Abdullah Khalid

Christopher Peters

ECE370-061

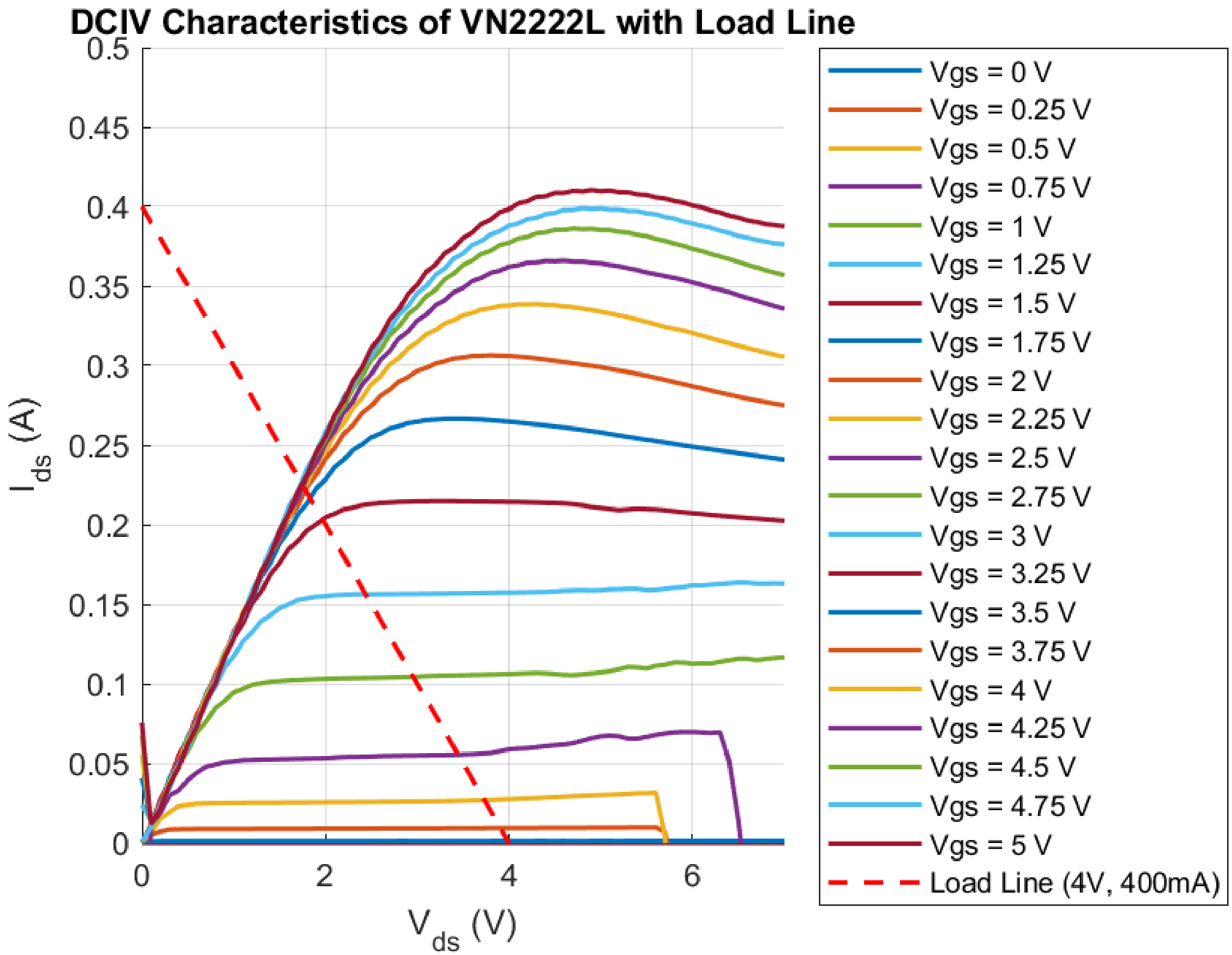
12 December 2024

FET Lab:

