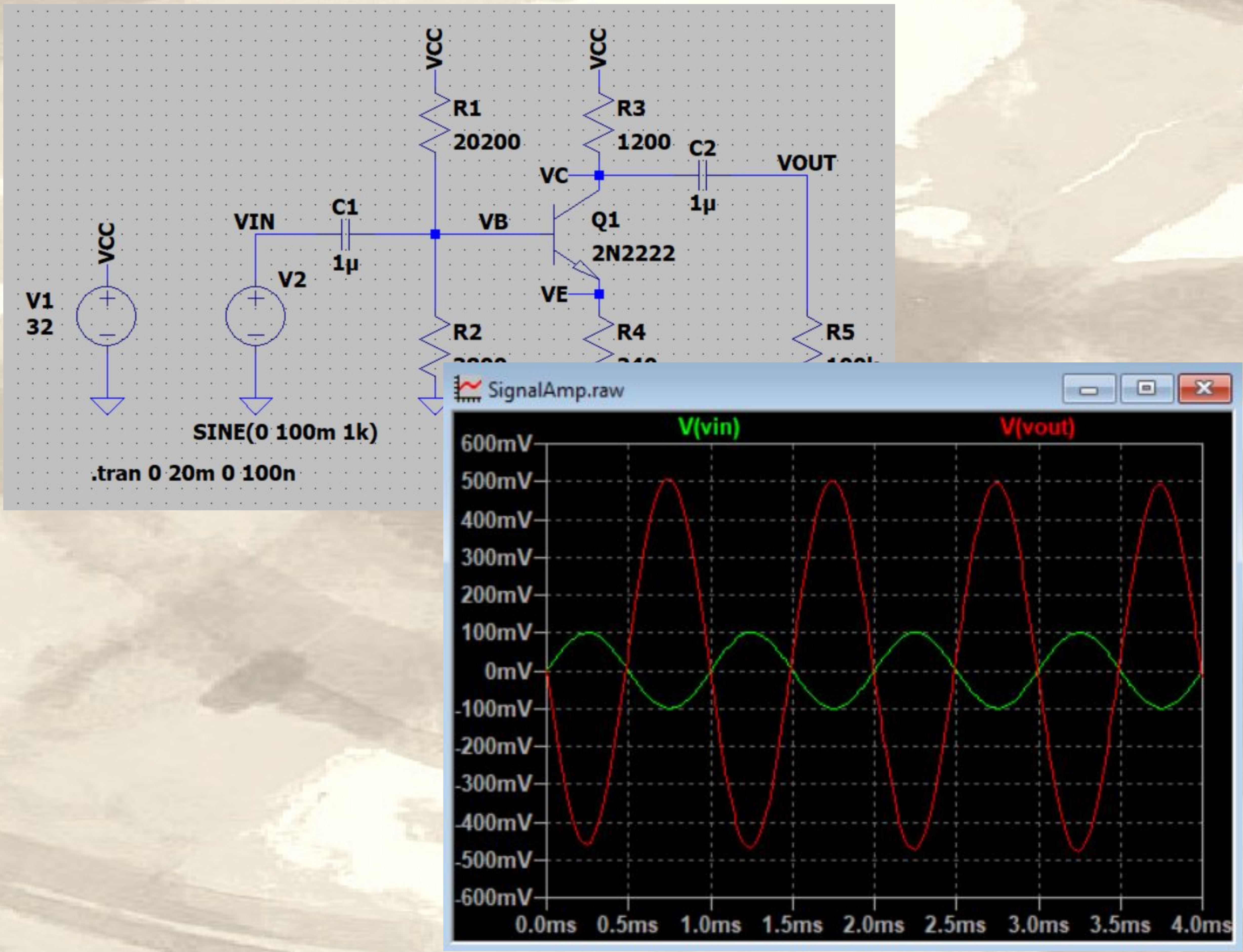
Drops of LTSpice

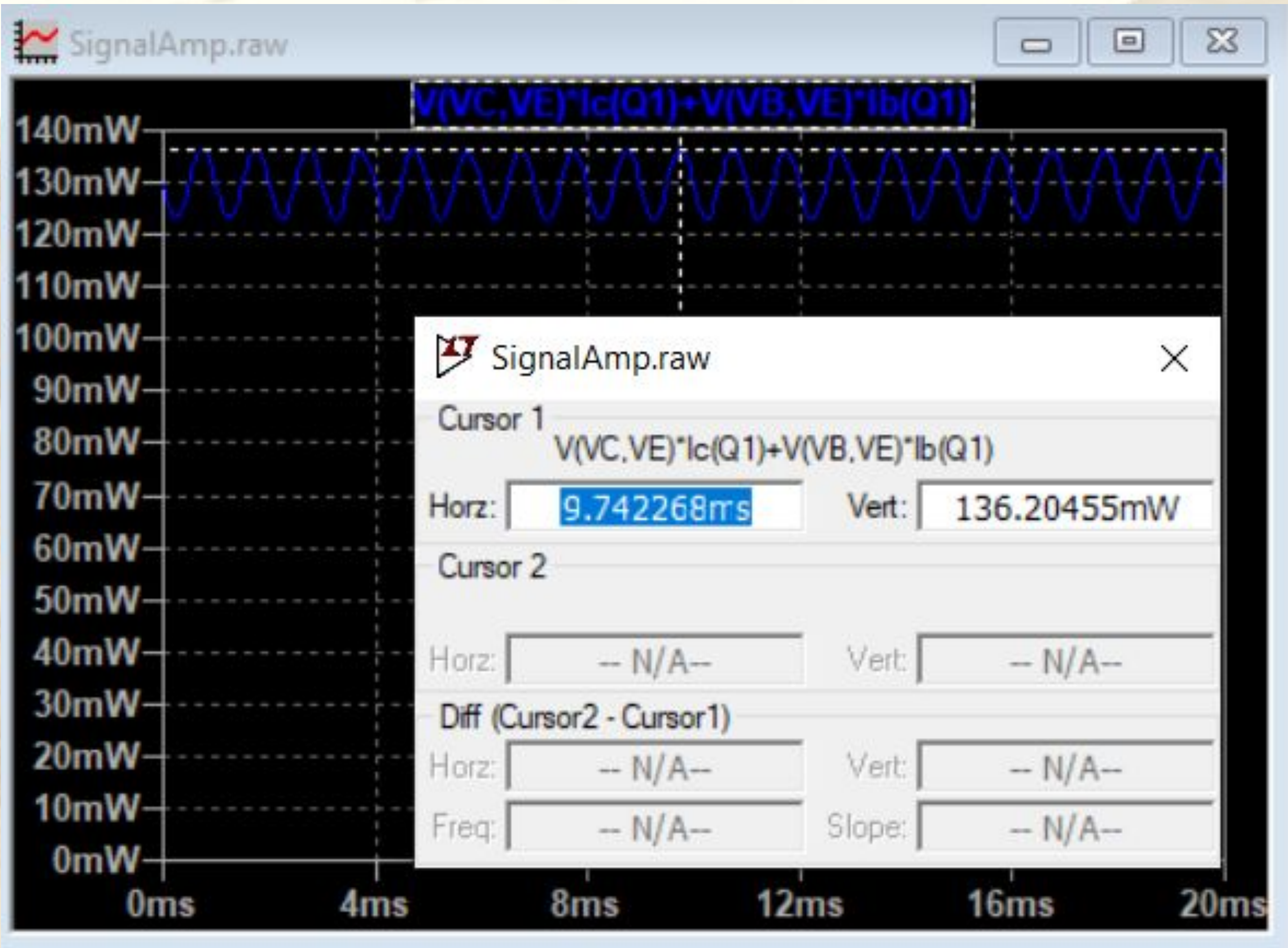
Calculate
Heat Dissipation

So, you've built an amplifier.



