SOLID STATE RELAYS FOR TRANSFORMER CONTROL

(AC-56a)

Proud to serve you

celduc® relais

USING SSRs ON SATURABLE INDUCTIVE LOADS PARTICULARLY PRIMARY WINDINGS OF TRANSFORMERS.

Driving a saturable inductive load often generates high peaks of voltage which may damage sem conductors used in ssrs.

I - WORKING ANALYSIS :

a) Non-saturable induction coil

It is preferable to control the induction of the induction coil at the maximum of the sine wave (peak starting) up to zero crossing (zero cross relay).

FIGURE 1:peak starting, no current surge

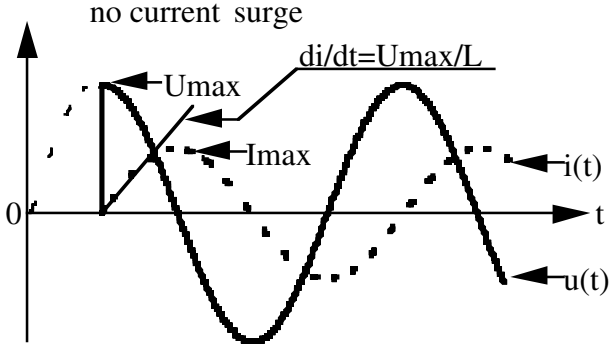
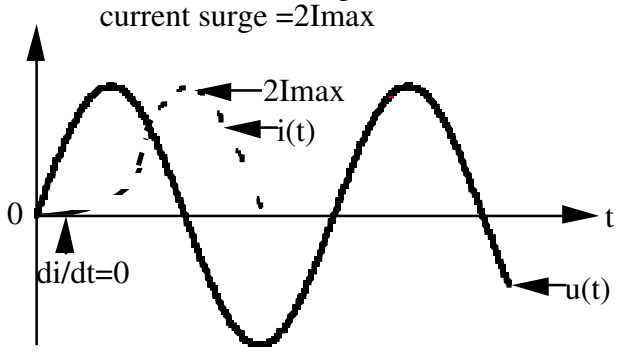


FIGURE 2:zero cross starting current surge =2Imax



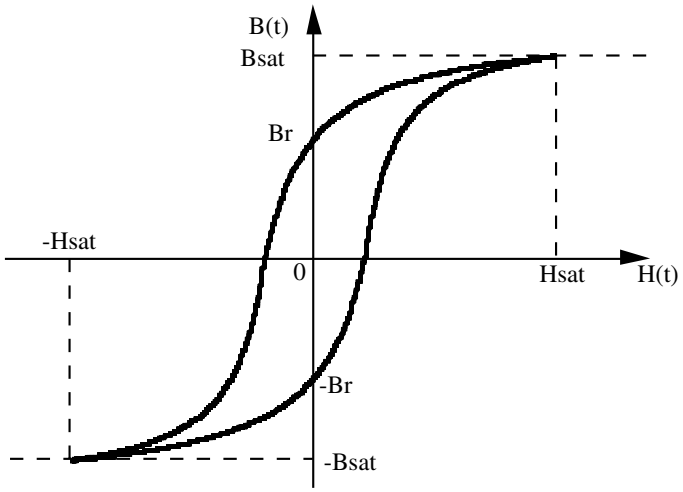
b) Saturable induction coil

Reminders :

