sistor Specifications Explained

are many different transistor specifications defining aspects of a bipolar tor's performance transistor to enable an informed choice of the right tor for any circuit .

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r Tutorial Includes:

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a huge number of bipolar transistors available both leaded and surface mount devices. These have been to fulfil a variety of different applications in all areas of electronics.

o define the parameters of a transistor there are many different specifications that are used. Each of these specifications define an aspect of the performance of the transistor.

manufacturers issue specification sheets for their transistors which are typically found on the Internet, years ago engineers used to study data books to find out the information.

2N3553 transistor in a TO39 metal can

onic circuit design, selecting the right transistor will need several of the transistor parameters to match the nts for the circuit. Therefore a variety of the parameters will need to be carefully matched.

e parameters are electrical - aspects such as the size of the package, and whether the device is a surface nsistor, i.e. surface mount device. With most PCB assembly now using surface mount technology to aid the d electronics manufacturing of products and equipment, most transistors manufactured these days are SMD s.

st transistors made these days are SMD transistors because of the automated PCB assembly techniques re are still many leaded devices as well. Specific transistor part numbers are normally available as leaded and also for SMD transistors with the same electrical specifications, although aspects like the heat n will differ because of the different package styles.

sistor specification parameters

e a number of standard parameters with abbreviations that are used to define the performance of a The definitions of these parameters are outlined in the table below:

14 JUNE 2025

Fact of the day: It was in this month in 1916 that W Schottky in Germany described the principle of the superhet radio as a powerful and selective amplifier. He never made the receiver to prove his idea and was beaten to this goal by Edwin Armstrong. Also on this day in 1923, Charles Jenkins, an inventor from Dayton, Ohio, who invented a mechanical television system called radiovision and claimed to have transmitted the earliest moving silhouette images.

Quote: *Science can purify religion from error and superstition. Religion can purify science from idolatry and false absolutes.* Pope John Paul II (Karol Wojtyla)

Point to ponder: A photon that takes eight minutes to travel from the Sun to Earth took 100,000 years to get from the centre to the surface of the Sun.

ifications for transistors, like any other electronics component are normally available on the website of the urer. Also electronic component distributors often have details of the specifications of components, or s a link to the specification on the manufacturer's website.

worth noting for electronic components that can be obtained from several manufacturers, that the ions may vary slightly between manufacturers. For any critical parameters it is wise to use the actual figures nanufacturer whose product is being used.

econd source and further sources may be required to give some level of insurance against a particular or manufacturer ceasing their operation and the part becoming obsolete. In this case the specification rs for all manufacturers should be closely checked to ensure they meet the requirements for the particular circuit design.

number

number of the device is a unique identifier given to each type of transistor. This enables the full data on its ions to be checked on the manufacturers transistor datasheet to investigate its performance.

three international schemes that are widely used: European Pro-Electron scheme; US JEDEC (numbers 2N for transistors); and the Japanese system (numbers start with 2S).

n just giving a standardised type number to the transistors, these schemes can provide information about istor performance. The European Pro-Electron scheme is particularly good for this as it distinguishes different types of transistor, for example a BC109 is a silicon audio frequency low power transistor, and a a low power RF transistor.

more about . . . . *transistor & diode numbering codes.*

when using automated PCB assembly techniques and surface mount devices, it is found that many s are too small to carry the full number that might be used in a data sheet. As a result, a rather arbitrary stem has developed, whereby the device package carries a simple two or three character identification

normally be accommodated on the small surface mount diode packages. However, identifying the urers' type number of an SMD diode from the package code may not be easy at first sight. There are some ID codebooks available that provide the data for these devices.

ity:

two types of transistor: NPN transistors and PNP transistors. It is important to choose the correct type all the circuit polarities will be wrong.

transistors are more widely used. Like for like they offer better performance than PNP transistors because are the majority carriers and their mobility is higher than that of holes which are the majority carriers in PNP s. The basic circuits for NPN transistors also fit well with the negative earth normally used in DC systems.

rial

transistor specification which will be given for any transistor is the material from which t is manufactured. type of material used for semiconductor devices is silicon.

other materials like germanium and gallium arsenide are available, silicon is the most popular because it is o process and in addition to this, the processes are more advanced than for other materials. As it is used for er semiconductor devices, there are many benefits of scale and technology available.

ers good overall performance with a base emitter junction turn on voltage of around 0.6 volts - it is 0.2 to 0.3 ermanium.

ctor to base breakdown voltage, specification, V_{CBO}

parameter is the maximum collector base voltage - again it is generally measured with the emitter left open is value should not be exceeded in the operation of the circuit.

