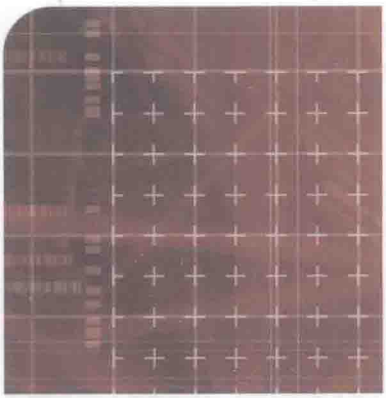
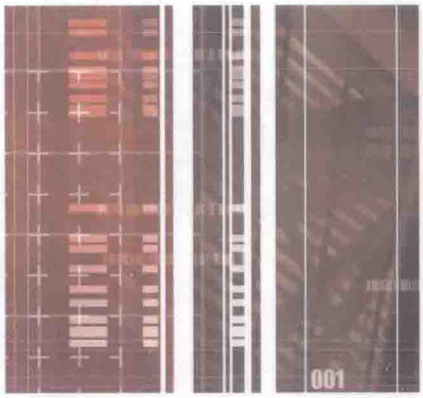



McGRAW-HILL COMMUNICATIONS

RFID IMPLEMENTATION

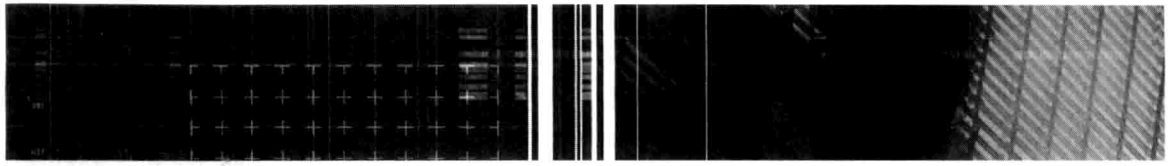
Initiate, install, and manage an effective RFID rollout

Use host computers, controllers, encoders, printers, readers, and tags

Deploy solid security and customer privacy policies

Implement cost-cutting tips from Wal-Mart's top 100 suppliers

DENNIS E. BROWN
President,
RFID Runner

RFID Implementation

Dennis E. Brown

New York Chicago San Francisco Lisbon
London Madrid Mexico City Milan New Delhi
San Juan Seoul Singapore Sydney Toronto

The McGraw-Hill Companies

RFID Implementation

1234567890 DOC DOC 019876

ISBN-13: 978-0-07-226324-4

ISBN-10: 0-07-226324-5

Sponsoring Editor
Jane K. Brownlow

Editorial Supervisor
Janet Walden

Project Editor
LeeAnn Pickrell

Acquisitions Coordinator
Jennifer Housh

Technical Editor
Joseph A. Yacura

Copy Editor
Sally Engelfried

Proofreader
Susie Elkind

Indexer
Karin Arrigoni

Production Supervisor
George Anderson

Composition
International Typesetting and Composition

Illustration
International Typesetting and Composition

Art Director, Cover
Brian D. Boucher

Cover Designer
12E

DEDICATION

This book is dedicated to Resa, my wife and my life for nearly 30 years.

ABOUT THE AUTHOR

Dennis Brown is president of RFID Runner, a company specializing in selection, configuration, sale, and support of RFID systems. The company is distinguished by its focus on data modeling, software integration, and business value beyond the simple requirements of customer mandates. Dennis has been a technical consultant, entrepreneur, and executive for nearly 30 years, helping companies discover and adopt new technologies. A senior executive at Ashton-Tate, he helped guide one of the most successful software companies of all time. He has spent the past ten years selling and installing asset management systems. His clients include Warner Bros., Boeing, Sony Pictures, the National Imagery and Mapping Agency (NIMA), and the National Security Agency (NSA). As a software author, Brown wrote the Financial Planning Language, an early bestseller in the microcomputer arena. He founded Information Access, a software publisher, and KRM/Analytics, a distributor of analytical software. Brown has a BS from Georgetown University and a masters degree from the University of Southern California (USC). He taught business information systems at the university level for six years.

About the Technical Editor

Joseph A. Yacura is co-founder and chief strategist of Supply Chain Management, LLC, a supply chain and cost-management consulting firm. The company provides consulting services related to supply chain management, accounts payable, finance, change management, quality management, and information systems. Joseph has spent over 30 years assisting companies in utilizing processes, quality, financial controls, and technology to enhance their competitive posture. During his early career he spent 10 years with IBM in various management positions. As a senior vice president and/or chief procurement officer at Pacific Bell, American Express, Bank of America, and InterContinental Hotels Group, he gained insight into several different vertical industries. Joseph received his undergraduate degree from the State University of New York at Oswego. He received an MBA and MS degree from Binghamton University and an MQM degree from Loyola University. He has also completed the Senior Executive Program at Stanford University.