And it is working properly.

But how much power is it dissipating?



We already know how to plot this. The maximum power is 136.21mW.

Checking the datasheet and doing some math, the junction temperature is...

P2N2222A

Amplifier Transistors

NPN Silicon

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

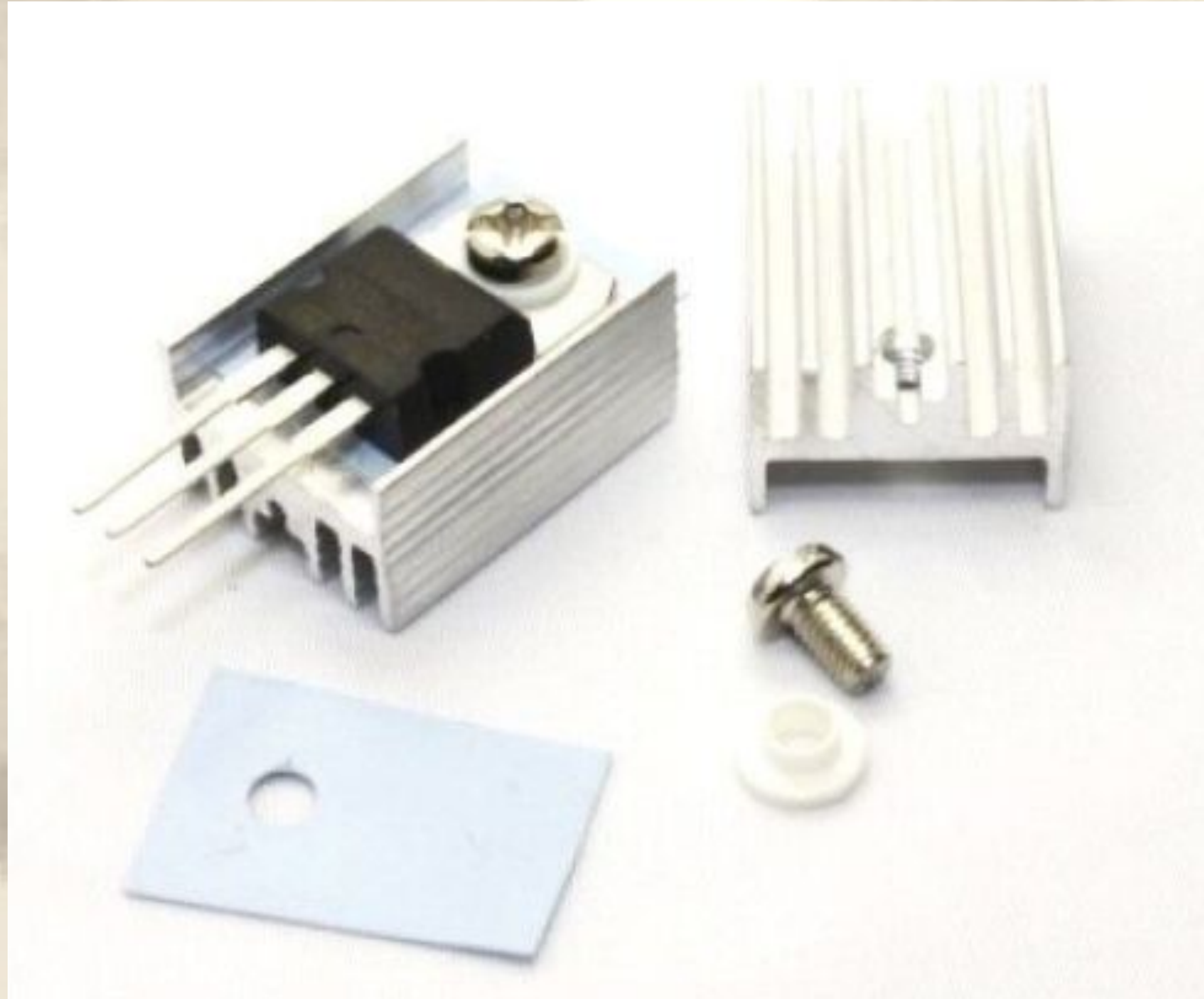
$$T_J = P_{MAX} \times R_{\theta} + T_A$$

$$T_J = (136.21 \times 10^{-3} \times 200) + 25 = 52.24^{\circ}C$$

Easy, isn't it?