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meter is important because some leakage current will flow between collector and base, causing the part to Alternatively excessive voltage can damage the collector base junction. As terminal damage can occur to ır transistor, this rating should not be exceeded and ideally the transistor should be run with a good margin

on the collector-base junction is reverse biassed, and a small reverse current will flow (I_{CBO}. As the reverse increased the electric field in the depletion region of the collector base junction increases, and the reverse arts to rise as minority carriers gain sufficient energy to generate hole electron pairs which then increase the urrent. Eventually avalanche breakdown occurs. This limits the maximum voltage that can be applied to the

ypically higher than V_{CEO} because with the base terminal of the BJT open, any leakage current will also be as externally applied base current, and this is amplified by the transistor. This will cause even more current ough the device, heating it up and for this reason, V_{CEO} is often lower than V_{CBO}.

ctor to emitter breakdown voltage specification, V_{CEO}

istor specification is the maximum voltage that can be placed from the collector to the emitter. It is normally with the base open circuit - hence the letter "O" in the abbreviation. During the electronics circuit design essential to ensure that this value is not be exceeded in operation, otherwise damage may occur. Ideally stor should be operated with a good margin in hand.

maximum voltage should only be allowed to rise to 50 or 60% of the maximum value for reliable operation. for circuits using inductors in the collector circuit, the collector voltage may rise to twice the rail voltage.

age applied between the collector and emitter terminals is high, and increased number of carriers start to o the collector region from the base. This causes the base emitter diode in the bipolar transistor to start to orward biassed, and this causes current to flow between the collector and emitter, even though no external ent has been applied. When a certain voltage, V_{CEO}, is reached the transistor can fully turn on, and in some can result in terminal damage to the device.

ctor current specification, I_C

ctor current specification of the transistor is normally defined in milliamps, but high power transistors may be amps.

rtant parameter is the maximum level of collector current. This figure should not be exceeded otherwise the may be subject to damage.

ctor emitter saturation voltage, V_{CEsat}

ctor emitter saturation voltage, i.e. the voltage across the transistor (collector to emitter) when the transistor hard on. It is normally quoted for a particular base and collector current values.

se circumstances the voltage between the collector and emitter is smaller than that across the base emitter often it is around 0.2 volts.

ard current gain, h_{FE} & h_{fe}

e current gain for a transistor expressed as an h parameter or hybrid parameter. The letter "f" indicates that it ırd transfer characteristic, and the letter "e" indicates it is for a common emitter configuration. The value for

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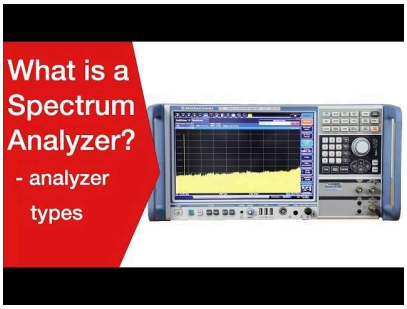

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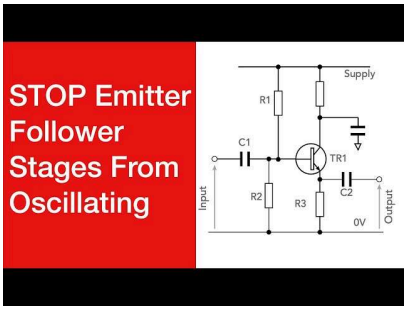

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roximately the same as β.

ons of this parameter are seen: h_{FE} refers to the parameter measured under DC conditions, whereas h_{fe} he parameter for AC signals.

sition frequency specification, FT

y Transition - this transistor specification details the frequency where current gain falls to unity. The should normally be operated well below this frequency.

ce power dissipation, P_{tot}

er dissipation for the device. It is normally quoted for an ambient external temperature of 25°C unless other ed. The actual dissipation across the device is the current flowing through the collector multiplied by the cross the device itself.

age type

s can be mounted in a variety of packages according to their applications. There are the standard leaded hat appear in a variety of packages - these packages normally conform to JEDEC standards and start with TO, standing for transistor outline. This is followed by a hyphen and a numeral which is typically up to three

eaded component sizes include TO5 (metal case, cap diameter of 8.1 mm), TO18 (metal case with cap of the cap is 4.5-4.95mm) and TO92 (also known as SOT54, plastic case off varying sizes but straight line ing of 1.27mm).

nount transistors, SMD transistors are used in vast quantities because most electronics manufacture and embly is undertaken using automated techniques and surface mount technology lends itself to this. Popular ude the SOT-23 and SOT-223 outlines.

r points to consider

the data sheet parameters are very important, there are also several other aspects to the selection of s components, and in this case transistors, for a particular circuit design.

ditional points, look at several points outside the data-sheet. These points can be just as important as the t parameters in the choice of the right component.

dering these points, the best transistors can be chosen, not only in terms of the basic parameter ions, but also in terms of other factors that are equally or even more important.

Aspects of Component Selection:

gh it is possible to make many decisions about selecting the right component for a circuit design from tasheet parameters, this is not the only basis for selecting the right components as there are several attributes not in the data-sheets that need to be embodied in any decision. These are equally important basic specification parameters, but not always taken into account. In our web page, we reveal the key nal aspects to consider so that the overall best choice is made.

more about ***secrets of selecting components.***

many different elements to transistor specifications, both both leaded and surface mount transistors. To demand for electronics manufacture there is a huge variety of transistors from which to choose. However it atively easy to choose a transistor when using a basic knowledge of the different transistor specifications neters.

al purpose applications many transistors will suffice, but for more specialised applications it is essential to right type of transistor.

covers it.

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