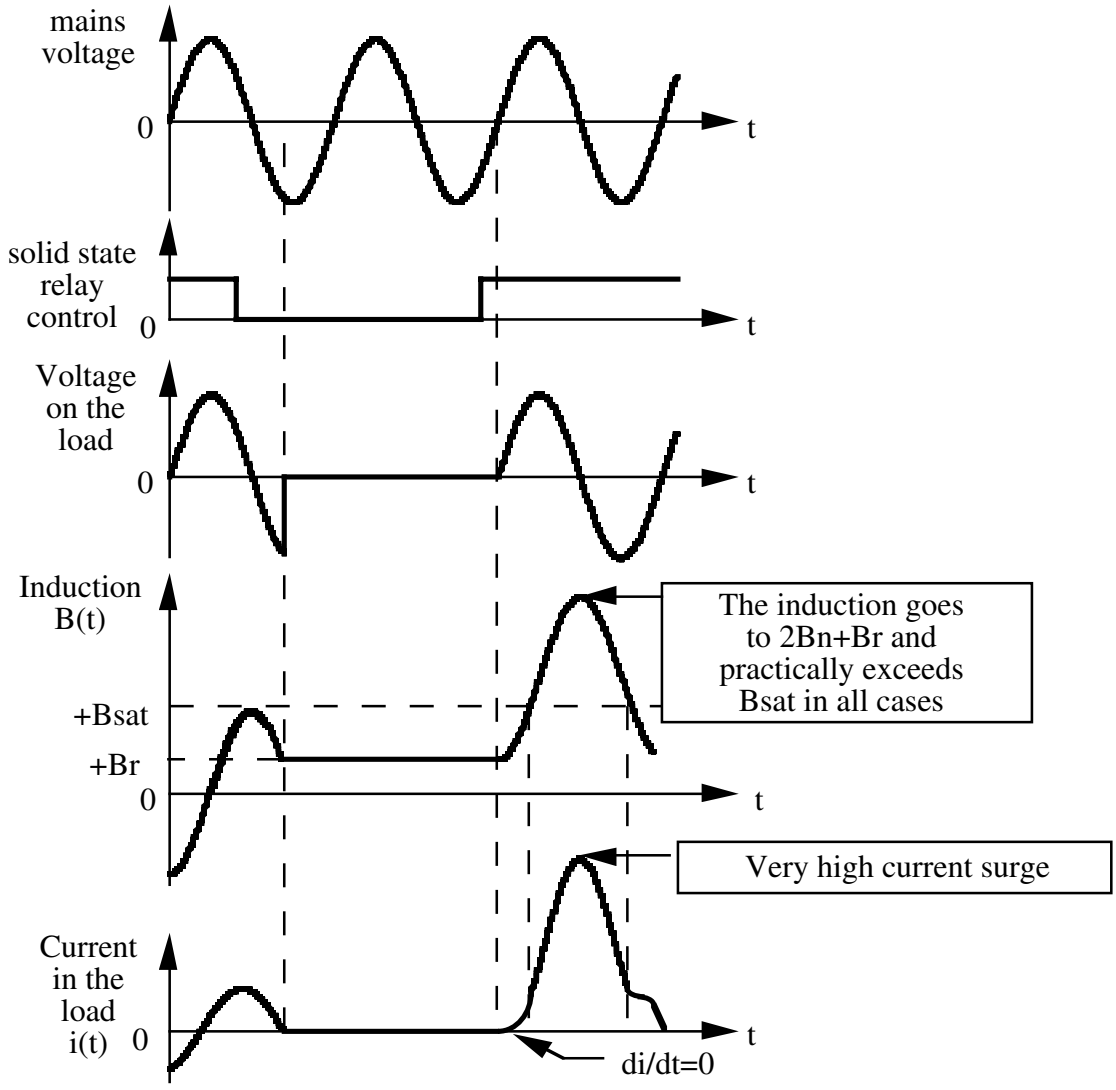
Voltage $u = -d\Phi/dt$ $\Phi=BS$ $B=\mu H$ $H=nI/l$ (i=winding current)

In permanent operation, the magnetic field H (proportional to the current) i varies according to the induction B according to Hyseresis cycle (fig 3), B is in quadrature with respect to U.
According to the stopping instant of the current, a residual induction persists (+BR -BR). The conduction instant is therefore of prime importance as saturation (Bsat) of the iron can be easily reached and gives rise to a significant increase of i.(u decreases).I may reach 100In.

FIGURE 3:hysteresis cycle



b-1 <u>Zero crossing start</u> : <u>Example</u> : control by zero cross SSR (zero cross)
Two cases can occur.
<u>Case n°1</u> : The starting is performed on the same half cycleas the previous stop.