ACKNOWLEDGMENTS

I would like to acknowledge and thank Mr. Gaylon Morris of the MetLab Company. When I needed exactly the right fact, Gaylon was always there.

I would also like to thank Mr. Patrick Sweeney of Odin Corporation for his encouragement and support.

Thanks are due to the folks at *RFID Journal*, RFID Update, Lowry Computer Products, and Paxar Corporation. That having been said, responsibility for any errors is strictly my own.

INTRODUCTION

RFID stands for *Radio-Frequency Identification*. It is the name given to systems that put "tags" on objects (items bought and sold commercially, documents, people, animals, vehicles, containers, and so on) so they can be identified, tracked, and managed automatically utilizing radio frequency equipment and supporting computer systems. Tags are very small radio transmitter/responders (also called "transponders") that store and broadcast data. There are a variety of types of tags, and they come in various shapes, sizes, and capabilities. The data in the tag may be a simple identification number that identifies the object, or it may fully describe it. It may give its history or contain relevant information such as warnings or instructions. The tag most often contains just a number, similar to a license plate on a car. The number serves as a key to a record in a database on a "host computer," which stores the actual data. The format of the number is an important consideration, as it must be read by a variety of systems, not all of which may be known at the time the system is designed. When the tags are in the vicinity of a reader, they broadcast their contents. The reader captures this information and sends it to a host computer. The host uses the data in an application program, such as a warehouse management system, inventory system, database or Enterprise Resource Planning (ERP) system. The data may also be stored in a data warehouse where analysts can use it to study, evaluate, and improve the movement of goods; reduce the time involved; and uncover various hidden dependencies and correlations.

RFID is one of many tools that perform automatic collection of data. Similar tools you may be familiar with are bar codes and credit cards with magnetic stripes on them. RFID differs from these in that it is more automatic, and it is capable of higher speeds of operation. Thus, RFID can automatically gather data that might not be collected otherwise. Having collected the data, you can then use it to improve your operations and solve several very complex and time-sensitive problems. In 2004, Wal-Mart and the Department of Defense decided they wanted to solve those problems. They announced a schedule by which their suppliers needed to attach RFID tags on the pallets and cases of goods they shipped to particular distribution centers. Best Buy, Target, Albertson's, and Metro Group in Europe all quickly made similar demands. These demands have been called "mandates" in the press. As people began to understand the scope of the mandates, RFID went from obscurity to celebrity very quickly.

The excitement around RFID centers on its "new" applicability to supply chain management, but RFID is in widespread use in other applications as well. As Chapter 5 describes, RFID technology has applicability for baggage handling, security, asset management, and a host of other uses. These applications, less dramatic in many cases than those in the supply chain, are nonetheless profitable uses of the technology. They benefit from the falling costs of tags and readers and the increased number of persons familiar with the techniques that arise from the supply chain uptake.

Background

RFID's basic technology dates from World War II, where it was used to identify friendly ships and airplanes. Today, low-cost tags and equipment and sophisticated applications support a variety of new uses for the technology beyond aircraft identification.

In June 2003, it was apparent that the following developments were either fully available or would be available soon:

- Protocols were becoming standardized.
- The price of tags was coming down.
- Higher-frequency technology was becoming available.
- The ability to send and receive data at faster data rates was being developed.
- The ability to read multiple tags in the same read zone at the same time was demonstrated.
- Software was becoming available that would utilize the RFID-generated data.

In addition to these developments, the rise of the Internet as a critical part of most companies' infrastructure means that connectivity is always on and always available. Tags anyplace in the world can communicate with a nearby reader and thus signal their location and telemetry (temperature, moisture, pedigree, radiation) to listening applications.

The United States Department of Defense (DoD) and Wal-Mart and other retailers felt they could justify requiring their vendors to tag pallets and cases being shipped to them. In July 2005, tags containing integrated circuit chips were commercially available for about 25–30 cents each in large quantities. By September, one firm announced they had reduced

their tag prices to 15 cents each. It is widely believed that when tags reach a price of 5 cents or less each, retailers will require that they be used on individual low-cost items, not just the cases, pallets, and containers. Experts now project that this will happen in the 2007–2008 timeframe.

