

# Junction Field Effect Transistor

The Junction Field Effect Transistor, or JFET, is a voltage controlled three terminal unipolar semiconductor device available in N-channel and P-channel configurations

The Junction Field Effect Transistor is a unipolar device in which current flow between its two electrodes is controlled by the action of an electric field at a reverse biased pn-junction.

In the Bipolar function Transistor tutorials, we saw that the output Collector current of the transistor is proportional to input current flowing into the Base terminal of the device. This makes the bipolar transistor a "CURRENT" operated device (Beta model) as a smaller current can be used to switch a larger load current.

The Field Effect Transistor, or simply FET however, uses the voltage that is applied to their input terminal, called the Gate to control the current flowing through them resulting in the output current being proportional to the input voltage. As their operation relies on an electric field (hence the name field effect) generated by the input Gate voltage, this then makes the Field Effect Transistor a "VOLTAGE" operated device.

The Field Effect Transistor is a three terminal unipolar semiconductor device that has very similar characteristics to those of their Bipolar Transistor counterparts. For example, high efficiency, instant operation, robust and cheap and can be used in most electronic circuit applications to replace their equivalent bipolar junction transistors (BJT) cousins.

Field effect transistors can be made much smaller than an equivalent BJT transistor and along with their low power consumption and power dissipation makes them ideal for use in integrated circuits such as the CMOS range of digital logic chips.

We remember from the previous tutorials that there are two basic types of bipolar transistor construction, NPN and PNP, which basically describes the physical arrangement of the P-type and N-type semiconductor materials from which they are made. This is also true of FET's as there are also two basic classifications of Field Effect Transistor, called the N-channel FET and the P-channel FET.



Typical Field Effect Transistor

The field effect transistor is a three terminal device that is constructed with no PN-junctions within the main current carrying path between the Drain and the Source terminals. These terminals correspond in function to the Collector and the Emitter respectively of the bipolar transistor. The current path between these two terminals is called the "channel" which may be made of either a P-type or an N-type semiconductor material.

The control of current flowing in this channel is achieved by varying the voltage applied to the Gate. As their name implies, Bipolar Transistors are "Bipolar" devices because they operate with both types of charge carriers, Holes and Electron. The Field Effect Transistor on the other hand is a "Unipolar" device that depends only on the conduction of electrons (N-channel) or holes (P-channel).

The Field Effect Transistor has one major advantage over its standard bipolar transistor cousins, in that their input impedance, (Rin) is very high, (thousands of Ohms), while the BJT is comparatively low. This very high input impedance makes them very sensitive to input voltage signals, but the price of this high sensitivity also means that they can be easily damaged by static electricity.

There are two main types of field effect transistor, the Junction Field Effect Transistor or JFET and the Insulated-gate Field Effect Transistor or IGFET), which is more commonly known as the standard Metal Oxide Semiconductor Field Effect Transistor or MOSFET for short.

#### The Junction Field Effect Transistor

We saw previously that a bipolar junction transistor is constructed using two PN-junctions in the main current carrying path between the Emitter and the Collector terminals. The Junction Field Effect Transistor (JUGFET or JFET) has no PN-junctions but instead has a narrow piece of high resistivity semiconductor material forming a "Channel" of either N-type or P-type slicon for the majority carriers to flow through with two obmic electrical connections at either end commonly called the Drain and the Source respectively.

There are two basic configurations of junction field effect transistor, the N-channel JFET and the P-channel JFET. The N-channel JFET's channel is doped with donor impurities meaning that the flow of current through the channel is negative (hence the term N-channel) in the form of electrons.

Likewise, the P-channel JFET's channel is doped with acceptor impurities meaning that the flow of current through the channel is positive (hence the term P-channel) in the form of holes. N-channel JFET's have a greater channel conductivity (lower resistance) than their equivalent P-channel types, since electrons have a higher mobility through a conductor compared to holes. This makes the N-channel JFET's a more efficient conductor

# <u>Junction Field Effect Transistor Or Jfet Tutorial</u>

Joachim N. Burghartz

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Advanced Field-Effect Transistors Dharmendra Singh Yadav, Shiromani Balmukund Rahi, Sukeshni Tirkey, 2023-12-22 Advanced Field Effect Transistors Theory and Applications offers a fresh perspective on the design and analysis of advanced field effect transistor FET devices and their applications. The text emphasizes both fundamental and new paradigms that are essential for upcoming advancement in the field of transistors beyond complementary metal oxide semiconductors CMOS This book uses lucid intuitive language to gradually increase the comprehension of readers about the key concepts of FETs including their theory and applications In order to improve readers learning opportunities Advanced Field Effect Transistors Theory and Applications presents a wide range of crucial topics Design and challenges in tunneling FETs Various modeling approaches for FETs Study of organic thin film transistors Biosensing applications of FETs Implementation of memory and logic gates with FETs The advent of low power semiconductor devices and related implications for upcoming technology nodes provide valuable insight into low power devices and their applicability in wireless biosensing and circuit aspects As a result researchers are constantly looking for new semiconductor devices to meet consumer demand This book gives more details about all aspects of the low power technology including ongoing and prospective circumstances with fundamentals of FET devices as well as sophisticated low power applications **Complete Electronics Self-Teaching Guide with** Projects Earl Boysen, Harry Kybett, 2012-07-09 An all in one resource on everything electronics related For almost 30 years this book has been a classic text for electronics enthusiasts Now completely updated for today s technology this latest version combines concepts self tests and hands on projects to offer you a completely repackaged and revised resource This unique self teaching guide features easy to understand explanations that are presented in a user friendly format to help you learn the essentials you need to work with electronic circuits All you need is a general understanding of electronics concepts such as Ohm's law and current flow and an acquaintance with first year algebra. The question and answer format illustrative experiments and self tests at the end of each chapter make it easy for you to learn at your own speed Boasts a companion website that includes more than twenty full color step by step projects Shares hands on practice opportunities and conceptual background information to enhance your learning process Targets electronics enthusiasts who already have a basic knowledge of electronics but are interested in learning more about this fascinating topic on their own Features projects that work with the multimeter breadboard function generator oscilloscope bandpass filter transistor amplifier oscillator rectifier and more You re sure to get a charge out of the vast coverage included in Complete Electronics Self Teaching Guide S.Chand'S Success Guide R/C B.Sc Physics Vol -3 C L Arora, 2011 Section I Solid State Physics Section with Projects Ii Electronics Section Iii Nuclear And Particle Physics **Electronics and Communication Engineering Guide for** GATE/ PSUs Disha Experts, 2017-08-01 Electronics and Communication Engineering for GATE PSUs exam contains exhaustive theory past year questions and practice problems. The book has been written as per the latest format as issued for

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