Characteristics Of Pn Junction Diode

p–n junctions represent the simplest case of a semiconductor electronic device; a p–n junction by itself, when placed in a circuit, is a diode. More complex devices can be created by further combinations of p-type and n-type semiconductors. Transistors such as the BJT, MOSFET, JFET, and IGBT all utilize p–n junctions for operation. Combinations of such semiconductor devices on a single chip allow for the creation of integrated circuits. a5ef3562d0 Tunnel diodes have a heavily doped PN junction that is about 10 nm (100 Å) wide. The heavy doping results in a broken band gap, where conduction band electron states on the N-side are more or less aligned with valence band hole states on the P-side. They are usually made from germanium, but can also be made from gallium arsenide, gallium antimonide (GaSb) and silicon materials. a5ef3562d0 A PIN diode operates under what is known as high-level injection. In other words, the intrinsic "i" region is flooded with charge carriers from the "p" and "n" regions. Its function can be likened to filling up a water bucket with a hole on the side. Once the water reaches the hole's level it will begin to pour out. Similarly, the diode will conduct current once the flooded electrons and holes reach an equilibrium point, where the number of electrons is equal to the number of holes in the intrinsic region. a5ef3562d0

Tunnel diode about 1960, and are still made in low volume today. Tunnel diodes have a heavily doped PN junction that is about 10 nm (100 Å) wide. Tunnel diodes were first manufactured by Sony in 1957, followed by General Electric and other companies from about 1960, and are still made in low volume today. In 1973, Esaki received the Nobel Prize in Physics for experimental demonstration of the electron tunneling effect in semiconductors. Robert Noyce independently devised the idea of a tunnel diode while working for William Shockley, but was discouraged from pursuing it. The heavy doping results A tunnel diode or Esaki diode is a type of semiconductor diode that has effectively "negative resistance" due to the quantum mechanical effect called tunneling. It was invented in August 1957 by Leo Esaki and Yuriko Kurose when working at Tokyo Tsushin Kogyo, now known as Sony a5ef3562d0

The wide intrinsic region is in contrast to an ordinary p–n diode. The wide intrinsic region makes the PIN diode an inferior rectifier (one typical function of a diode), but it makes it suitable for attenuators, fast switches, photodetectors, and high-voltage power electronics applications. a5ef3562d0 When diodes switch from forward conduction to reverse cut-off, a reverse current flows briefly as stored charge is removed. It is the abruptness with which this reverse current ceases which characterises the step recovery diode. a5ef3562d0 == Mechanism == a5ef3562d0

Schottky diode diode, consisting of a pn-diode or Schottky diode and an operational amplifier, provides an almost perfect diode characteristic due to the effect of negative The Schottky diode (named after the German physicist Walter Schottky), also known as Schottky barrier diode or hot-carrier diode, is a semiconductor diode formed by the junction of a semiconductor with a metal. It has a low forward voltage drop and a very fast switching action. The cat's-whisker detectors used in the early days of wireless and metal rectifiers used in early power applications can be considered primitive Schottky diodes a5ef3562d0

== Types == a5ef3562d0

PIN diode This increases the volume where A PIN diode is a diode with a wide, undoped intrinsic semiconductor region between a p-type semiconductor and an n-type semiconductor region. region is much larger than in a PN diode and almost constant-size, independent of the reverse bias applied to the diode. The p-type and n-type regions are typically heavily doped because they are used for ohmic contacts a5ef3562d0

Step recovery diode recovery characteristics of certain types of pn-junction diodes exhibit a discontinuity which may be used to advantage for the generation of harmonics In electronics, a step recovery diode (SRD, snap-off diode or charge-storage diode or memory varactor) is a semiconductor junction diode with the ability to generate extremely short pulses. It has a variety of uses in microwave (MHz to GHz range) electronics as pulse generator or parametric amplifier a5ef3562d0

P–n junction The "n" (negative) side contains freely-moving electrons, while the "p" (positive) side contains freely-moving electron holes. "P-N Junction" – PowerGuru A p–n junction is a combination of two types of semiconductor materials, p-type and n-type, in a single crystal. How Diodes Work. related to PN-junction diagrams. (English version) Educational video on the P-N junction. The PN Junction. Connecting the two materials causes creation of a depletion region near the boundary, as the free electrons fill the available holes, which in turn allows electric current to pass through the junction only in one direction a5ef3562d0

== Operation == a5ef3562d0 == Construction == a5ef3562d0 The first published paper on the SRD is (Boff, Moll & Shen 1960): the authors start the brief survey stating that "the recovery characteristics of certain types of pn-junction diodes exhibit a discontinuity which may be used to advantage for the generation of harmonics or for the production of millimicrosecond pulses". They also refer that they first observed this phenomenon in February, 1959. a5ef3562d0

P–n diode The diode conducts current in only one direction, and it is made by joining A p–n diode is a type of semiconductor diode based upon the p–n junction. The diode conducts current in only one direction, and it is made by joining a p-type semiconducting layer to an n-type semiconducting layer. A p–n diode is a type of semiconductor diode based upon the p–n junction. Semiconductor diodes have multiple uses including rectification of alternating current to direct current, in the detection of radio signals, and emitting and detecting light a5ef3562d0

