ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

7.1- Alimentations stabilisées

Principes

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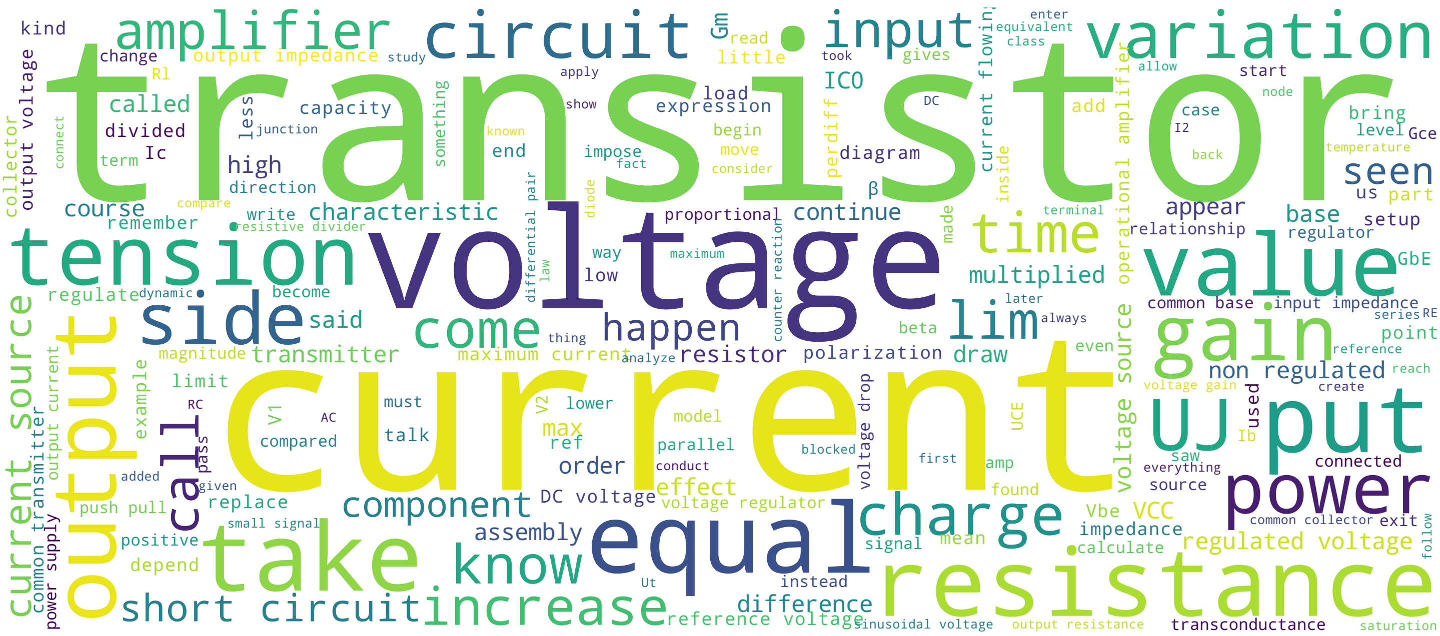
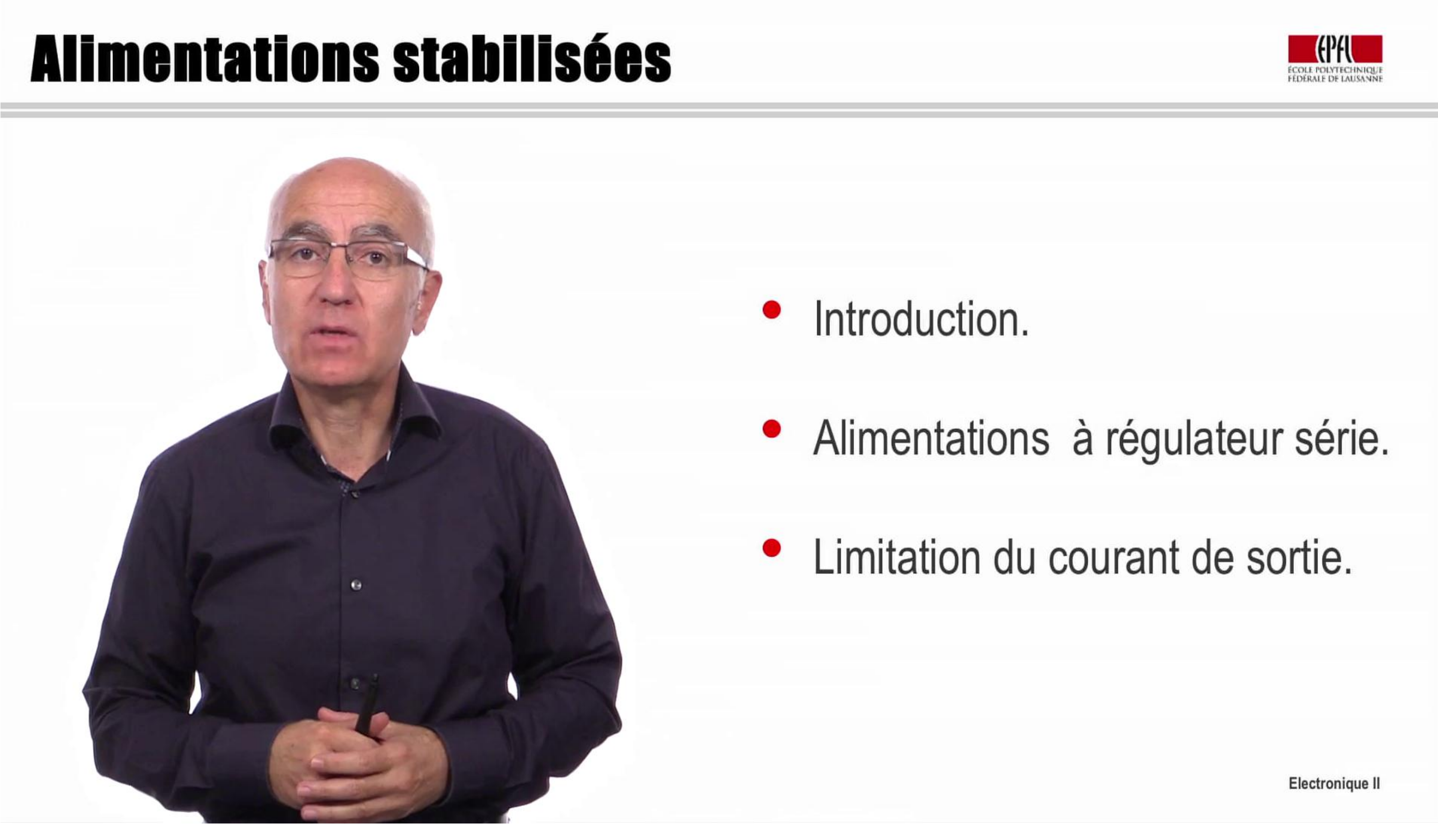


Video

EPFL

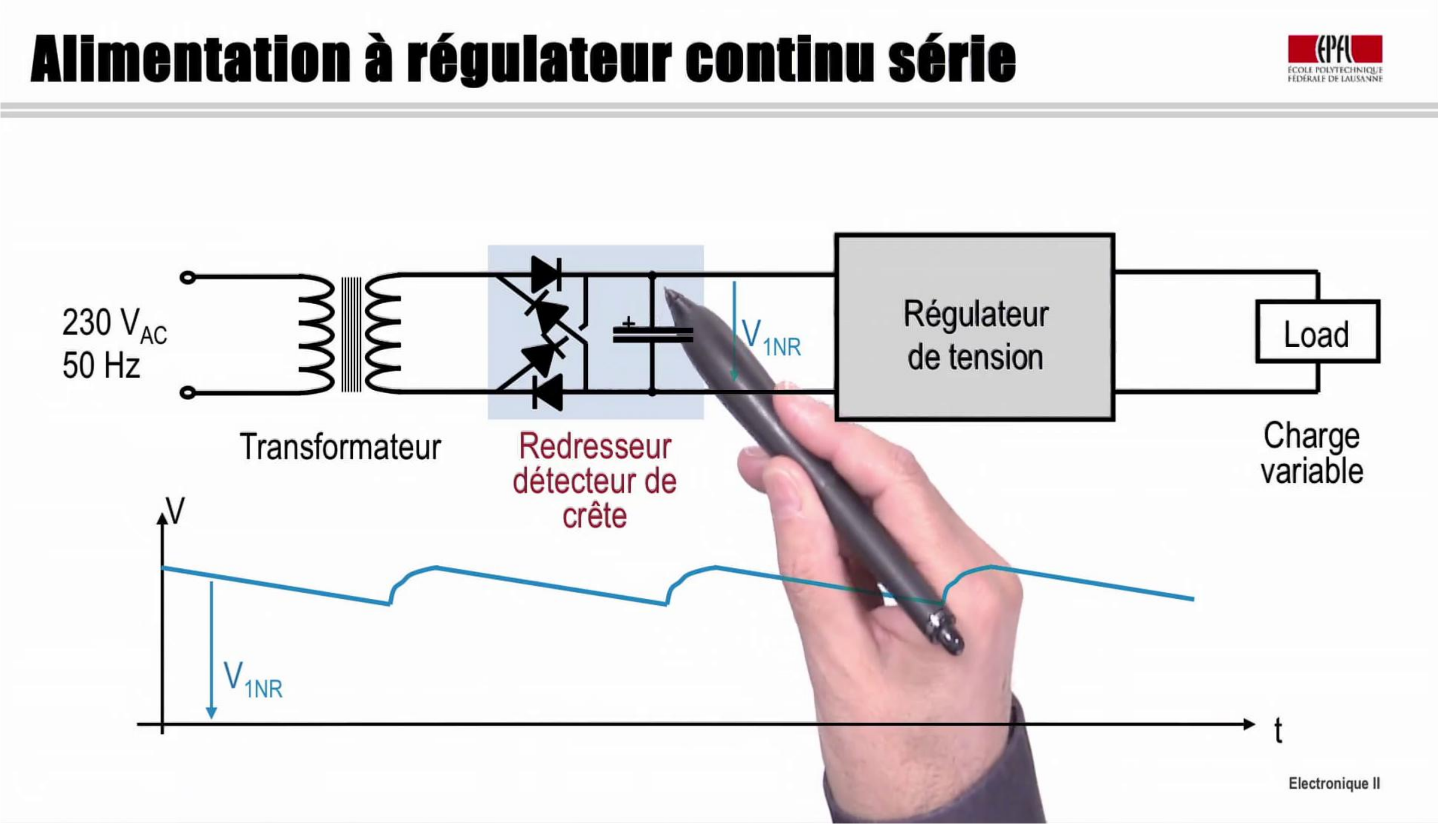


Well Hello everyone. Today we'll tackle a lesson which is an excellent presentation of the bipolar transistor use. We will study the steady supplies. We will not go through all the techniques that allow us to make a regulated power supply, we will settle with what we call the series control supply. So this is an example where we will use a single transistor to regulate a non regulated voltage, we'll see what it is and get from it an ideal voltage source with a current limitation and we will see the implementation details of this kind of supply.

Notes

Summary

0m 04s

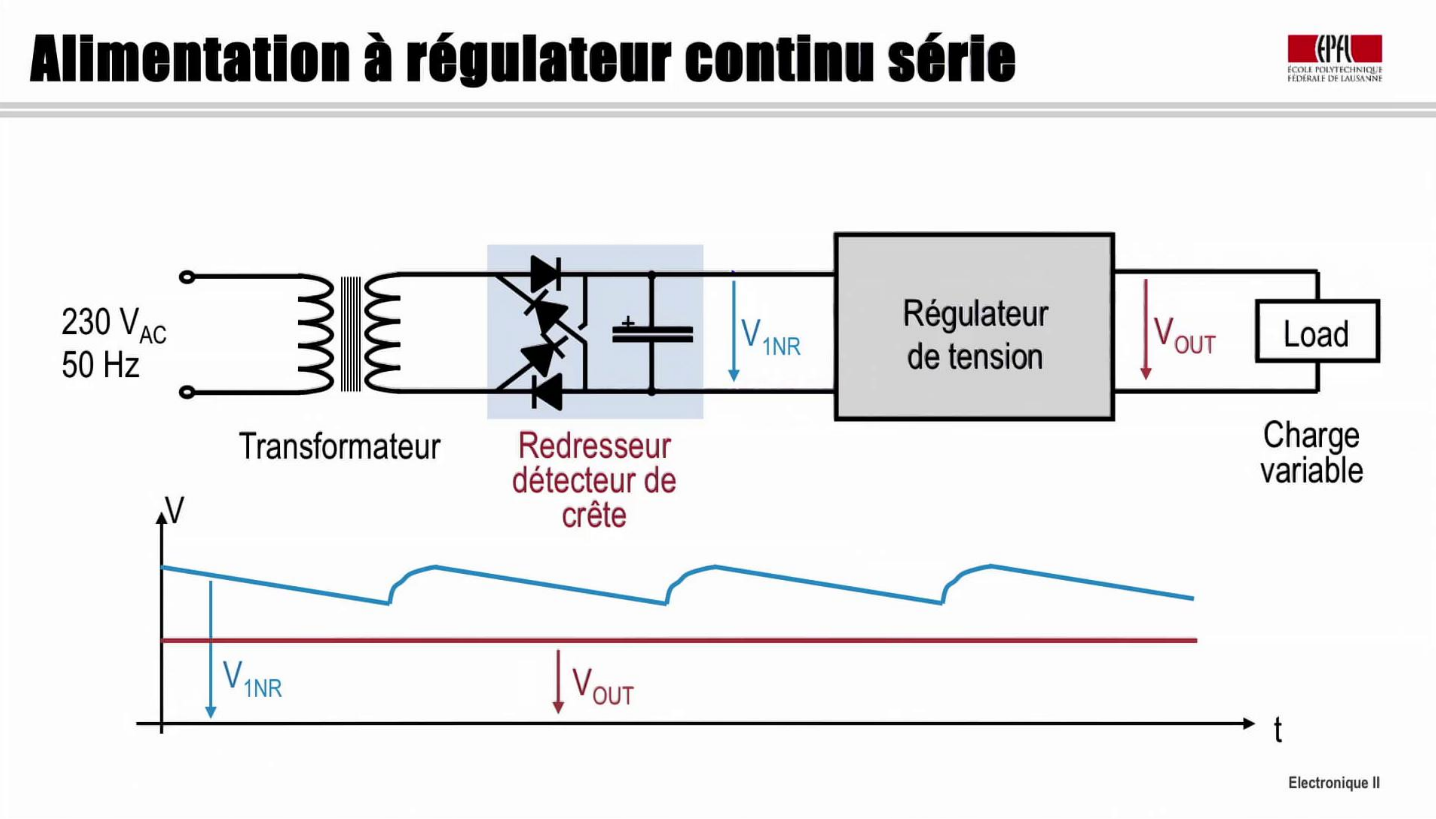


A controlled DC series power supply is generally one of the mostly used circuits. You know very well that we have a sinusoidal supply type provided by the sector, that starts from an electrical outlet, we have this sinusoidal voltage level of the order of 130 V, with a transformer we get to reduce tension, then we use a diode bridge whose objective is to make a full-wave rectification. So we seek with this with this 4 diode circuit the absolute value of a sinusoidal voltage. In other words, the sinusoidal voltage that appears at the entrance is found on the other side entirely positive, the negative part of the sinusoidal voltage appears rectified. Then we put a filter based on a capacitance and this capacitance is intended to to charge itself through the sinusoidal voltage and then after discharge from the other side in what is called the charge, if the charge on this side is the part where the user plugs his electronic devices like you have a computer that you want power with DC or you have a radio or you have any electronic device which receives a DC voltage.

Notes

Summary

0m 45s

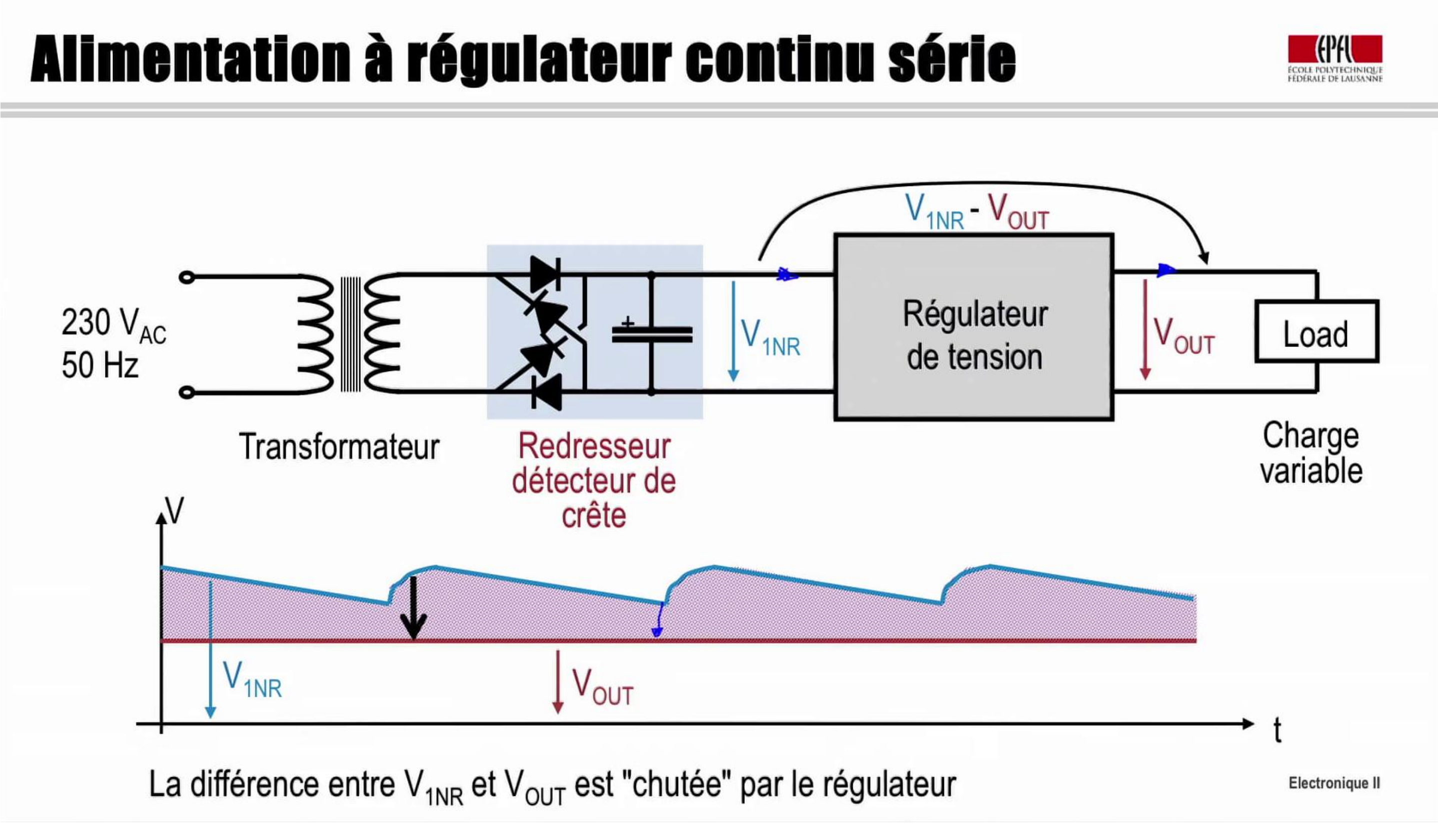


From that side we have what is typical with a voltage that is rectified and filtered what we call this voltage corresponding to a portion of the end of the exponential that appears here after a discharge of the capacitor through the regulator to provide power to the charge and we have this residual ripple so the value of this ripple depends heavily on the current we draw from the other side So if you want to regulate this tension, this is the non-regulated voltage, this is what we known at the exit of this kind of circuit, we put a voltage regulator and the voltage regulator should receive the unregulated voltage in blue and give us a continues voltage and behave as an ideal voltage source that side. The DC voltage at the output, it is always and necessarily lower than that at the input. So our regulator is seen with a non-regulated voltage which is the blue voltage and the voltage in red that is a DC voltage at the output and the difference between the two is the voltage which is between the input and the regulator output the subject of our lesson today which we will put in an electronic function which transforms this tension like this in a perfectly DC voltage and provides power to the charge.

