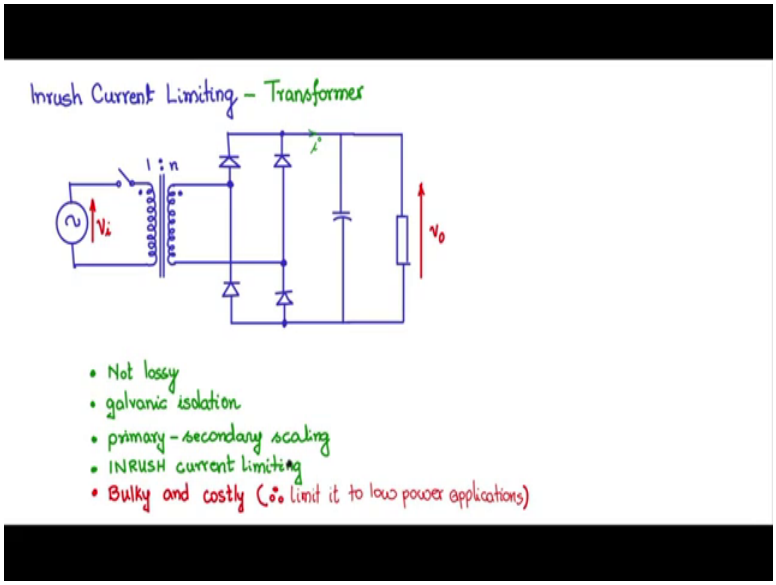
Fundamentals of Power Electronics
Prof. L. Umanand
Department of Electronics Systems Engineering
Indian Institute of Science, Bengaluru

Lecture – 20
Inrush current limiting – Transformer solution

(Refer Slide Time: 00:27)



Another inrush current limiting solution is by using a Transformer. So, let us interpose a transformer in between. So, let me include a transformer like this. So, you have the primary, you have the secondary with a dot polarities like this as shown and let us say the primary to secondary turns ratio is 1 is to n. So, if you have a Voltage V primary V secondary is equal to n times V primary. So, that is what it would mean. So, this is a transformer and this is how it is connected and this has very many advantages.

First of all it is not lossy, it is not a lossy element and therefore, efficiency is not affected. Secondly, there is galvanic isolation what it means galvanic isolation is that there is a physical isolation. The conductors here on the output side and the conductors on the input side or physically isolated which means that if there are any surges here due to any part the circuit on this side or there are any surges on this part of the side they are not communicated to the other side. So, therefore, any surges appearing on the grid or the mains will not go and destroy the components on the load side. So, that is one major advantage of galvanic isolation.

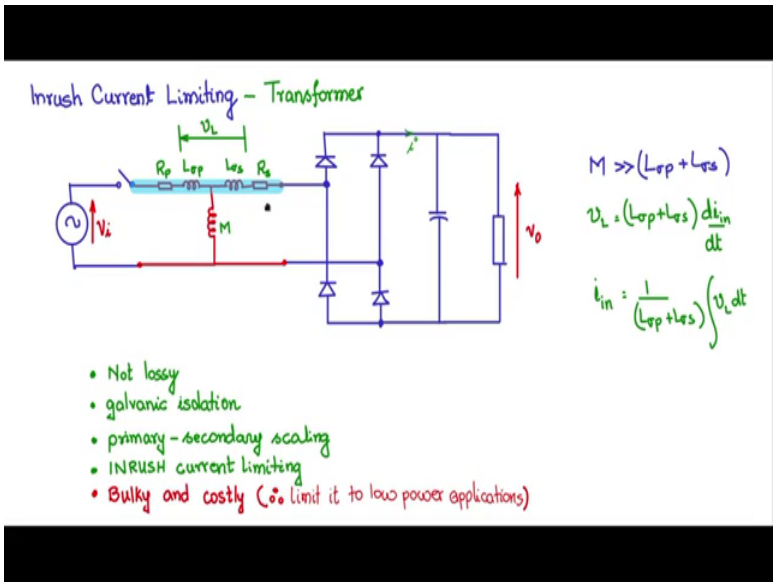
Another advantage is that the primary and the secondary coils can have different turns number of turns, as a consequence you can have a turns ratio which will result in scaling. So, let us say for example, you have 230 Volts here and I want here a 15 Volts to give to a 15 Volt power supply. You can adjust the turns ratio such that it is a step down transformer or if this is a lower Voltage AC and you would like to have a higher Voltage here it can be a step up transformer. So, n is degree of freedom that it gives to the designer to choose a proper scaling factor to make the Voltages between input and the output compatible, where as in the case of the one without the transformer the output Voltage is link tightly to the input Voltage amplitudes and fluctuations

Another advantage is the inrush current limiting and that is why we propose the solution. So, inrush current limiting is a natural spin off by putting the transformer. I will tell you how this comes about if we draw the equivalent circuit you will see that there are leakage inductance was which will prevent the first cycle current inrush happening.

One main, a one and only main disadvantage that I can say at this point in time is that the low frequency transformer is bulky and secondly, it is costly. Now, these two these two points bulky and costly are the ones which I can consider as major disadvantages more from the expense point of view from the point of view of theoretical operation putting a transformer is really good, one of the best because it is bulky and costly, we normally limit this kind of a circuit putting a transformer to low power circuits, low power applications where you do not need to spend too much on the transformer in terms of real estate and price.

Now, let us see how this transformer will solve the inrush current limiting problem.

(Refer Slide Time: 04:43)



So, what we shall do? We shall replace this transformer with its equivalent circuit. I will take n is equal to 1 for now it really does not matter even if n is other than 1. So, we will replace it by a transformer t network equivalent where this is the mutual inductance M, this is the primary leakage, secondary leakage or primary or secondary; so, the winding resistances.

Now, this would be the equivalent of the transformer and all these impedance, if I take M very large compare to all these impedances there will be a very small amount of current magnetizing current only that will flow through this and all the load current flow through in this fashion. So, all these impedances will act to limit the surge current, so that is the logic. So, if we take M very large compared to L sigma P, plus L sigma S, then if you say the Voltage across this as leakage inductance is V L then by Faraday's law you have V L is L sigma P plus L sigma S, di in by dt.

So, assuming that this is very large and the current through this is very small compared to the current load reflected current that flows through. So, the current is basically an integral relationship with respect to the Voltage V L have developed across the leakage inductances. So, initially when you switch it on capacitor here is not charged is like a short coming across here and all the Voltage will drop across the inductance because that will give the maximum impedance at that instant of switch on omega is very high, omega L will be very large and all the Voltage will drop across thus or across the inductance and

gradually the current will start building up. So, it is like an integral filter and you will see the current gradually building up and thereby inrush current limiting happens in a natural sense.

So, this is one of the very good by-products or spin offs of using a transformer in the circuit.