplying power.

Just to be sure I measured the output voltage and although slightly low (7.39 instead of 7.5 V) it was certainly in the ball park and should not be the source of the problem. As a test I switched the adapter output to 9 V and tried again but still only the power LED lit up.

It was fairly easy to identify two step-down regulators on the hub's circuit board, one of them was producing 3.32 V which is a fairly typical supply value for modern LSI devices while the other had an output of only 1.18 V. This value seemed way too low to power the chips on the PCB.

With the finger of suspicion now pointing back at the mains adapter it was time to break out the bench supply again, this time set to 7.5 V with a 1 A current limit. Bingo, the hub booted up and all the LEDs lit up as if Christmas had come. It seems that the mains adapter had not been delivering the goods despite the power LED indicator.

### Mains adapter

With the adapter safely disconnected from the mains and its cover off I had a closer look inside to see if anything was obviously amiss. This unit had performed flawlessly for the last three years and seemed in good condition but my eye was drawn to an electrolytic output capacitor which had a 'lightly toasted' appearance. More disturbing were the bulges in its aluminium casing and swelling of the rubber gasket around the leads, this device had at some point obviously sustained a high internal pressure and over-temperature event.

The picture shows the PCB with a new capacitor fitted; the red arrow points to the old one. It was a little curious, the power LED had indicated that the supply was OK and the no-load output voltage was almost correct but the hub did not function correctly. Markings printed on the case indicated that it was a 1000  $\mu\text{F}$  capacitor but measurement with a component tester yielded a value of just 65.4  $\mu\text{F}$ . A loss of 93.46 % of its capacitance would produce abysmal supply regulation especially under load. The truth is an LED is not at all fussy about the quality of its dc supply but the same cannot be said for the high tech chips found in modern equipment.

So the lesson here is don't be fooled by the reassuring glow of an LED and while it may be true that the equipment is only as good as its power supply, in this case the power supply is only as good as its capacitors...

(080077-1)

