

TOOL: The universal AC model for FETs presented here provides a mechanism for determining the input resistance, R_{in} , the output resistance, R_{out} , and the AC gain, A_v , of a single FET. In most cases, model results may be combined for multistage configurations to determine R_{in} , R_{out} , and A_v . The universal model allows AC inputs to the gate, source, or drain, and it allows for inputs from more than one of these sources simultaneously.

The universal model assumes that DC conditions have been established by resistors and DC voltage sources, as in the generic circuit shown in Fig. 1.

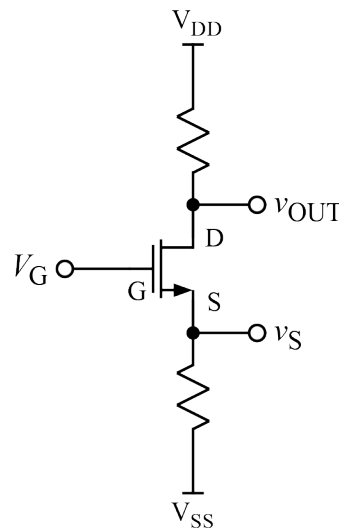


Fig. 1. Generic DC FET circuit.

For the AC model, we take source resistor, R_S , and drain resistor, R_D , to be the resistances after taking the Thévenin equivalent of AC inputs to source, or drain. Thus, R_S and R_D may differ from the " R_S " and " R_D " in the DC model. The universal AC model allows for AC (not DC!) inputs, v_{ss} and v_{dd} , to the source and drain along with the usual AC input, v_g , to the gate. Typically, v_{ss} will be reference, and v_{dd} will almost always be reference.

We use the universal model to find input resistance, R_{in} , output resistance, R_{out} , and gain, A_v . In the case where channel modulation, r_o , is absent, we obtain correct formulas by taking the limit as r_o approaches infinity.

Fig. 2 shows the universal model, which is a voltage divider.

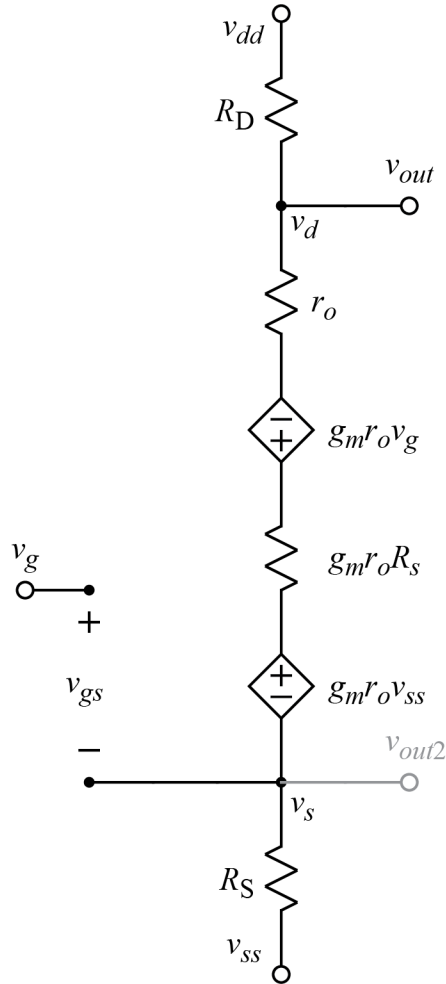


Fig. 2. Universal AC model for FET circuit.

Note: Inputs must come through v_g , v_{dd} , or v_{ss} . To find input or output resistance from locations of v_{out} terminals, remove the adjacent R_S or R_D circuitry, attach a test v -source at the adjacent v_{ss} or v_{dd} , determine the " R_{FET} " from the test voltage divided by the current from the test source, and then place the original adjacent R_S or R_D circuitry in parallel with R_{FET} . to obtain the desired input or output resistance.

REF: Behzad Razavi, *Fundamentals of Microelectronics with Robotics and Bioengineering Applications, 3rd Ed., Enhanced eText*, New York, NY: Wiley, 2021. ISBN: 9781119694397