on this grot. Not my cup of tea and I am cancelling my subscription.

G. Kratzin (Germany)

A bemusing response indicating that Mr Kratzin has missed the point about our Retronics articles entirely, see the footer printed with every instalment.

Anti-Standby Switch — a sequel on safety

Dear Editor —on your green standby switch project (January 2008, *Ed.*), a current transformer MUST always work into a very low impedance load. It is extremely dangerous to not have a low-value load resistor across the secondary, across which a small ac voltage is developed. So dangerous that some commercial current transformer manufacturers install the load resistor within the transformer module. Without such a load, under transient and high current events several thousand volts can be developed across the secondary as it tries to drive its secondary current into a non-existent load.

Without a load a CT looks like a voltage step-up transformer multiplying the 240VAC mains input being pushed through it. Only the saturation of the core limits the energy.

The secondary winding, load resistor and PCB must be rated for the divided down primary load current. For example if the primary is rated for 13 Amps and there is a 1:10 turns ratio then the secondary must be designed for a steady state current of 1.3 Amps and a peak current of say 5 Amps (typical domestic 0.2 second fault current is 50 Amps).

Obviously with a low impedance load and suitable conductors the power dissipation is very small.

(name withheld at request of correspondent)

The designer, Thomas Scherer, replies

Dear Jan — I thank the correspondent for being so concerned about security issues. But in my eyes he is too concerned about this and misses the point in some way. Specifically, the rule he mentions is no law of nature. In fact this is pure theory which doesn't match the real circumstances. Especially transients may happen with every inductive load, with coils and ordinary transformers too. This is nothing special. But they do not occur at the high energy levels he mentions. Therefore this never is as dangerous as you believe — otherwise a big part of commercially produced electronic devices would be dangerous. What he has not considered really is the amount of energy a pulse can have which is provided by this little current transformer. Like you said: this energy is limited by the core of this transformer and therefore is not insignificant. Second, there is no 'no load' condition. Connected to the secondary coil of the current transformer is found a 10-k resistor in series with a 100-nF capacitor which has nearly zero ohms for transients. A transient pulse of 1 kV peak should produce a current of 0.1 A which equals a peak power of about 100 W (for some μs). This little transformer is never able to produce such a peak power. And if you still believe in your theory: I measured the voltages which occur at the secondary windings of the current transformer during shutting off currents of 10 A on the primary side. The result is that the maximum measured pulse peaks do not reach 20 V. Is this dangerous? Not even for the following opamp, I believe, because the voltage at the 100-nF capacitor never exceeds 1 V.

Lastly the correspondent is completely wrong in thinking that the parts at the secondary winding of the current transformer need to withstand 5 A peaks. This really really never will happen. This is a practical case of impossibility ;-) So I am really sure the PCB is totally safe and nobody can be killed but your theory of unsafety....

Dr. Thomas Scherer

The original correspondent replies

Dear Jan — as your contributor Thomas points out it is all a matter of coupling. The CTs I was working with were designed to accurately measure (to within a percent or so) the primary current (typically 300 A) and in that application had many thousands of secondary turns to scale the primary current down to an electronics-friendly few milliamps using a substantial core. I have seen capacitors and ICs explode off the board when a load of 1 ohm was inadvertently omitted and in once case a senior engineer was thrown the length of the test bay when a technician

perhaps deliberately removed the working load.

In this application the CT is mostly sensing any significant primary current. I do not fully accept that the capacitor is a load since its contribution would be out of phase. The transient I am concerned about is the switch-on surge of the connected appliance, which with modern switch mode power supplies can sometimes be as much as 50 A for the first cycle.

So-called power factor corrected PSUs sometimes have a lower in-rush current. Providing the core saturates at the odd amp or so the energy fed into the secondary is relatively small. Even so the 10 k resistor becomes a safety item, should this fail, downstream electronics would probably be damaged.

At one time we considered putting voltage limiters across the CT secondary but our Safety Committee could not resolve a satisfactory fail-to-safe mechanism and concluded that the reliability of a quality ohmic load was such that it far less likely to fail than the protection components proposed to protect the system should it fail. Every component was subject to such analysis which sometimes took weeks and sometimes needed experiments on live systems with induced failures.

Perhaps Elektor should publish a follow-up advising readers only to use the specified core and winding specification and not to substitute a genuine current transformer which is likely to have a very significantly higher coupling efficiency.

Current transformers are very weird components that few readers are likely to have had experience of. Although I never had a shock or caused others to have a shock off them, what I have seen has made me very wary of such an innocent looking device!

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