When the diode is forward... a5ef3562d0 == Historical note == a5ef3562d0 As of 2024 the best lab examples of traditional crystalline silicon (c-Si) solar cells had efficiencies up to 27.1%, while lab examples of multi-junction cells have demonstrated performance over 46% under concentrated sunlight. Commercial examples of tandem cells are widely available at 30% under one-sun illumination, and improve to around 40% under concentrated sunlight. However, this efficiency is gained at the cost of increased complexity and manufacturing price. To date, their higher price and higher price-to-performance ratio have limited their use to special roles, notably in aerospace... a5ef3562d0 In a photodiode, with a low reverse bias voltage, the leakage current changes linearly with absorption of photons, i.e. the liberation of current carriers (electrons and/or holes) due to the internal photoelectric effect. However, in a SPAD, the reverse bias is so high that a phenomenon called impact ionisation occurs which is able to cause an avalanche current to develop. Simply, a photo-generated carrier is accelerated by the electric field in the device to a kinetic energy which is enough to overcome the ionisation energy of the bulk material, knocking electrons out of an atom. A large avalanche of... a5ef3562d0 Traditional single-junction cells have a maximum theoretical efficiency of 33.16%. Theoretically, an infinite number of junctions would have a limiting efficiency of 86.8% under highly concentrated sunlight. a5ef3562d0 The UJT is not used as a linear amplifier. It is used in free-running oscillators, synchronized or triggered oscillators, and pulse generation circuits at low to moderate frequencies (hundreds of kilohertz). It is widely used in the triggering circuits for silicon controlled rectifiers. In the 1960s, the low cost per unit, combined with its unique characteristic, warranted its use in a wide variety of applications like oscillators, pulse generators, saw-tooth generators, triggering circuits, phase control, timing circuits, and voltage- or current-regulated supplies. The original unijunction transistor types are now considered obsolete, but a later multi-layer device, the programmable unijunction transistor, is still widely available. a5ef3562d0 == Uses == a5ef3562d0

Multi-junction solar cell Each material's p–n junction will produce electric current in response to different wavelengths of light. Since solar cells are designed to Multi-junction (MJ) solar cells are solar cells with multiple p–n junctions made of different semiconductor materials. solar cell under illumination are obtained by shifting the J-V characteristics of a diode in the dark downward by Iph. The use of multiple semiconducting materials allows the absorbance of a broader range of wavelengths, improving the cell's sunlight to electrical energy conversion efficiency a5ef3562d0

When sufficient forward voltage is applied, a current flows in the forward direction. A silicon p–n diode has a typical forward voltage of 600–700 mV, while the Schottky's forward voltage is 150–450 mV. This lower forward voltage requirement allows higher switching speeds and better system efficiency. a5ef3562d0 Solar cells and light-emitting diodes (LEDs) are essentially p–n junctions where the semiconductor materials are chosen, and the component's geometry designed, to maximise the desired effect (light absorption or emission). A Schottky junction is a similar case to a p–n junction, where instead of... a5ef3562d0

Unijunction transistor It acts exclusively as an electrically controlled switch. magnetic flux. This affects the frequency of UJT relaxation oscillators. The Hall effect modulates the voltage at the PN junction. This only works with UJTs A unijunction transistor (UJT) is a three-lead electronic semiconductor device with only one junction a5ef3562d0

The PIN photodiode was invented by Jun-Ichi Nishizawa and his colleagues in 1950. It is a semiconductor device. a5ef3562d0 The figure shows two of the many possible structures used for p–n semiconductor diodes, both adapted to increase the voltage the devices can withstand in reverse bias. The top structure uses a mesa to avoid a sharp curvature of the p+-region next to the adjoining n-layer. The bottom structure uses a lightly doped p-guard-ring at the edge of the sharp corner of the p+-layer to spread the voltage out over a larger distance and reduce the electric field. (Superscripts like n+ or n− refer to heavier or lighter impurity doping levels.) a5ef3562d0

Single-photon avalanche diode As with photodiodes and APDs, a SPAD is based around a semi-conductor p-n junction that can be illuminated with ionizing radiation such as gamma, x-rays, beta and alpha particles along with a wide portion of the electromagnetic spectrum from ultraviolet (UV) through the visible wavelengths and into the infrared (IR). fundamentally linked with basic diode behaviours. As with photodiodes and APDs, a SPAD is based around a semi-conductor p-n junction that can be illuminated with A single-photon avalanche diode (SPAD), also called Geiger-mode avalanche photodiode (G-APD or GM-APD) is a solid-state photodetector within the same family as photodiodes and avalanche photodiodes (APDs), while also being fundamentally linked with basic diode behaviours a5ef3562d0

== Structure == a5ef3562d0 The negative differential resistance in part of their operating range allows them to function as oscillators... a5ef3562d0

Zener effect August 25, 2009. "PN junction breakdown characteristics". It occurs in a reverse biased p-n diode when the electric field enables tunneling of electrons from the valence to the conduction band of a semiconductor, leading to numerous free minority carriers which suddenly increase the reverse current. Retrieved In electronics, the Zener effect (employed most notably in the appropriately named Zener diode) is a type of electrical breakdown, discovered by Clarence Melvin Zener. breakdown, and decreases the contribution of the avalanche effect. Circuits Today a5ef3562d0

Under a high reverse-bias voltage, the p-n junction's depletion region widens which leads to a high-strength electric field across the junction. Sufficiently strong electric fields enable tunneling of electrons across the depletion region of a semiconductor, leading to numerous free charge carriers. This sudden generation of carriers rapidly increases the reverse current and gives rise to the high slope conductance of the Zener diode. a5ef3562d0

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