The AC/DC coil, arcing, partial discharge and EMI

Why simple relay and valve coils sabotage automation
and drives and what you can do about it

The 2002 presentation ”Små reläer stjälper ofta stora projekt” (http://gke.org/presentationer/files/Smaa%20relaer%20stjelper%20ofta%20stora%20projekt.pdf) in English version.

Please note that this presentation is based on an almost ten years old Swedish original and that there may be a few obsolete and/or national data that don’t apply universally.

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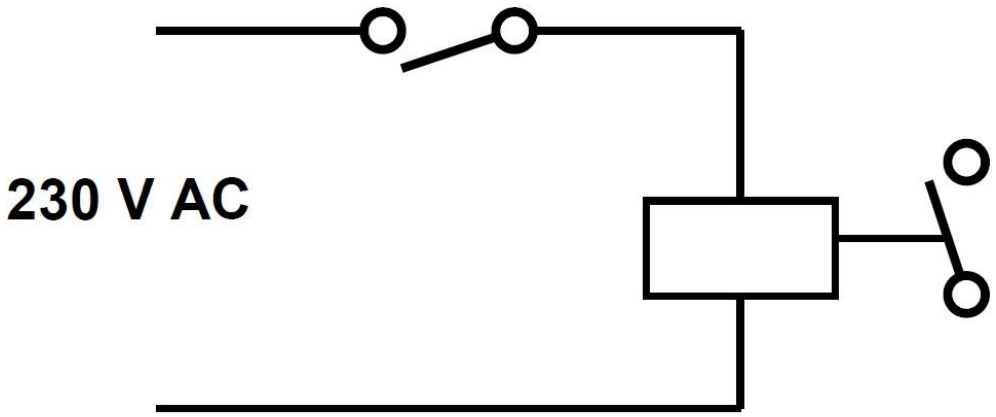
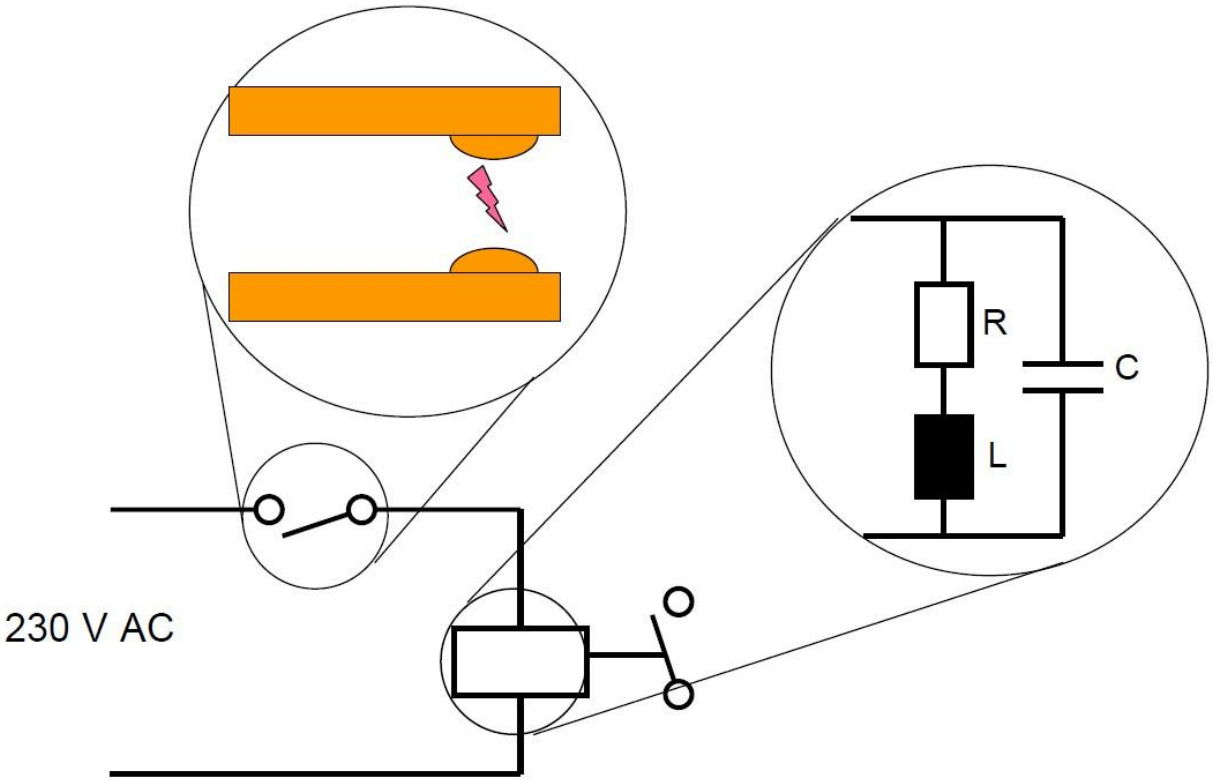
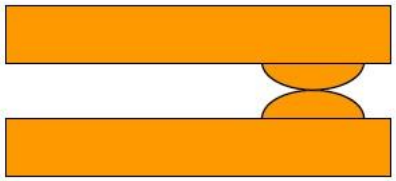
It looks very innocent…



