ELECTRICALENGINEERING

Design a simple transistor amplitude modulator circuit

Asked 1 year, 4 months ago Modified 4 months ago Viewed 955 times

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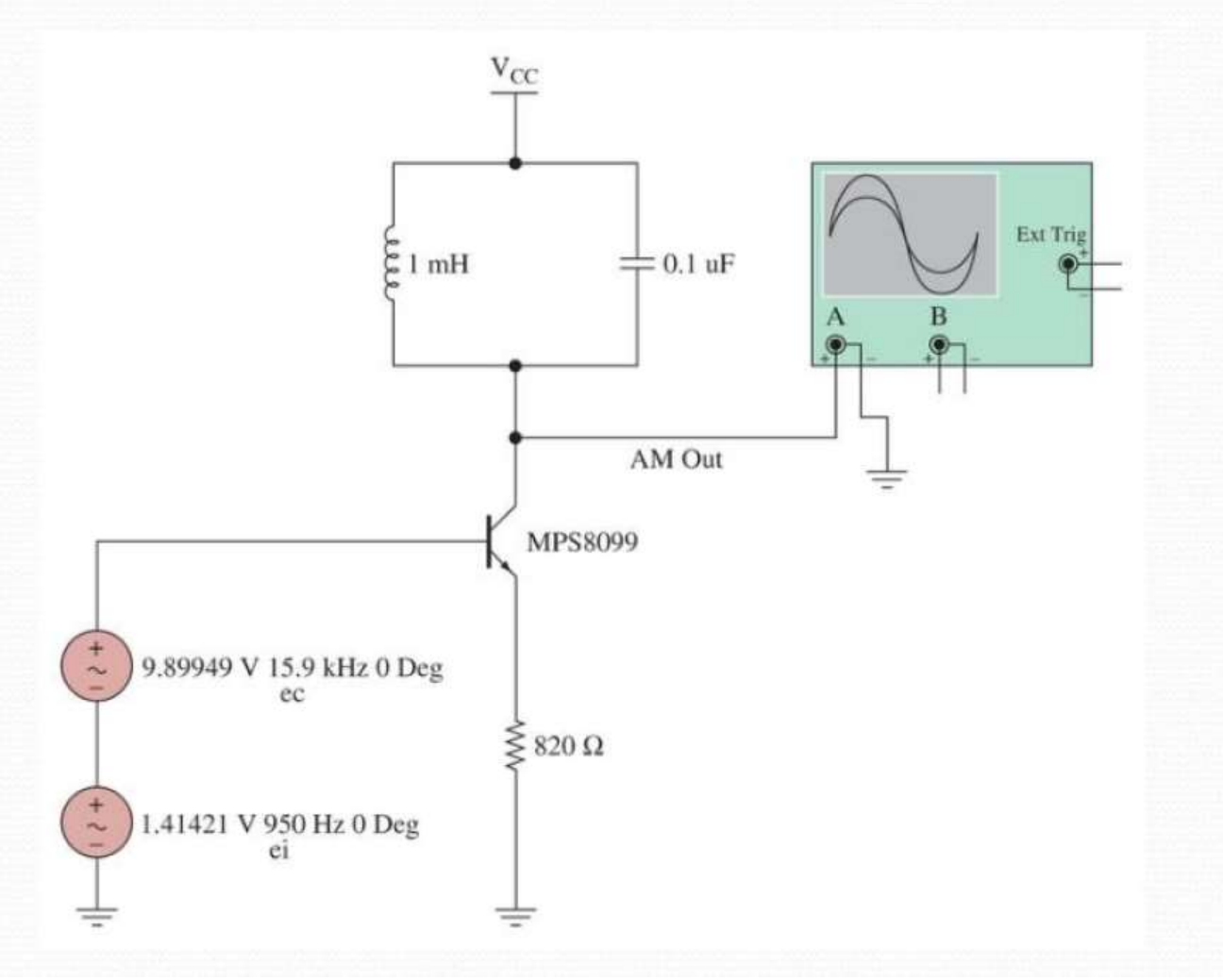
I saw a simple transistor amplitude modulator circuit on the Internet (image attached below).

I have to build a simple amplitude modulator circuit using a transistor for my school project. I understand the concept that the signals are mixed and the transistor acts as a diode and rectifies due to the emitter-base junction, while the LC circuit oscillates to produce the other half of the modulated signal.