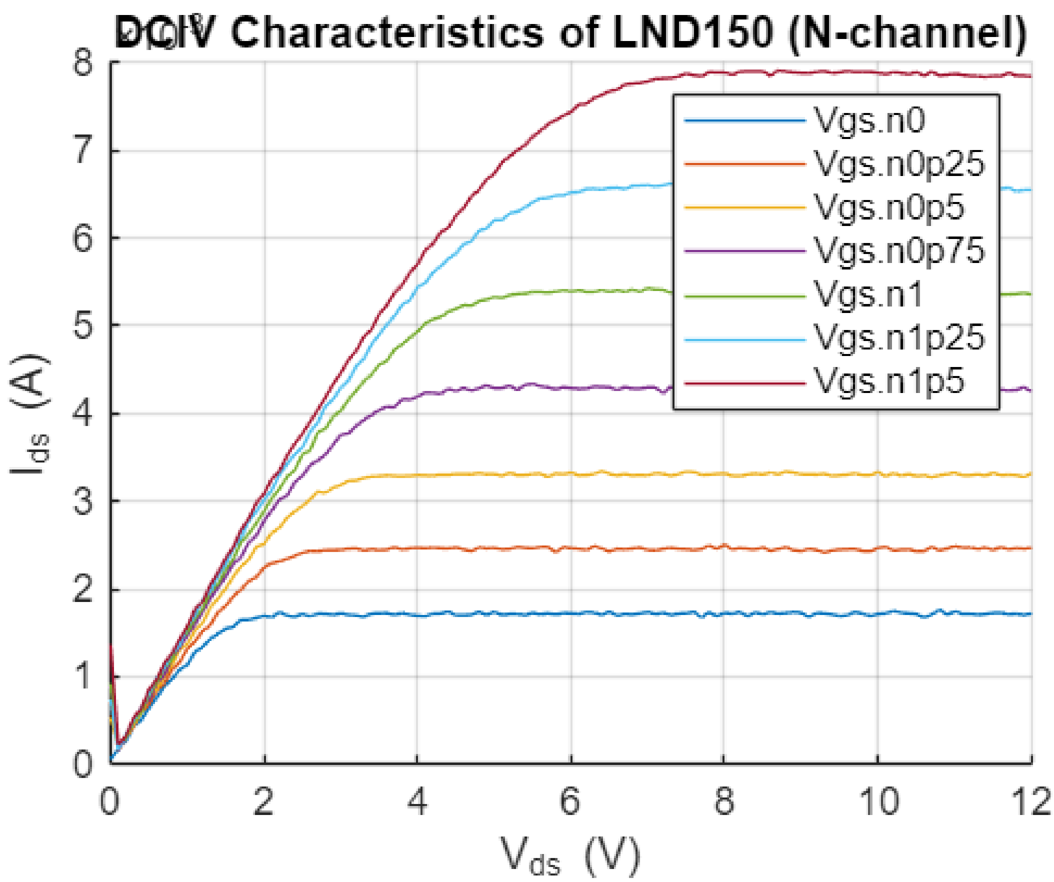
- Briefly describe how the MOSFET works
  A MOSFET controls the flow of current from its source to its drain using an electric field created by the voltage at its gate. The gate is insulated from the channel by a thin oxide layer which means the gate voltage sets up a field that either "pulls" electrons into the channel or pushes them away. In an n-channel MOSFET, applying a positive voltage at the gate attracts electrons, forming a conductive path and letting current flow when you apply a voltage between drain and source. How much current flows depends on that gate-to-source voltage (Vgs)
- Provide measured DCIV plots for VN2222L and LND150 FET devices
- Provide a copy of the LND150 FET DCIV characteristic with regions of operation labeled
- Provide a copy of the VN2222L FET DCIV characteristic with load line for a 4V source with a 400mA current limit
- Use the DCIV characteristics of each FET to estimate the threshold voltage of each device. Compare to the respective datasheets.
  By looking at where the drain current starts to rise sharply as we increase Vgs, we estimated the VN2222L's threshold voltage around 1.75V. Checking that against its datasheet range (0.6V to 2.5V), it's right where we'd expect it. For the LND150, which is a depletion-mode device, the threshold voltage is around 0V (or slightly negative). This lines up with what the datasheet says: typically, somewhere between -1V and -3V. The fact that we're seeing it conduct with basically no positive gate drive matches the expectation that depletion-mode devices start off "on" by default.
- Provide a plot of measured transconductance of the VN2222L
- Provide a plot of measured transconductance of the VN2222L with regions of operation labeled
- Estimate the threshold voltage based on this transconductance plot.
  Vth = 1.75V
- Estimate the transconductance of the VN2222L based on this plot. Compare to the datasheet
  $g_m = .1503\ s$

