

ELECTRONICS TASK

Task 1: part a: MOSFET parameters

MOSFET have 3 operating regions:

-) triode region: normal operating region
-) saturation region: when drain current I_D becomes independent of gate to source voltage V_{GS}
-) cut-off region: $V_{GS} < V_{TH}$ (threshold voltage) ($I_D = 0$)

consider threshold voltage to be 0 volts:

| MOSFET Type | $V_{GS} \ll 0$ | $V_{GS} = 0$ | $V_{GS} \gg 0$ |
|-----------------------|----------------|--------------|----------------|
| N-channel Enhancement | OFF | OFF | ON |
| N-channel Depletion | OFF | ON | ON |
| P-channel Enhancement | ON | OFF | OFF |
| P-channel Depletion | ON | ON | OFF |

Key parameters:

-) Load voltage
-) load max power
-) $I_D \text{ max}$
-) V_{DSS}
-) $R_{ds_{on}}$ (NOTE: different values for $R_{ds_{on}}$ might be used depending on the load voltage)
-) R_{THJA}

Step by step guideline to select a suitable MOSFET for a given load:

-) check voltage rating and maximum power consumption for the given load
-) calculate max current through the load $I_{max}^2 = (\frac{P_{max}}{V})$
-) use the formula $P_D = R_{ds_{on}} * I_{max}^2$ (P_D : Thermal power dissipated)

$R_{ds_{on}}$ = internal drain to source resistance

$$T_{total} = (R_{THJA} * P_D) + T_A$$

T_A = ambient temperature of environment (25 – 35 °C)

T_{total} = total temperature of MOSFET

R_{THJA} = amount of heat created per watt of thermal power lost

If total temperature exceeds rated maximum of MOSFET then load is not compatible and another MOSFET with a lower $R_{ds_{on}}$ should be considered

(NOTE: multiply the $R_{ds_{on}}$ value by 1.2-1.3 as a safety factor as in practice we can't provide a constant perfect signal to the MOSFET)

Example of datasheet: <https://www.onsemi.com/pdf/datasheet/ntb5860nl-d.pdf>