Notes

Summary

2m 09s



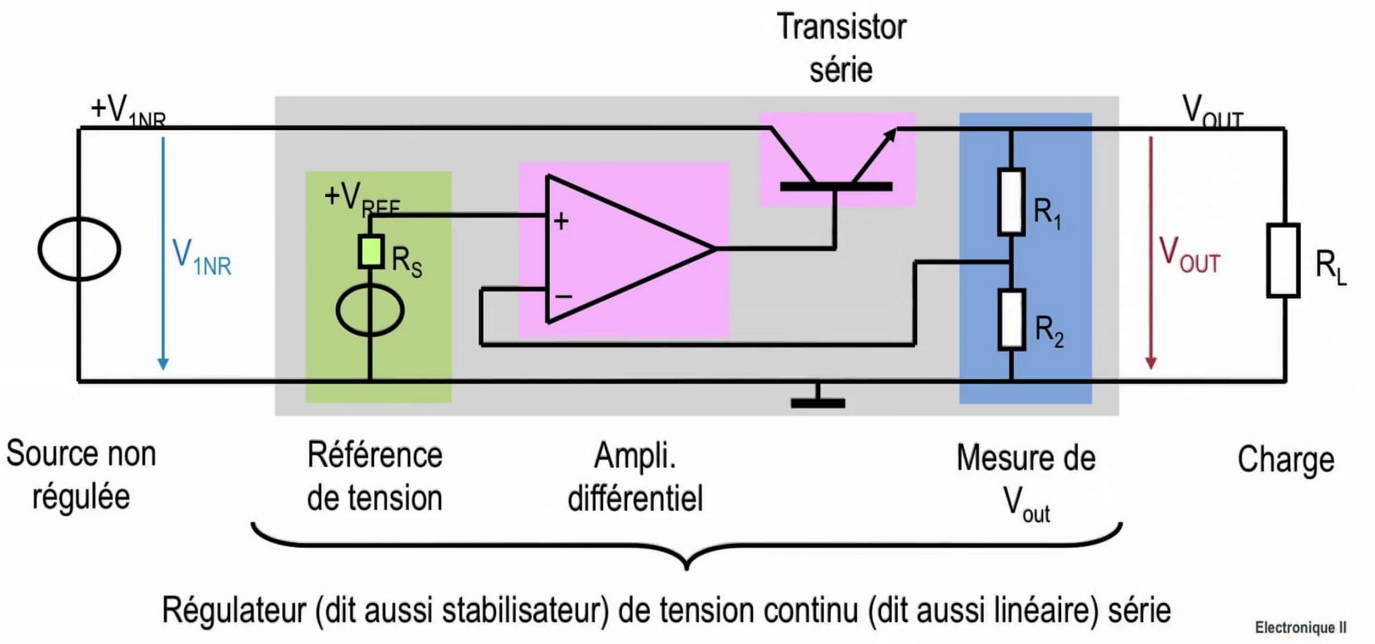
So the difference of the tension is fully embedded in that block one. So we absolutely understand that there will be current entering here this current then provides a current which goes through the regulator and the current will come out the other side and it will be the power we use in the load. Here the voltage is unregulated, Here the voltage is regulated, and the current is approximately if we neglect the necessary consumption in the controller to operate and although this current is the scepter height of greatness of what comes out of the other side. Against by the difference of the voltage must depend on the arrow, that means we see it when the voltage goes through a maximum here, we have this quantity which increases otherwise when it passes through a minimum, we have this quantity becoming lower, it does not prevent that all this amount of voltage variation is supported by our regulator. So the more this difference is high, more is high power is dissipated inside What he will have within it? So we said the difference between this voltage, I call V1NR, NR is for non-regulated and the voltage V Out, V Out is DC voltage red to exit and drop this difference by the controller. Well it will be between the two, it is a simple transistor.

Notes

Summary

3m 45s

Régulateur de tension continue série



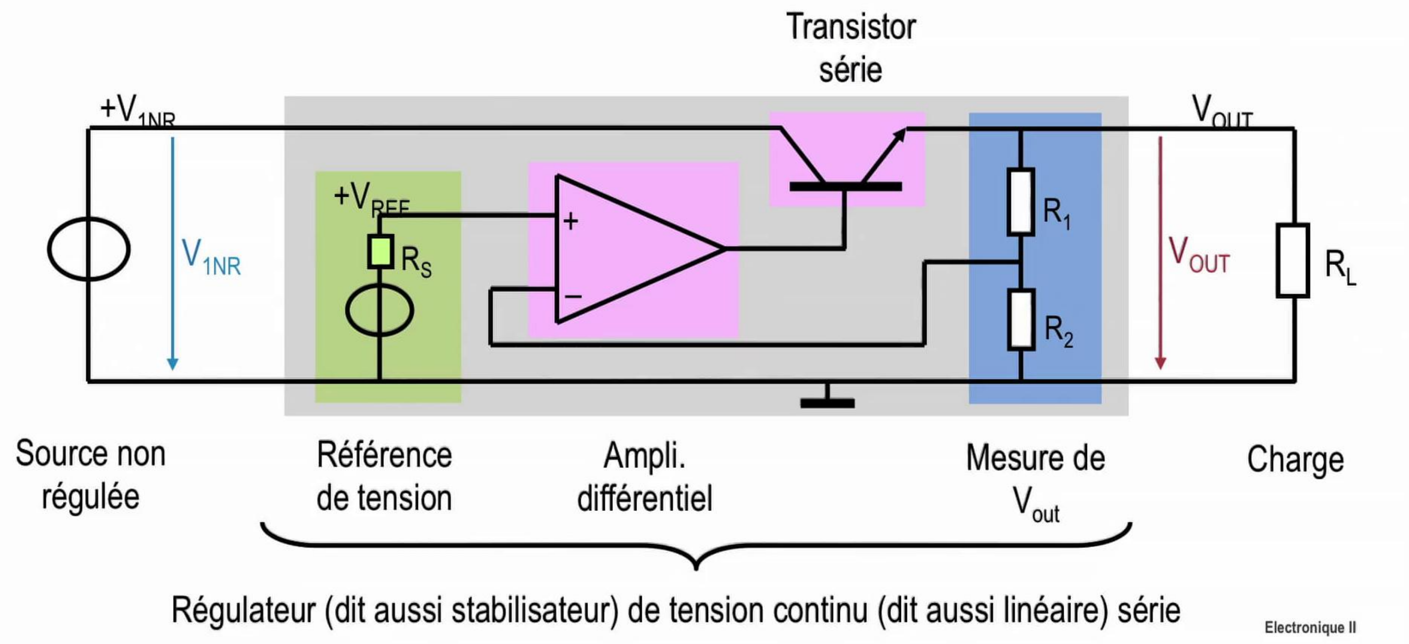
We will enjoy the characteristic of the transistor, the one that now you know very well for as to regulate the current flowing in this transistor, it is taken from a non-regulated voltage, It is returned to the regulated voltage and the voltage difference is made by this characteristic we saw This tension is all the time changing between the node and then knot and we know that a transistor it is capable of passing current more or less the same if it regulates the current or the base-transmitter voltage and the voltage between collector-transmitter is not intended to affect its behavior in this transistor because the UCE output voltage, once we regulate from the base keeps the same current in the same component without being affected by the voltage variation. This characteristic, we will use it to achieve what called the series regulator because the transistor which is connected in series between the non-regulated voltage and the non-regulated voltage manages the current flowing from the source that is and the output which is here. So I pay your attention that the input of this circuit it is here the output is here.

Notes

Summary

5m 19s

Régulateur de tension continue série



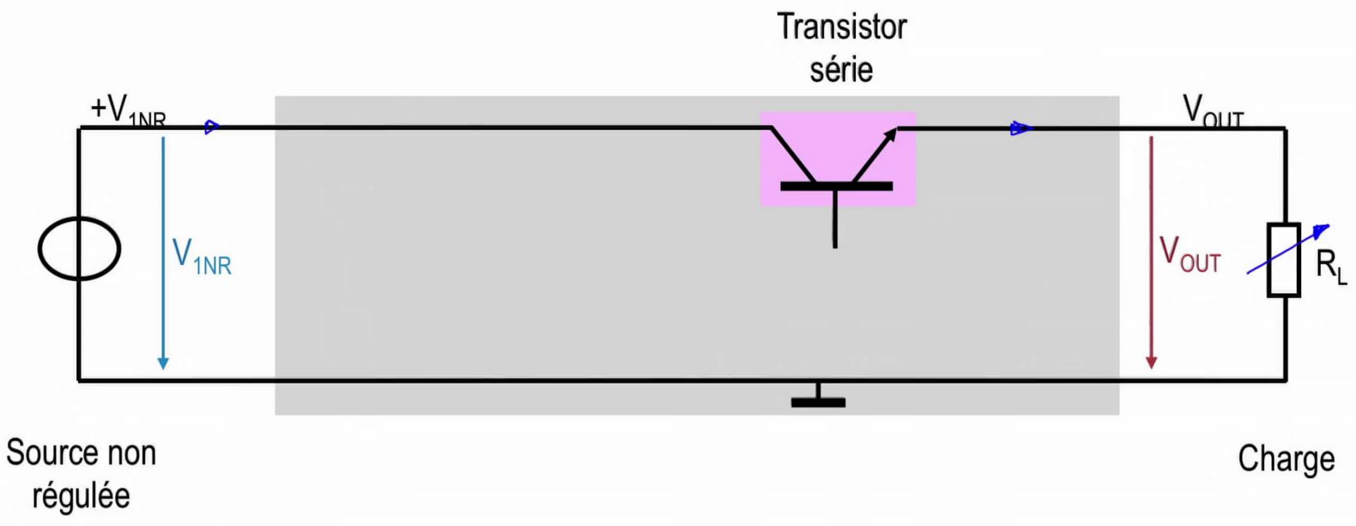
So we enter a voltage, it outputs a voltage and is used a circuit inside that I'll go through step by step but before going further to see it, we find that there is this famous transistor called ballast it is called in English the bypass, it is called the series transistor or the voltage regulator which is controlled by a counter reaction loop made with an operational amplifier and a feedback against. And we use a reference voltage that we generate inside for that voltage then by this setup against feedback allow us to guarantee that the voltage V Out is a DC voltage proportional to the reference voltage multiplied by a gain that we will study now.

Notes

Summary

6m 42s

Régulateur de tension continue série



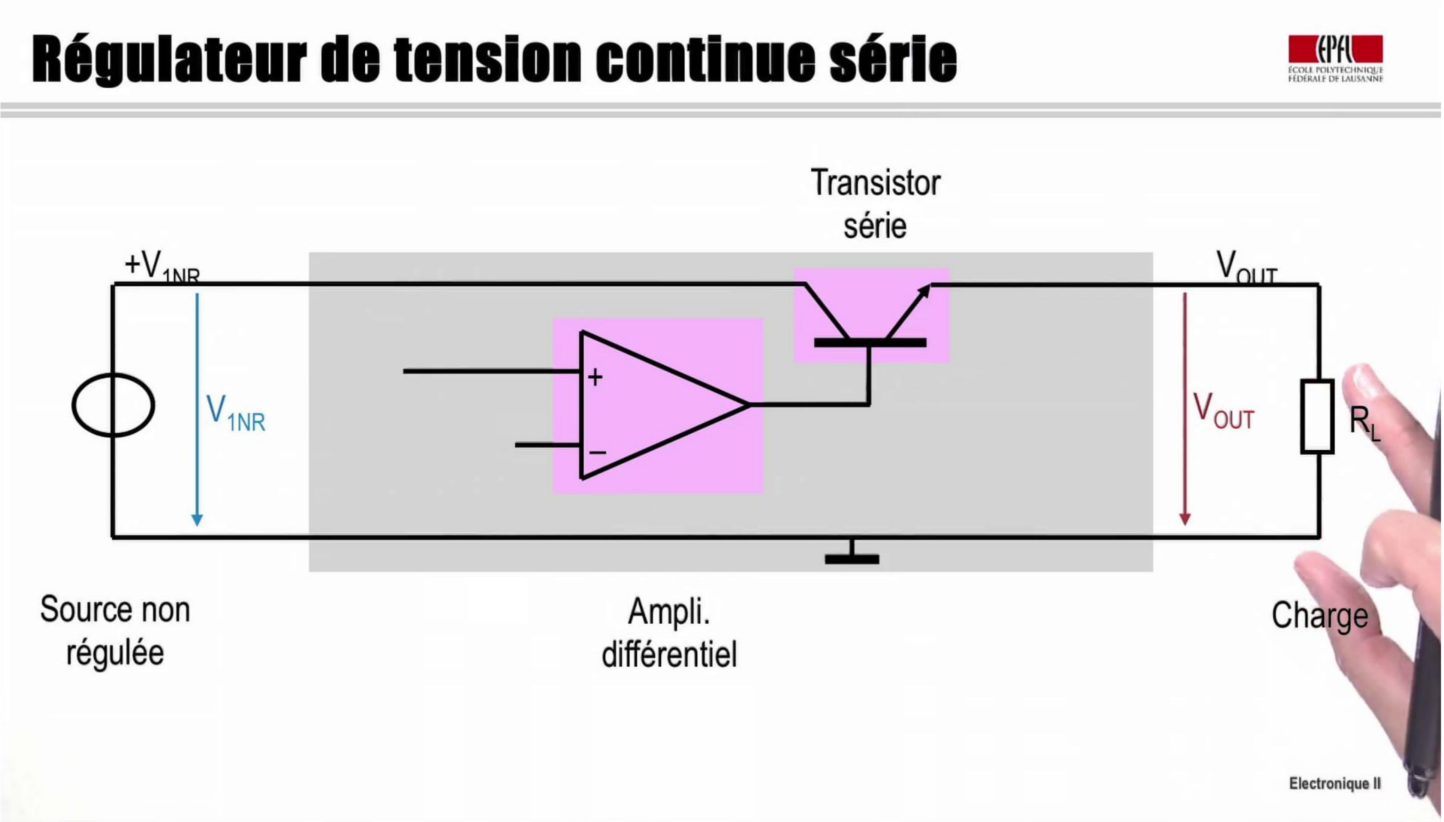
Electronique II

Let's go through the series transistor, the one who is between the input and the output, I repeat my explanation, if the current that enters here is found at the output, the current we take comes from a non-regulated source, as in the example I have shown, this is nothing but the power of 220 V followed by a rectifier followed by a filter, and we take the current inside there and here is a resistance which is often variable because it about charge, this charge here could be a computer, may be a radio or whatever you want to plug in that side, so this is a radio, it depends on the power you use to the output This means that this current, it is all the time being modified. What we wish, is that this voltage here be absolutely stable, constant, regardless of the variation in current therefore regardless of the nature of the load. I forgot to say this charge here appears as a resistance, we'll talk all the time of resistance but it could be an inductive, capacitive or any complex charge which is the case today of our devices that we connect.

Notes

Summary

7m 31s

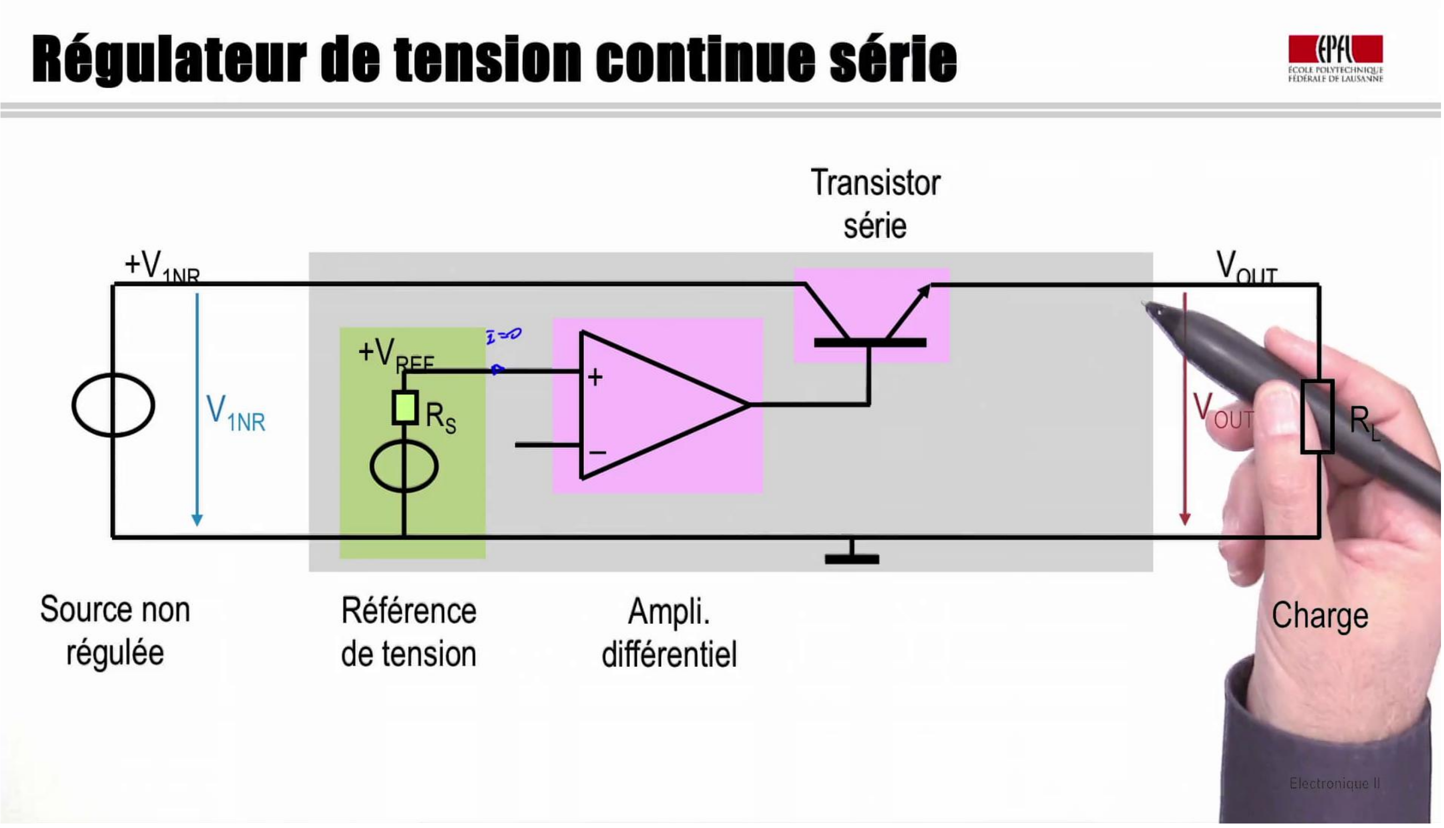


Now I will now take my transistor and add on it the famous operational amplifier that we call the error amplifier.

