Application Note : Common Parameters & Equations

N-Channel JFET Characteristics Curve

(Plot of Drain Current, I_D (mA) vs. Drain to Source Voltage, V_{DS} (V). Regions labeled: Breakdown Region, Saturation Region, Ohmic Region, Cutoff Region. Curves: $V_{GS} = 0.0V$, $V_{GS} = -1.0V$, $V_{GS} = -2.0V$, $V_{GS} = -3.0V$. I_{DSS} marked near 8.5 mA.)
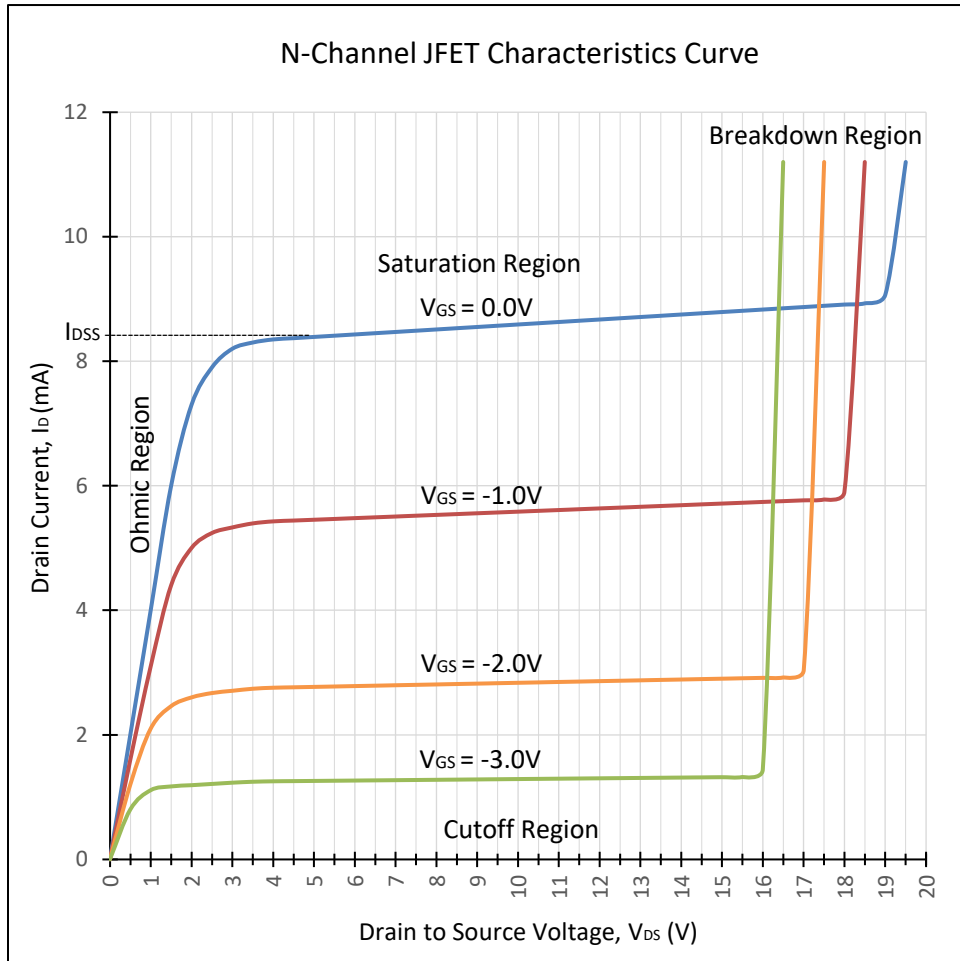
JFET Parameters

