

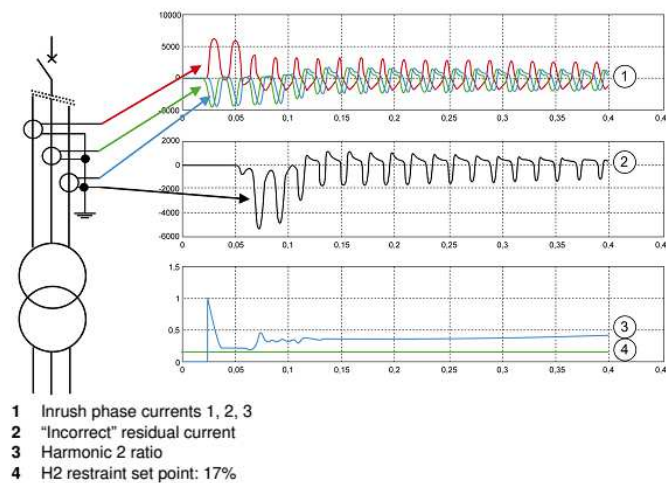
What is the role of Harmonic 2 setting in Earth fault protection setting?

In case of using phase CT summation for residual current measurement, there is a general agreement that the second harmonic is the preferred harmonic for use in harmonic restraint in current protection relays, especially for transformer applications. The second-harmonic component is by far the most prevalent in all inrush waveforms.

The diagram below is explaining, during a transformer start-up, how relay will measure incorrect residual current. As you see figure in below, the curve No.2 is showing this summation. This mal-summation is because of DC-off set in phases, consequently a wrong I₀ would be calculated by relay. So this will cause to nuisance tripping by 50N/51N protection. So it is a must to find a way to inhibit this protection during power transformer start-up.

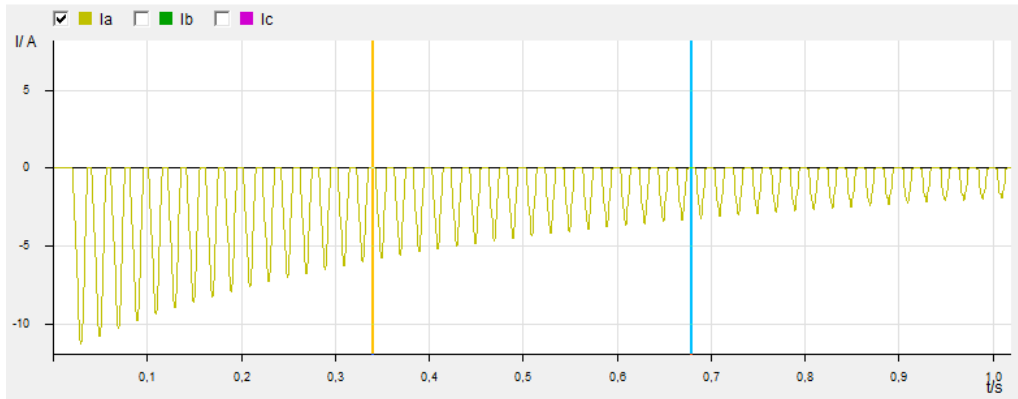
As it was explained in first paragraph, we would have significant amount of second-harmonic component in all phases. So this parameter is a convenient way to inhibit the protection. As you see in below figure, the curve No.3 is showing Harmonic 2 ratio to fundamental during power transformer start up. And the curve No.4 is showing the relay setting. At the end of this FAQ some data is given for setting.

The graph below illustrates the "incorrect" residual current and the change in the transformer inrush current harmonic 2 ratio:

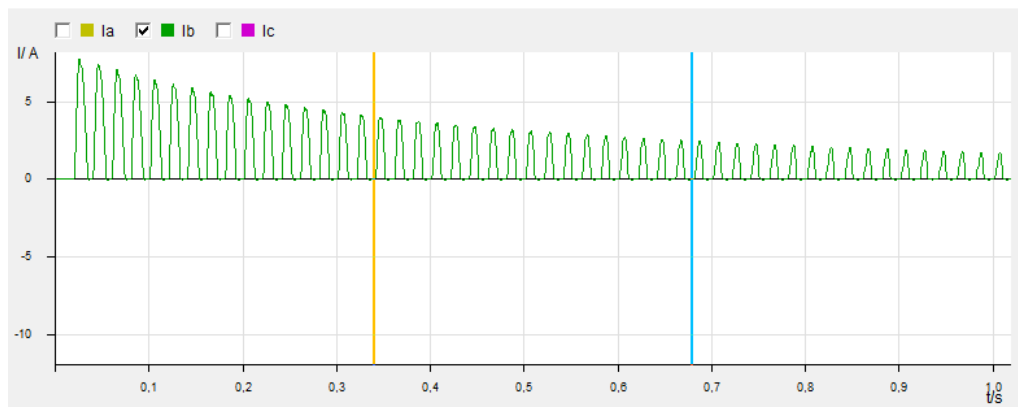


To be more practical here in below you will find a very typical set of transformer inrush waveforms. These waveforms were captured of primary side of a 2000 KVA power transformer during its start-up the in the field. All phases waveform IA and IB are fully non-sinusoidal and offset, and IC as is shown at the beginning of each period has just little symmetry about the horizontal axis but still highly non-sinusoidal.

