2N7000 Variable Resistor

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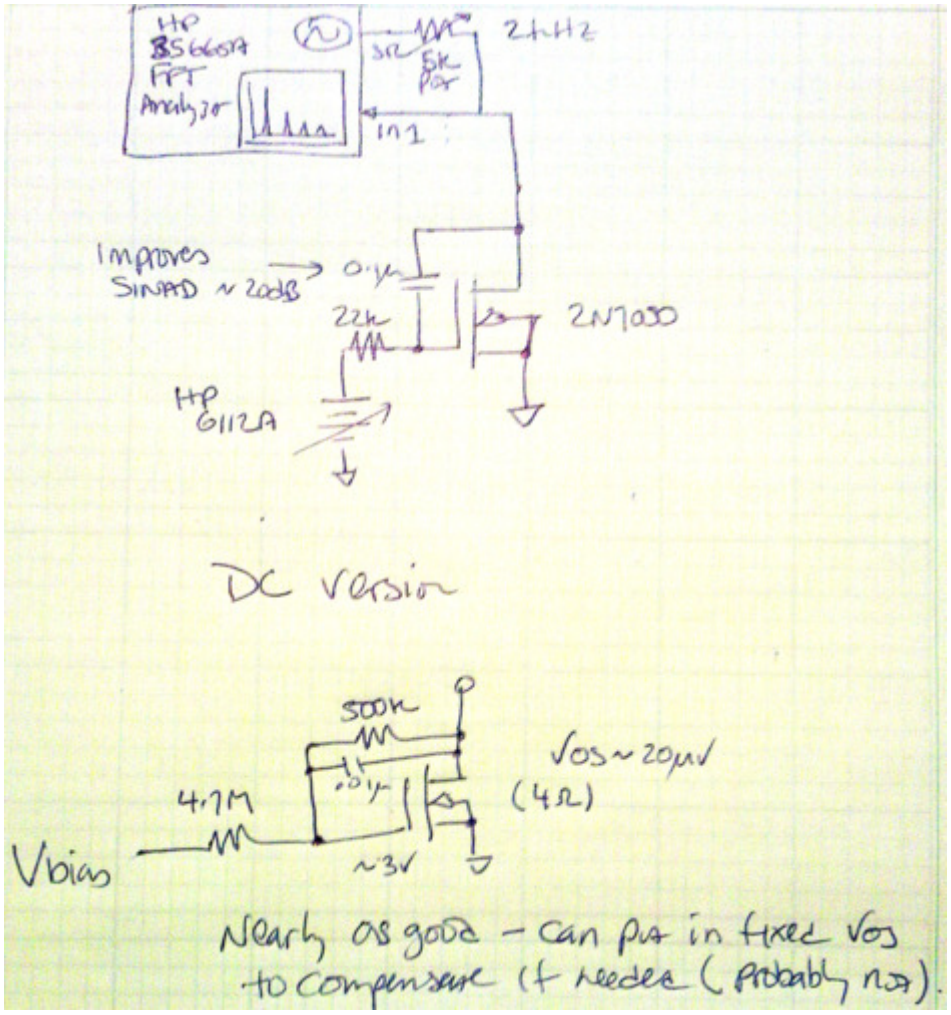
Setup: HP 35665A source (5 Vpk) -> 1k / 5k resistor -> 2N7000 D-S

Source resistor 22k, 0.1 uF G->D bypass! (1:1 NOT 1:2 ratio)-> 16 dB THD reduction



$imax := 20 \quad i := 0 .. imax - 1 \quad Vgs_i := 2.0 + i \cdot 0.1 \quad mV := 0.001$