Notes

Summary

8m 49s

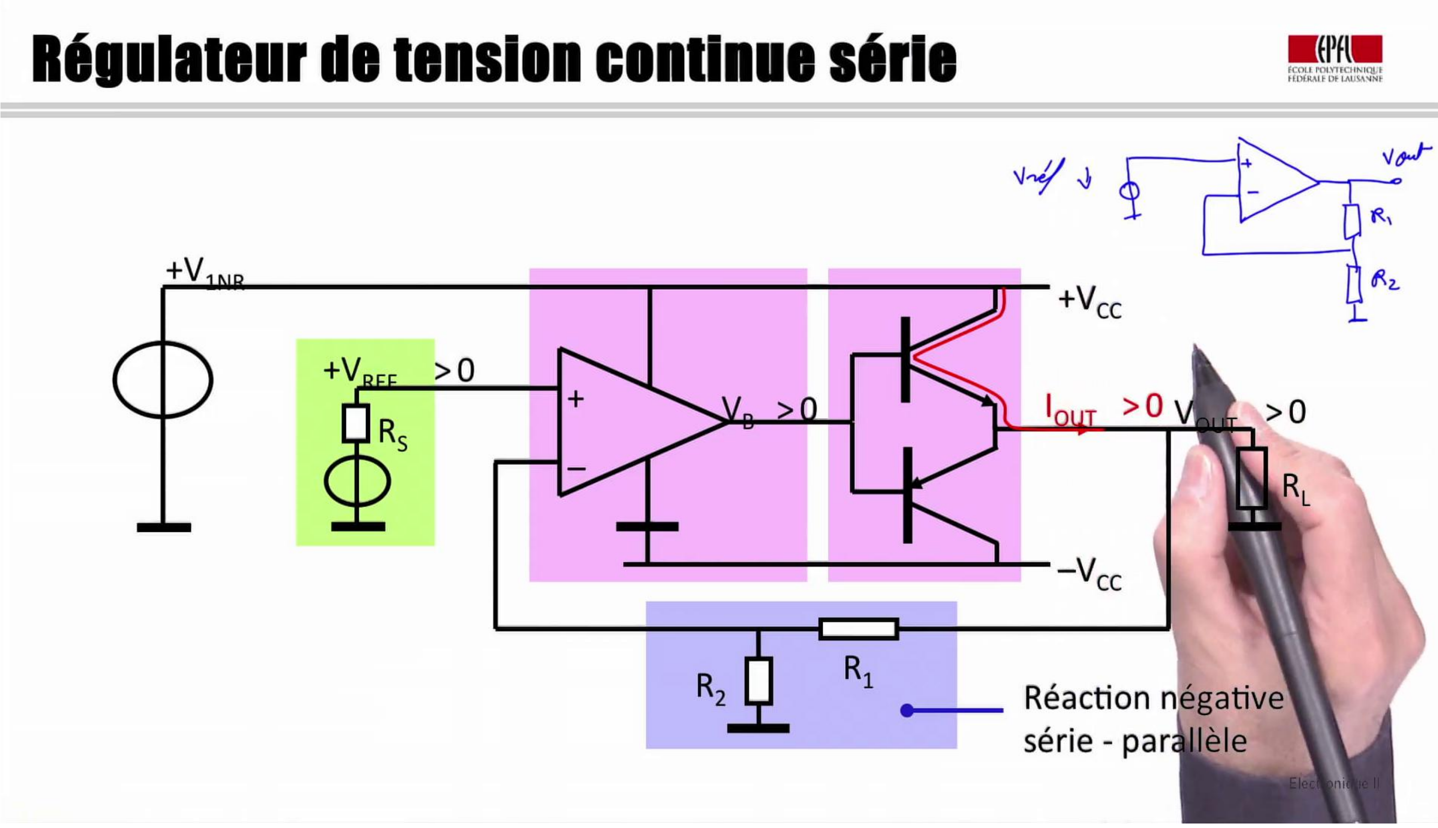


It uses the name error amplifier because it has a role, that role is to read the tension here watch well what I will do, I'll take my operational amplifier, connect a reference voltage, so if this is really an ideal operational amplifier, This current here is null so we're not going to take power from in here, so that it is a reference voltage. We will learn to realise a voltage references in the following video, we'll see what's inside Now from this side, we'll read this tension, divide it with a divisor and return it back and compare all the time in this reference hence the name error amplifier because it is all the time trying to regulate for these two voltages become the same, which is the role of an amplifier to stay in the linear area. So it amplifies or it is sensitive, it variations what happens to regulate the current in transistor and keep constant voltage at the exit thanks to its very high gain and the capacity to regulate the two voltages at the same value. Let's see how we will read it.

Notes

Summary

8m 58s



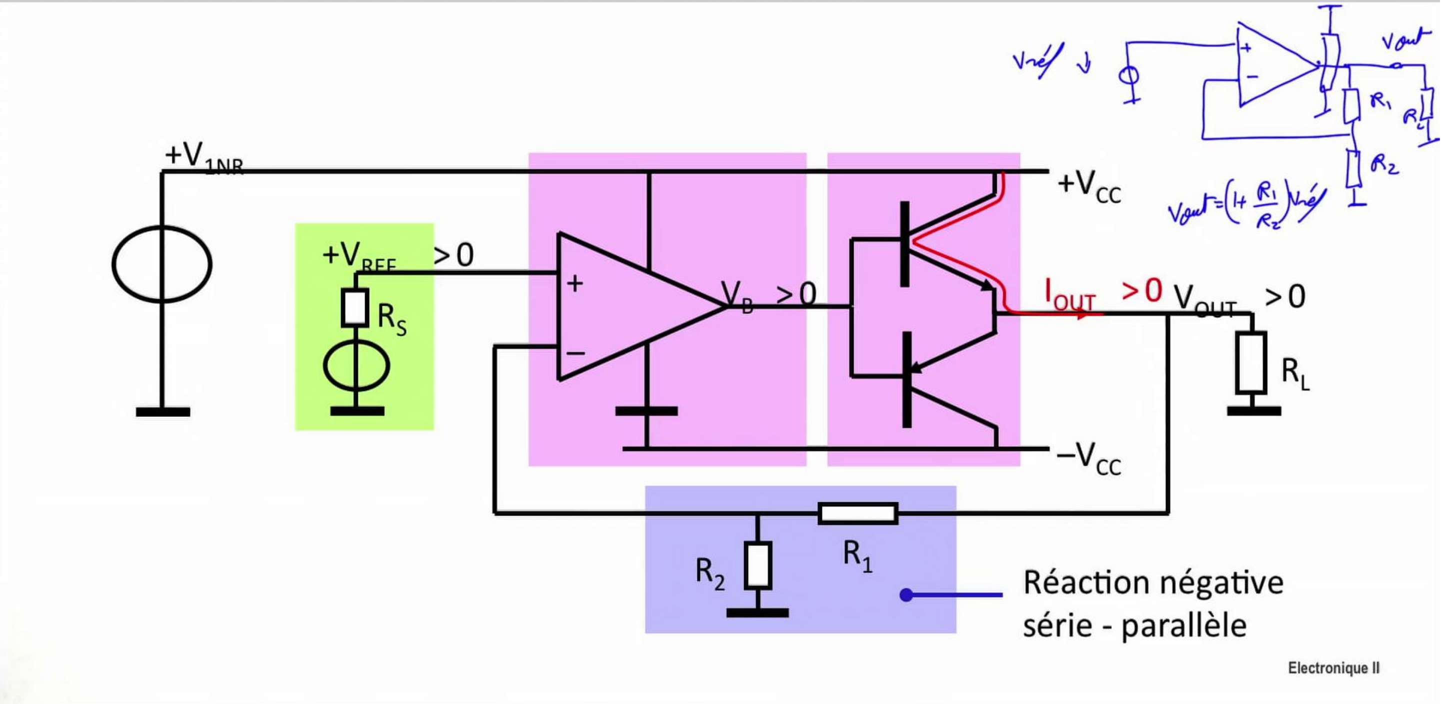
So here I'll take here a resistive divisor and I will use the voltage V Out that I divided by a report and then I compare to this reference voltage and that, it will give me what I call the DC voltage regulator as we just defined. The power element is this, it's the one that absorbs more and increased the value of current. There was very little current flowing and generally we power our operational amplifier with a tension which comes from this non-regulated voltage and our amp is powered by the unregulated part and that have the mass here and this voltage V Out, it is compared with the reference voltage through the counter reaction. I take something that probably you know. I'll draw something here, if I take a normal operational amplifier, I make it a reaction against, and I add a stable voltage source that I call V ref, a reference voltage, and I look at the voltage that appears here compared to the tension that I put there and 2 resistors one of the resistors I call it R1, the other resistor R2 and that is the voltage V out. I can easily write this voltage according to V ref. Say V Out equal to 1 plus the ratio of the R1 on R2 resistance, all that multiplies V ref.

Notes

Summary

10m 15s

Régulateur de tension continue série

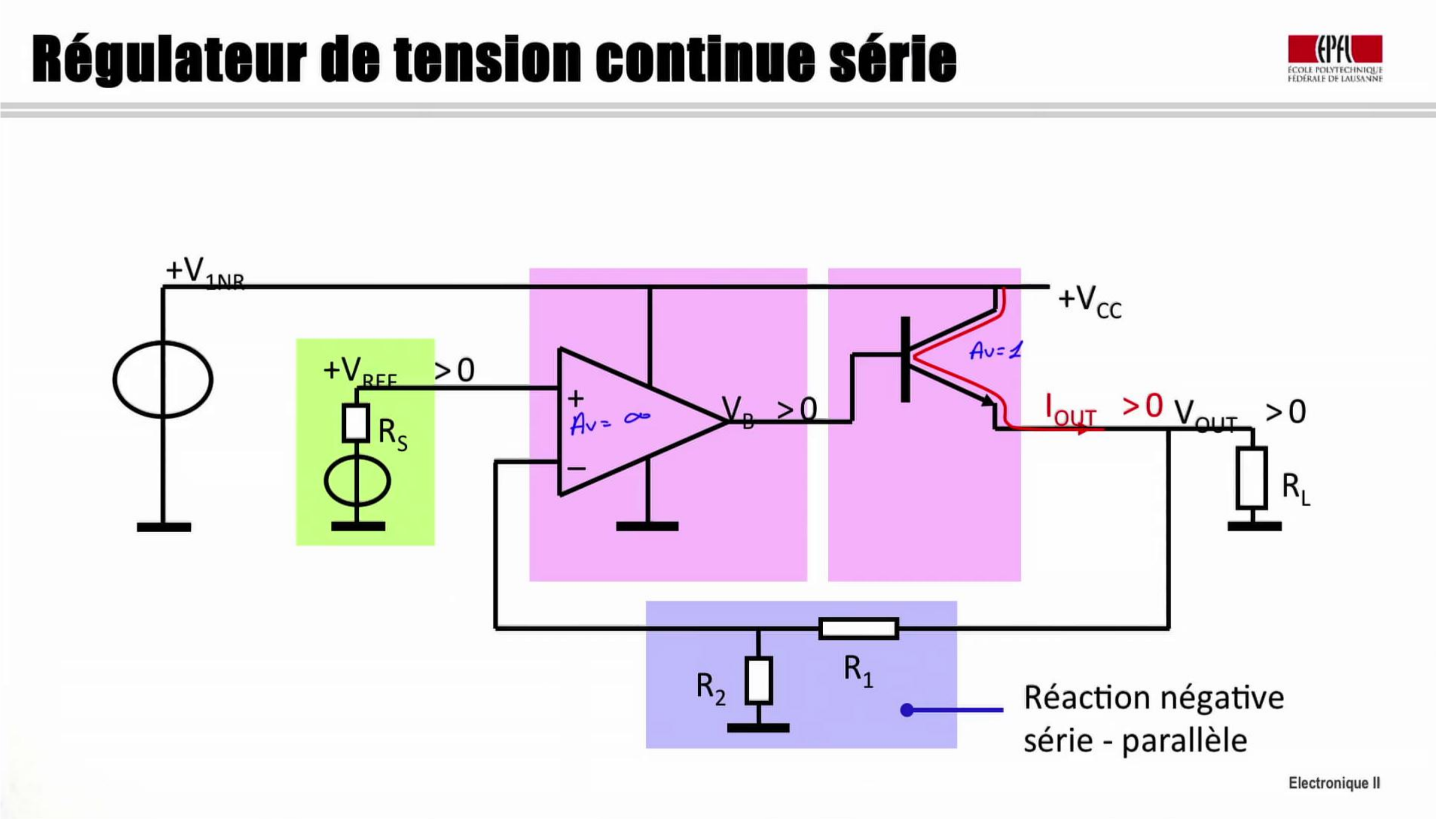


That we know this basic instalation a non-inverting amplifier which gives us this kind of characteristics. There I took this amp and I put behind a push-pull setup So I inserted here a push-pull installation and this push-pull installation is designed to have a gain equal to 1. It takes the tension here and brings it back to its output multiplied by 1 and it is capable of being supply by an external supply what we see here, So it picks it from the non-regulated voltage and the non-regulated voltage allows it to provide a current and the charge connects here, So here is the RL. If that's RL, we understood that the push-pull level which has a gain 1, we can well imagine that it is part of the amp, it is simply a power level and that he was carried with 2 floors. First, let's ask the question, do we need a push-pull? When do we use the push-pull? It is used when there is a current that can enter and a current that can come out from our amplification level. In our case here, we need a supply voltage positive all the time V Out or all the time negative therefore a transistor is enough. So I can transfer in the case where the current must pass through the load in that direction having a positive voltage V out all the time, I can turn the transistor which is here what I'm going to do right now.

Notes

Summary

12m 03s

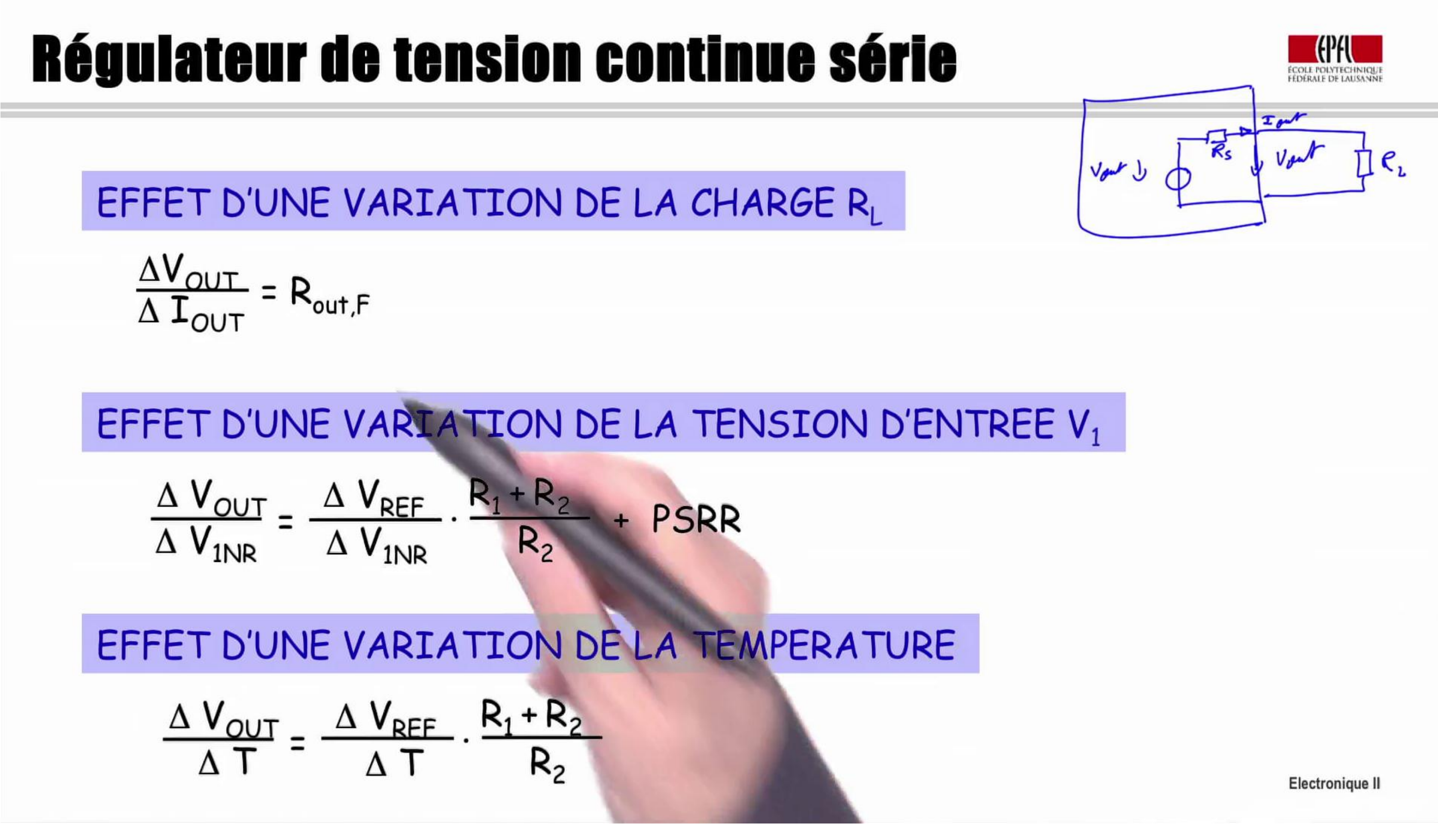


So through our scheme we just saw and I draw differently, we will see that the common manifold instalation output has a unique role: to be a voltage follower, allows me to do against a feedback between the output and the input of my amp. The amplifier achieves a voltage gain that will be infinite, this one gives me a voltage gain equal to 1, 2 realize an instalation with amplifier and a feedback against which taking this tension there, multiplied by the resistance ratio R1 / R2 + 1, returns it to the exit and that is the DC voltage regulator series that we have presented which is nothing else like classic diagram of which a transistor the interface between the non-regulated voltage and the regulated voltage at the output. So this is not rocket science as a type of circuit for someone who knows a little bit of electronics, he sees what the amplifier is used for to maintain a constant voltage and each changing of this voltage has an effect on the output and we do the counter-reaction on the output. Now if you look at this pattern here, I will go to the implementation of our operational amplifier, what there is inside here and what there is inside there and that is what we will study. That's the basic component, this is the series transistor and this is the component that I have to make as well as this and it will be what we'll study next in the videos that follow.