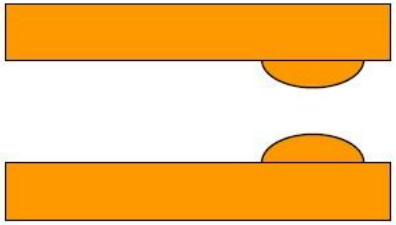
..but is a wolf in disguise



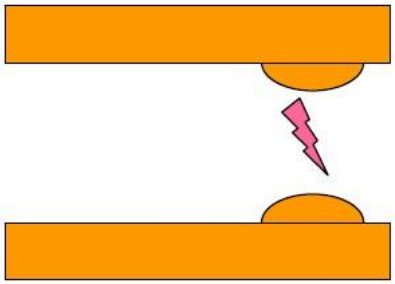
Opening the contact leads to a couple of repeating events



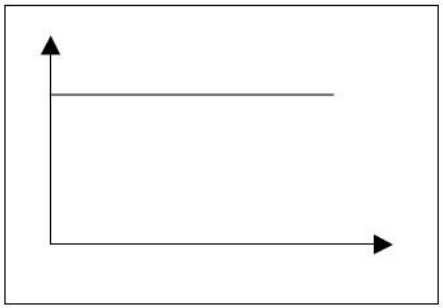
First: Current flows normally through the coil. Energy is stored in the magnetic field in L.

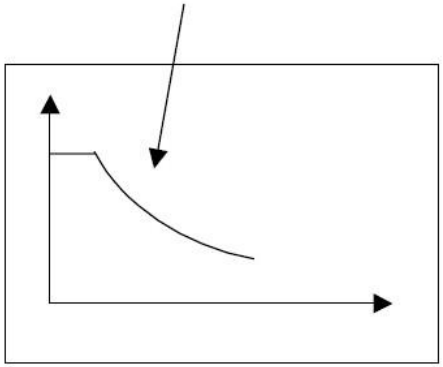


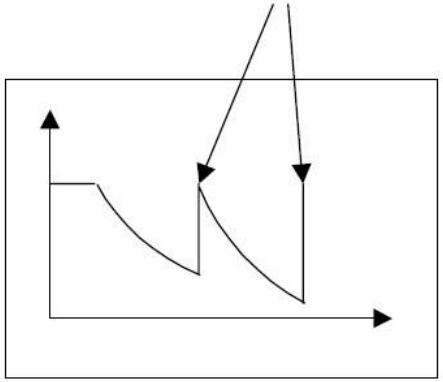
Second: Contact opens. Magnetic energy needs to go somewhere and charges C.



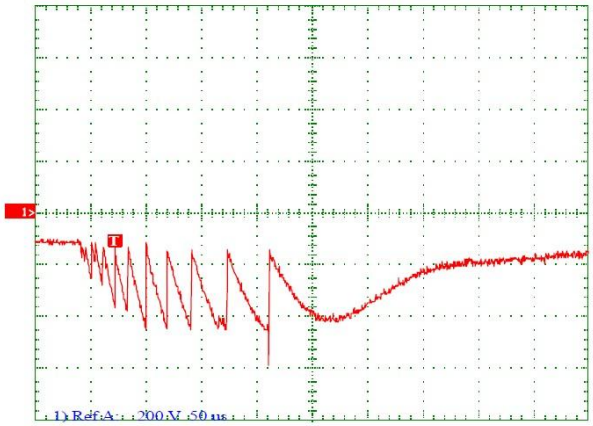
Third: Voltage across C increases as energy is transferred. At a certain voltage, there is a break down and C discharges.