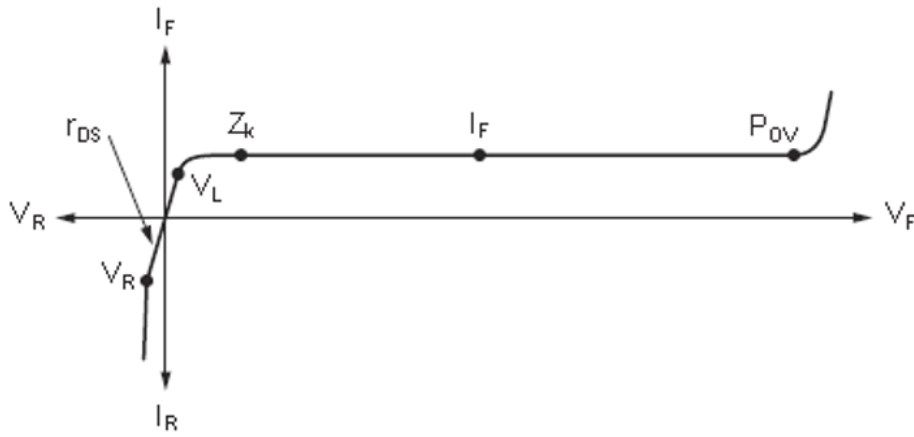| Equations	Description
$C_{ISS} = C_{GS} + C_{GD}$	Common Source Input Capacitance.
$C_{OSS} = C_{DS} + C_{GS} + C_{BD}$	Common Source Output Capacitance.
$C_{RSS} = C_{QD}$	Reverse Feedback Capacitance.
$G_{FSO} = \dfrac{K\, I_{DSS}}{I_{DSS(OFF)}}$	Forward transconductance as a function of I_{DSS} and $V_{GS(OFF)}$ at zero gate-source voltage (K= 1.5 to 2.5, typically 2 for N-channel JFETs).
$G_{FS} = G_{FSO}\, \dfrac{(1 - V_{GS})}{V_{GS(OFF)}}$	Variation of G_{FS} with gate bias. Forward common source transconductance.
$G_{FS} = G_{FSO}\sqrt{I_D}/I_{DSS}$	Variation of G_{FS} with drain current. Forward common-source transconductance.

JFET Parameters (Continued)

Equations	Description
I_{GSS}	Gate-Source cutoff voltage in terms of I_{DSS} and G_{FSO}.
$V_{GS(F)}$	Gate reverse current with the Drain shorted to the Source.
$V_{GS(OFF)} = \dfrac{2\,I_{DSS}}{G_{FSO}}$	Gate-Source Forward Voltage.
$V_{DS} = \dfrac{V_{GS(OFF)}(I_D)^2}{G_{FSO}}$	Drain voltage at which drain current saturates.
$R_{DS} = 1/G_{FS}$	Reciprocal relationship between drain-source resistance and forward transconductance. Accurate when $V_{DS} < V_{GS(OFF)}$ (in the triode region).
$R_{DS} = \dfrac{(V_{GS(OFF)})^2}{K\,I_{DSS}(V_{GSS})^2}$	K= 1.5 to 2.5, typically 2 for N-channel JFETs. (Variation of drain resistance in the triode region)
$I_D = \dfrac{I_{DSS}(1 - V_{GSS})^2}{V_{GS(OFF)}}$	Variation of drain current with gate-source voltage. The square law transfer characteristic.
$NF = 10\,Log_{10}\left(\dfrac{1 + e_N{}^2 + IN^2 R_G{}^2}{4KTR_G B}\right)$	Noise Figure in which R_G is the equivalent Gate resistance, T is absolute temperature, B is bandwidth in Hz, k is Boltzmann's constant 1.38E-23 J/°K
$e_N{}^2 = \dfrac{(4kTB\;0.63)^2}{V_{GS(OFF)}}$	Equivalent Short-Circuit Input Noise Voltage.
$V_P = V_{GS(OFF)}$	Pinch-off Voltage is very similar to Gate Source Cutoff Voltage – The Voltage at the transition point from the Linear Region to the Saturation Region.
$V_{(BR)GSS}$	Breakdown Voltage with the Gate short circuited to the Source. The maximum Voltage the device can be operated at without damage.
$I_{DZ} = I_{DSS}\,\dfrac{I_{DSS}\,(0.63)^2}{V_{GS(OFF)}}$	Drain Current at the Zero TC point. The biasing point on the I_D vs. V_{GS} Transfer Characteristic chart where the mobility factor and the depletion factor offset the changes in drain current relative to temperature.
$V_{GZ} = V_{GS(OFF)} + 0.7V$	The Zero temperature coefficient gate voltage is about 7/10th of a Volt above the Gate Source Cutoff Voltage.
I_{DSS}	Saturation drain current with the Gate shorted to the Source. (Max Drain Current)
$A_V = \dfrac{G_{FS}R_s}{1 + GFSR_s}$	The Voltage Gain at the Source with a resistor R_s between the Source and Ground.

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Current Regulator Diode Characteristic Curve

Current Regulator Diode Parameters

Equations	Description
PoV	Peak Operating Voltage – Also known as the Breakdown Voltage
I_{PoV}	Current at the Peak Operating Voltage
V_K	Knee Voltage – Also known as the Pinch-off Voltage – The Voltage at the transition point from the Linear Region to the Saturation Region.
I_K	Knee Current – Current at the Knee Voltage.
I_F	Forward Current – The Current flowing through the device in the Saturation region.
V_F	Forward Voltage – The Voltage across the device during operation.
$Z_D = \dfrac{I_{PoV} - IK}{PoV - VK}$	Dynamic Impedance – The slope of the I-V curve in the saturation region.
Z_K	Knee Impedance – The Impedance at the Knee point.

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