Optocouplers and Cigarettes

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Optocouplers and cigarettes have a lot in common. Both burn excessive energy during operation and get hot as a result. Both are overpriced for what they provide, and the use of either product is strictly habitual. Both shorten the lifespan of the user (humans in the case of the cigarettes, electronic systems in the case of optocouplers). Lastly (and undeniably), both stink while being used – the cigarette from byproducts of combustion, and the optocoupler from incredibly crummy performance and reliability.

Nevertheless, like Pavlov and his dogs; we system designers instinctively reach for the optocoupler for our signal isolation fix…and why not? After all, if optocouplers are so bad, why are they widely used in such high volumes? Surely the commercial success of optocouplers suggests some degree of product goodness, right?

Wrong! And here’s why: until recently the technology to build viable optocoupler alternatives did not exist. This lack of options enabled optocouplers to dominate what amounts to a decades-long, captive market. Round about the time man first walked on the moon, a device called a “light cell” hit the market and was the first commercially available “optocoupler-like” device. The light cell consisted of a tiny light bulb and two photo resistors wrapped in a heat-shrunk tube.

Energizing the light bulb caused the ohmic value of the photo resistors to change in proportion to the bulb current…sound familiar? Back then, virtually all electronic equipment (except computers) were implemented with analog components, with light cells serving as analog signal isolators. A few short years later, semiconductor LED and photodiode technology went mainstream, enabling what are now called optocouplers. Optocouplers not only replaced light cells, but seized their market momentum as well. It was the light cell that generated a follow-on optocoupler market in much the same way the Marlboro Man generated follow-on teen cigarette markets. Unchallenged, optocouplers maintained the lion’s share of the isolator market for decades…not bad for a schlock hybrid device that grew from a heat-shrink tube!

But the paradigm is shifting. Today, we instinctively understand that each electronic gadget generation must be smaller and deliver more features than the previous generation. Semiconductor manufacturers meet these demands with new, higher integration and value-added ICs that eclipse their predecessors.

So given all this, why limit isolator design options to thirty-year-old optocoupler technology? Why not kick the optocoupler habit once and for all and experience real 21st century CMOS isolation technology? After all, would any of us trade our CMOS MCU for its NMOS predecessors? No. Would we trade our CMOS static RAMs for the old bipolar stuff? No. Are we impressed with the low-power, high-speed and robust nature of modern-day CMOS products? Absolutely. Well, then why not CMOS isolators?

Consider the facts surrounding optocouplers: their operating parameters wander all over the place with temperature changes and device age…hardly an asset. On top of that, they often die young from self-inflicted wounds, such as light output (LOP) failure when operated at elevated temperatures and/or high LED currents. These two drawbacks alone should frighten any designer interested in system reliability, high temperature operation and long system lifetimes. But wait, there's more….

The wimpy optocoupler is both single-ended and has a generous amount of input/output capacitive coupling. These two deficiencies combine to reduce common mode transient immunity (CMTI). Is that bad? You bet it is. Let's say a fast voltage transient were to appear on the optocoupler output side. Low CMTI enables this transient to couple through to the optocoupler input side where it can yank the LED terminals around hard enough to erroneously turn the LED off or on. The result is multiple optocoupler output errors. So how does one fix that? By driving the LED hard when it's supposed to be on, and reverse biasing the LED when it's supposed to be off. But of course, these actions accelerate LOP failure, which in turn forces the designer to trade good reliability for CMTI or vice-versa. Then there's the optocoupler's robust power appetite that can range from tens of milliwatts to hundreds of milliwatts per isolation channel – hardly "green." There's even more beyond this: the optocoupler's glacial operating speed, need for external passives in the signal path, low channel count per package and missing specs.

So how do CMOS isolators stack up against the optocouplers? Above all, CMOS isolators have none of the issues described above. Beyond that, CMOS isolators offer highly stable operating parameters over temperature (-40 to +125 degrees C) and voltage (2.7V to 5.5V), fast, tight timing performance, high CMTI (>25V/uS), high integration (up to 6 channels per package), low power operation (as low as 7mW/channel) and 10x higher reliability than optocouplers.
Yes, optocouplers have a lot in common with cigarettes: both have outlived their market appeal, and consumption of both products is falling as potential users abandon impulsive urges in favor of well-informed decisions – like using CMOS isolators.

To learn more about digital isolation, visit www.silabs.com/isolation [1], download some digital isolator and isolated gate driver datasheets, and read all about all the CMOS isolator attributes waiting to enhance the performance of your next design.

Links:
[1] http://www.silabs.com/isolation