In most of cases, the Bsat saturation induction is reached. The amplitude of the current (proportional to H), becomes very high.

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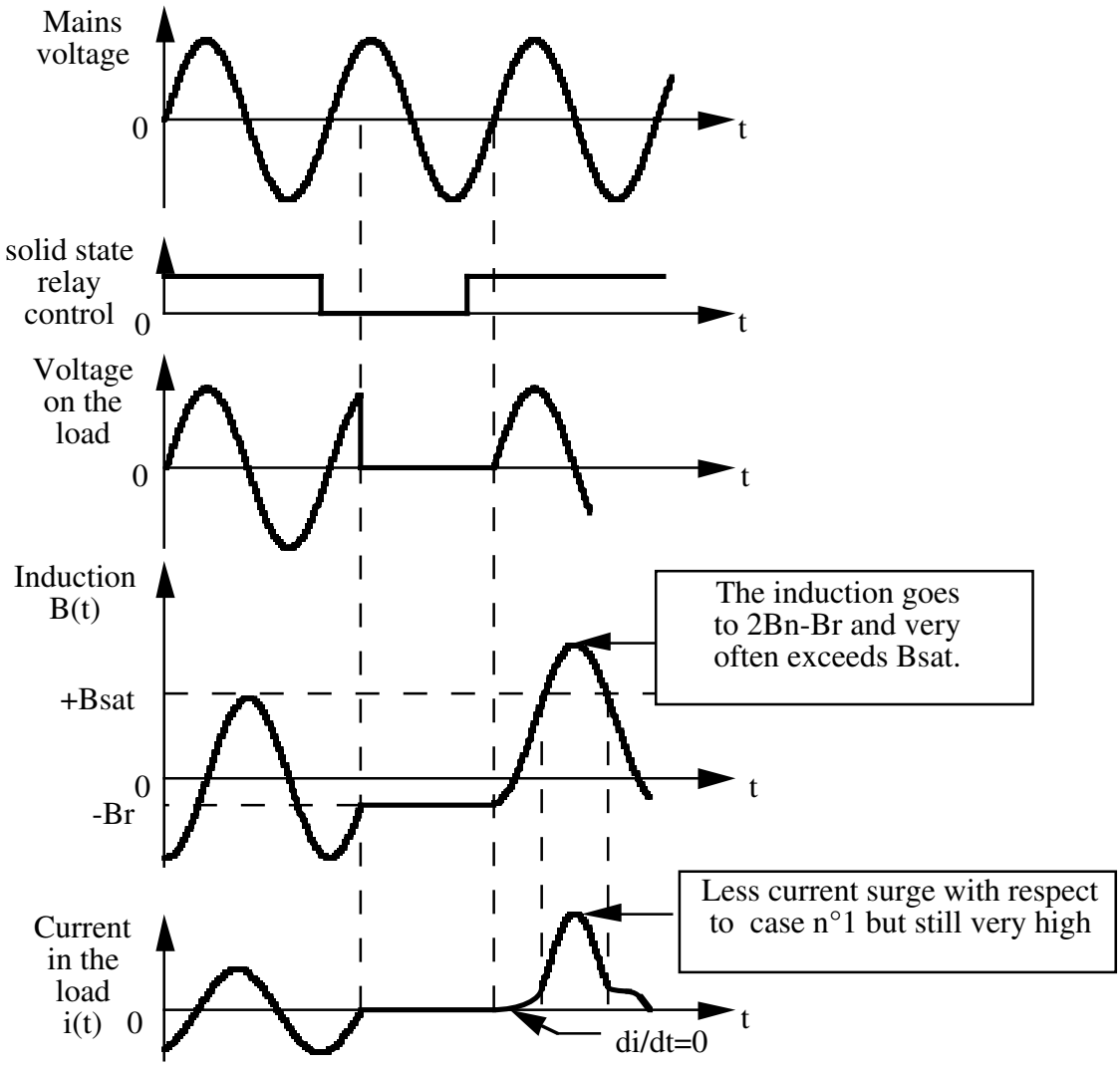
This type of control produces the most surges

Case n°2 : In order to decrease this current surge, it is preferable to have full cycles. The starting only takes place on the half cycle opposite that of the stop.
=> With a use of a zero cross solid state relay, the stopping phase and the starting phase must therefore be known to send the control.