Now, how should I calculate the value of Vcc as well as the resistor at the emitter? I understand the frequency of the LC circuit should be the same as the carrier frequency, in my case 50MHz (my professor wants to modulate a high frequency).



transistors amplitude-modulation

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edited Nov 15, 2021 at 9:29
ocrdu
8,485 20 29 42

asked Nov 15, 2021 at 7:49
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Eddy Miner
61 6

1 In some ways you are getting closer to a old-time plate modulation circuit (the collector tank.) That's good. And yet a lot further away from a practical circuit (your stacked supplies.) Is this something you need to actually build? Or is this just some kind of cyborg (cybernetic organism) -- half reality, half simulation, thing? – jonk Nov 15, 2021 at 7:59

@jonk I face quite many problems in order to solve this project. So I have to try any ways that I saw... Btw, the circuit simulated works well. – Eddy Miner Nov 15, 2021 at 8:03

Okay. Kind of vague and, well, I don't really see how I can help here, so far. I'll leave it to others to worry over. Thanks for your time. – jonk Nov 15, 2021 at 8:08

As you have two SERIAL generators, it can be an "additive" mixer and then it is the non linearity (exponential curve) of the BE junction that dictates the behavior. But if the signals are bigger, then it became a "multiplier" mixer (switching base current) ... which is a "different" behavior. – Antonio51 Nov 15, 2021 at 9:00

Try running this circuit in the Falstad circuit simulator and you'd quickly come upon the right values. – ee_student Aug 17, 2022 at 9:16

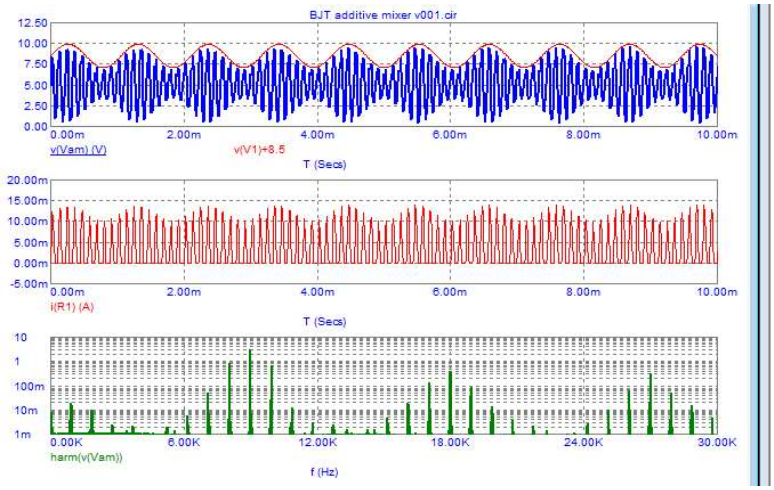
1 Answer

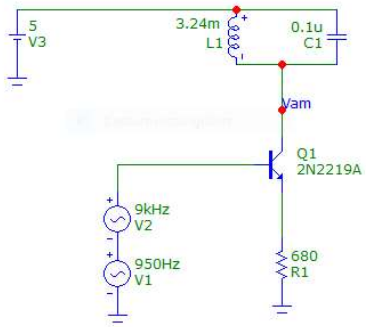
Sorted by: Highest score (default)

1

The schematic is a "additive" mixer, but with these circuits, you have also many spurious. See the harmonic analysis. So, it is not pure AM.

For "multiplying" mixer, one might consider that "carrier" is a square wave function (+1, 0), as in balanced 4 diodes mixer.