RFID systems generate data that organizations can use to improve operations. RFID's proponents claim that these systems:

- Improve management of facilities, assets, and resources
- Reduce theft or misplacement of goods, tools, equipment, files, prisoners, or small children
- Keep detailed records of the history of each item in trade
- Increase the speed and accuracy of nearly all business transactions
- Enable suppliers to comply with customer mandates

Accomplishing these goals requires that you keep data that is current, complete, and error free. This perfecting of the data in databases is an often-overlooked prerequisite to utilizing the collected data for decision making. But RFID is unique because other currently available methods of data collection are costly, cumbersome and, in some cases, unreliable and too slow to provide high quality, synchronized data. The payoff for an RFID project comes from the utilization of the data to drive down errors, theft, cost, and inefficiency and to increase the speed of a company's activities and transactions.

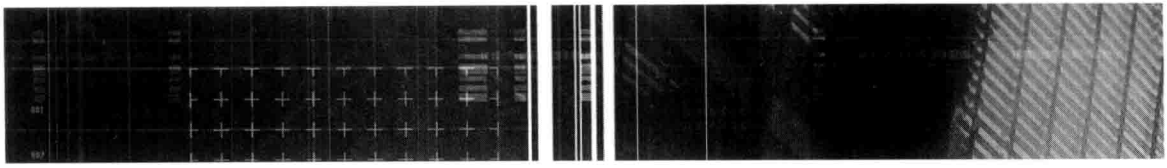
Major Vendor Support for RFID

RFID has attracted the attention of the most sophisticated companies in the technology sector. IBM, Accenture, Sun, HP, Microsoft, and Intel have all announced major investments in RFID products and services. Oracle and SAP have RFID initiatives. And companies such as Symbol and Intermec, RFID industry leaders, are seeing substantial growth. Many large consumer goods companies are conducting pilots, and several have begun large-scale deployments.

RFID today delivers value for companies, with the ability to provide real-time error-free information that they can use to solve complex business problems. As the cost of tags continues to come down, companies will find new and innovative uses for the technology. As new global

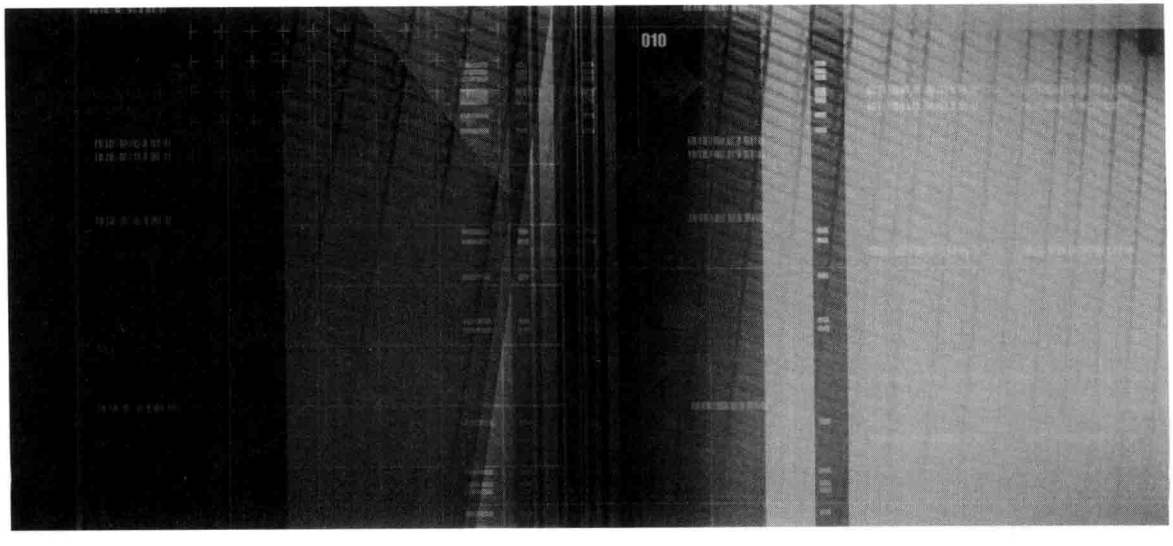
standards are announced and embodied in available products, the barriers to adoption are reduced. With leading companies demanding RFID tags on products and shipping containers, the technology will continue its rapid adoption throughout the total supply chain. Consumers will become better educated about the technology to allay their privacy fears. As with other disruptive technologies, companies that master RFID early will enjoy competitive advantages as compared with those that wait. Companies around the world are starting pilot projects and learning how to work with this exciting technology.