Notes

Summary

13m 36s



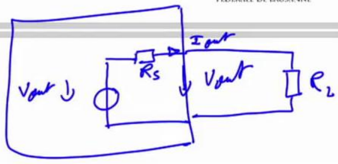
When you make a voltage regulator, I would like to regulate an output voltage so I'm achieve by a voltage regulator an ideal voltage source So is this what I'm doing. I want to make a voltage source whose resistance series is very low. So that is the voltage source V Out I would like to have here and I would like this series resistance to be very very low and I get it by a very high gain counter-reaction amplifier. Therefore for this voltage to be the same as the latter, it must be almost zero, so I put it this way: I say I can draw a current I Out and even if this current I delta Out becomes variable, it should have very little effect on V Out and that, that brings me to the effect of a variation in load Because my charge is something that would come to hook up. This is your charge, this is what we just realized within our circuit. And we hope that when the resistance variations, therefore it impacts the variation of this current, I would like this delta V Out being the lowest possible and that in reality it is the output impedance of this level there. So we always try to minimize the output impedance and as you have seen that it about a mounting when I go out on the transmitter to my transistor, So this is the lowest impedance that I can see for a transistor that I would see on R Out.

Notes

Summary

15m 19s

Régulateur de tension continue série



EFFET D'UNE VARIATION DE LA CHARGE R_L

$$\frac{\Delta V_{OUT}}{\Delta I_{OUT}} = R_{out,F}$$

EFFET D'UNE VARIATION DE LA TENSION D'ENTREE V_1

$$\frac{\Delta V_{OUT}}{\Delta V_{1NR}} = \frac{\Delta V_{REF}}{\Delta V_{1NR}} \cdot \frac{R_1 + R_2}{R_2} + PSRR$$

EFFET D'UNE VARIATION DE LA TEMPERATURE

$$\frac{\Delta V_{OUT}}{\Delta T} = \frac{\Delta V_{REF}}{\Delta T} \cdot \frac{R_1 + R_2}{R_2}$$

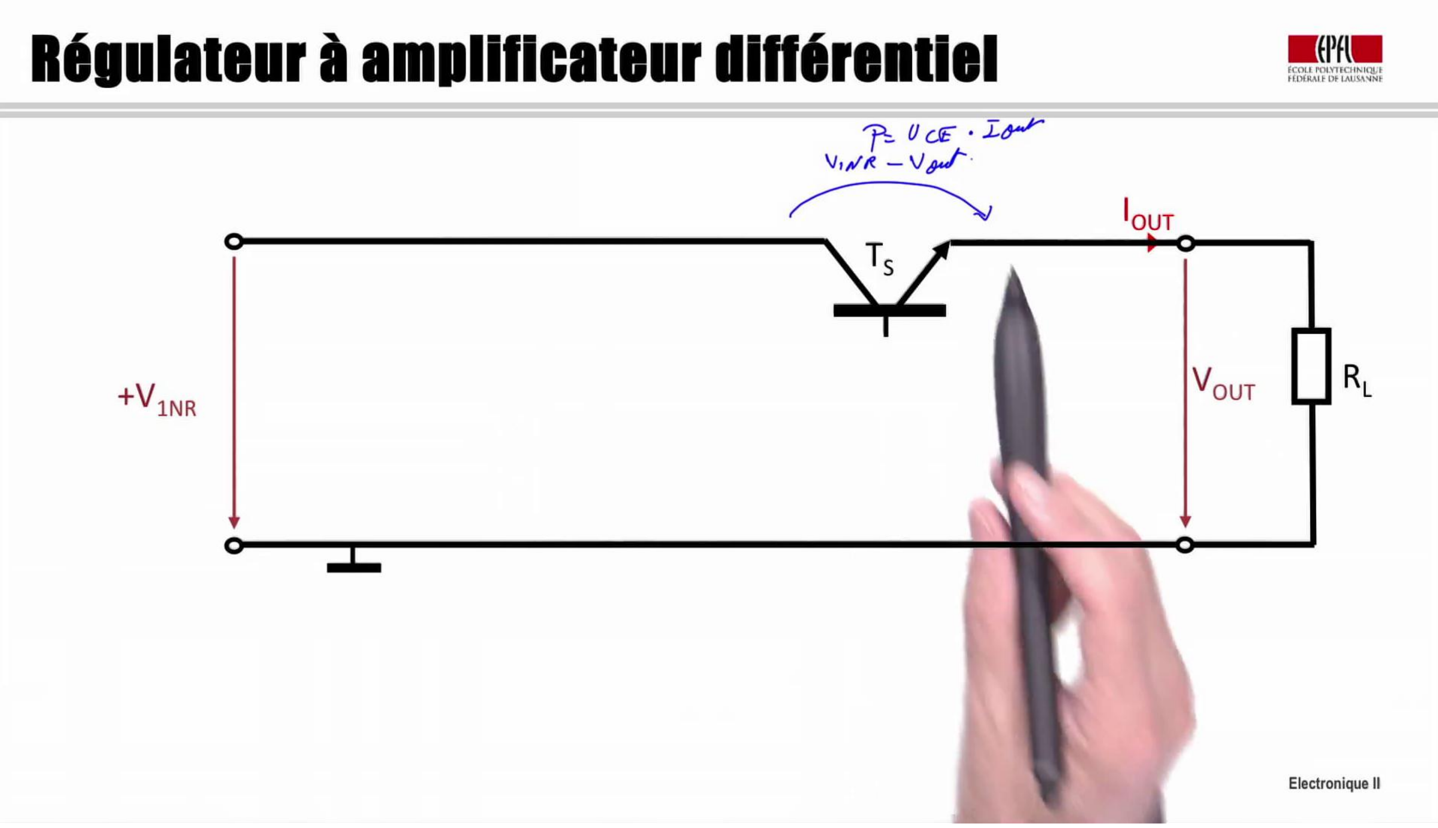
Electronique II

now on R Out, there are other effects. There is the effect of the non-regulated voltage, Remember that your supply or your regulator, it is powered by the non-regulated voltage. We hope that this non-regulated voltage has very little effect on the variation of output, So that brings us back to see the quality of our reference voltage multiplied by the gain of our amplifier and of course the amplifier should have a very good PSRR, it is to said a Power Supply Rejection Ratio which is very well done to does not pass from the disturbance of the unregulated supply to the voltage which must be specific to the output. And finally we also want V Out to be independent of the temperature variation and this often comes from the quality of V ref, the reference, if V ref has a temperature effect, we will see the exit. So when we call a voltage regulator, we look V out, V out, V out, we look at the facts of the current from the output V Out, the effect of the non-stabilized voltage which should become stabilize acording with V Out and we look at the effect of temperature on V Out and it gives us the 3 parameters that we call the effect of the variation of the charge, the effect of a variation of the input voltage, and the effect of a temperature variation. These are very important settings whenwe receive a stabilized power supply.

Notes

Summary

16m 59s



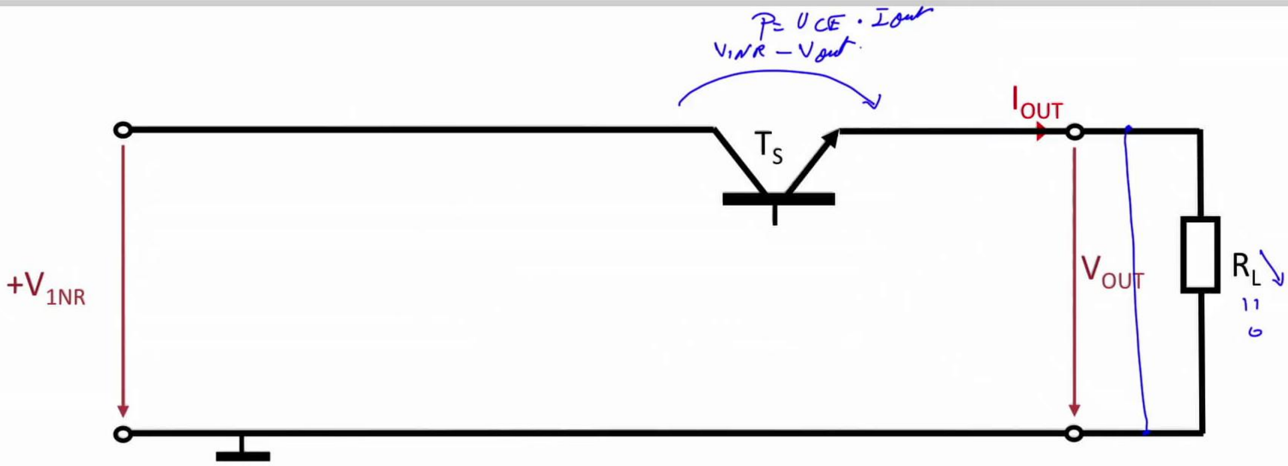
Well there is another parameter that will appear. If you take your transistor just say it's a power component, so it's a transistor designed to see a variation in voltage and it is traversed by a current and we know that the power that runs through it, is UCE that multiplies I out. So this is the variation... the variation of the voltage or it is rather UCE which quantity of tension it is between here and there and what is the current flowing through it? Well it will give us the power dissipated in this component. If you go from a non-regulated voltage and you move towards a V Out voltage, the less this voltage is high, so this is V1NR minus V Out, less this voltage is high, it is the UCE of the transistor, less is the power dissipated in the transistor. So we try to make power where this tension is quite close to it, of course the ideal is 0, if you have 0 that is mean there, there is no power and we talk about LDO type series regulator or in English Low Drop Out voltage. So when you make a voltage where the regulator is extremely close de celle-ci qui dissipe très très peu qui a un excellent rendement, it means we managed to have very little voltage variation between the collector and the transmitter of this transistor.

Notes

Summary

18m 41s

Régulateur à amplificateur différentiel



Electronique II

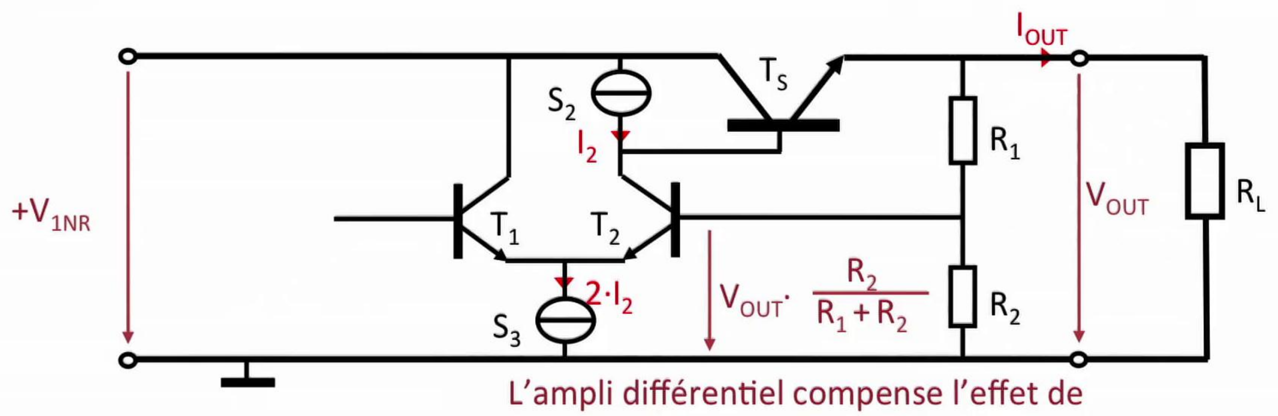
Now what happens if someone comes to the output of a voltage source and creates a short circuit? So he takes this resistance, it puts such a low resistance it is 0, So it creates a short circuit between this and that. And if you create a short circuit, the V1NR voltage compared to V Out, I will give you an example, you have 12 V unregulated and you are looking to have 8V regulated, therefore the difference between the two is of the order of 4 V and why that V Out instead it being 8V it becomes 0? The 12 V appear here, therefore we has a whole V1NR voltage of about 12 V on average value which appears across my transistor instead of 4 V. So this is the power dissipated in my transistor will be excessive because it's instead of 4 x I out, I end up with 12 x I out. So suddenly, I have a lot of power and that we can not tolerate it. So what we need to do is to limit this current and have a current I called Max Out to limit the current at the output and it is an integral part of the embodiment of a voltage regulator because it is with this maximum current that we know what is the power dissipated and we choose the transistor according to the dissipated power in our...

Notes

Summary

20m 13s

Régulateur à amplificateur différentiel



L'ampli différentiel compense l'effet de la température sur les jonctions BE de T_1 et T_2

Electronique II

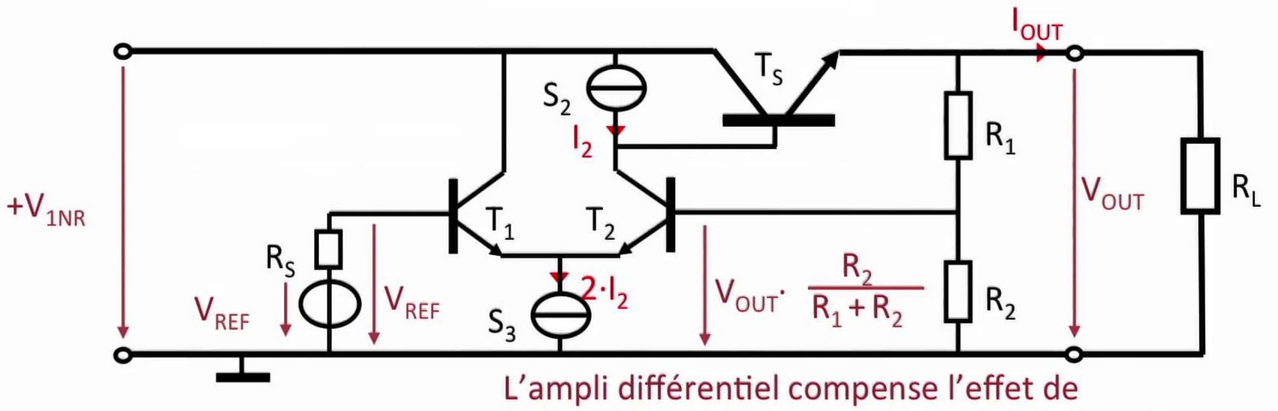
in our transistor and depending on this current I out max. Before watching this and see how are we going to limit it, I'll take you gradually into the internal structure of my series regulator. It must be said, there is the output transistor, there will have after a limitation, there the amplifier, there is the against-reaction, there is the reference voltage. Just take an example of a very simple amplifier, is the famous differential pair with active load and as you have just learned in previous lessons, is that it is a theoretical gain if that resistance is very high, we find ourselves with a gain extremely high, I do not speak of the burden of that side there, So I'll find myself with a GN times the impedance, if it is infinite and good, it's would be an infinite gain. So if we start with a simple structure of our amplifier which is foolishly the perdiff with active load and we put a resistive divisor here which takes the V Out voltage which multiplies by the resistance ratio if he bring it back here, so this is V out by R2 / R1 + R2 will be the tension that I see there.

