6. OTHER FIELD-EFFECT-TRANSISTORS

Silicon  MOSFET  Metal – Oxide - Semiconductor FETs
GaAs or  III-V Alloys  MESFET  Metal – Semiconductor FETs
          HEMFET  High – Electron – Mobility FETs

6.1 MESFETs

Similar to JFET except the gate P-N junction is replaced with Schottky contact.

![Diagram of MESFET with depletion mode and enhancement mode devices](image_url)

- Depletion Mode Devices
  - Normally conducting at zero bias
  - Threshold voltage $V_{TO}$
  - Current $I = 0$
- Enhancement Mode Devices
  - Normally off
  - Current $I = 0$
N+ doping under the Schottky (Metal-Semiconductor) contacts turns rectifying Schottky to simple ohmic contacts.

GaAs has very high electron mobility $\mu_n$. Electrons can travel the source to drain distance at much faster speed than in Silicon. Therefore, GaAs FETs switch at much higher clock speeds or frequencies than silicon transistors. Problem in GaAs is to make P-N junctions. MESFET gets FET characteristics without needing to form a P-N junctions. The hole mobility is low in GaAs and Schottky Barriers formed on P-typed GaAs are poor in quality. Therefore, P-channel or complementary MESFETs are not available in GaAs.

All JFETs and MESFETS make use of a depletion layer created by a P-N junction or Schottky Barrier to decrease cross-sectional area of an existing channel. Therefore, these devices normally conduct, when gate reverse bias is applied their conductance decrease and eventually turned off. They are called “Depletion” mode devices.

Enhancement Mode Devices: MOSFETs and HEMT (or HEMFETs)  
Depletion Mode Devices: JFETs, MESFETs and MOSFETs

6.2. MOSFETs

Depletion Mode/Type MOSFET:

Enhancement
Problems with $V_{GS} < 0$ and $V_{DS} > 0$: In digital applications logic levels are typically zero to five volts. Therefore, input-output incompatibility.

**Enhancement Mode/Type MOSFETs:**

The two back to back formed PN-diodes block $I_D$ in both directions ($V_{DS}$ + or -).

But, if $V_{GS} > + V_{TO}$

![Diagram of MOSFET](image)