But, couldn't we take advantage of LTSpice to do this for us?

Yes, we can do that!

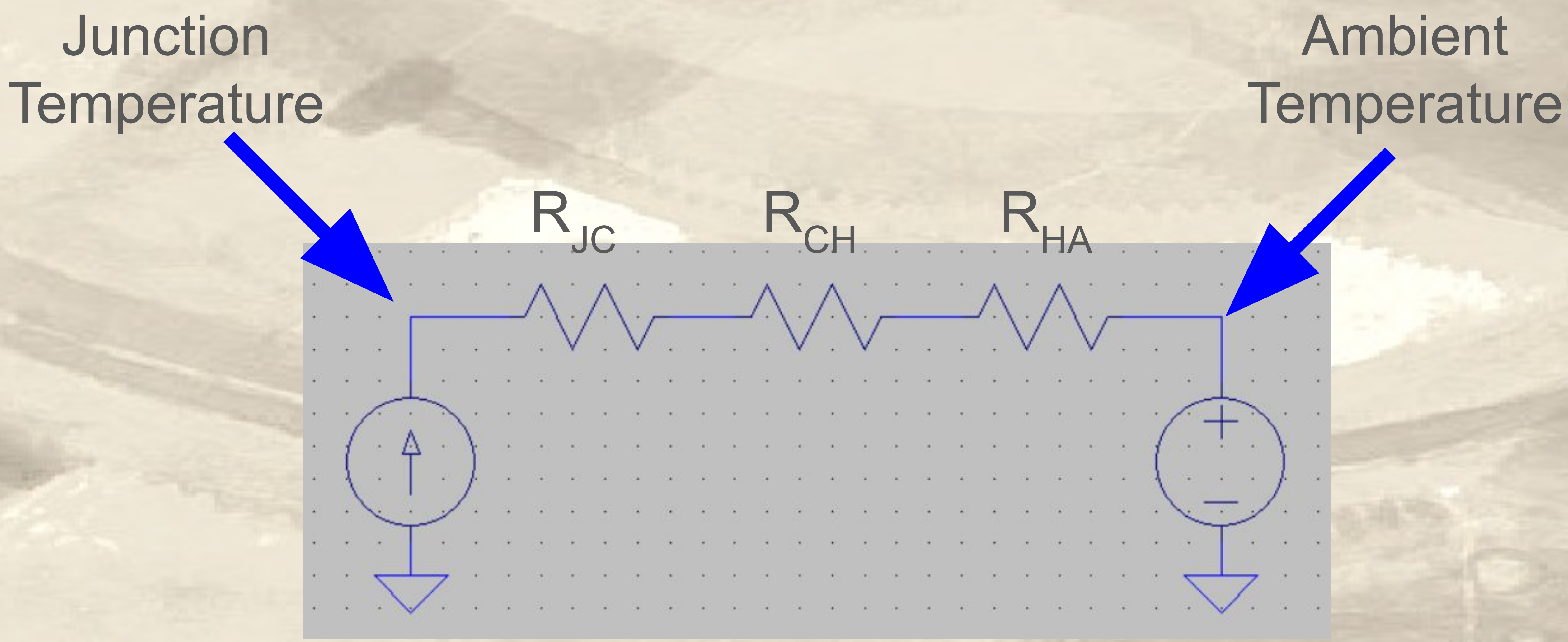


First, we need understand how to transform thermal dissipation into an electronic circuit.