Notes

Summary

21m 44s

Régulateur à amplificateur différentiel



L'ampli différentiel compense l'effet de la température sur les jonctions BE de T_1 et T_2

Le courant de sortie n'influence pratiquement pas le courant dans la référence

V_{OUT} est réglable en modifiant le rapport R_1/R_2

$$V_{OUT} = V_{REF} \cdot \frac{R_1 + R_2}{R_2}$$

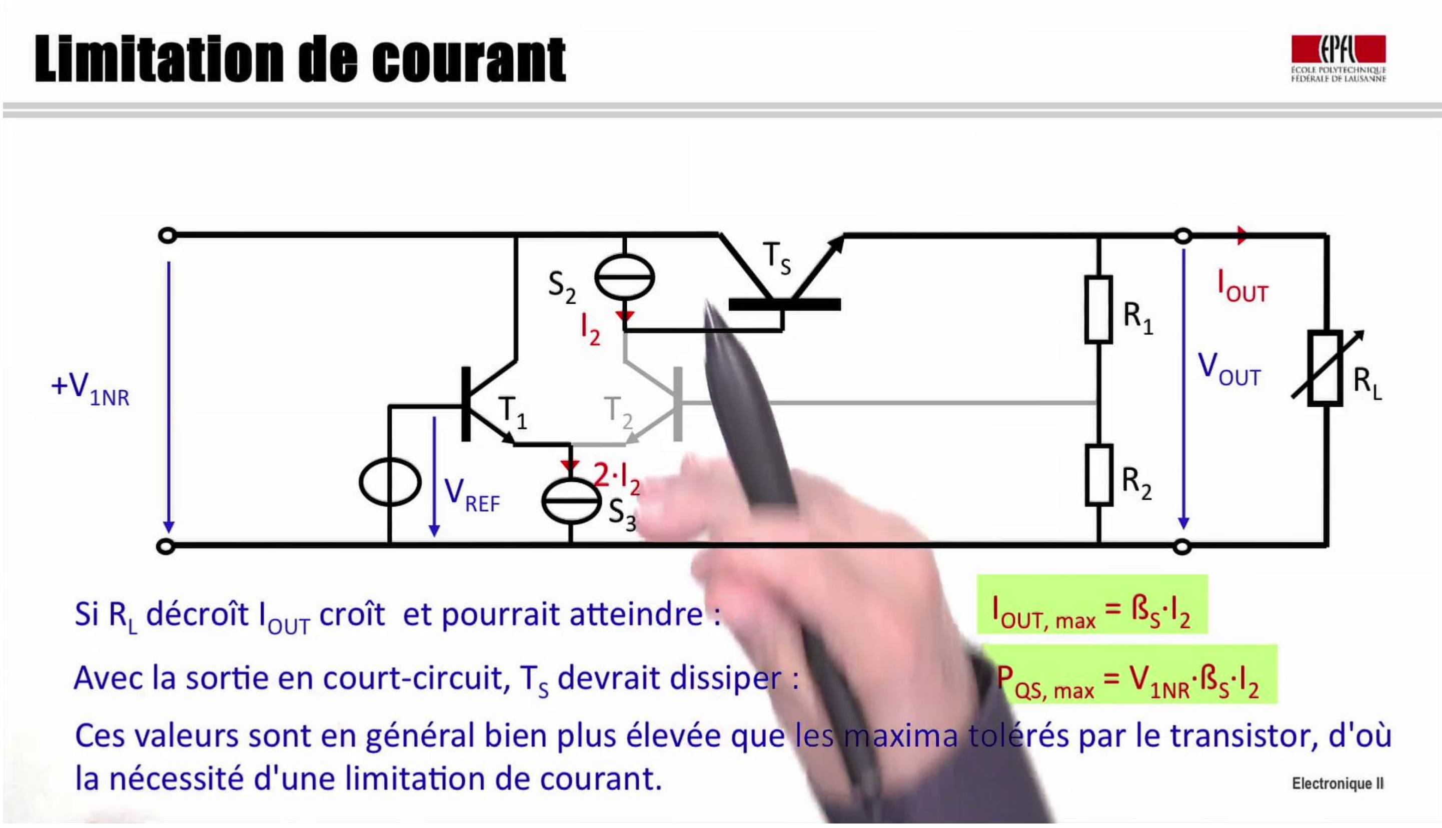
Electronique II

On one side, I have the voltage V Out, I would now like to put on the other side a voltage to which I compare and this is the perdiff which will compare the two voltages and ensure that the gain of the amplifier is still constant. Remember that after perdiff I have a voltage follower. I leave since the exit of my perdiff where I made a voltage gain, it amplifies the difference between the 2, after I have a gain equal to 1 which is made by this instalation there. From that side, I have to plug my reference voltage, So there will be after a zener diode or a bandgap, we will study it just now and we will see that any variation in voltage, it is always returned here and I'm always looking for that voltage equal to this voltage as it happens in my operational amplifier because all that level can be brought to a diagram of an operational amplifier. The gain V Out function of V ref, is when I equalize that expression to that expression, because my differential pair is in balance, so it'll give me that equal to it and I find myself with this relationship that I see here that V Out is really proportional to V ref, so if I want to have comparative to a constant V ref I only have to change the resistance ratio here and I'll have a diet whose the output voltage is variable.

Notes

Summary

23m 04s



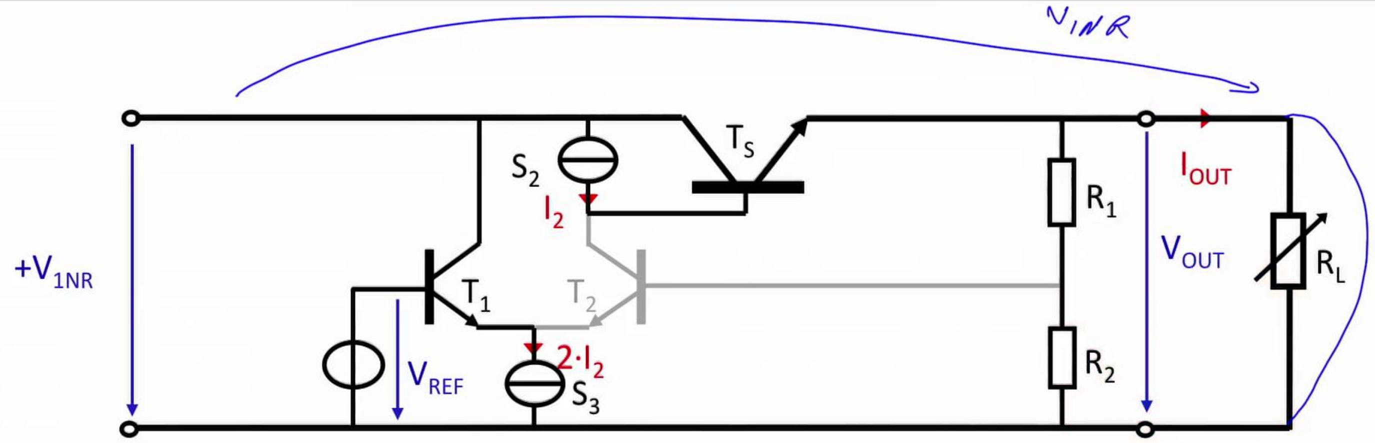
we has just seen the regulator of our structure, we have just seen that the output current, it is the current that flows like this, therefore the current that passes in that direction will be the current I Out comes from there. This transistor then will take a current in the base and it will come out a current in the collector and transmitter that beta times the current that I send in the database. You remember how is works the perdiff when you put him a current source as active load. You know that perdiff, it is in balance, is to said it should in the linear zone compare this voltage to the voltage and stay in the linear region. Now, more you ask the perdiff to make variations on the operating point, more current flows more in a branch to... and less in the other until all your current source passes through a transistor and not in the other. So I'll take this extreme case. When I begin to lower the voltage V Out, I lower it to the point where I get out my perdiff of the linear region. The style that I get this voltage compared to there and all the power source pass throught in this transistor, so my perdiff is unbalanced.

Notes

Summary

24m 39s

Limitation de courant



Si R_L décroît I_{OUT} croît et pourrait atteindre : $I_{OUT,\,max} = ß_S \cdot I_2$

Avec la sortie en court-circuit, T_S devrait dissiper : $P_{QS,\,max} = V_{1NR} \cdot ß_S \cdot I_2$

Ces valeurs sont en général bien plus élevée que les maxima tolérés par le transistor, d'où la nécessité d'une limitation de courant.

Electronique II

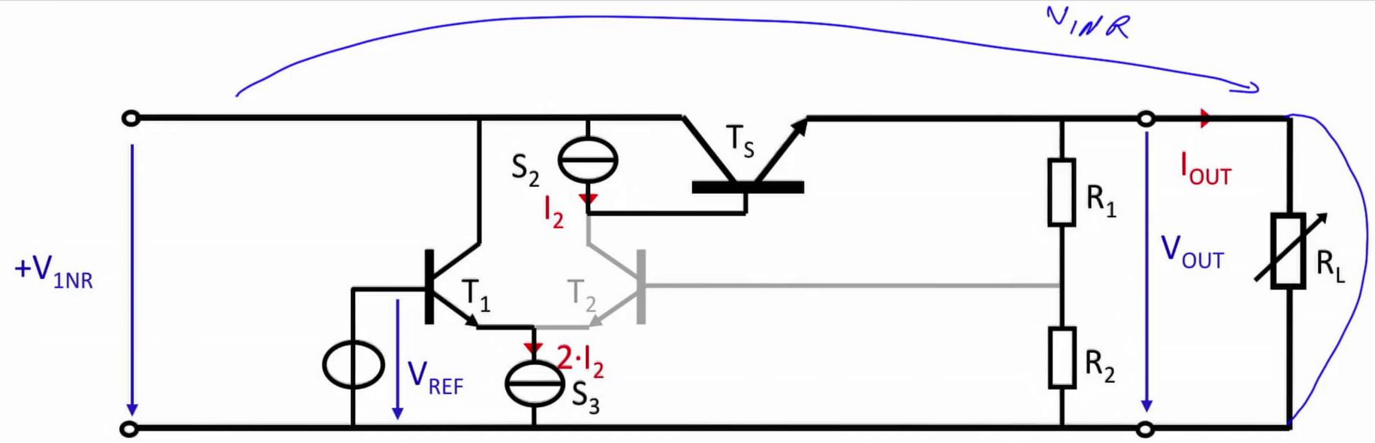
It is not in the linear region and of course there is no regulation, we get to the saturation of the differential pair. All power who was in this current source will pass in this transistor. it will be multiplied by the beta of this transistor which I called beta S and provide me with the output current so there is at somme point I reach this maximum current, I could not in this configuration one overstep this maximum current that clearly written I out max, it is proportional to the quantity of current that I have put in there multiplied by the beta of the transistor which has a fixed value, so I get to I max out. then of course in this situation when the perdiff is no longer works, we are already in the perdiff saturation, so this voltage is then no longer regulated, may continue to fall, you can even go up to make V Out equal to 0 and then I fall back in the situation that I described at the beginning. If it's I out max and if this voltage then equal to 0 So I really have a short circuit here So the tension V1R its this voltage which is then the same as that one, it is also the VNR. So I have a voltage V1NR Which appears at the terminals of my transistor and this transistor is driven by the current I out max.

Notes

Summary

26m 08s

Limitation de courant



Si R_L décroît I_{OUT} croît et pourrait atteindre : $I_{OUT,\,max} = ß_S \cdot I_2$

Avec la sortie en court-circuit, T_S devrait dissiper : $P_{QS,\,max} = V_{1NR} \cdot ß_S \cdot I_2$

Ces valeurs sont en général bien plus élevée que les maxima tolérés par le transistor, d'où la nécessité d'une limitation de courant.

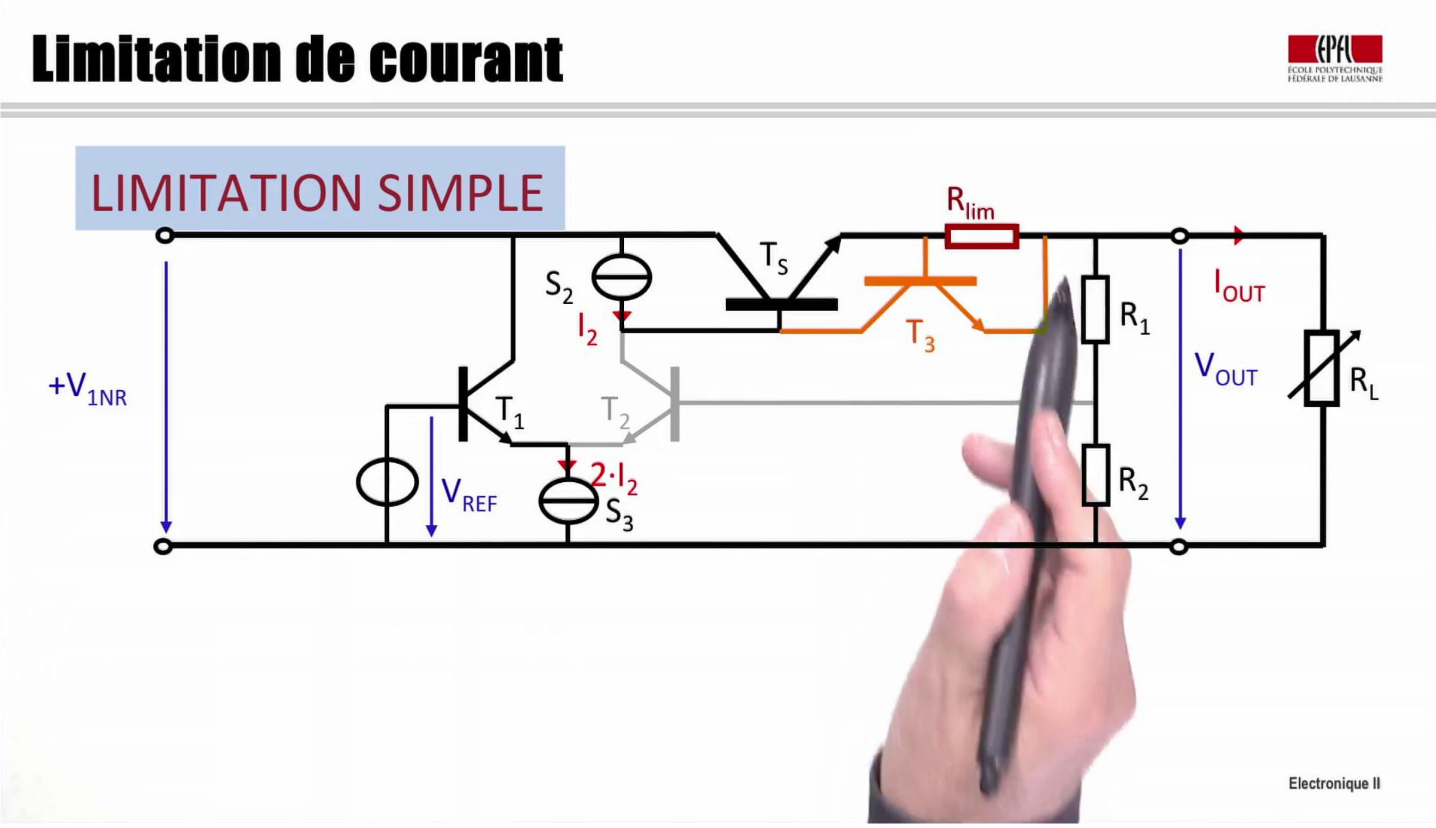
Electronique II

And there, I can reach a limit where this transistor may suffer in terms of power dissipation and even slam because of the heat which is dissipated in and I would avoid this situation.

Notes

Summary

27m 35s



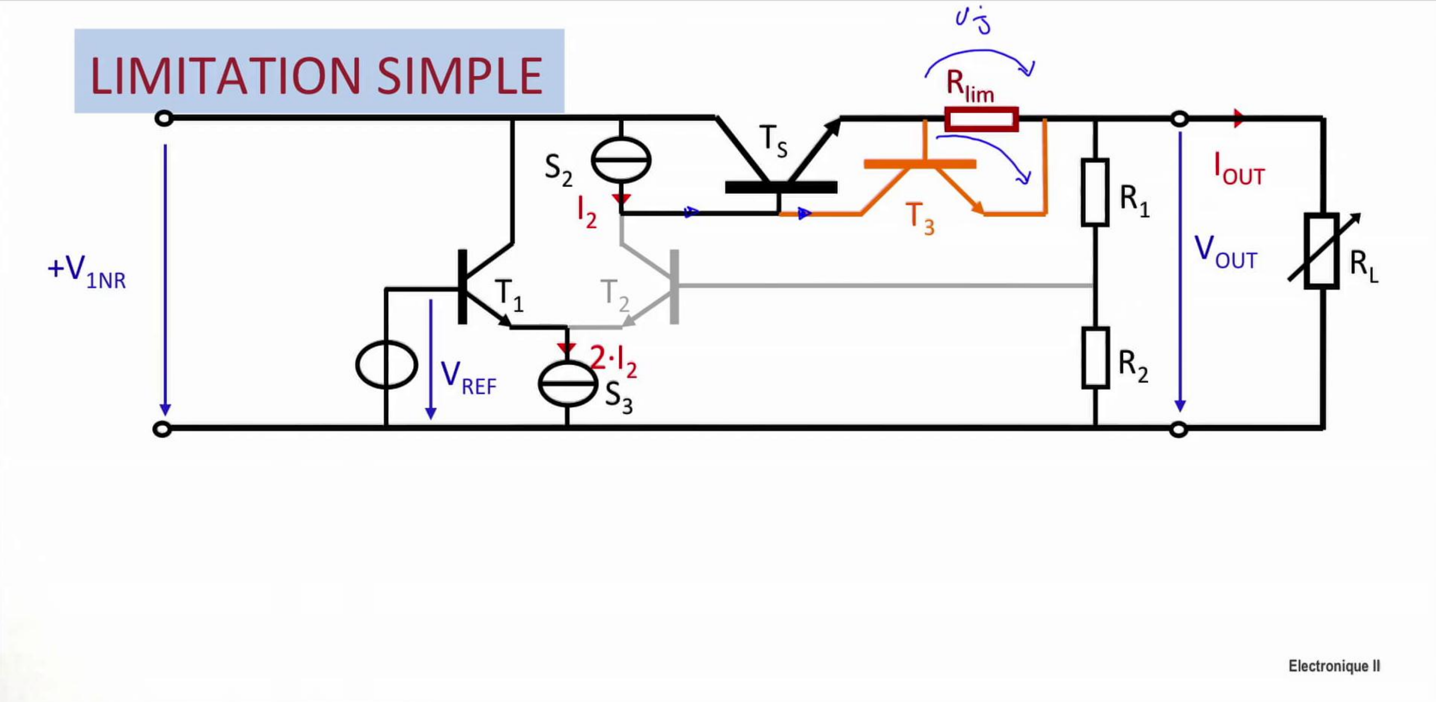
So what we do as limiting circuit the output current, is that we will add strength that we call in this example here R lim. I am in this condition, I reach to a maximum current I want to establish its value. How do I establish its value? Establish its value against a resistance that I would put here. I will arrange to make a comparator here like put a component Which will read the voltage at the terminals of R lim and when I reach to the value I max out, interrupt function inherited from this to avoid that I continue to draw a current in this way through the TS transistor, I want to prevent that. So how will I prevent that? If the current flowing in the base of this transistor, I succeeded in deviating it elsewhere, this transistor then he is no longer going to suffer By this excessive current which will go to the end. And if I can limit that tension one to a value I determine myself and I have to make a comparator which reads this value and stop it. And I do it in a very simple way, I do it at once with a single transistor, a single transistor could come read a voltage. What kind of pressure? Look at a simple transistor, we had seen that a transistor begins to conduct when the base-transmitter voltage is of the order of magnitude of UJ.