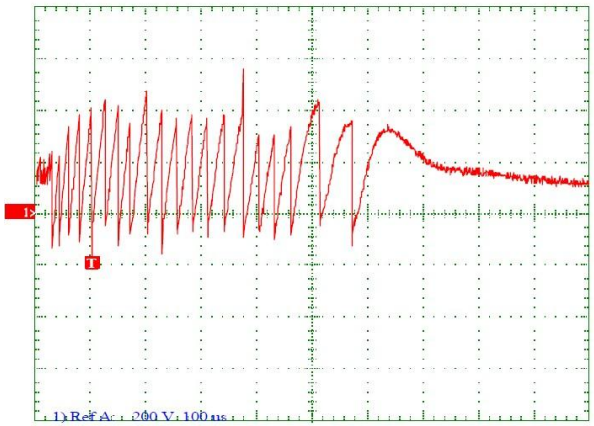


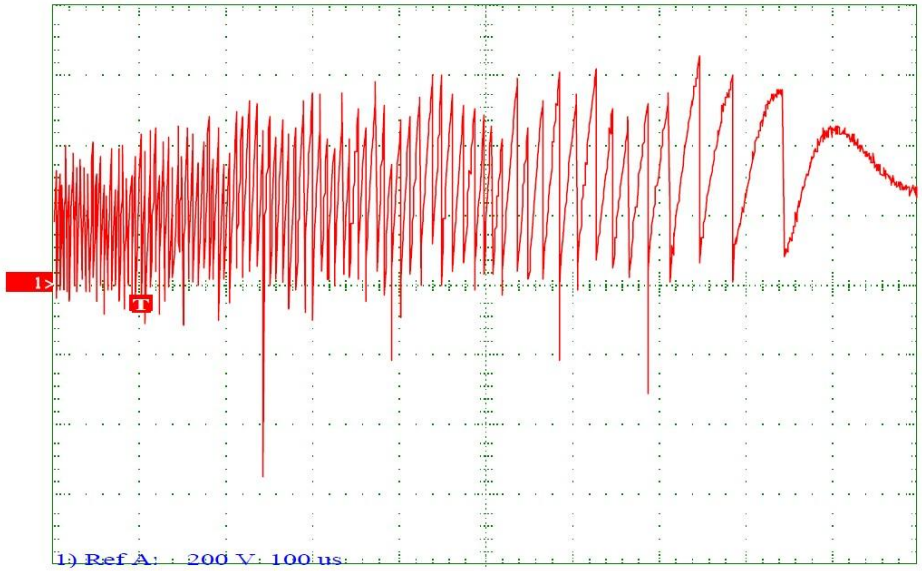




IRL, it looks like this:



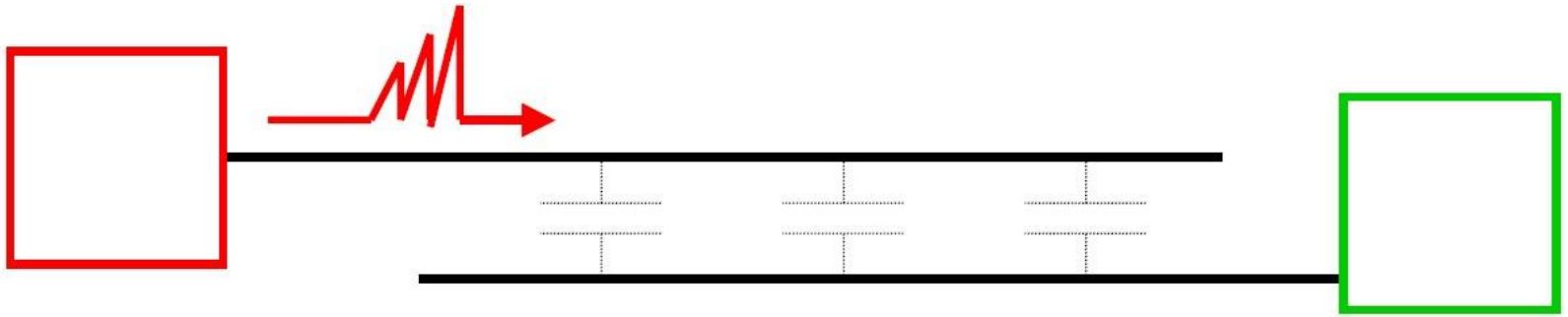




All recordings are from a 230 V AC relay coil and shows that there is mild, normal and severe arcing and that severity is purely random. For AC coils it mostly depends on where on the sinewave contacts open.

The discharges in these recordings have very fast edges and contain lots of HF energy.

The energy is coupled through (mostly) parasitic capacitance in wiring and cables and finds its way to other devices/components.

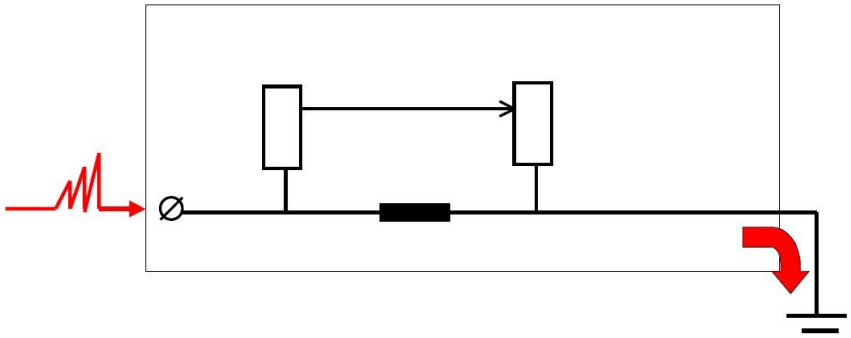


Red: coil (offender)

Green: victim

The capacitive coupling is sometimes difficult to predict and it is not always possible to separate offender and victim or change the wiring.

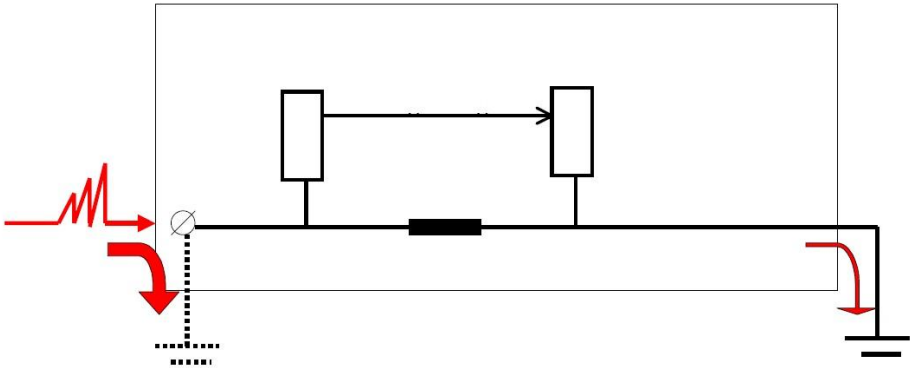
One thing one can do is to create ’early routes’ to ground. Consider the following rather common situation:



HF current enters the automation system (a computer board or VFD) to the left. Current creates internal parasitic signals across conductor inductance and (sometimes) resistance.

The parasitic signals (aka interference) add to signals in the system and can reset a counter, upset a latch and even destroy sensitive inputs.

Arranging an easy and ’early’ route to ground can often help. This ’multiple grounding’ is sometimes avoided by electricians. OK, that’s their problem. It is not against code and it helps.



