This document is intended to be used with the TINA-TI program (*www.ti.com/tool/TINA-TI*) loaded with the CP-80.TSC spice file from the TINA Spice Files Folder and the 2SK30 N-channel JFET data sheet (located in the "Part Data Sheets" folder).

The main reasons I decided to go through the work of entering the entire schematic into TINA are as follows:

- JFETs have extremely wide parameters (e.g. V_{GS} can range from -0.4 to -5V and I_{DSS} can range from 0.3 to 6.5mA) so I wanted to characterize the circuit over this range.
- Certain parts are very difficult to find if they need replacement, such as the 2 audio transformers for the balanced line out. I want to know that my replacements will not alter the original sound.

The schematic drawn in the CP-80 Spice file is a slightly modified version of the actual CP-80 preamp schematic. As you can see, the 3 position Brilliance switch is set up to manually open and close each contact. Additionally, you can see there are 4 options for the 2SK30 JFET. These options cover the 4 I_{DSS} classifications from the data sheet.

Before we continue, we need to talk about JFETs, their extremely wide parameter set (i.e. Very large part to part variations), and a couple of definitions.

I_{DSS} (zero-gate-voltage drain current) is a characteristic that varies between individual devices, even those of the same part number. However, a JFET's characteristics are determined by its I_{DSS} value, and this value, along with the pinch-off voltage ($V_{GS(off)}$), can be used to classify or group devices for specific applications like voltage-controlled resistors or current sources. Devices are primarily classified by their type, either **N-channel** or **P-channel**, which dictates the polarity of the gate-source voltage required to control the drain current.

How JFETs are classified and characterized

- **Channel Type**: The most fundamental classification is the channel type, which can be either N-channel or P-channel. In our case the only JFETs we use are the 2SK30 N-channel JFET.
    - **N-channel**: Requires a negative gate-source voltage to decrease drain current.
    - **P-channel**: Requires a positive gate-source voltage to decrease drain current.

- **I_{DSS} and $V_{GS(off)}$**: Within a channel type, devices can be grouped based on I_{DSS} and $V_{GS(off)}$values, which are measured through testing. When manufacturers do this, it is called binning.
    - **I_{DSS} (Zero-gate-voltage drain current)**: The drain-source current when the gate-source voltage (V_{GS}) is zero. This is a measure of the maximum current a JFET can conduct at $V_{GS} = 0$.
    - $V_{GS(off)}$ **(Pinch-off voltage)**: The gate-source voltage required to turn the JFET off (reduce the drain current to near zero).
    - These two parameters are directly related, and a higher I_{DSS} will have a different corresponding $V_{GS(off)}$ value than a lower I_{DSS}.

Applications where I_{DSS} and VGS(off) are used for grouping or binning

- **Matching**: Devices can be grouped or "matched" by similar I_{DSS} and $V_{GS(off)}$ values for applications where this is critical, such as stereo audio amplifiers or balanced circuits.
- **Current Source**: A JFET with a specific I_{DSS} can be used to create a current source or sink. By adding a resistor from the source to ground, the current can be set to a specific value, and the I_{DSS} value of the device can be used to calculate the appropriate resistor value.
- **Voltage Controlled Resistor**: In a voltage-controlled resistor application, the I_{DSS} value is used in conjunction with $V_{GS(off)}$ to select devices that have the same "on-resistance" ($R_{DS(on)}$) range.