Notes

Summary

27m 50s

Limitation de courant

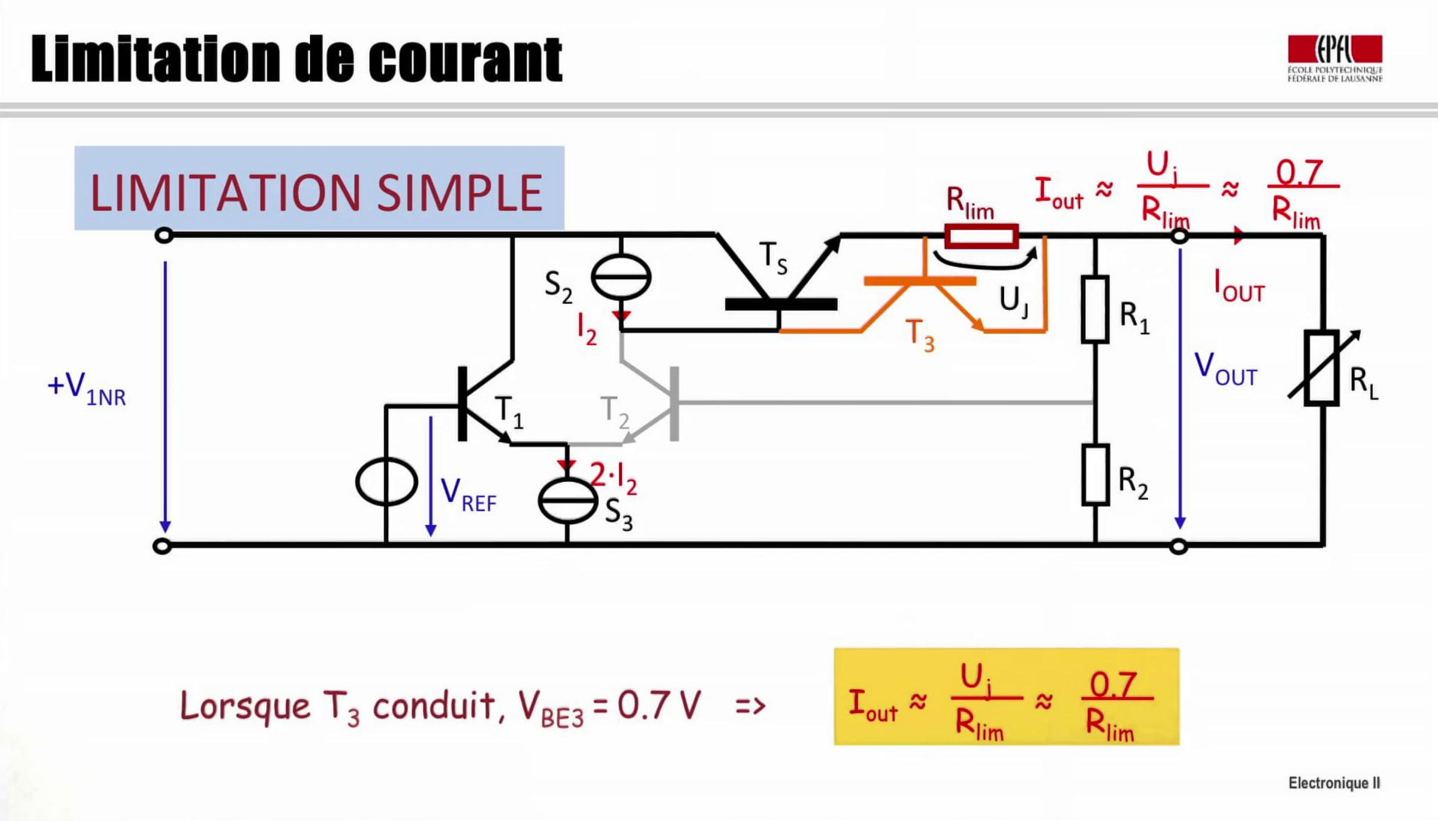


So I just have to fix me so I x R lim Out is of the order of magnitude of UJ for this transistor to starts conducting. I neglects the current flowing here I consider the current which pass in that branch then is low enough that I Out here it's the same that I see here: I Out x R lim, the moment where I Out x R lim gives me a tension here who causes the transistor which is of the order of UJ well look at I2, it will be like this the small portion that would go there, we begins to bite in there and move it in that direction. So this transistor here, could no longer regulate one side and on the other side, it is not drawing current beyond this current that will be I max Out which will be proportional to that UJ which appears here multiplied by... sorry, divided by R lim and that will give us the maximum of current that I withdraw. And it is a supply that has at this moment a current limitation and as we said it was absolutely essential.

Notes

Summary

29m 19s



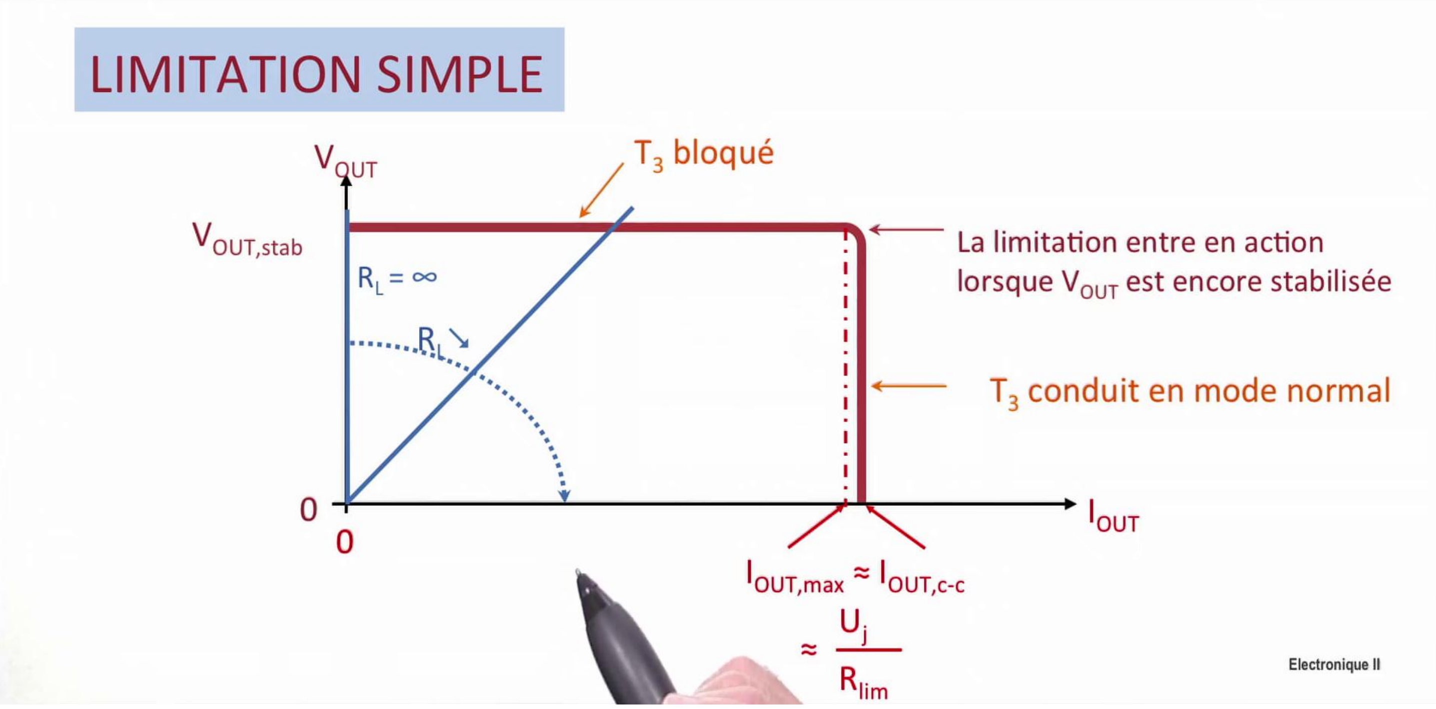
Let's see it! The same explanation presented in a simple way I Out = UJ / R lim, That was the idea. I just have to say: what is the maximum current? And the maximum current it depends on the power that I can dispel in the transistor TS because it is I Out x UCE that will allow me to see this maximum current and this will be even up until V Out 0, it is as soon as I reached this value then even if this voltage is equal to 0, so it will give me the V1NR tension from here to there minus UJ because I would have lost that UJ on it, one can almost overlook it compared to a full voltage level from here to there will give me the UCE voltage of the transistor, I multiply by I Out will give me the power I'll dispel in this transistor and this is the expression of the current limitation I Out is equal to UJ divided by R lim.

Notes

Summary

30m 29s

Limitation de courant

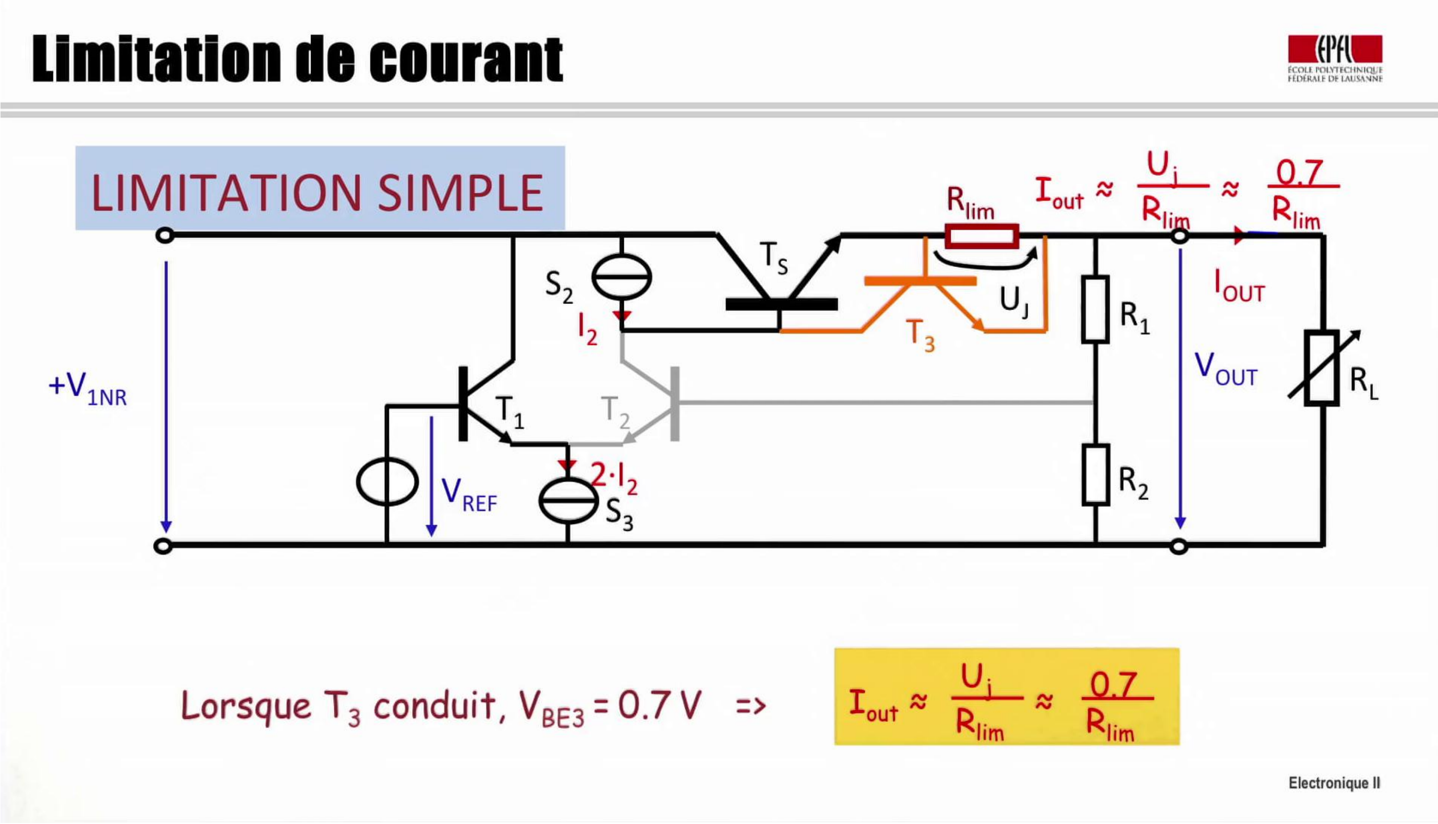


And the characteristic of such of supply become thereof : regulated supply. that's your charge at the output, as long as your transistor, I come back to the slide before, As long as your transistor is blocked, it's does not exist I can remove it completely.

Notes

Summary

31m 35s

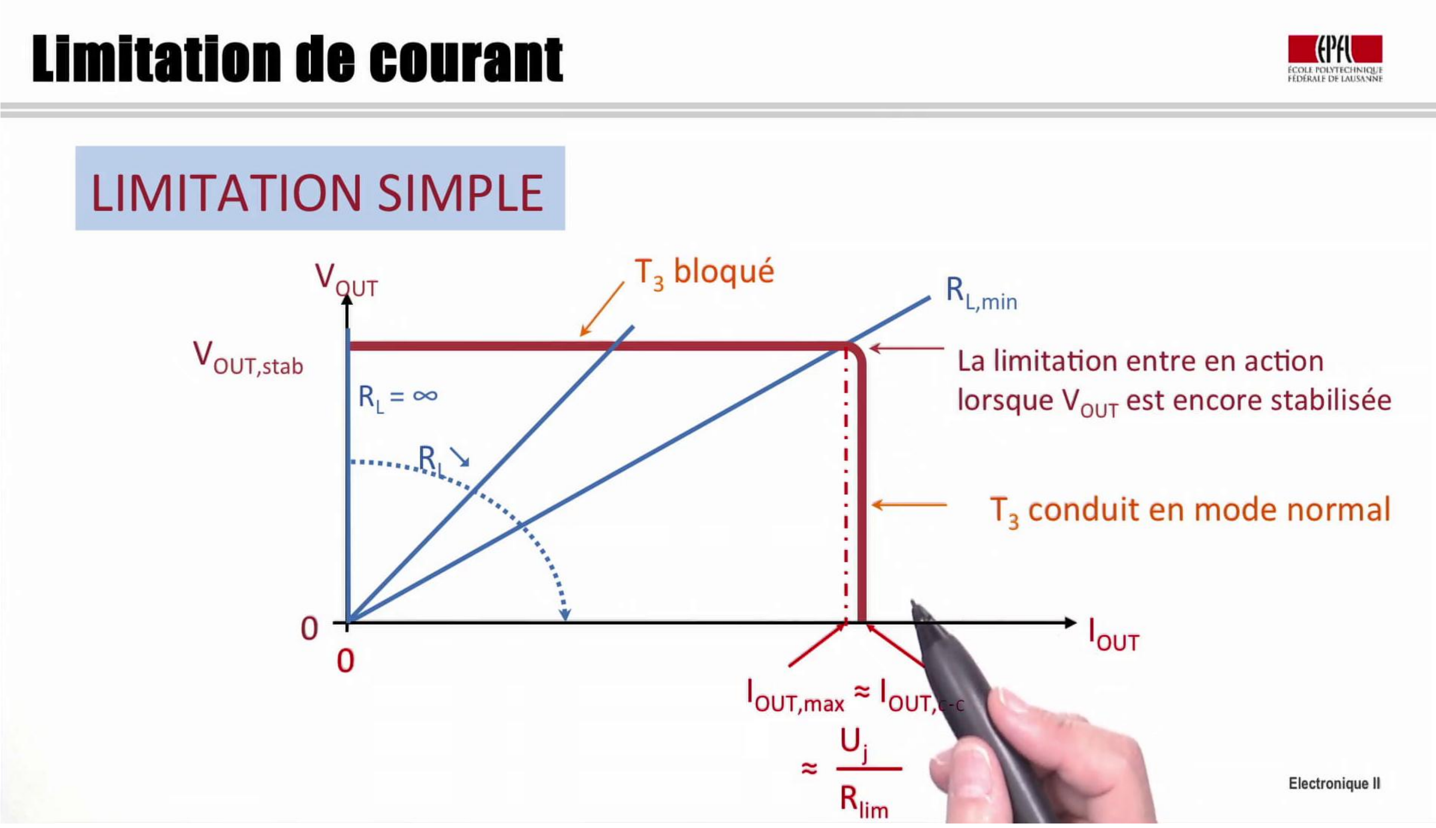


Although I have the I Out who's continues his way, I lose a little of this resistance as voltage drop until I tend to value where I Out R lim equal to UJ and this transistor starts to conduct. So when does it happen? It happens at this moment!

Notes

Summary

31m 57s



It happens when you look at the resistance and you continue to draw current, look this is the current axis. When you get to this I max out So here, in this point one, this is where you have I Out max = UJ / R lim, your transistor T3 which was orange in orange color will start driving and immediately after, You will no longer be able to increase the current, you want to increase the current, you increase very little, it is because we took an UJ approximation but the transistor begins to conduct perhaps around... less than 0.65 or 0.7, it begins to drive and there you're going to have the output voltage which will drop until we reach to a short-circuit current and then we can say that the output voltage is 0. And we are inside there!

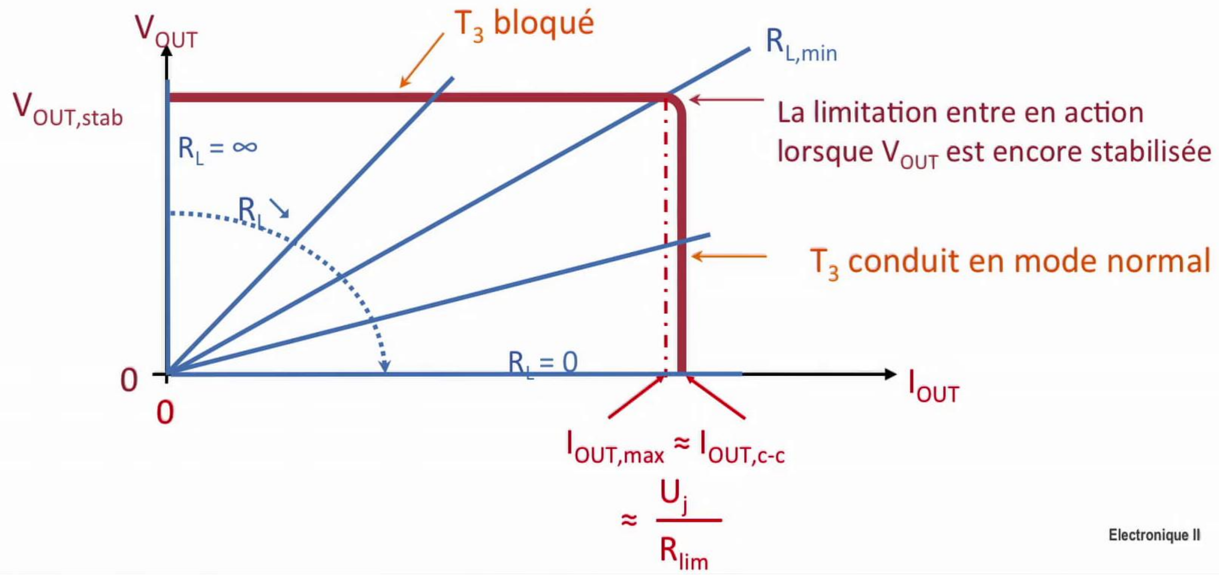
Notes

Summary

32m 17s

Limitation de courant

LIMITATION SIMPLE



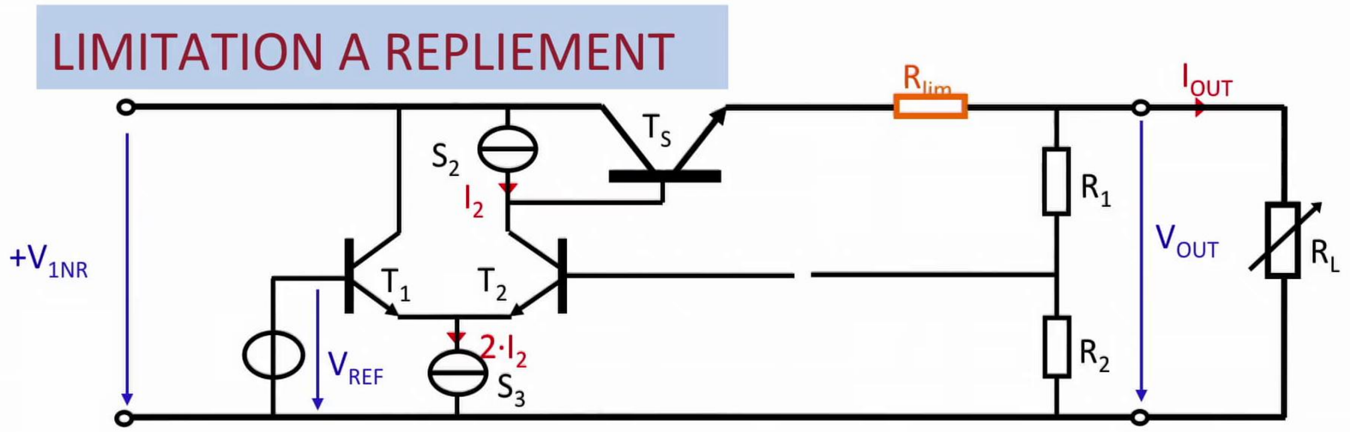
We are at R lim which lead and when R lim is currently driving, we may continue to fall and then we will move towards an output voltage which will be even equal to 0 and we end up with a short-circuit current close enough to I Out max because everything will turn around this detection of 0.7 V with the junction of the transistor and we will have a characteristic of a voltage source which is great until I Out max and quickly collapses even until the output short circuit. But then I still drawn this current short circuit, it continues to move in my transistor of bypass, so the series transistor between the input and the output, we still keep them, it continues to have exactly the same quantity of current and dissipate power. This is something we do not like, we should improve it.