The standard burst test is the IEC 801-4

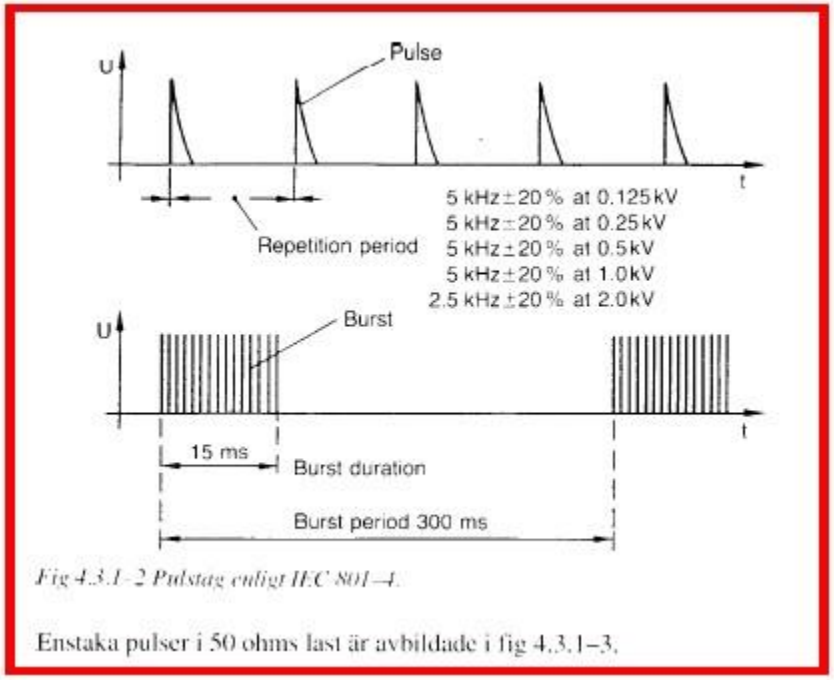
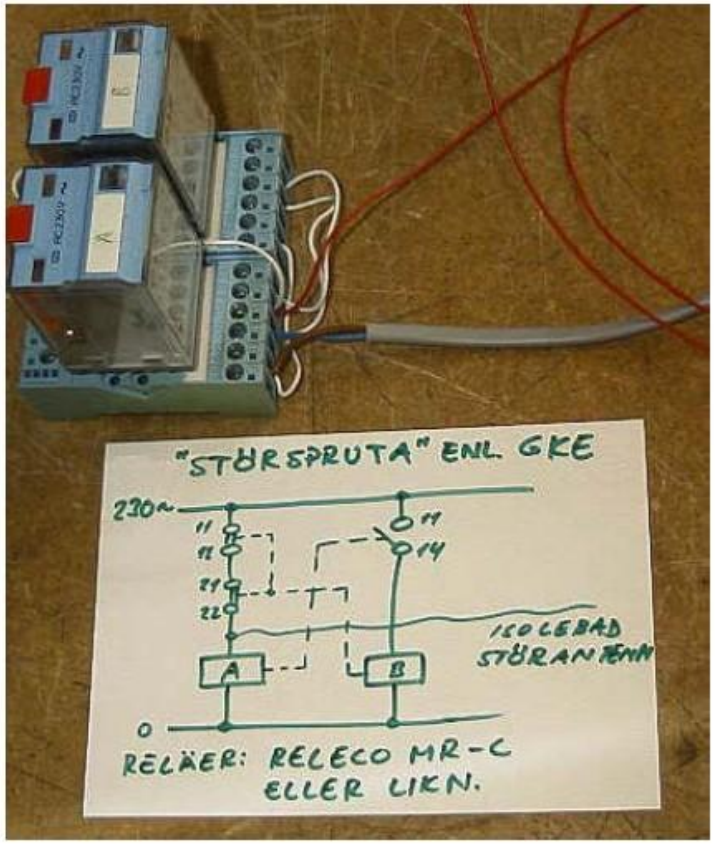


Fig 4.3.1–2 Pulstag enligt IEC 801–4.

Enstaka pulser i 50 ohms last är avbildade i fig 4.3.1–3.

We find it rather awkward and unrealistic to set up a test like this in an actual installation. It is very seldom just one or a few signal wires that one needs to test, but rather a whole system. The 50 Ω LISN isn't realistic either. Instead, we use a simple 'interference blaster'. Drop the antenna among cables in a cabinet and see what happens. Results in minutes instead of days. Not 801-4 – but efficient.

Build an ’interference blaster’ yourself



This one works with 230 V AC. Select relays according to your voltage. The red wire is the antenna. It is insulated and can be dropped down in any system for a quick and effective test.