Fundamentals of Power Electronics

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Lecture – 35
Applications of shunt regulator

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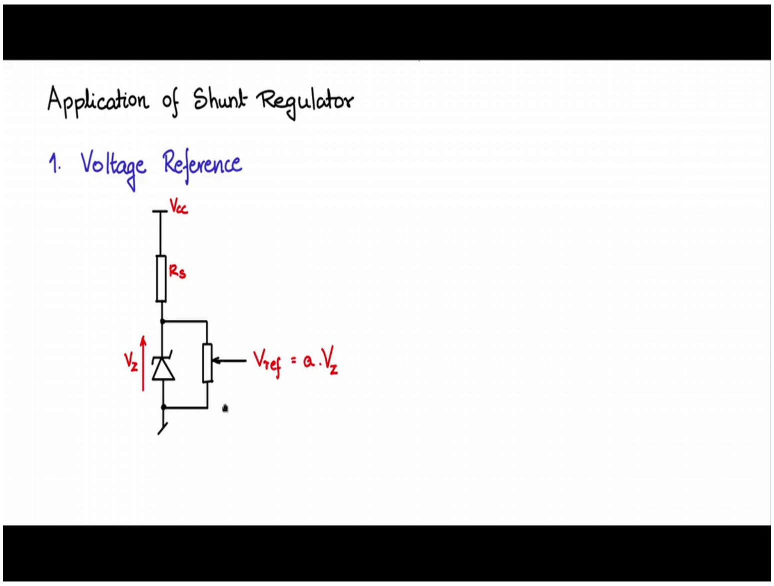

Let us now discuss where we use shunt regulators, what are the applications of shunt regulators. We will look at couple of important ones, one is as a voltage reference. This is a very popular circuit used at many places in bigger circuits as a voltage reference. So, we have the shunt regulator, I am writing it in this fashion a V cc here and the Zener diode and we have a load connected like this. Now, this is a shunt regulator.

This V cc here is unregulated DC voltage, have an R s, a Zener voltage V z and across this you get a regulated constant V z voltage. And many a times we would like to get a variable voltage reference, so you replace this resistance with the potentiometer and I reference is given by a times V z, where a is the attenuation ratio of this potentiometer at this tap of point. So, this is a very common and popular circuit that you would use in many bigger circuits where this will come in as a voltage reference circuit.

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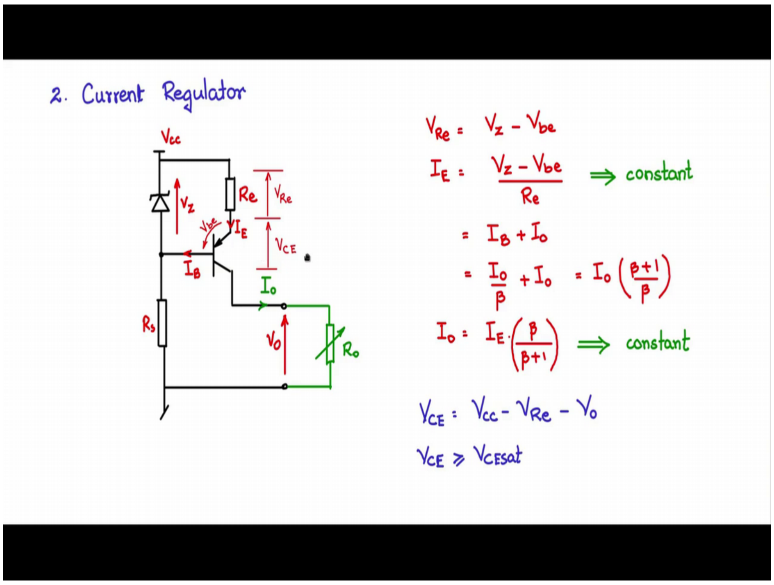

Another important application of the shunt regulator is in making a constant current regulator. Let us see how we make a constant current regulator. Let us first draw a Zene,r I will now put the Zener up and the series resistance R s down below is V cc. And at this point I will introduce a transistor I am using a PNP transistor in this case. One can make a constant current regulator with NPN transistor also. It is easy for explanation now.