Notes

Summary

33m 06s

Limitation de courant



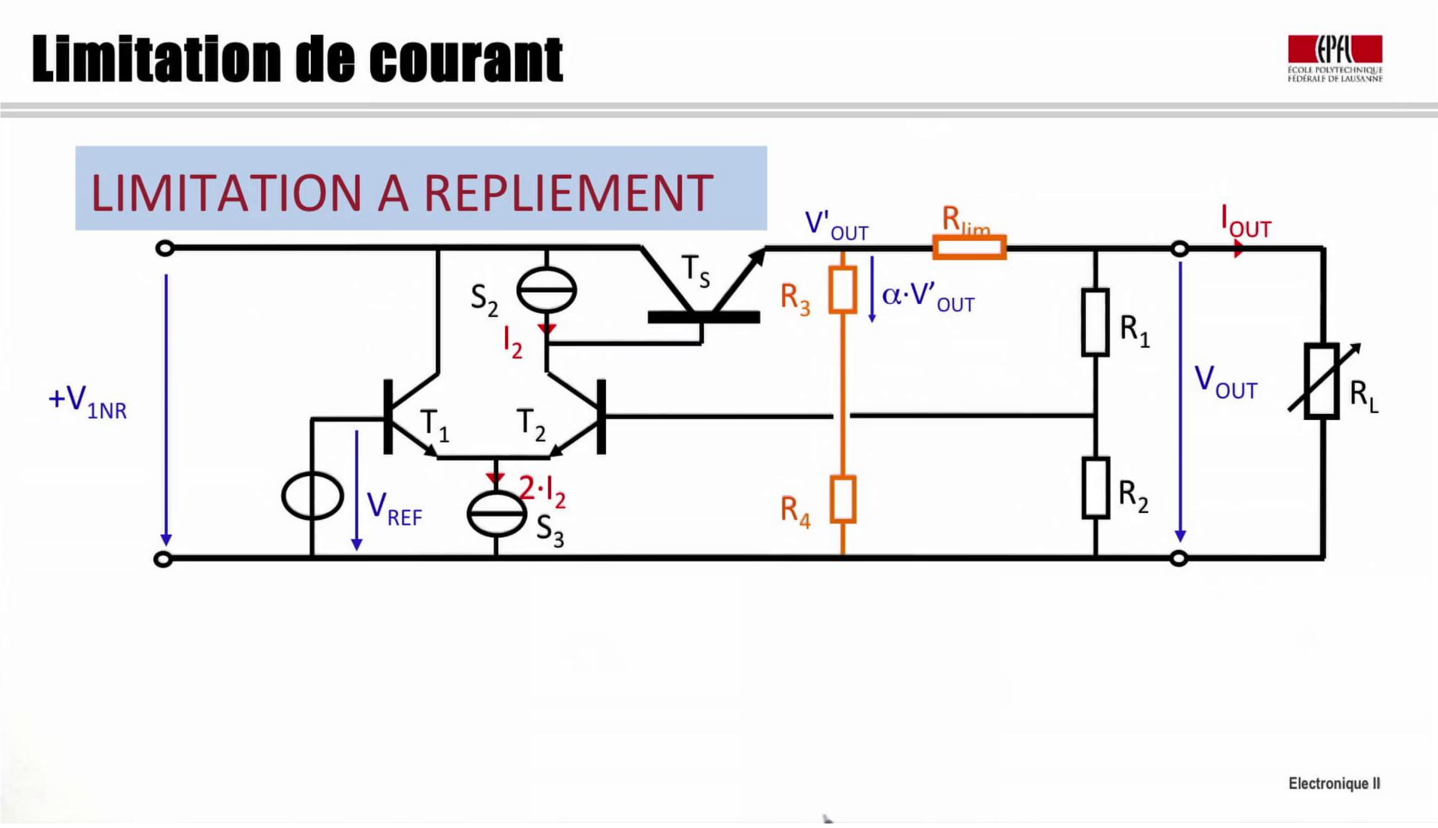
Electronique II

To improve it, there are the following diagram, instead of imposing a voltage: only read the UJ voltage to terminal of R lim, we will do this: we'll add our resistive divider, the one that...

Notes

Summary

34m 06s



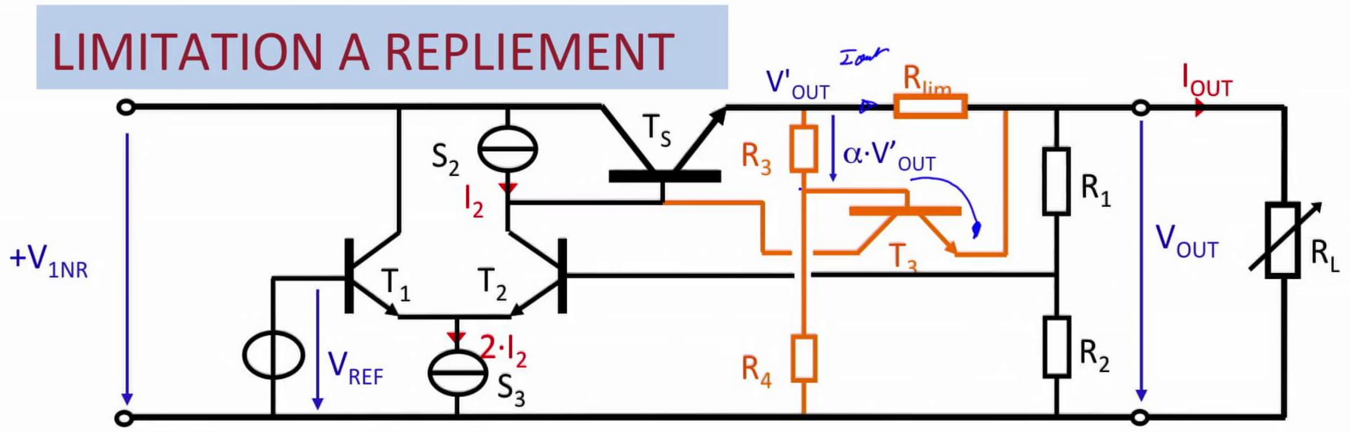
more so another resistive divider will... we keep our R Lim we add two large resistors preferably large resistors for that current flowing through them will be very low, for it... all the current flowing in there or in there it will be subtracted from I Out and that we do not like. So it is stirred and we will take our earlier transistor which is there to limit the current and instead to simply put it as comparison across to R lim we will also use the term of V Out inside by putting the resistive divider. This resistive divider, if R lim is very low and the voltage drop is negligible, it is as if V Out is there and we neglect the voltage drop here you will see that V Out like here, So, I have a divider that will make me appear a proportion of V out like this.

Notes

Summary

34m 26s

Limitation de courant



$V_{BE3} = I_{OUT} \cdot R_{lim} - \alpha \cdot V'_{OUT}$

avec: $\begin{cases} V'_{OUT} = V_{OUT} + I_{OUT} \cdot R_{lim} \\ \alpha = R_3 / (R_3 + R_4) \end{cases}$

Lorsque T_3 conduit, $V_{BE3} = U_j$ =>

$$I_{OUT} = \frac{U_j + \alpha \cdot V_{OUT}}{(1-\alpha) \cdot R_{lim}}$$

Electronique II

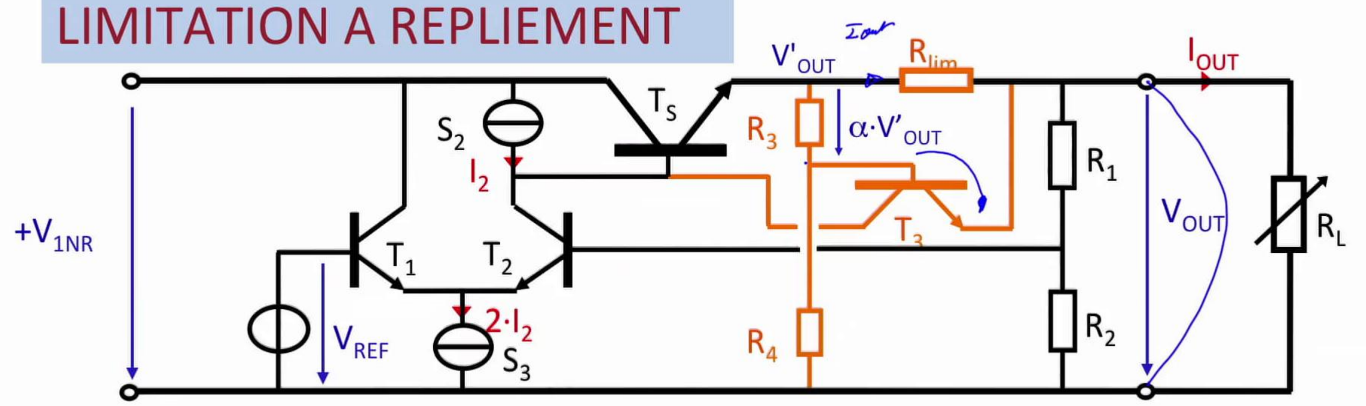
I would see an alpha voltage, I call it V Out such that V' Out is I Out R lim + V Out and I will now add my transistor here I'll add my transistor here therefore UJ voltage or the control voltage transistor appears between this node and that node and I will write the expression of the tension... the maximum current at that time. So the VBE voltage of the transistor sees all this mesh, in this maille, I see I Out R lim, it's that's I Out And there... And there is also the voltage that is a proportion of V out which is alpha V 'Out and alpha comme from a resistive divider, it is a relationship between the resistors R3, R3 + R4. So the voltage V 'Out, it's like I'd just say it's the tension I lim R Out plus V Out I have noted here. I use these two words together to put them outside Out and it will give me this: VBE3 this is actually the UJ, the voltage which is from here to there which operates my comparator and begins to drift current which should go into the base and I find myself with a current R Out equal to UJ plus alpha V Out divided by 1 minus alpha R lim. Analyze this together.

Notes

Summary

35m 21s

Limitation de courant



$V_{BE3} = I_{OUT} \cdot R_{lim} - \alpha \cdot V'_{OUT}$

avec: $\begin{cases} V'_{OUT} = V_{OUT} + I_{OUT} \cdot R_{lim} \\ \alpha = R_3 / (R_3 + R_4) \end{cases}$

Lorsque T_3 conduit, $V_{BE3} = U_j$ =>

$$I_{OUT} = \frac{U_j + \alpha \cdot V_{OUT}}{(1-\alpha) \cdot R_{lim}}$$

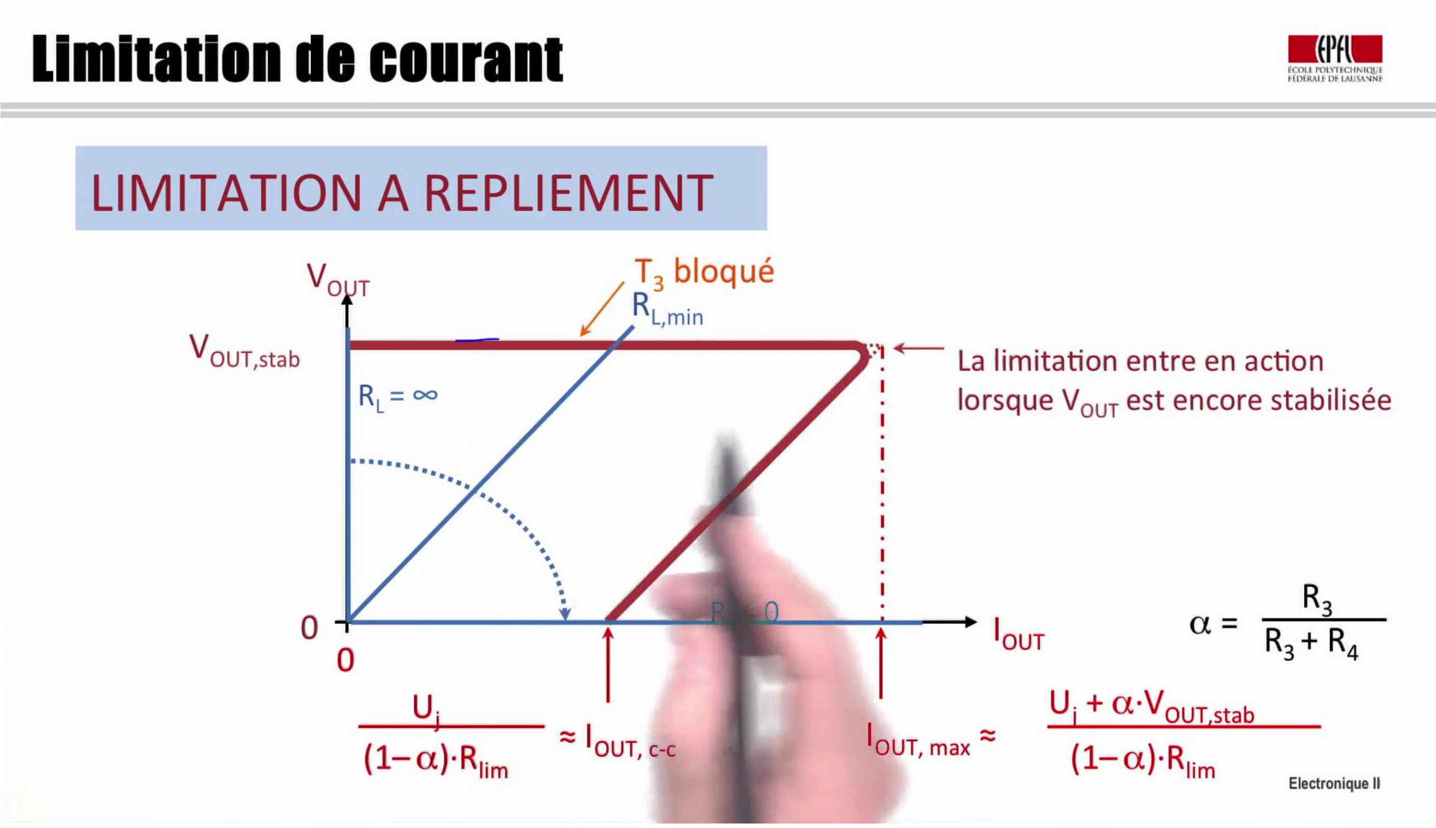
Electronique II

Earlier when I had not put this, le I Out max depended on R Lim, So there I am saying that I Out max exist but it may be also have a I Out CC, so short-circuit, is when this tension and this tension are the same So when there really V Out equal to 0 when I bypasses, when that term equal to 0 So this term falls so you can have a maximum current and still have your circuit which regulates with a V Out finite and known and you go after to want to regulate and you continue to lower V Out until V Out equal to 0 and has 2 values. There is a value for the I out max and one value for the I out CC So it is when V Out equal to 0.