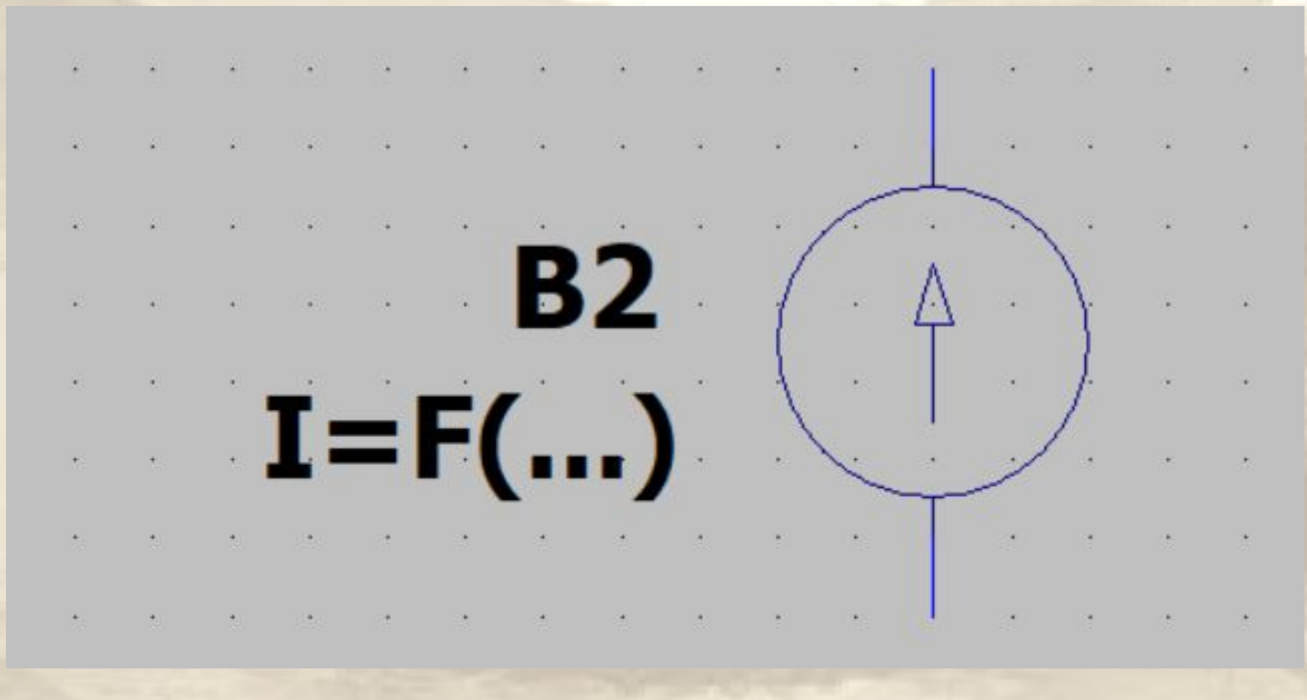
The flow of temperature is like the flow of direct current. So, we can consider this conversion:

Power	[W]	→	Current	[A]
Thermal Resistence	[°C/W]	→	Resistence	[Ω]
Temperature	[°C]	→	Voltage	[V]

And the circuit is simple:



The secret to assembling this circuit in LTSpice is the Arbitrary Behavioral Current Source.



It allows you to create a current source numerically equal to the power of the transistor.

For our circuit, this is the formula.

$$I=V(VC,VE)*Ic(Q1)+V(VB,VE)*Ib(Q1)$$

As we are using 2N2222 in the TO92 package, we only have one thermal resistance.

Let's use $R_{\theta JA}$, which is the thermal resistance of the Junction to the Ambient.