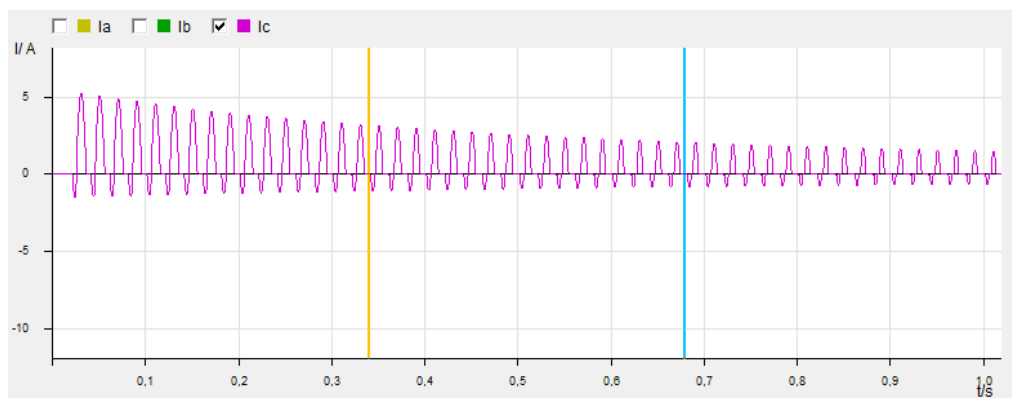
1a:



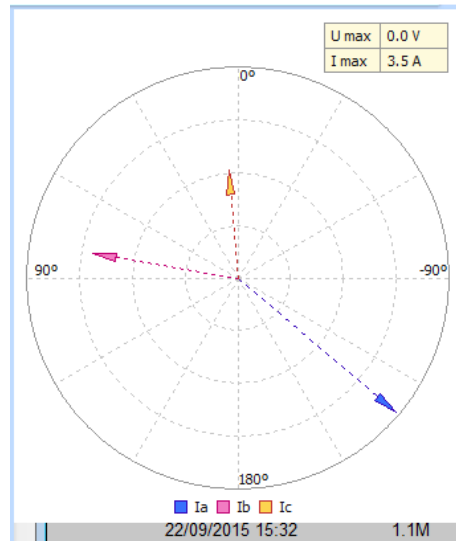
1b:



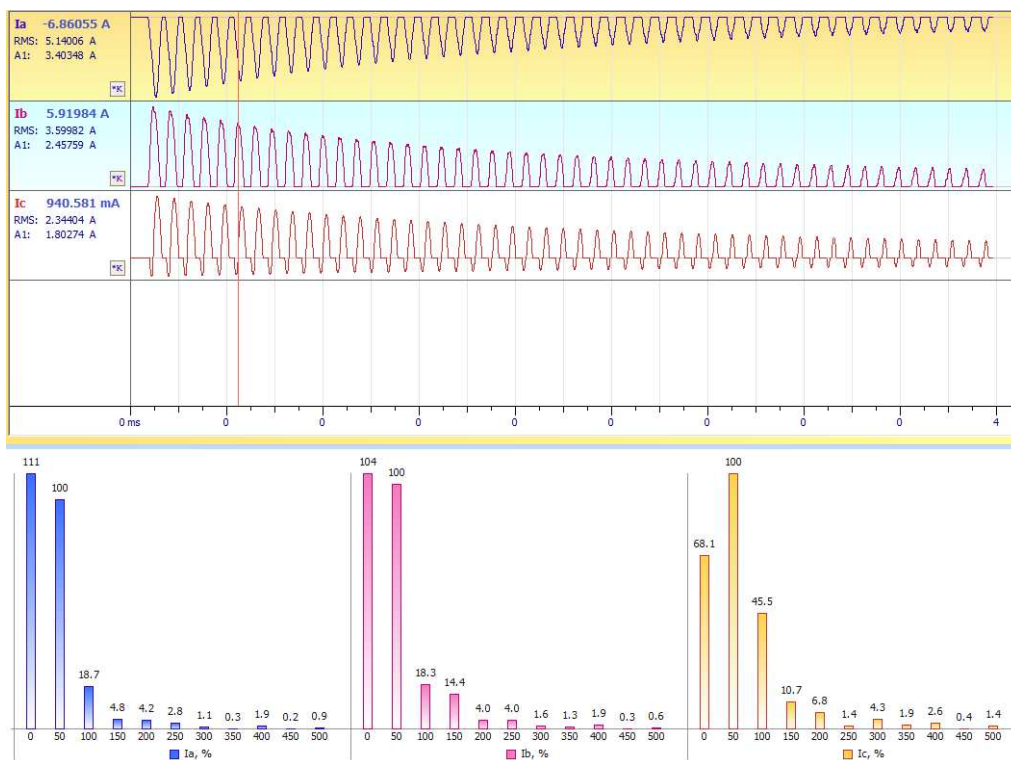
1c:



The vector diagram of each phase is shown as well. It is easy to estimate that there is some I0 which may cause to relay pick-up by earth fault protection. Consequently the relay will have nuisance tripping.



Closer examination of these waveforms, with harmonic analysis, shows that these waveforms have a strong second-harmonic component, in at least one out of three phases. As an illustration as you see in below Ia and Ib has 18% , and Ic has 45.5% of harmonic two.



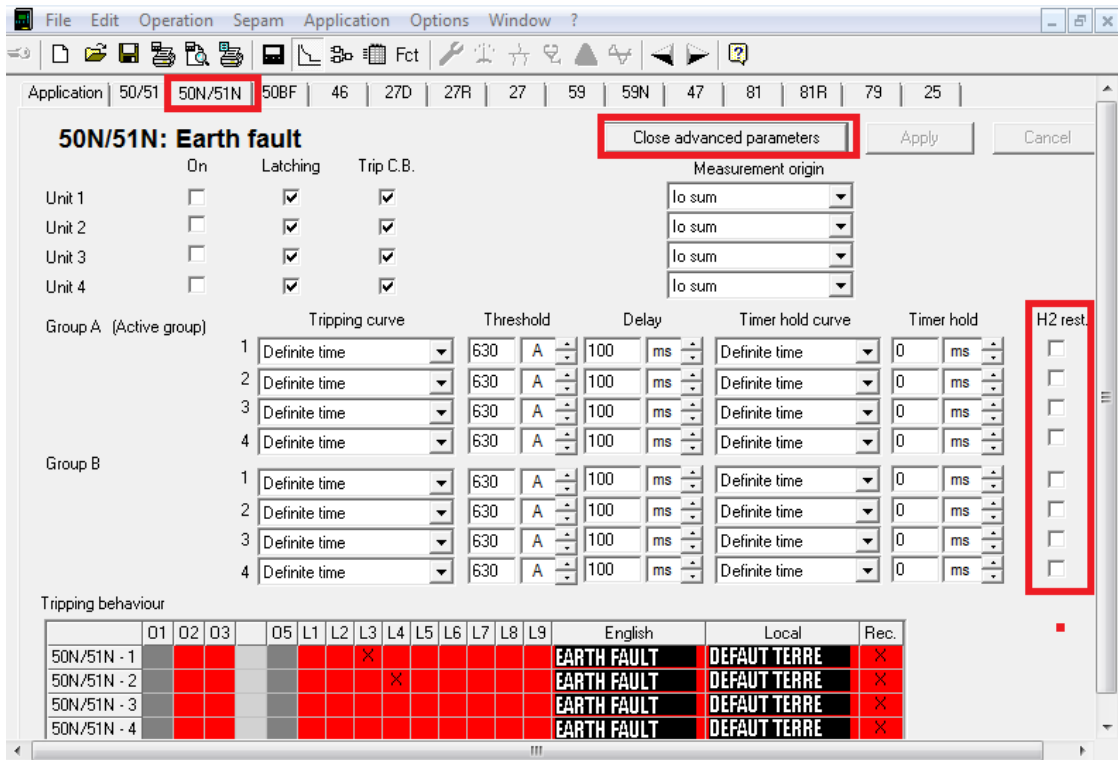
Solution:

We are sure that during Inrush current of a transformer we have got some harmonics 2 and 3. Also we know that harmonic 3 will pick up the “earth fault” logic. If we do not enable H2 restraint parameter for earth fault then will cause the nuisance tripping of relay because of a normal transformer Inrush current(just in case of using Sum 31 for residual measurement).

So it is mandatory to enable H2 setting to inhibit earth fault protection during this transient period. The protection is inhibited as long as harmonic 2 ratio is bigger than fixed setting in relay.

Next question is that: Where to enable this setting and what the setting ranges are?:

For enabling the setting go to → 50N/51N protection / advanced parameters / H2 restraint



The setting is fixed for Sepam protection relays according to following table:

Sepam series	H2 option	H2 Ratio setting
20	Yes /No	Fixed-17%
40	Yes/No	Fixed-20%
60	Yes/No	Fixed-17%
80	Yes/No	Fixed-17%