Teardown: Lightning strike explodes a switch's IC

Brian Dipert - October 24, 2014

In my last product teardown, as well as in a recent Brian's Brain blog post, I mentioned that my Rocky Mountain residence had recently barely dodged a lightning bolt (something that in my three years here I've learned happens all the time). Although the strike was a near-miss, the EMP (electromagnetic pulse) that it generated still fried several electronics devices inside the house. One of them, a LG-Ericsson ES-1105G five-port GbE switch, was my last teardown victim. Another, D-Link's GO-SW-8GE eight-port GbE switch, gets the teardown treatment this time.
Both the ES-1105G and GO-SW-8GE exhibit the exact same post-lightning strike (non-)behavior; a refusal to power up. When I took the ES-1105G apart, I was able to see no visible evidence of IC, passive component, etc. damage. Nonetheless, I postulated:

*If I had to guess, I'd suspect that the lightning bolt-generated EMP entered through one or multiple of the switch's [Ethernet] ports and KO'd the [Realtek] RTL8367 controller inside.*

Will an inspection of the GO-SW-8GE's insides provide more tangible clues as to the reason for its and its five-port sibling's demise? Let's find out. Removing four Philips head screws, two on each side, enables removal of the switch's top panel.
Perhaps the first thing you'll notice are the row of four Bi-Tek FM-3178LLF dual LAN transformers across the top of the system board in the photo, near the switch's rear panel. Or maybe your eyes will be drawn first to the eight activity LEDs along the bottom of the board, next to the power LED, and all located at the switch's front panel. Or maybe you'll notice the "wall wart" power connector on the left.

Probably not, though. Instead, I suspect that most if not all of you will first notice the IC with several explosion holes in its package top lid ;-) . From the remaining discernible markings, I can tell that it came from Realtek. And if I had to hazard a guess, I'd suspect it was the RTL8370. But in this case, there can be no doubt as to the reason for the switch's demise: the lightning bolt-generated EMP definitely did KO the controller.

In the spirit of completeness, I decided to remove two more screws and see if there's anything else notable on the PCB underside:
The answer: not much, unless you're into passive components and solder joints. Discoloration of the latter does, however, suggest which of the transformers (therefore Ethernet ports) specifically got lightning-zapped. If memory serves me correctly, that was the port whose long span of Ethernet cable connected it to the five-port switch that also died. I also see PCB discoloration in the trace paths between the Realtek controller and the LEDs, and the power connector. And in fact, my multimeter has revealed that the “wall wart” has also expired. But I remain convinced that the system's death blow entered via Ethernet, and traveled elsewhere from there. For the reasons why, stay tuned for next time's teardown.

P.S. As I peruse the GO-SW-8GE PCB, I once again can't help but notice how highly integrated cost-sensitive designs such as this are. I also can't help but notice the complete absence of a standalone code storage device, specifically an in-system- and on-board-reprogrammable flash memory.

Admittedly, there's nothing keeping a semiconductor supplier like Realtek from integrating some amount of code memory on-controller. And I suppose it could be reprogrammable memory. But that’s the beauty of a chip designed to only support an industry-standard specification. Assuming the chip design is bug-free in its inherent silicon implementation, there's no specification evolution that needs to be comprehended, particularly at this system design entry level. And industry standardization leads to another benefit: the ability to implement as much of the design as possible in hard-wired circuits versus in software running on a CPU.

This teardown is part of a series on equipment damaged by a lightning strike. Read the rest of the series here:

- Lightning strike becomes EMP weapon
- Teardown: Gigabit Ethernet switch shut down by lightning strike
- Teardown: Ethernet and EMP take out TV tuner

Also see:
- Lightning strikes
- The anatomy of a network switch: an eight-port, gigabit glitch
- The effect of a nuclear EMP event on a dental implant