Letter to the editor

Marcel van de Gevel from Haarlem, The Netherlands, writes:

Dear Editor,

I highly appreciate the considerable amount of effort that Morgan Jones has put into his article "Rectifier snubbing - background and Best Practices" in Linear Audio volume 5. It is good to see that these circuits can be designed more scientifically than by just randomly selecting a capacitance between 10 nF and 100 nF, which, to be honest, is the procedure I've always followed.

Still, his article leaves me with a couple of questions. The most important one is which problem he is trying to solve. He wants to prevent ringing, but it isn't entirely clear to me why.

Mr. Jones refers to the capacitors across rectifiers as snubbers. I know the term snubbers from power electronics, where it usually refers to some RC network that is there to prevent large voltage peaks that might otherwise blow up the power semiconductors. If that is the purpose of the snubbers in this article, how can one determine from small-signal analyses with swept diode bias points whether the ringing could be severe enough to blow up the rectifier diodes in the first place?

In my native language, Dutch, the capacitors across rectifiers are commonly known as ‘ratelcondensatoren’, rattle capacitors. I've always been told that the purpose of a ratelcondensator is to prevent interference on nearby radios by unintended modulation. The mains wiring and the chassis of an electronic apparatus can act as an aerial. The parasitic capacitance between primary and secondary side of the mains transformer couples the main wiring to the rectifier diodes. The impedance of the rectifier diodes changes with the current through them, so they act as a mixer, mixing mains hum on any received radio signal. This modulated signal then gets retransmitted by the mains wiring/chassis aerial and causes interference on any nearby radio. I know from experience that these capacitors can be extremely effective against this kind of interference, even at FM frequencies.

If Mr. Jones wants to solve this issue, then I don't understand how a capacitor across the secondary of the transformer can help, at least not for a transformer with no centre tap that is connected to a full-wave bridge rectifier. The parasitic modulation effect is basically a common-mode phenomenon, so a differentially connected capacitor cannot have any effect. You would at least need a capacitor from each secondary pin of the transformer to the chassis (ground), which still requires only half the number of capacitors of the traditional solution.

Morgan Jones replies:

Mr van de Gevel asks pertinent questions. Why prevent ringing? My experience is that when a circuit rings, that ringing finds its way into other circuits, usually via interwinding capacitance in the mains transformer (a common-mode effect, as Mr van de Gevel points out). We can add filters to block unwanted frequencies, but the best cure is always to prevent interference at its source. The problem is the series resonant circuit made up of transformer leakage inductance, diode depletion capacitance, and loop resistance. If we can reduce this circuit's Q to < 0.7, we can prevent ringing – making it unnecessary to worry about amplitude and large-signal effects. The traditional solution reduced Q (Q = 1/R sqrt(L/C)) by increasing C – adding a large capacitance across the diode's depletion capacitance, and making it lossy by adding series resistance. But we could also correct transformer leakage inductance to a resistance, thus reducing L, and that is what the network across the transformer secondary does.

I had not considered the transformer/rectifier as a mixer, with rectifier switching causing double sideband suppressed carrier modulation to a capacitively coupled carrier from mains wiring acting as an aerial. However, the forward resistance of a semiconductor diode is very low, so I don't see how a rattle capacitor (lovely term) would have reduced modulation. I can't help feel that the modulation scenario is rather lossy, requiring large signals to be present in the mains wiring, whereas mains transformer primary/secondary capacitance could easily couple a rectifier's bursts of ringing onto the mains wiring aerial, allowing a nearby radio to demodulate it as hum simply because of the repetition rate.