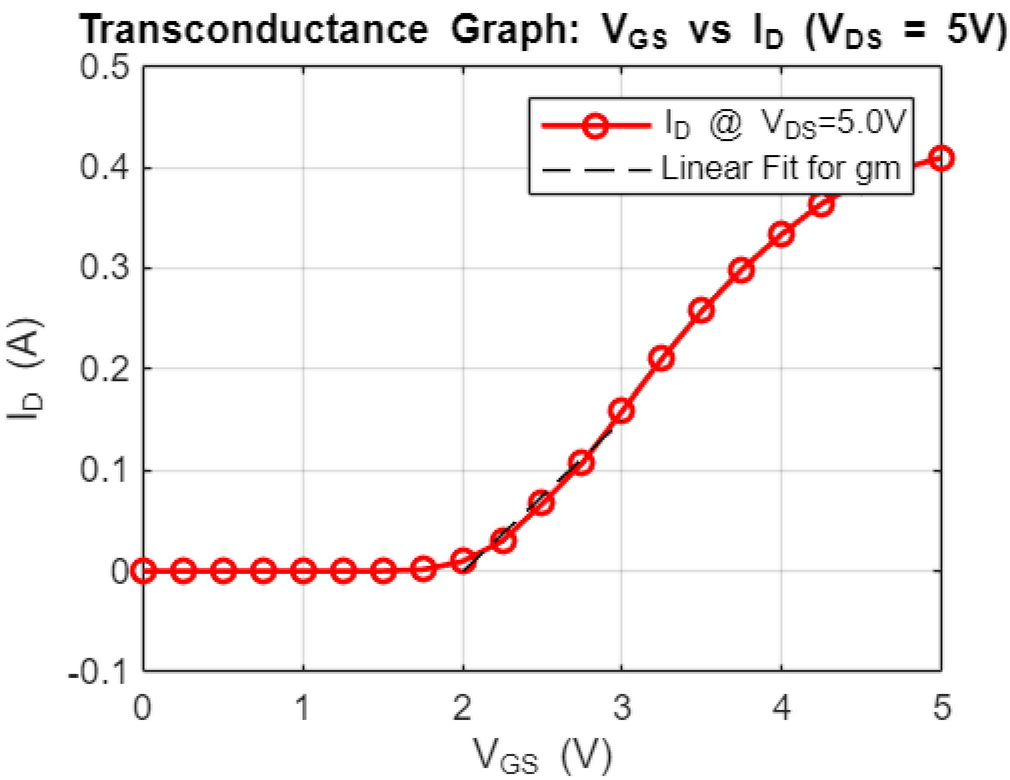
- Provide a plot of measured voltage transfer of the VN2222L
- Provide a plot of measured voltage transfer of the VN2222L with regions of operation labeled
- Estimate the voltage gain of the VN2222L
  V = 150.30V
- Compare the datasheet transconductance of these two FET. Which is better and why?
  The calculated transconductance is 0.1503s while the one mentioned in the datasheet is 100µs. This is in the range, but something to note is that the transconductance was taken over the saturation region which is the reason for such a high value and why our measurement is in s instead of µs.
- Compare the measured VN2222L transconductance to the measured 2N2222 BJT transconductance. Which is better and why?
  The transconductance found in the BJT was 0.170s while the MOSFET is 0.1503s. This indicates that there is a greater magnitude of gain and the BJT at least observed in the lab previous to this can handle amplification better than the MOSFET. This may not always be the case though as there are extraneous factors such as human error, faulty transistors, noise, etc that can all affect the measured results.
- Compare the DCIV characteristics between FET and BJT
  BJTs are controlled by current—if you push a small current into the base, you get a larger current flowing from collector to emitter. Their DCIV plots show collector current rising sharply with small increases in Vce until it flattens out. MOSFETs, on the other hand, are controlled by voltage at the gate. Their DCIV curves shift up with increasing Vgs, and the device moves smoothly from cutoff to saturation. So in short, BJTs give you high gain from a small base current, while MOSFETs offer easy voltage-driven control and very high input impedance, making them good for low-power or high-speed switching.
- What applications would you use an enhancement mode FET for and which applications would you use a depletion mode FET for?
  Enhancement-mode FETs (like the VN2222L) are off at zero gate voltage, so you only turn them on when you apply a positive gate voltage. This behavior makes them ideal for all kinds of switching circuits in digital systems, and for linear amplification stages in analog circuits. They're common in power supplies, DC-DC converters, and as drivers in microcontroller projects. Depletion-mode FETs (like the LND150) start off at zero gate voltage. To "turn them down," you apply a negative voltage. They're often used as constant-current sources, in fail-safe circuits (since they conduct even if your gate drive fails), and in biasing applications. They also show up in some RF and microwave circuits where their stable current conduction at zero gate voltage is useful.
- Comment on how FET or BJT are utilized in your area of interest within ECE
  In wireless communication and networking, FETs are great for high-frequency applications like RF amplifiers and low-noise front ends. Their high input impedance and

