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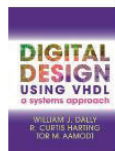
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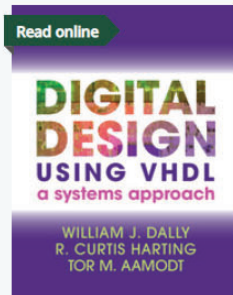


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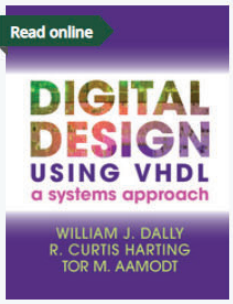
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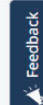
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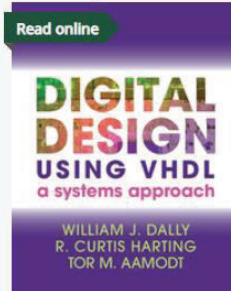
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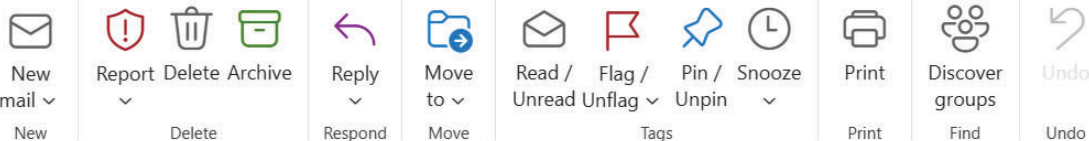
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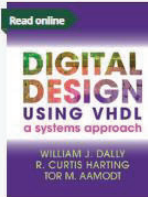


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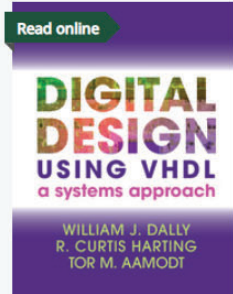
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[Testing of Digital Systems](#)

[N. K. Jha](#), [S. Gupta](#)

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The digital abstraction

Digital systems are pervasive in modern society. Some uses of digital technology are obvious – such as a personal computer or a network switch. However, there are also many other applications of digital technology. When you speak on the phone, in almost all cases your voice is being digitized and transmitted via digital communications equipment. When you listen to an audio file, the music, recorded in digital form, is processed by digital logic to correct errors and improve the audio quality. When you watch TV, the image is transmitted in a digital format and processed by digital electronics. If you have a DVR (digital video recorder) you are recording video in digital form. DVDs are compressed digital video recordings. When you play a DVD or stream a movie, you are digitally decompressing and processing the video. Most communication radios, such as cell phones and wireless networks, use digital signal processing to implement their modems. The list goes on.

Most modern electronics uses analog circuitry only at the edge – to interface to a physical sensor or actuator. As quickly as possible, signals from a sensor (e.g., a microphone) are converted into digital form. All real processing, storage, and transmission of information is done digitally. The signals are converted back to analog form only at the output – to drive an actuator (e.g., a speaker) or control other analog systems.

Not so long ago, the world was not as digital. In the 1960s digital logic was found only in expensive computer systems and a few other niche applications. All TVs, radios, music recordings, and telephones were analog.

The shift to digital was enabled by the scaling of integrated circuits. As integrated circuits became more complex, more sophisticated signal processing became possible. Complex techniques such as modulation, error correction, and compression were not feasible in analog technology. Only digital logic, with its ability to perform computations without accumulating noise and its ability to represent signals with arbitrary precision, could implement these signal processing algorithms.

In this book we will look at how the digital systems that form such a large part of our lives function and how they are designed.

1.1 DIGITAL SIGNALS

Digital systems store, process, and transport information in digital form. Digital information is represented as discrete symbols that are encoded into ranges of a physical quantity. Most often we represent information with just two symbols, “0” and “1,” and encode these symbols into voltage ranges as shown in Figure 1.1. Any voltage in the ranges labeled “0” and “1” represents a “0” or “1” symbol, respectively. Voltages between these two ranges, in the region labeled “?,” are undefined and represent neither symbol. Voltages outside the ranges, below the “0” range, or above the “1” range are not allowed and may permanently damage the system if they occur. We call a signal