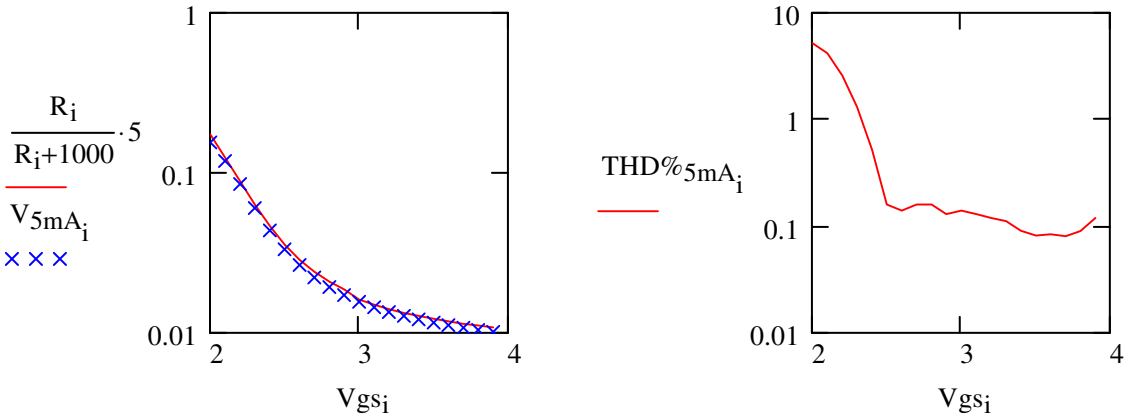
$Vgs_i =$

2
2.1
2.2
2.3
2.4
2.5
2.6
2.7
2.8
2.9
3
3.1
3.2
3.3
3.4
3.5

$$R := \begin{pmatrix} 36.17 \\ 25.7 \\ 18.11 \\ 12.85 \\ 9.40 \\ 7.19 \\ 5.77 \\ 4.85 \\ 4.21 \\ 3.77 \\ 3.25 \\ 3.01 \\ 2.83 \\ 2.68 \\ 2.56 \\ 2.46 \\ 2.37 \\ 2.29 \\ 2.23 \\ 2.17 \end{pmatrix} \quad V_{5mA} := \begin{pmatrix} 155.2 \\ 118.6 \\ 85.5 \\ 60.46 \\ 43.8 \\ 33.35 \\ 26.6 \\ 22.24 \\ 19.35 \\ 17.25 \\ 15.64 \\ 14.46 \\ 13.53 \\ 12.78 \\ 12.16 \\ 11.63 \\ 11.18 \\ 10.79 \\ 10.45 \\ 10.14 \end{pmatrix} \cdot mV \quad THD\%_{5mA} := \begin{pmatrix} 5.2 \\ 4.2 \\ 2.6 \\ 1.32 \\ 0.52 \\ 0.16 \\ 0.14 \\ 0.16 \\ 0.16 \\ 0.13 \\ 0.14 \\ 0.13 \\ 0.12 \\ 0.112 \\ 0.091 \\ 0.082 \\ 0.084 \\ 0.081 \\ 0.09 \\ 0.12 \end{pmatrix}$$

THD is an amplitude parameter, so 0.1% THD == 60 dB SINAD

5 mA peak current--this is more than we'd ever actually have



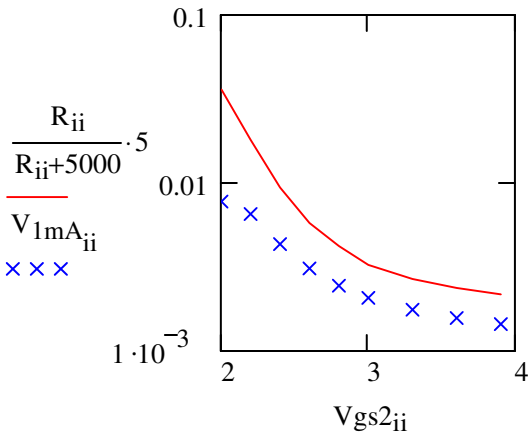
The distortion is significant up to Vgs=2.4 V, but that's a 9-ohm resistance.

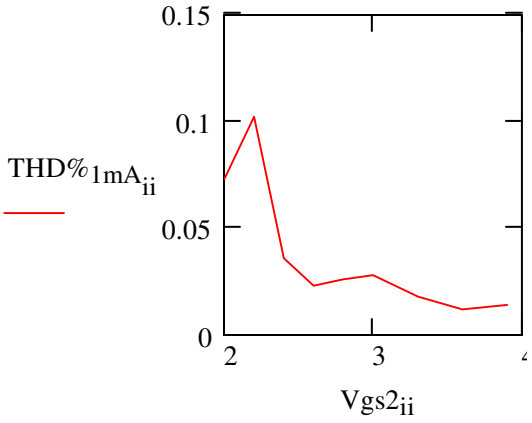
Now let's look at the 1 mA peak current numbers