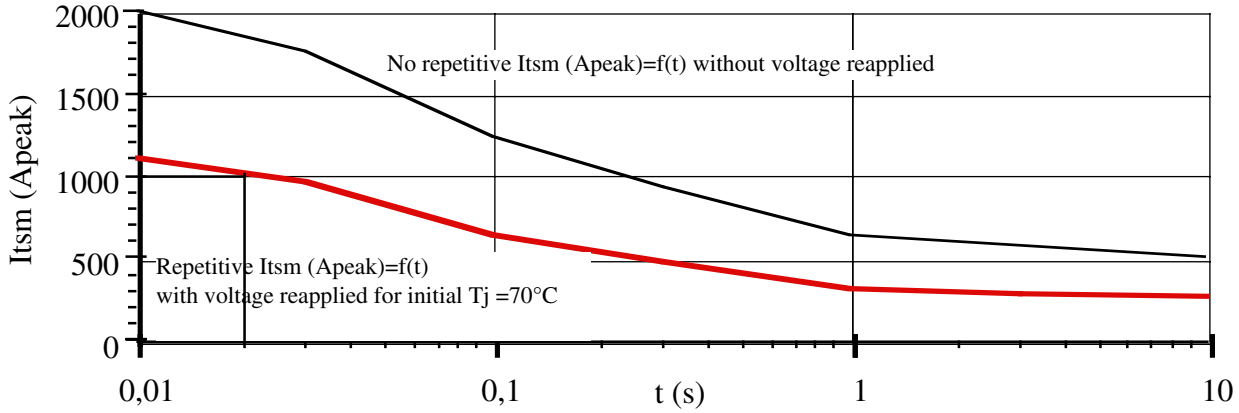


The induction reached is less important but often exceeds ahigh current surge remains.

It results that zero cross starting must be avoided on this type of load.

If the transformer is on load, the magnetising current value also takes on the secondary current brought to the primary winding which is weighted in the established rating but which can require zero cross switching in transient rating. This is the case of transformers secondary windings loaded with capacitors and where switching on at zero crossing is preferable.
In this case, it is necessary to adapt the rating of the SSR to the max. currents likely to be reached on starting.
This must therefore be checked with the curve Itsm = f(t) repetitively.

Surge current Itsm (A peak) = f(t) for 125A models with Itsm =2000A



Extreme example : with a relay of 125 A. With a surge of 20ms, the relay can withstand approximately 1000A about.
On a transformer, taking 100In at starting, the max. pilot controlable current with this relay would be 10A i.e. 4KV in 400VAC.

Note : on low loads, (small transformers...) the component R reduces the significant current peaks.

With a so-called (Random) solid state relay

The making occurs at any point of the sine wave. The probability of zero cross starting is less than at the peak. This type of relay is preferable to a zero cross relay, however, as the control is random, the current peaks are too. Starts can be optimised with the right control using this type of relays.

