Digital Fundamentals

Tenth Edition

Floyd

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Summary

Analog Quantities

Most natural quantities that we see are **analog** and vary continuously. Analog systems can generally handle higher power than digital systems.

Digital systems can process, store, and transmit data more efficiently but can only assign discrete values to each point.

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Summary

Analog and Digital Systems

Many systems use a mix of analog and digital electronics to take advantage of each technology. A typical CD player accepts digital data from the CD drive and converts it to an analog signal for amplification.

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Summary

Binary Digits and Logic Levels

Digital electronics uses circuits that have two states, which are represented by two different voltage levels called HIGH and LOW. The voltages represent numbers in the binary system.

In binary, a single number is called a *bit* (for *b*inary dig*it*). A bit can have the value of either a 0 or a 1, depending on if the voltage is HIGH or LOW.

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Digital Waveforms

Digital waveforms change between the LOW and HIGH levels. A positive going pulse is one that goes from a normally LOW logic level to a HIGH level and then back again. Digital waveforms are made up of a series of pulses.

(a) Positive–going pulse (b) Negative–going pulse

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Summary

Pulse Definitions

Actual pulses are not ideal but are described by the rise time, fall time, amplitude, and other characteristics.

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Summary

Periodic Pulse Waveforms

Periodic pulse waveforms are composed of pulses that repeats in a fixed interval called the **period**. The **frequency** is the rate it repeats and is measured in hertz.

$$f = \frac{1}{T} \qquad T = \frac{1}{f}$$

The **clock** is a basic timing signal that is an example of a periodic wave.

What is the period of a repetitive wave if f = 3.2 GHz?

$$T = \frac{1}{f} = \frac{1}{3.2\text{ GHz}} = 313\text{ ps}$$

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Summary

Pulse Definitions

In addition to frequency and period, repetitive pulse waveforms are described by the amplitude (A), pulse width (t_W) and duty cycle. Duty cycle is the ratio of t_W to T.

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Summary

Timing Diagrams

A timing diagram is used to show the relationship between two or more digital waveforms,

A diagram like this can be observed directly on a logic analyzer.

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Serial and Parallel Data

Data can be transmitted by either serial transfer or parallel transfer.

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Basic Logic Functions

AND True only if ***all*** input conditions are true.

OR True only if ***one or more*** input conditions are true.

NOT Indicates the ***opposite*** condition.

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Summary

Basic System Functions

And, **or**, and **not** elements can be combined to form various logic functions. A few examples are:

The comparison function

Basic arithmetic functions

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Basic System Functions

The encoding function

The decoding function

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Basic System Functions

The data selection function

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Summary

Basic System Functions

The counting function

…and other functions such as code conversion and storage.

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Summary

Basic System Functions

One type of storage function is the shift register, that moves and stores data each time it is clocked.

Initially, the register contains only invalid data or all zeros as shown here.

First bit (1) is shifted serially into the register.

Second bit (0) is shifted serially into register and first bit is shifted right.

Third bit (1) is shifted into register and the first and second bits are shifted right.

Fourth bit (0) is shifted into register and the first, second, and third bits are shifted right. The register now stores all four bits and is full.

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Summary

Integrated Circuits

Cutaway view of DIP (Dual-In-line Pins) chip:

The TTL series, available as DIPs are popular for laboratory experiments with logic.

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Integrated Circuits

An example of laboratory prototyping is shown. The circuit is wired using DIP chips and tested.

In this case, testing can be done by a computer connected to the system.

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Summary

Integrated Circuits

DIP chips and surface mount chips

Dual in-line package

Small outline IC (SOIC)

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Summary

Integrated Circuits

Other surface mount packages:

End view

SOIC

End view

PLCC

End view

LCCC

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Summary

Test and Measurement Instruments

The front panel controls for a general-purpose oscilloscope can be divided into four major groups.

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For measuring digital signals, use DC coupling

Normally, trigger on the slower of two waveforms when comparing signals.

Test and Measurement Instruments

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Test and Measurement Instruments

The logic analyzer can display multiple channels of digital information or show data in tabular form.

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Summary

Test and Measurement Instruments

The DMM can make three basic electrical measurements.

- Voltage
- Resistance
- Current

In digital work, DMMs are useful for checking power supply voltages, verifying resistors, testing continuity, and occasionally making other measurements.

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Summary

Programmable Logic

Programmable logic devices (PLDs) are an alternative to fixed function devices. The logic can be programmed for a specific purpose. In general, they cost less and use less board space that fixed function devices.

A PAL device is a form of PLD that uses a combination of a programmable AND array and a fixed OR array:

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Selected Key Terms

Analog Being continuous or having continuous values.

Digital Related to digits or discrete quantities; having a set of discrete values.

Binary Having two values or states; describes a number system that has a base of two and utilizes 1 and 0 as its digits.

Bit A binary digit, which can be a 1 or a 0.

Pulse A sudden change from one level to another, followed after a time, called the pulse width, by a sudden change back to the original level.

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Selected Key Terms

Clock A basic timing signal in a digital system; a periodic waveform used to synchronize actions.

Gate A logic circuit that performs a basic logic operations such as AND or OR.

NOT A basic logic function that performs inversion.

AND A basic logic operation in which a true (HIGH) output occurs only when all input conditions are true (HIGH).

OR A basic logic operation in which a true (HIGH) output occurs when when one or more of the input conditions are true (HIGH).

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Selected Key Terms

Fixed-function logic	A category of digital integrated circuits having functions that cannot be altered.
Programmable logic	A category of digital integrated circuits capable of being programmed to perform specified functions.

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