THERMAL CHARACTERISTICS

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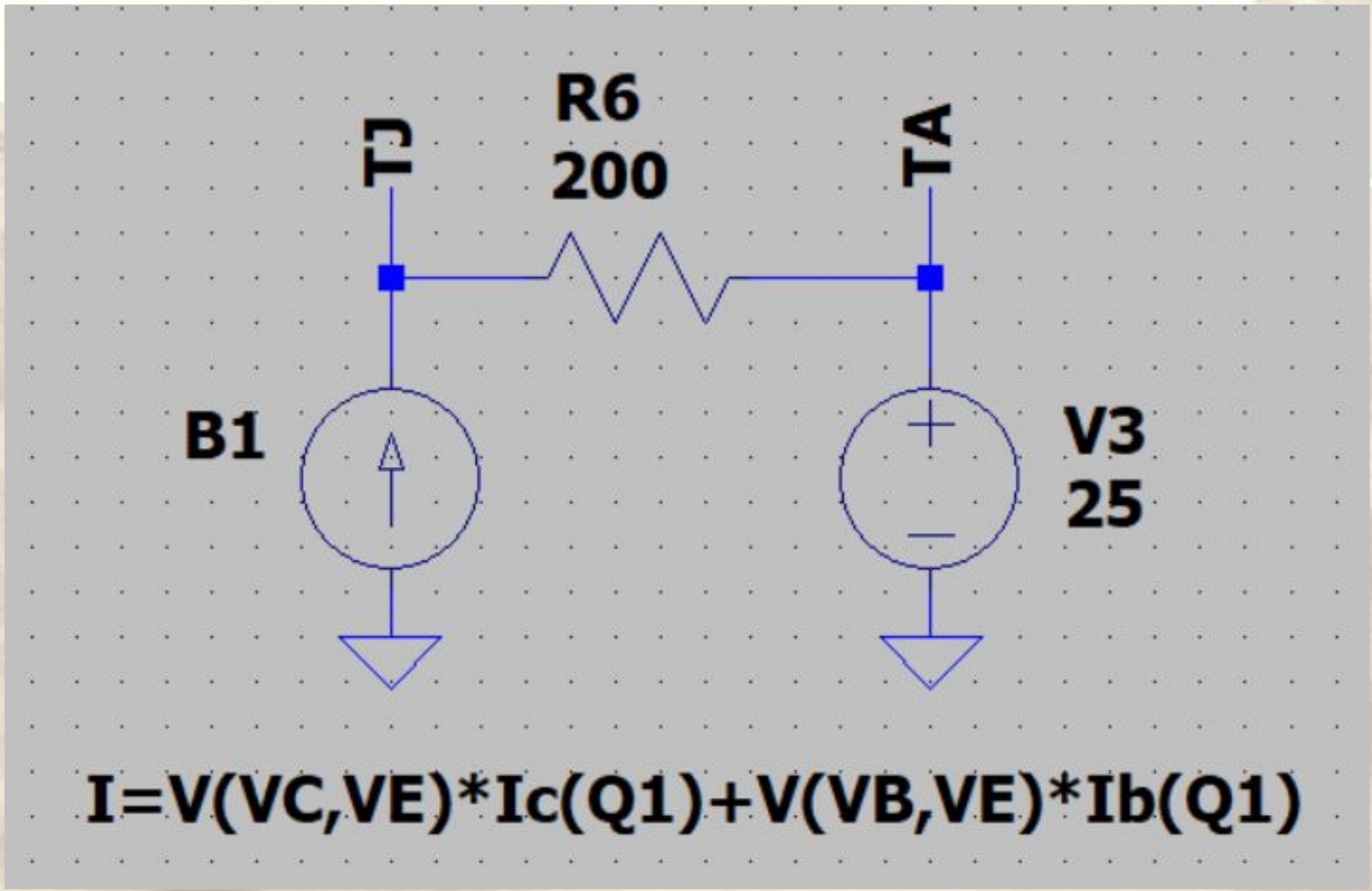
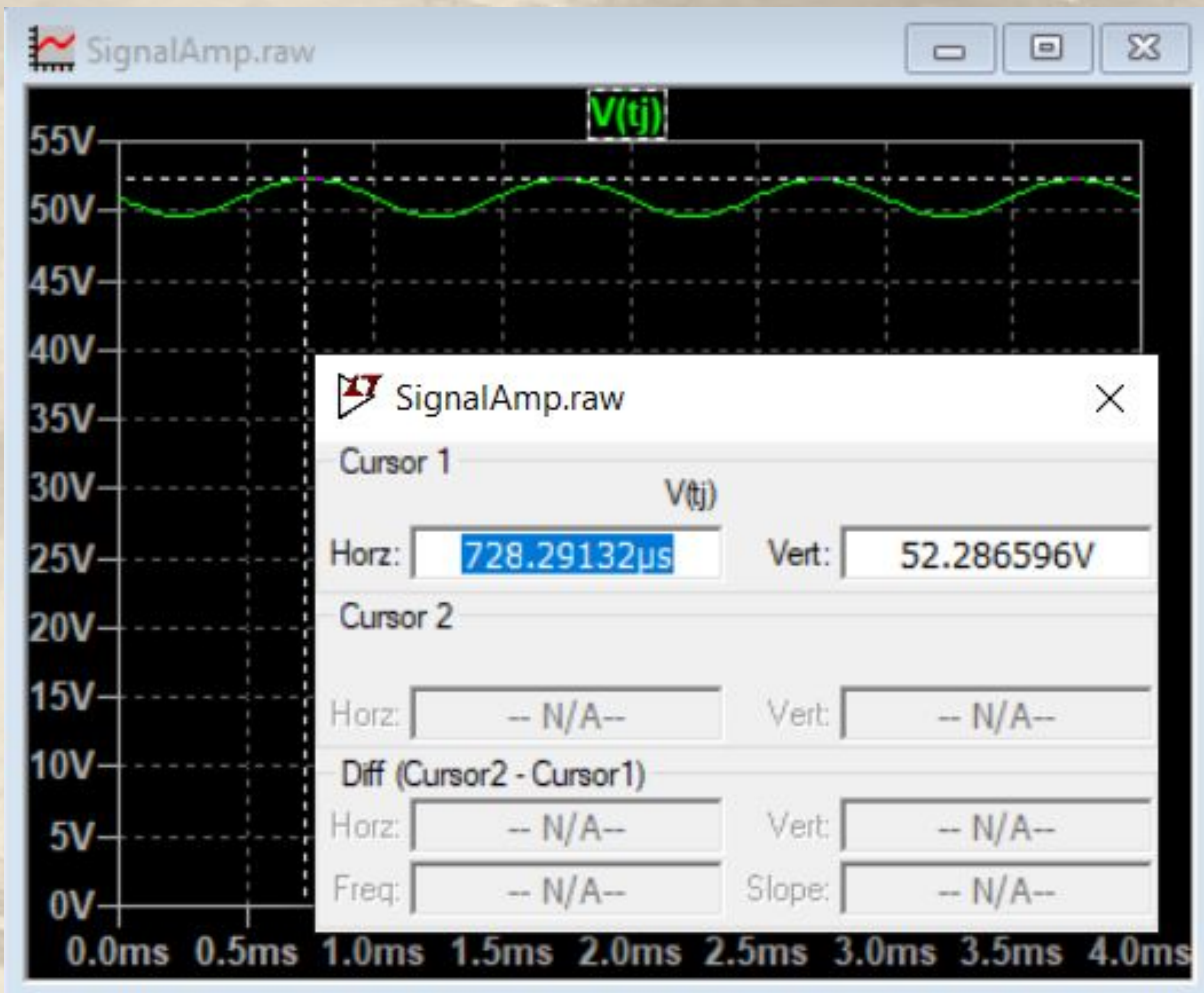
And this is the circuit that simulates the Junction temperature.



Keep in mind that we converted temperature [ºC] to Volts, so we are interested in the voltage across the junction.

As we can see, the circuit agrees with the calculation.

The 52V in T_J is the 52ºC on the junction.



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