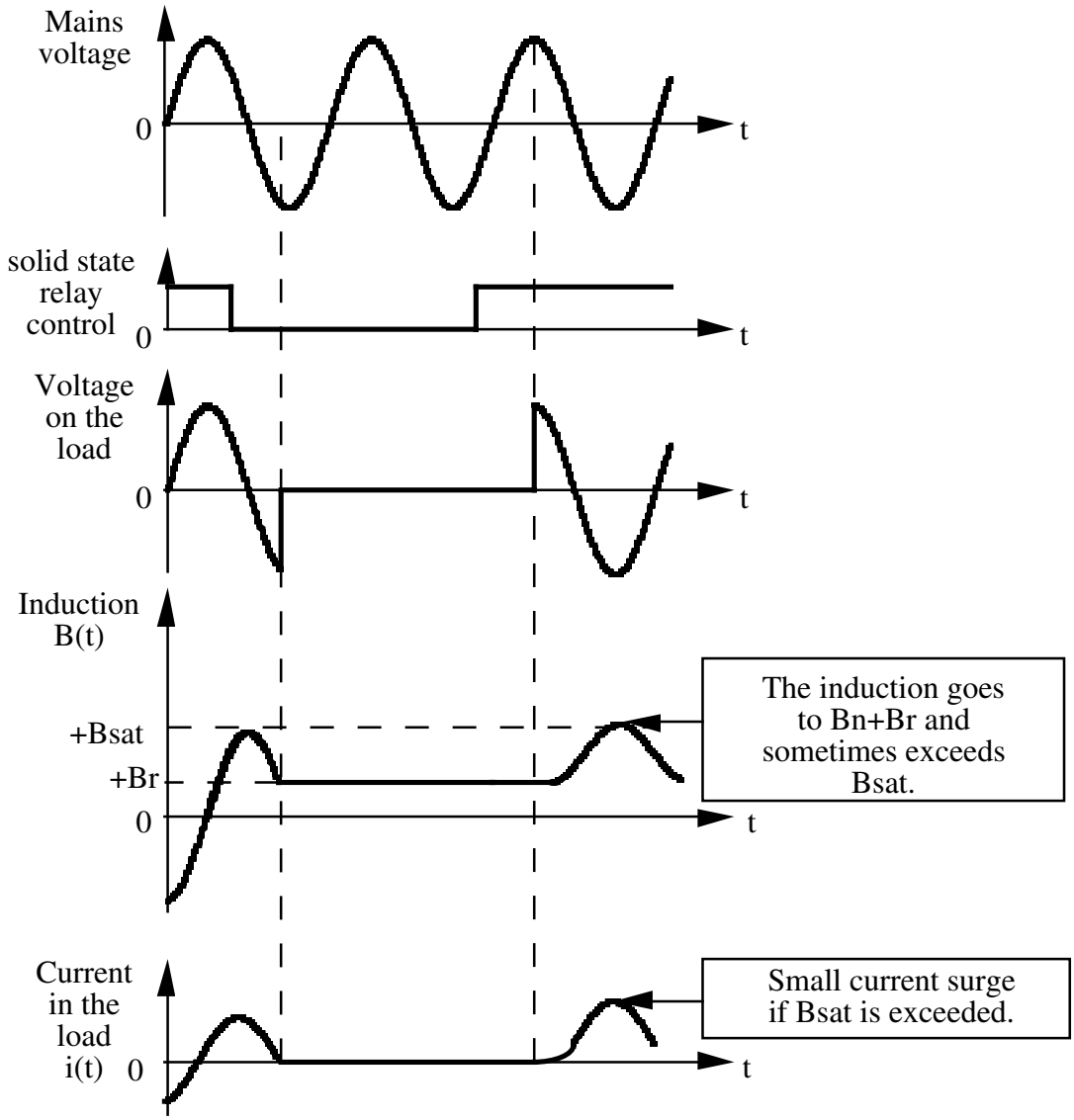
With standard SSRs, it is preferable to use random relays, but in all cases, the rating of the SSR should be oversized.

OTHER SOLUTIONS :