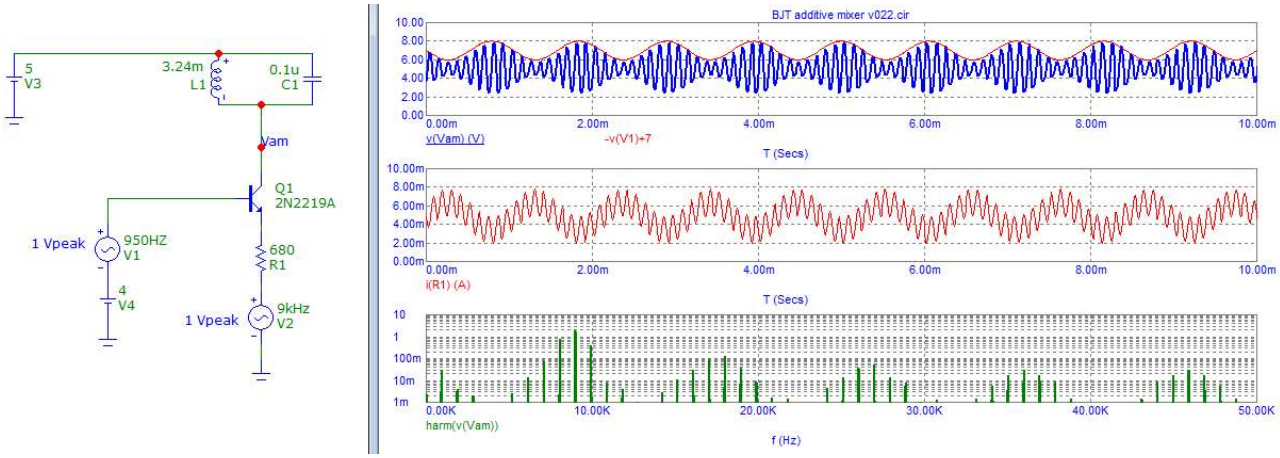




Just modified value of inductor for "improving" wave voltage.

For weak signals, see also my answer this post, same method : [Hearing the radio by touching a jack plug]

Do you see the difference ? (see current waveform).



Here is Maple sheet example :

Be aware that for carrier $omega1$ (for example), some terms are involved ...

i.e. $cos(omega1 * t) * (A1 + 3/2 * A1 * A2^2 + 3/4 * A1^3)$

Modulation creates also a displacement of "Quiet Point" -> $1 + 1/2 * A1^2 + 1/2 * A2^2 + \ldots$

```
> restart;
> #  Study mixer "low voltage" (simplified), really must use exponential
  #    current always near dc value
  Vbe:=K0+K1*vin+K2*vin^2+K3*vin^3;
  vin:= A1*cos(omega1*t)+ A2*cos(omega2*t); # omega1 carrier
```

$$Vbe := K0 + K1\ vin + K2\ vin^2 + K3\ vin^3$$

$$vin := A1\cos(\omega 1\ t) + A2\cos(\omega 2\ t)$$

```
>
> K0:=1: K1:=1: K2:=1: K3:=1: # omega1:=2*Pi*f1; omega2:=2*Pi*f2;
  combine(Vbe, trig) ;
  # target modulated signal is (omega1=carrier,omega1-omega2,omega1+omega2)
  # all others are spurious frequencies
```

$$1 + A1\cos(\omega 1\ t) + A2\cos(\omega 2\ t) + \frac{1}{2}A1^2\cos(2\,\omega 1\ t) + \frac{1}{2}A1^2 + A1\,A2\cos(\omega 1\ t - \omega 2\ t) + A1\,A2\cos(\omega 1\ t + \omega 2\ t)$$
$$+ \frac{1}{2}A2^2\cos(2\,\omega 2\ t) + \frac{1}{2}A2^2 + \frac{1}{4}A1^3\cos(3\,\omega 1\ t) + \frac{3}{4}A1^3\cos(\omega 1\ t) + \frac{3}{4}A1^2\,A2\cos(-\omega 2\ t + 2\,\omega 1\ t)$$
$$+ \frac{3}{4}A1^2\,A2\cos(\omega 2\ t + 2\,\omega 1\ t) + \frac{3}{2}A1^2\,A2\cos(\omega 2\ t) + \frac{3}{4}A1\,A2^2\cos(\omega 1\ t - 2\,\omega 2\ t)$$
$$+ \frac{3}{4}A1\,A2^2\cos(\omega 1\ t + 2\,\omega 2\ t) + \frac{3}{2}A1\cos(\omega 1\ t)\,A2^2 + \frac{1}{4}A2^3\cos(3\,\omega 2\ t) + \frac{3}{4}A2^3\cos(\omega 2\ t)$$

Share Cite Follow edited Nov 15, 2021 at 12:13 answered Nov 15, 2021 at 9:19

Antonio51
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