Notes

Summary

37m 03s

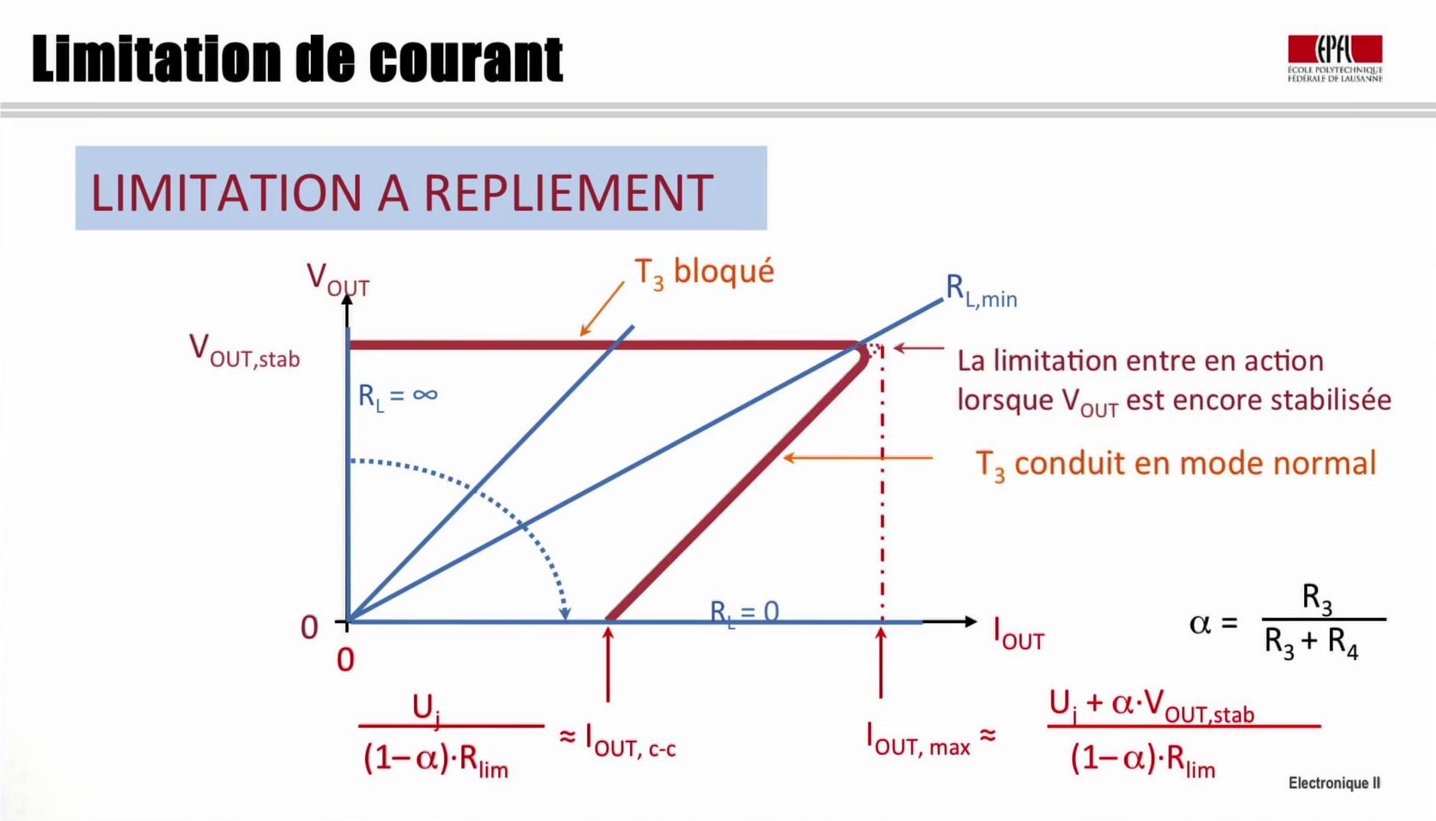


So we will see that this expression has the following thing I can describe it as this, your regulator regulates the voltage as it is usual, there is no effect due to... it's a T3 transistor because it's always blocked and it's like it does not exist. And you get to a point where your T3 transistor will want to conduct and you continue to draw current, more you draw the current, so the more you lower V Out which tends to 0, that will go to 0, when V Out equal to 0, you will end up with UJ divided by a report, it will give you what is going to happen with your characteristic that we call a stabilized power supply with input characteristic, in other words we have a regulation characteristic and after more we draw current, the more we want to draw more current, it becomes impossible because it no longer regulates so the voltage drops down, look at the voltage it is going down, but at the same time I draw less current, the opposite of what I had done early when I'm here in the first simple limitation, I still found myself with a current equivalent to I Out max, here I am with a current I Out CC in which this term here has disappeared and it led me to this term equal to 0 so UJ over 1 minus alpha R lim.

Notes

Summary

37m 53s



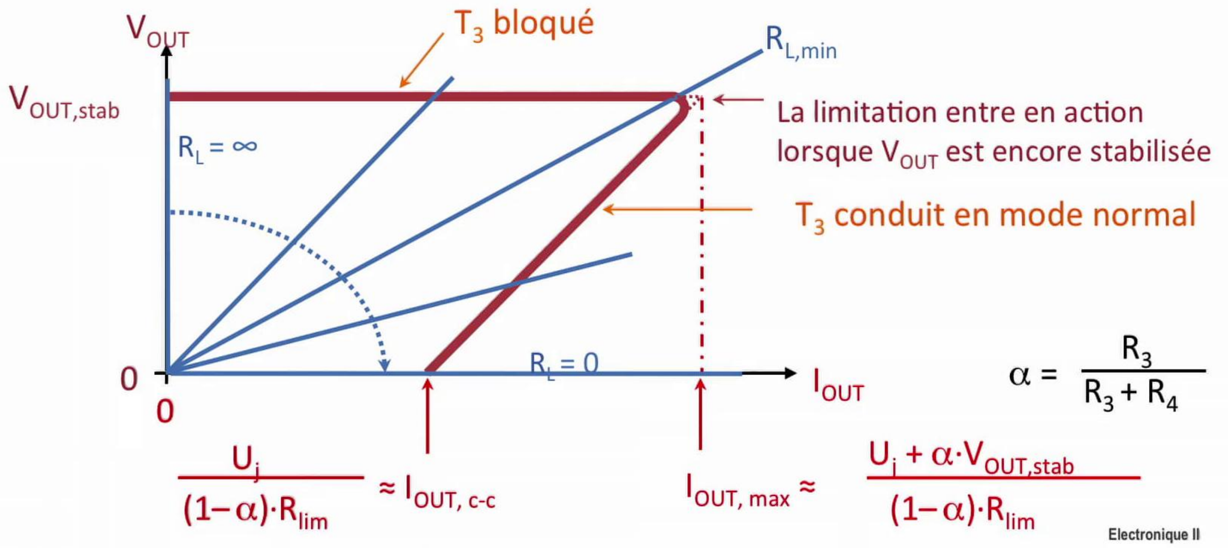
So I have a less current that's the max and that's the short-circuit current so I have less power, so less dissipation in my transistor that is in series. Let's see with a little more current which increases. Here, See now here is what happens when you reached the point of resistance, a minimum output which brings me to the maximum current beyond that I no longer regulate and this is what I get when actually my output resistance is equal to 0. When my output resistance is equal to 0, I have a lower current and we get this limitation characteristic the output current of incoming Nature which is much more interesting than we had seen at the beginning for several reasons and mainly for the power dissipation in my series transistor.

Notes

Summary

39m 30s

LIMITATION A REPLIEMENT

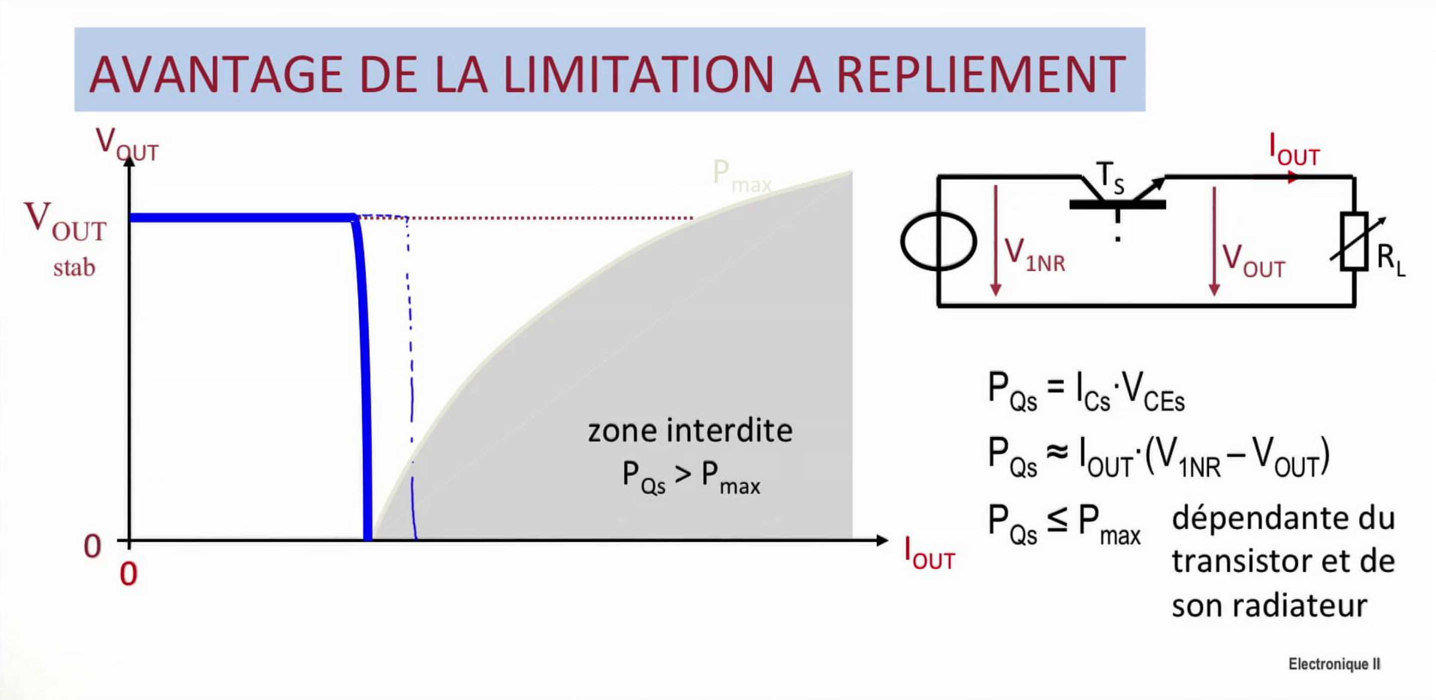


This is the final figure, I'll let you analyze it and see the difference between the two currents and see that everything will depend of course on my alpha parameter which also depends on my ratio strength that I just choose to do this kind of circuit.

Notes

Summary

40m 29s

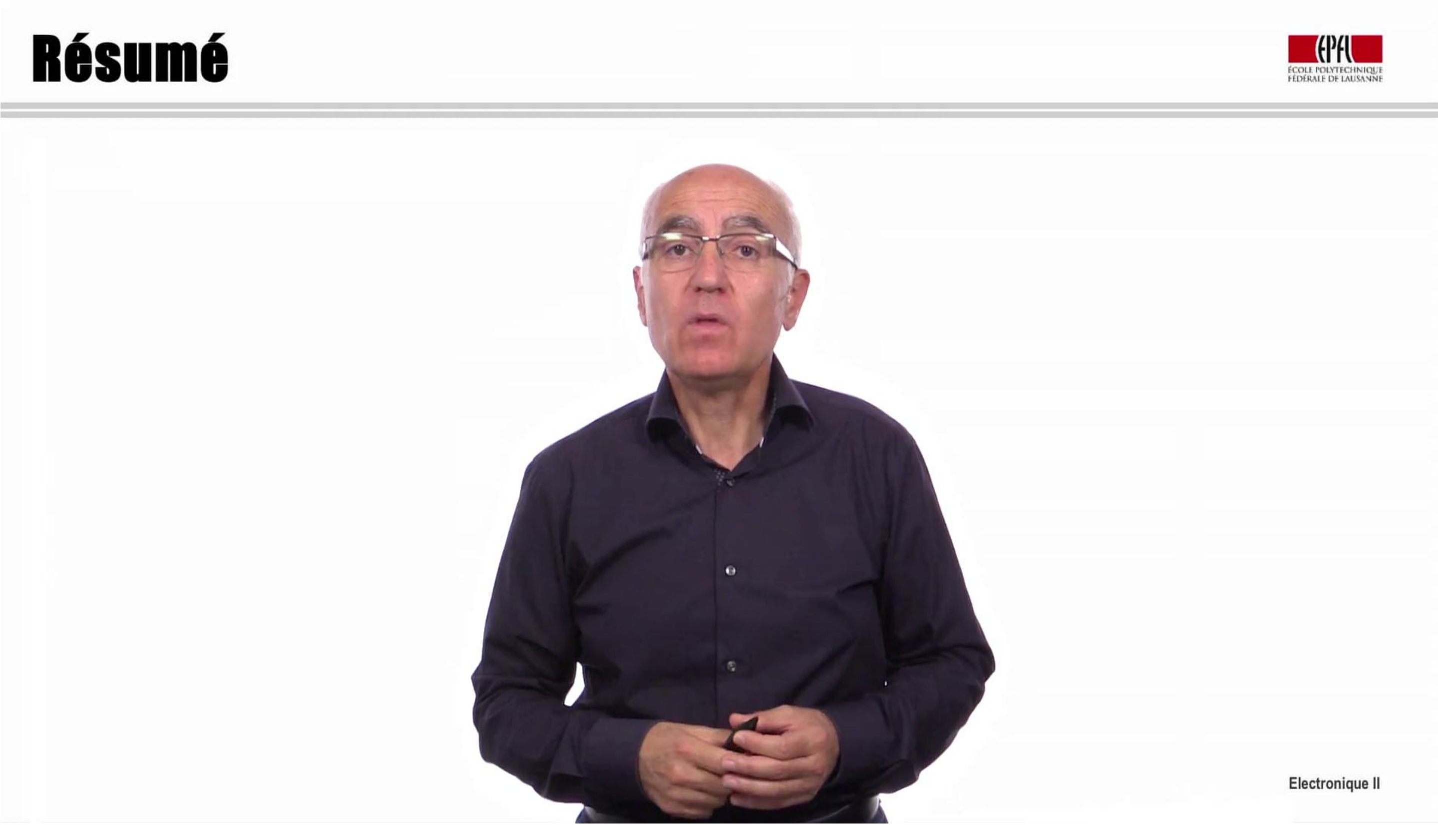


I would like to compare what will happen with my transistor here when I foolishly put a resistance and I make a simple characteristic like this. Suppose that your transistor, it has a power characteristic which is stop us or prevents us to have U x I in the transistor so if I am here, here I am with a voltage UCE which is this and a maximum current which flowing through it Which brings me to have dissipated power in my transistor perhaps superior in this example, I am not the limit that the maximum power of this transistor. So any additional current I start wanting to draw if I fall into the short circuit, the output voltage is equal to 0 I'm in the prohibited zone where the manufacturer forbids me to dispel beyond an quantity that depends of course... the housing my transistor and its radiator. So if I have a current limiting incoming Nature like that, I can continue to have the regulated voltage and draw more and more current look I have a current I Out much higher given that after the current it will drop down when the voltage goes to 0 So see the area that I can not go into it because my transistor does not allow me to do so.

Notes

Summary

40m 48s

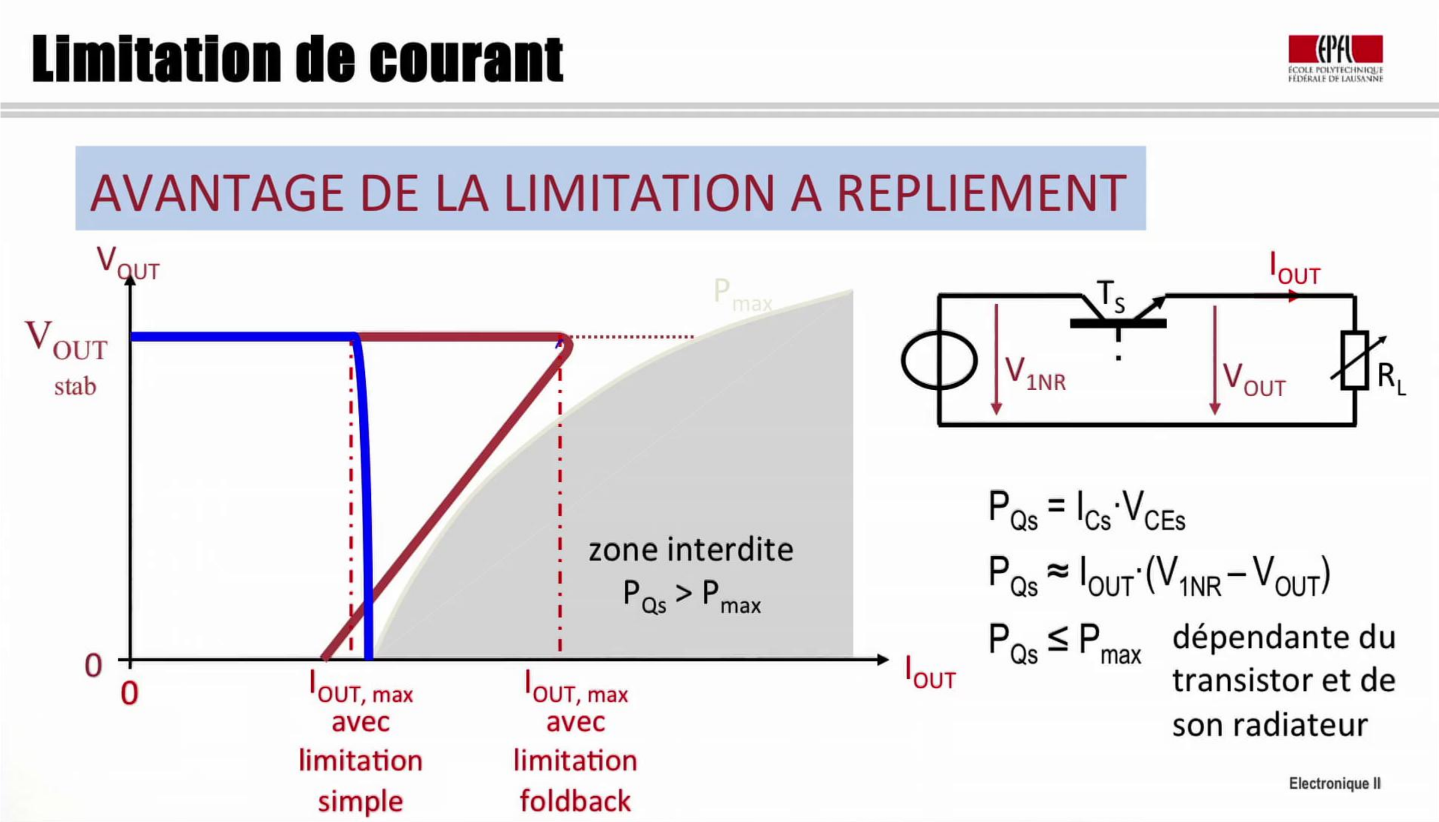


In that example one, I absolutely can not do it, if the control or the output limitation do not let me draw more current because I enter the prohibited area, there by the incoming inclined shape of this characteristic, I can draw more and more current and continue to regulate with the same circuit while having a limitation which go to this value then which is the I Out max because I succeeded to differentiate the maximum current than the short-circuit current which are there and there for this characteristic. We have seen the implementation of a series feed a series regulator, This regulator series is an excellent example to show us the first use Of the differential pair that makes us the basic amplifier followed by an transmitter- follower setup type In which a low output impedance In which one can get out a low output impedance and it was analyzed that a transistor used almost in switching as a comparator but really very simple where the fact lead is a very useful tool in stabilized power supplies And which would allow us to limit the output current. So with this kind of setup, it gives you some applications of bipolar transistors and we'll see in the video that follows immediately How do we make a voltage reference?

Notes

Summary

42m 22s



And in there, there will also have circuits with transistors And we would have seen a whole set of applications around transistors which represents an important chapter for those who want to go beyond, to understand how the transistor works and begin to understand analog electronic systems that use regulation for example, or other functionalities with the transistors.

Notes

Summary

43m 56s