Peak starting

Two cases can occur

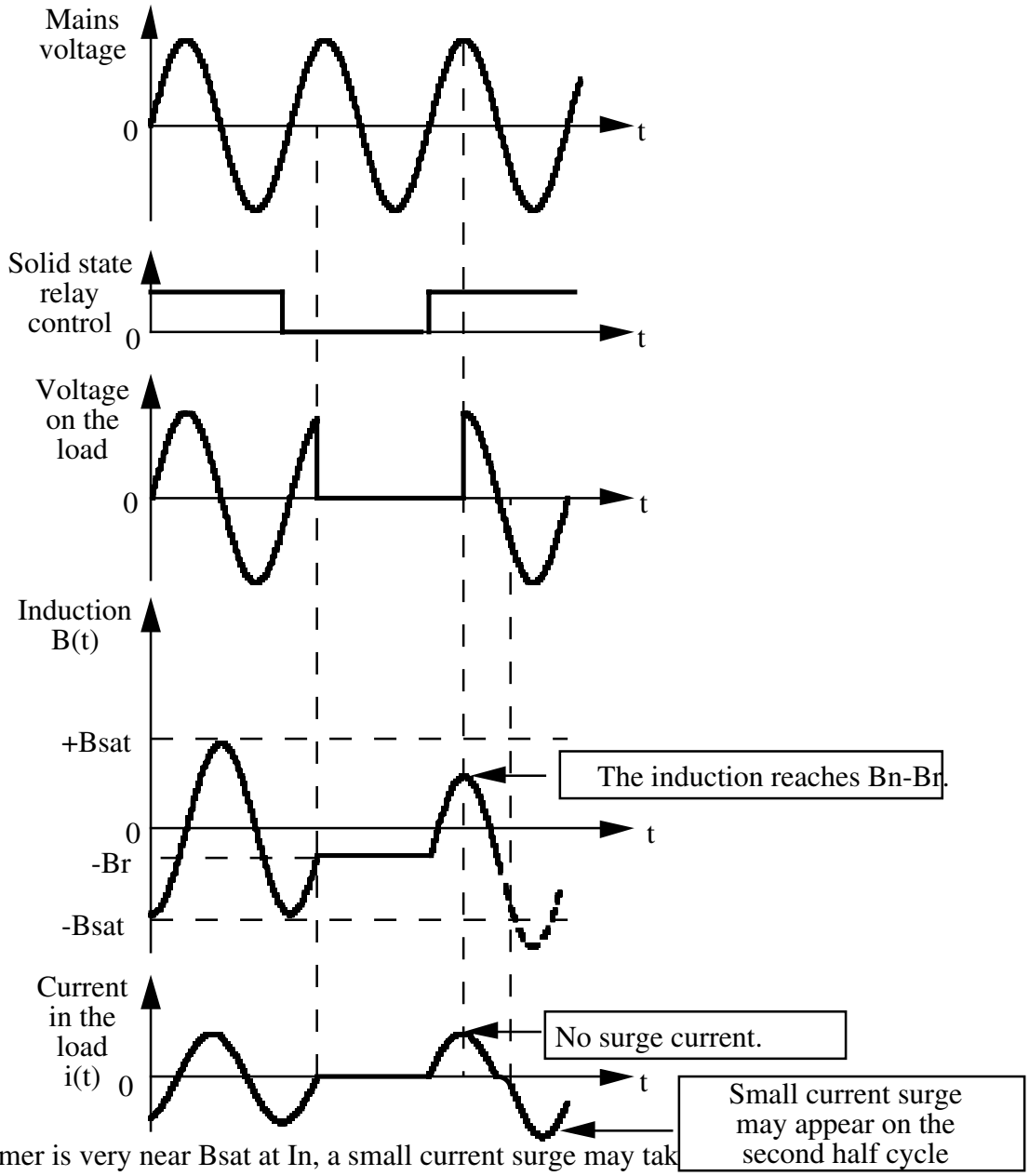
Case n°1 : Tha starting takes place at the peak but on the same half cycle as that of the previous stop.



In this type of control, in the most unfavourable case, the max. induction reaches Bn+Br.
In general, Bsat is not reached, and current stays within the allowable proportions. This type of relay is developped by celduc with the ref SCP. Model 230V and 400VAC 40Amp, and can be produced upon request up to 125 Amps.

Case n°2 :The starting takes place at the peak but on the half cycle opposite that of the stop.

In the case of the use of a "peak starting" relay : celduc SCP relay without phase angle control (case n°1). This case ocurs 1 out of 2 times (statistically).



Note: If a transformer is very near Bsat at In, a small current surge may tak
cycle.