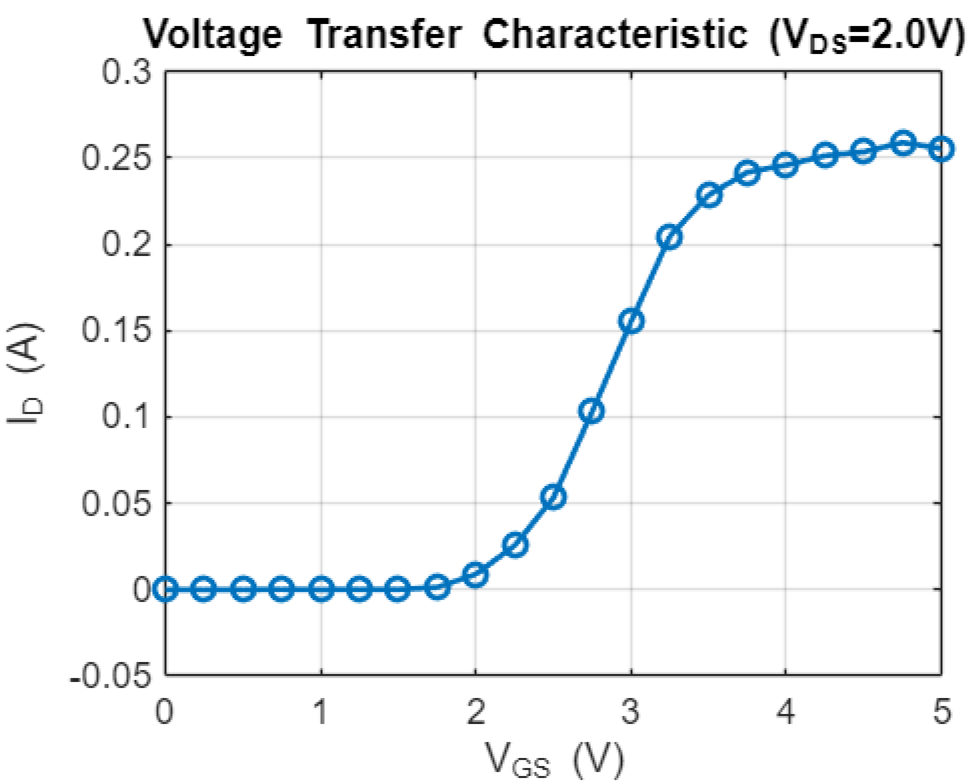
low noise floor come in handy for sensitive signal processing. Enhancement-mode MOSFETs show up in LNAs, mixers, and other RF blocks that need fast switching and precise control with minimal power draw. Depletion-mode FETs are often tucked away in the biasing networks of these circuits, serving as stable current sources. BJTs, on the other hand, might show up when you need a stable, high-gain amplifier—think high-power RF amplifiers or certain linear stages where their current-driven nature and well-defined gain are helpful. In power electronics, BJTs are still sometimes used for high voltage switching or robust linear amplification stages. Overall, the choice depends on the specific requirements of the application—frequency, power, gain, noise, linearity, and so on.



DCIV Characteristics of VN2222L with Load Line
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
I_ds (A)
0
2
4
6
V_ds (V)
Vgs = 0 V
Vgs = 0.25 V
Vgs = 0.5 V
Vgs = 0.75 V
Vgs = 1 V
Vgs = 1.25 V
Vgs = 1.5 V
Vgs = 1.75 V
Vgs = 2 V
Vgs = 2.25 V
Vgs = 2.5 V
Vgs = 2.75 V
Vgs = 3 V
Vgs = 3.25 V
Vgs = 3.5 V
Vgs = 3.75 V
Vgs = 4 V
Vgs = 4.25 V
Vgs = 4.5 V
Vgs = 4.75 V
Vgs = 5 V
Load Line (4V, 400mA)


DC IV Characteristics of LND150 (N-channel)
Vgs.n0
Vgs.n0p25
Vgs.n0p5
Vgs.n0p75
Vgs.n1
Vgs.n1p25
Vgs.n1p5
Ids (A)
Vds (V)
0
1
2
3
4
5
6
7
8
0
2
4
6
8
10
12


Transconductance Graph: VGS vs ID (VDS = 5V)
ID @ VDS=5.0V
Linear Fit for gm
ID (A)
VGS (V)
0.5
0.4
0.3
0.2
0.1
0
-0.1
0
1
2
3
4
5


Voltage Transfer Characteristic (VDS=2.0V)
ID (A)
VGS (V)
0.3
0.25
0.2
0.15
0.1
0.05
0
-0.05
0
1
2
3
4
5