Digital electronics: advantages and disadvantages

Digital electronics, or digital (electronic) circuits, represent signals by discrete bands ofanalog levels, rather than by a continuous range. All levels within a band represent the same signal state. Relatively small changes to the analog signal levels due to manufacturing tolerance, signal attenuation or parasitic noise do not leave the discrete envelope, and as a result are ignored by signal state sensing circuitry.

In most cases the number of these states is two, and they are represented by two voltage bands: one near a reference value (typically termed as " ground" or zero volts) and a value near the supply voltage, corresponding to the " false" (" 0") and " true" (" 1") values of the Boolean domain respectively. Digital techniques are useful because it is easier to get an electronic device to switch into one of a number of known states than to accurately reproduce a continuous range of values. Digital electronic circuits are usually made from large assemblies of logic gates, simple electronic representations of Boolean logic functions.

Advantages An advantage of digital circuits when compared to analog circuits is that signals represented digitally can be transmitted without degradation due to noise. [2] For example, a continuous audio signal transmitted as a sequence of 1s and 0s, can be reconstructed without error, provided the noise picked up in transmission is not enough to prevent identification of the 1s and 0s. An hour ofmusiccan be stored on a compact disc using about 6 billion binary digits. In a digital system, a more precise representation of a signal can be obtained by using more binary digits to represent it.

While this requires more digital circuits to process the signals, each digit is handled by the same kind of hardware. In an analog system, additional resolution requires fundamental improvements in the linearity and noise characteristics of each step of the signal chain. Computer-controlled digital systems can be controlled by software, allowing new functions to be added without changing hardware. Often this can be done outside of the factory by updating the product's software. So, the product's design errors can be corrected after the product is in a customer's hands.

Information storage can be easier in digital systems than in analog ones. The noise-immunity of digital systems permits data to be stored and retrieved without degradation. In an analog system, noise from aging and wear degrade the information stored. In a digital system, as long as the total noise is below a certain level, the information can be recovered perfectly. [edit]Disadvantages In some cases, digital circuits use more energy than analog circuits to accomplish the same tasks, thus producing more heat which increases the complexity of the circuits such as the inclusion of heat sinks.

In portable or battery-powered systems this can limit use of digital systems. For example, battery-powered cellular telephones often use a low-power analog front-end to amplify and tune in the radio signals from the base station. However, a base station has grid power and can use power-hungry, but very flexible software radios. Such base stations can be easily reprogrammed to process the signals used in new cellular standards. Digital circuits are sometimes more expensive, especially in small quantities. Most useful digital systems must translate from continuous analog signals to discrete digital signals.

This causes quantization errors. Quantization error can be reduced if the system stores enough digital data to represent the signal to the desired degree of fidelity. TheNyquist-Shannon sampling theorem provides an important guideline as to how much digital data is needed to accurately portray a given analog signal. In some systems, if a single piece of digital data is lost or misinterpreted, the meaning of large blocks of related data can completely change. Because of the cliff effect, it can be difficult for users to tell if a particular system is right on the edge offailure, or if it can tolerate much more noise before failing.

Digital fragility can be reduced by designing a digital system for robustness. For example, a parity bit or other error management method can be inserted into the signal path. These schemes help the system detect errors, and then either correct the errors, or at least ask for a new copy of the data. In a state-machine, the state transition logic can be designed to catch unused states and trigger a reset sequence or other error recovery routine. Digital memory and transmission systems can use techniques such as error detection and correction to use additional data to correct any errors in transmission and storage.

On the other hand, some techniques used in digital systems make those systems more vulnerable to single-bit errors. These techniques are acceptable when the underlying bits are reliable enough that such errors are highly unlikely. A single-bit error in audio data stored directly as linear pulse code modulation (such as on a CD-ROM) causes, at worst, a single click.

Instead, many people use audio compression to save storage space and download time, even though a single-bit error may corrupt the entire song. A digital circuit is a circuit that functions on a number of different logic gates.

The logic gates differentiate power signals. The power signals are then transferred to different parts of the digital circuit through other gates to create an output signal directly pertinent to the energy level at the moment of signal input. Most digital circuits are comprised mainly of smaller analog components that, because of the logic gate occurrence, only operate within a certain frame of voltages. Usually these operate at extremely low voltage signals. Digital circuits also require that the analog components located throughout the circuit not be placed in a manner that will allow them to perform analog functions.

This usually means there is a logic gate both before and after the analog component. Digital circuits are becoming more and more popular astechnologyrequires the electronic devices used every day to become smaller and smaller, making the items more readily accessible regardless of location or circumstance. A digital circuit reacts quickly as power or signal is delivered to them, as long as the signal it receives is within the correct frame of voltage or energy. Digital circuits usually work best with low voltage signals, as they are more capable of handling these signals than higher voltages.

Analog circuits typically require much more voltage behind the input signal to perform with the speed that digital circuits provide. An electronic circuit is composed of individual electronic components, such as resistors, transistors, capacitors, inductors and diodes, connected by conductive wires or traces through which electric current can flow. The combination of components and wires allows various simple and complex operations to be performed: signals can be amplified, computations can be performed, and data can be moved from one place to another. 1] Circuits can be constructed of discrete components connected by individual pieces of wire, but today it is much more common to create interconnections by photolithographic techniques on a laminated substrate (a printed circuit board or PCB) and solder the components to these interconnections to create a finished circuit. In an integrated circuit or IC, the components and interconnections are formed on the same substrate, typically a semiconductor such as silicon or (less commonly) gallium arsenide. [2] Breadboards, perfboards or stripboards are common for testing new designs.

They allow the designer to make quick changes to the circuit during development. An electronic circuit can usually be categorized as an analog circuit, a digital circuit or a mixed-signal circuit (a combination of analog circuits and digital circuits). analog circuit analog circuit, electronic circuit that operates with currents and voltages that vary continuously with time and have no abrupt transitions between levels. Generally speaking, analog circuits are contrasted with digital circuits, which function as though currents or voltages exist only at one of a set of discrete levels, all transitions between levels being ignored.

Since most physical quantities, e. g. , velocity and temperature, vary continuously, as does audio, an analog circuit provides the best means of representing them. However, digital circuits are often preferred because of the ease with which their outputs can be manipulated by computers, and because digital signals are more robust and less subject to transmission errors. There are special analog-to-digital and digital-to-analog circuits to convert from one type of signal to the other.