



Experiential Learning Report On:
FET : OPERATION AND ITS REAL-TIME APPLICATIONS

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ABSTRACT

Field Effect Transistors (FETs) are crucial components in modern electronic systems, functioning primarily as voltage-controlled devices for amplification and switching purposes. Characterized by high input impedance and low power consumption, FETs play a vital role in analog and digital circuits. This report explores the fundamental operation of various types of FETs, including JFETs and MOSFETs, and highlights their working principles based on electric field modulation of current flow through a semiconductor channel. Additionally, it provides an overview of real-time applications of FETs in fields such as signal amplification, digital logic design, power electronics, radio frequency communication, sensor technology, and memory devices. The versatility and efficiency of FETs underscore their significance in both low- and high-power applications, making them indispensable in advancing electronic and embedded system technologies.

Introduction

In the rapidly evolving world of electronics, the **Field Effect Transistor (FET)** plays a fundamental role in shaping how devices process and manage electrical signals. Introduced in the mid-20th century, FETs have become one of the most widely used components in both analog and digital circuits due to their efficiency, versatility, and compact size.

Unlike Bipolar Junction Transistors (BJTs), which are current-controlled devices, FETs operate through **voltage control**, making them highly energy-efficient. They are especially valued for their **high input impedance, low power consumption, and fast switching capabilities**—qualities that are essential in today's low-voltage, high-speed electronics.

FETs are integral to countless electronic applications, ranging from **amplifiers and switches to processors, power regulators, and communication systems**. Their design flexibility and performance characteristics have made them a cornerstone of modern electronic devices, including smartphones, computers, automotive electronics, and industrial control systems.

This report delves into the working principle of FETs, their various types, and explores their practical applications in real-time scenarios.

Basic Structure and Working Principle

A Field Effect Transistor typically consists of three terminals:

- **Source (S)** – The terminal through which carriers enter the channel.
- **Drain (D)** – The terminal through which carriers leave the channel.
- **Gate (G)** – The terminal that controls the flow of current between the source and drain by creating an electric field.

Operation Principle

FETs operate by using the voltage applied to the gate terminal to control the conductivity of a channel between the source and drain. Unlike Bipolar Junction Transistors (BJTs), FETs are **voltage-controlled** devices and require minimal input current at the gate. This characteristic results in low power consumption and high input impedance.

Characteristics of FETs

Field Effect Transistors have several unique electrical and operational characteristics that make them suitable for a wide range of applications. These characteristics contribute to their high efficiency, stability, and integration capabilities.

- High Input Impedance
- Voltage-Controlled Device
- Low Power Consumption
- Low Noise
- Thermal Stability
- Unipolar Operation
- High Frequency Response
- Linearity (in small signal mode)
- Small Physical Size
- Better Suitability for Integrated Circuits

Real-Time Applications of FETs

FETs are integral to various real-world electronic systems. Below are some of the major application areas:

1. Amplifiers

FETs are used in small signal amplification due to their high input impedance and low noise characteristics. Common in audio systems, medical instruments, and radio receivers.

2. Switching Devices

MOSFETs act as efficient switches in digital circuits, microcontrollers, and logic gates. Their fast switching speed and low on-resistance make them ideal for power electronics and embedded systems.

3. Analog Signal Processing

Used in modulators, demodulators, and analog switches where accurate control of signal is needed. FETs handle analog signals with precision and minimal distortion.

4. Voltage Regulators

FETs control the output voltage and current in power supply circuits. They are commonly used in linear and switching voltage regulators.

5. Oscillators

Used in frequency generation circuits in communication devices such as mobile phones, radio transmitters, and RF systems.

6. Automotive Electronics

FETs are widely used in automotive systems including Electric Power Steering (EPS), Engine Control Units (ECUs), and electric vehicles due to their reliability and efficiency.

Conclusion

Field Effect Transistors (FETs) are indispensable components in modern electronics, offering a unique combination of high efficiency, low power consumption, and excellent electrical characteristics. Their voltage-controlled nature and high input impedance make them especially suitable for a wide range of applications, from simple amplifiers to complex integrated circuits found in smartphones, computers, and automotive systems.

With advancements in technology, newer forms of FETs such as FinFETs and LDMOS are enabling faster, smaller, and more energy-efficient electronic devices. As electronic systems continue to evolve toward higher performance and miniaturization, the role of FETs will only become more significant.

In summary, the versatility and effectiveness of FETs across both analog and digital domains ensure their continued relevance in current and future electronic innovations.