

EXPERIMENT REPORT

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| **Experiment Name** | Extraction of DC Characteristics of BJT and MOSFET |
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| **Group Number and**  **Experiment Date** | D27  11.10.2013 |

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| **Report Score** | **Deliver Date** | **Receive Date** |
|  | 21.10.2013 |  |

**Aim of the Experiment**

In this experiment, we investigate basic understanding of current voltage relationship of Bipolar Junction Transistor (BJT) and Metal Oxide Semiconductor Field Effect Transistor (MOSFET) in transistor’s DC operation regions.

We started first MOSFET experiments and then BJT experiments.

**Study of the MOSFET Element Behavior**

Corresponding drain current equations for operation regions are:

1) For VGS – Vtn < 0 Cut-Off ID  = 0

2) For VGS – Vtn > VDS  Active Region ID  = kn[(VGS – Vtn) VDS – VDS2](1 + λn VDS)

3) For VGS – Vtn > VDS Saturation ID  = (VGS – Vtn)2(1 + λn VDS)

Vtn = Vtn0 + γn |(

**Experiment 2.3:**

We built the circuit according to Fig-2.4 in lab sheet. We changed R2 rheostat from 100kΩ step by step and observed changing between VGS and ID.

Fixed values are:

VG = 10V and VD = 5V so VDS = 5V

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| **VGS** | **ID** |
| 9.17 V | 13.28 mA |
| 8.79 V | 12.33 mA |
| 8.27 V | 11.08 mA |
| 7.87 V | 10.13 mA |
| 7.00 V | 8.08 mA |
| 6.25 V | 6.43 mA |
| 5.32 V | 4.56 mA |
| 4.03 V | 2.32 mA |
| 3.26 V | 1.26 mA |
| 2.51 V | 0.51 mA |
| 2.06 V | 0.21 mA |

We observed that ID depends on VGS according to operation region exactly the formulas say. In saturation, increasing of VGS effects ID more like exponential, but in the active region VGS effects ID more linear.

**Experiment 2.4:**

We built same setup like experiment 2.3, but this time R2 rheostat is fixed to 100kΩ and VG = 5V. Then we change VD between 0-10V.

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| **VDS** | **ID** |
| 0 V | 0 mA |
| 1 V | 2.03 mA |
| 2 V | 3.14 mA |
| 3 V | 3.23 mA |
| 4 V | 3.26 mA |
| 5 V | 3.27 mA |
| 6 V | 3.29 mA |
| 7 V | 3.30 mA |
| 8 V | 3.31 mA |
| 9 V | 3.319 mA |
| 10 V | 3.327 mA |

We observed that ID fixed approximately 3,2mA level when VDS is around 2-3V. VGS - Vtn > VDS. VGS and Vtn are constant values so VDS is critic value between 2V-3V for operation region change. The MOSFET operation mode is changed from saturation region to active region.

**Study of the BJT Element Behavior**

Collector current equations for BJT in active region are:

1) IC ≅ IS eVBE/VT

2) IC = 𝛽FIB

**Experiment 2.1 – Forward Active Region and Saturation of BJT:**

We built the circuit according to Fig-2.2 in lab sheet. We changed R1 potentiometer for adjust base current. We fixed VCE = 5V and measure VBE, IC, VR2 values. Then we calculated IB and β by BJT current formulas.

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| **R1** | **VBE** | **IC** | **VR2** | **IB** | **β** |
| 1 MΩ | 0.62 V | 0.97 mA | 40.32 mV | 4.032 μA | 240.57 |
| 680 kΩ | 0.639 V | 1.42 mA | 57.96 mV | 5.796 μA | 244.99 |
| 470 kΩ | 0.652 V | 2.31 mA | 93.7 mV | 9.370 μA | 246.53 |
| 330 kΩ | 0.660 V | 3.10 mA | 125.27 mV | 12.527 μA | 247.46 |
| 220 kΩ | 0.671 V | 4.50 mA | 181.51 mV | 18.151 μA | 247.93 |
| 150 kΩ | 0.678 V | 6.06 mA | 0.24 V | 24 μA | 252.5 |
| 100 kΩ | 0.691 V | 9.85 mA | 0.38 V | 38 μA | 259.21 |
| 68 kΩ | 0.701 V | 14.09 mA | 0.55 V | 55 μA | 256.18 |
| 47 kΩ | 0.711 V | 19.85 mA | 0.77 V | 77 μA | 257.79 |
| 33 kΩ | 0.715 V | 24.58 mA | 0.94 V | 94 μA | 261.48 |
| 22 kΩ | 0.724 V | 34.64 mA | 1.32 V | 132 μA | 262.42 |

As it can be seen 0.65-0.70V interval of VBE is critical value for BJT. After that threshold value of VBE, IC starts to increase exponentially.

In active region, while IB increases IC also increases linear proportional to IB.

**Experiment 2.2 – Reverse Active Region of BJT:**

In this experiment, we change direction of the BJT. Base remained same but collector and emitter terminals were swapped so BJT starts to operate in reverse active region.

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|  | **VBE** | **VCE** | **IB** | **IC** | **β** |
| **Forward-active Mode** | 0.724 V | 5 V | 132 μA | 34.64 mA | 262.42 |
| **Reverse-active Mode** | -4.37 V | -5 V | 197 μA | 1.036 mA | 5.25 |
| **Saturation** | 0.705 V | 34.54 mV | 435 μA | 4.34 mA | 9.97 |