So, I will put a resistor in the emitter like this, and here across these terminals we will take the load resistance R naught. So, constant current is supposed to flow through the load resistance. Whatever may be the variation in R naught the current that flows through R naught, I naught will be a constant. So, let us see how this is a constant current regulator, this is V cc let us name this as R e, this is R s this is V z and there is a drop V be across the base emitter of the PNP transistor.

Let me mark this and take the potential across V Re in this fashion V Re, this I E and this is the base current, ok. So, now, V Re is V z constant minus V be drop will be the voltage. So, if you take this loop and apply the Kirchhoff's voltage equation you will get V z minus V be. And I E is V Re divided by R e and there for you have I R e which is V z minus V be V by R e. Now, this is a constant, V z is a constant V be is a constant and R e is a fixed value therefore, I E is a constant.

Now, I E is nothing but I B plus I naught and I B is nothing but I naught by beta, beta is the current gain of the transistor. So, I naught by beta plus I naught, so which is I naught into beta plus 1 by beta. So, therefore, we can write I naught as I E into beta divided by beta plus 1. Now, here I E is a constant as we saw here beta is a constant value for the transistor, so therefore, you can say I naught is a constant. So, I naught is constant irrespective of power supply variations V cc irrespective of variation in R naught as we see that R naught does not figure in this equation. Therefore, this is a constant current regulator. So, a very nice circuit has lot of a applications.

Now, if you see this is V naught and let us say the voltage across the collector emitter of the BJT, V CE. What is the limiting value of R naught? On one end I can short circuit these R naught can be 0. Now, R naught is 0, V naught is 0, there is constant current that is going to flow through it. It will operate perfectly well. What is the max value? Can I open circuit it? If I open circuit it there is no way current can flow through and therefore, I naught is no longer constant. So, there is a upper limit on R naught. So, what is the upper limit on R naught?

Now, let us write this voltage equation for this loop. So, V CE, V CE this is given by V cc minus this flop minus I naught so which is V cc minus V Re minus V naught. Now, V CE for the circuit to operate this drop has to be greater than 0 in the ideal case or it should be greater than V CE sat in the ideal case. So, therefore, V CE should be as shown here it should be positive, the positive, negative should be greater than V CE sat and therefore, you will see that V naught should be less than V cc minus V Re minus V CE sat.

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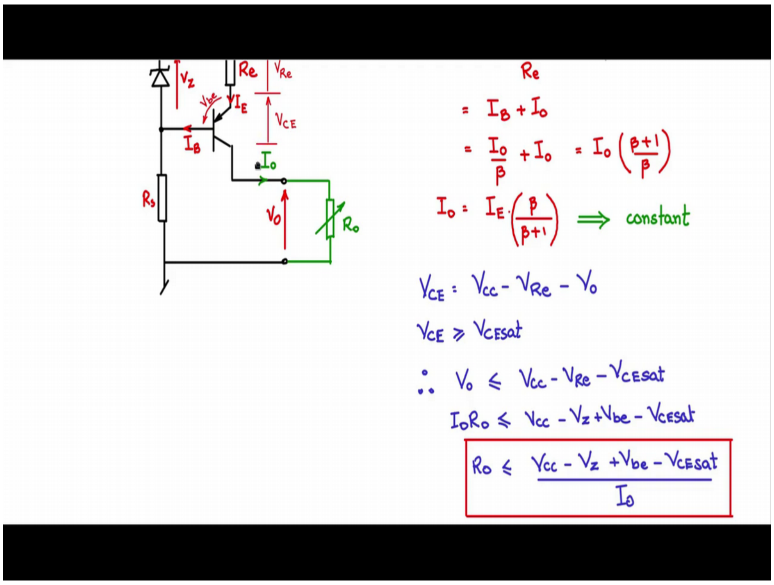

If you apply this relationship here at this value should be greater than V CE sat, V naught will be less than. What is V naught? V naught is nothing but I naught into R naught that should be less than V cc minus V z plus V be, because V Re is nothing but V z minus V be and minus V CE sat.

And therefore, R naught should be less than V cc minus V z plus V be minus V CE sat divided by I naught and that is the limiting value R naught max that you can go up to. So, you can vary from 0 to this value of R naught for the circuit to be perfectly in the constant current operating mode. So, this is a constant current regulator, a very interesting circuit has many applications.