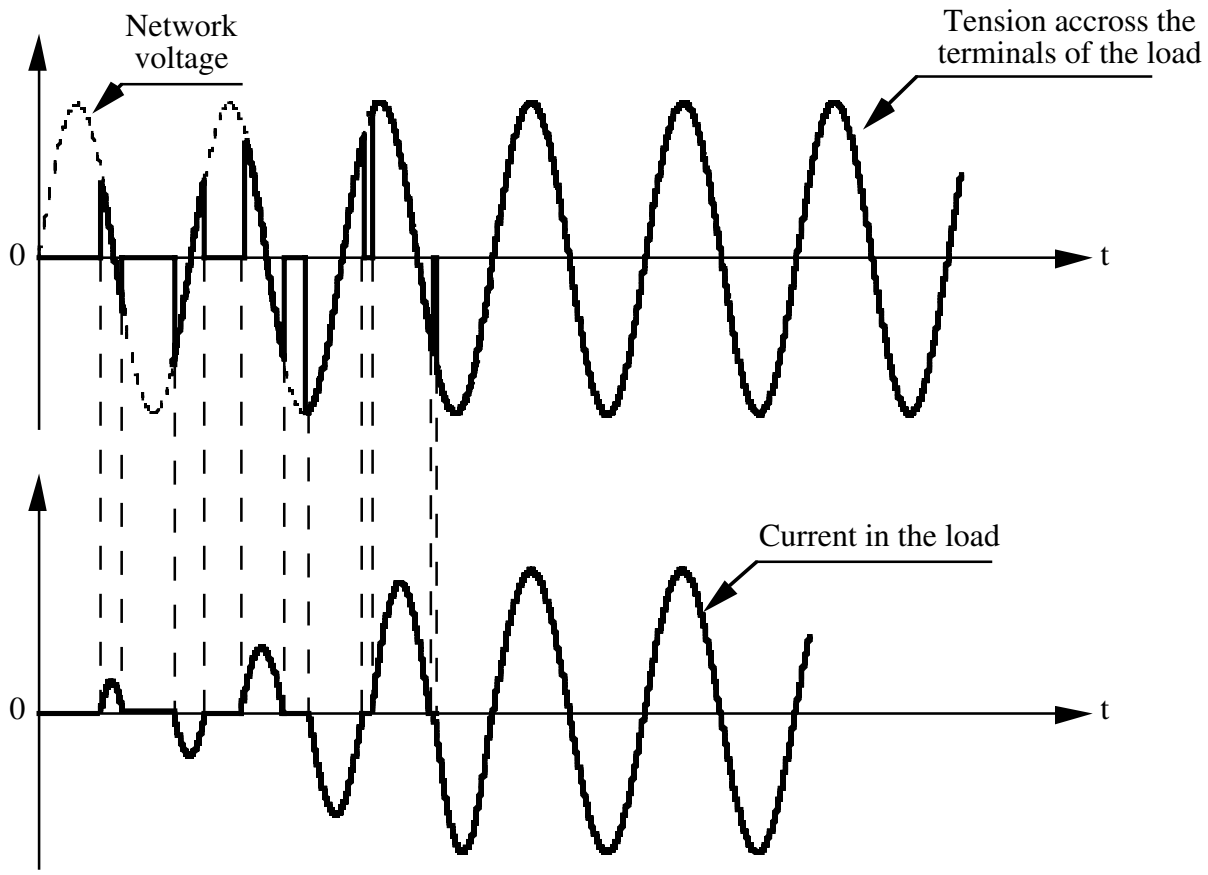
This is a good control for a transformer : peak starting+full cycles.

A peak starting relay allows for the starting current of a transformer to be reduced which avoids protection devices from breaking. Mains microcuts must, nonetheless, be accounted for.

The solid state relay must reesist the allowable peak current in the worst of condition (zero cross control).

Soft start relay.

Another solution entails a soft start of the transformer.



the SSR is lit up at the end of the half cycle and gradually offset until the full half cycle.

With a mora or less fast variation speed ramp, thje transformer and its load are gradually supplied without current surge.

This process can be provided by a proportional controller relay by celduc, type SG4 controller.

The new range of SMCW SOFT START three phase relays also allow for the starting of three phase transformers.

To ensure correct operation of these devices, it is nonetheless, necessary to have a minimum load on the transformer (a transformer at no load presents problems for the zero crossing of the relays). See the special application notes (SMCW on transformers).