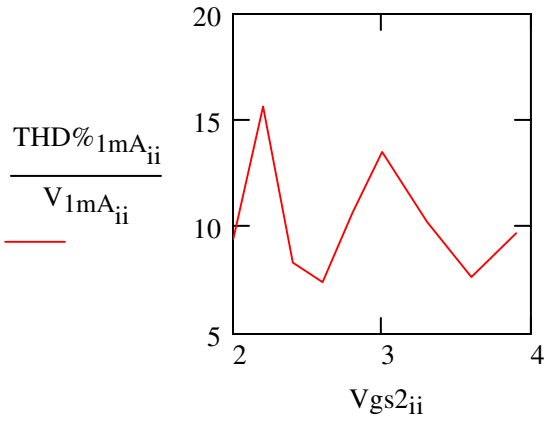
$j := 1 .. 10$

$$Vgs2 := \begin{pmatrix} 2.0 \\ 2.2 \\ 2.4 \\ 2.6 \\ 2.8 \\ 3 \\ 3.3 \\ 3.6 \\ 3.9 \end{pmatrix} \quad R := \begin{pmatrix} 36.17 \\ 18.11 \\ 9.40 \\ 5.77 \\ 4.21 \\ 3.25 \\ 2.68 \\ 2.37 \\ 2.17 \end{pmatrix} \quad V_{1mA} := \begin{pmatrix} 7.73 \\ 6.53 \\ 4.32 \\ 3.10 \\ 2.44 \\ 2.07 \\ 1.754 \\ 1.567 \\ 1.441 \end{pmatrix} \cdot mV \quad THD\%_{1mA} := \begin{pmatrix} 0.073 \\ 0.1022 \\ 0.036 \\ 0.023 \\ 0.026 \\ 0.028 \\ 0.018 \\ 0.012 \\ 0.014 \end{pmatrix}$$

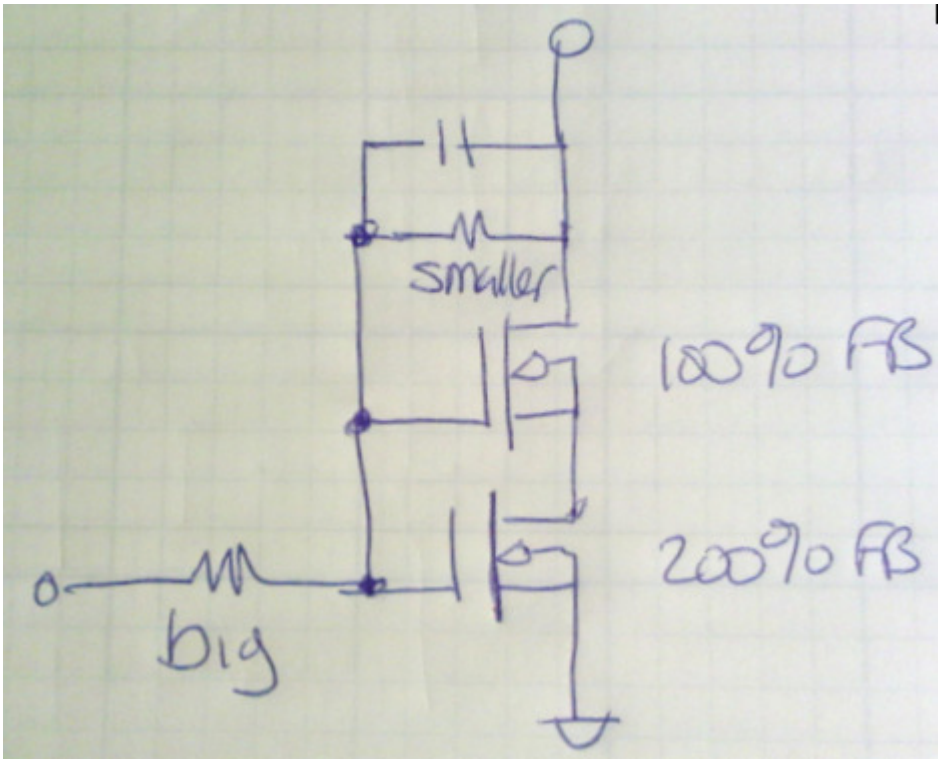
$ii := 0 .. rows(Vgs2) - 1$







The wisdom here is that 2N7000s don't behave like JFETS--you have to bypass the gate to the drain, not to (Vg+Vd)/2. The difference is pretty big--more than 15 dB in the distortion. For a practical device, probably a 20:1 voltage divider is OK (e.g. 2M:100k--that won't cause a lot of offset error with 5 ohms).


smaller
100% FB
200% FB
big