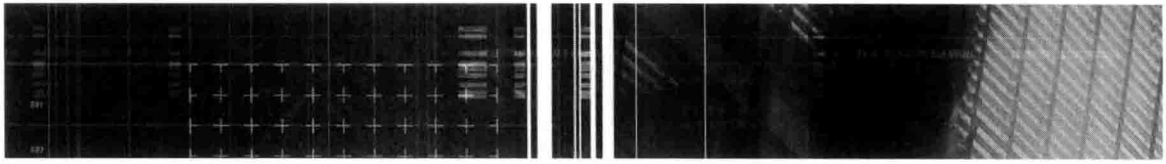
CONTENTS



PART I

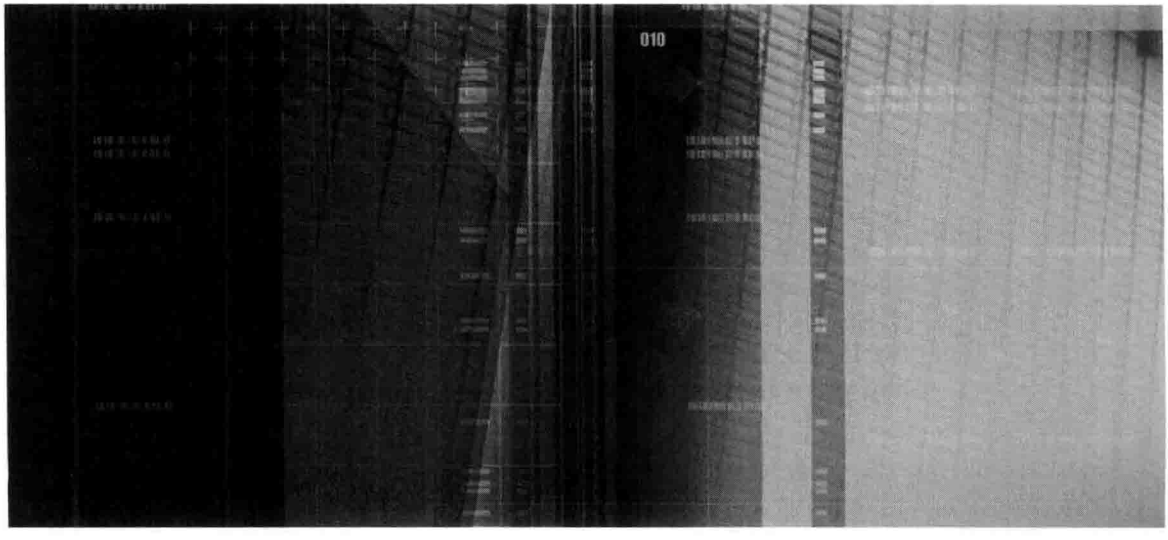
The Basics





CHAPTER 1

RFID Physics, Standards, and Regulations



Too many RFID systems are installed based on "one-size-fits-all" starter kits and trial-and-error project methodologies. These two approaches ignore the physics and distinctive characteristics of the radio waves that govern how well the systems will work in practice. The result is predictable: tag-read rates are low and the systems perform ineffectually. This chapter describes the science behind your RFID system, the underlying mechanics on which all RFID systems are built. It then goes on to explain the standards and regulations that enable systems built by different manufacturers to work together.

1.1 RFID Physics

A wave is a disturbance that carries energy from one place to another. Radio waves are created when electrons are passed through a conductor, like an electrical wire. The current creates a magnetic field. Fluctuations in the current produce changes in the magnetic field, creating *waves* of electromagnetic energy. These are called electromagnetic (EM) waves.

There are many types of EM waves you encounter other than radio waves, such as microwaves, gamma waves, x-rays, and light. EM waves oscillate, or vibrate. *Radio waves* are low-frequency electromagnetic waves, which means they oscillate more slowly, and their wavelengths are longer than other types of EM waves. Radio waves share many characteristics with other EM waves, but they differ from light and microwaves in important ways.

Radio waves and light waves both pass readily through air. But unlike light, radio waves can pass through many other materials such as plastic, cardboard, wood, cloth, and so on. Radio waves are less efficient at passing through metal, graphite, sodium, and liquids. We call these *opaque materials*. See Section 1.1.1 for a discussion of this important topic. Different wave frequencies differ in their ability to penetrate opaque materials. We will return to this point often in this book, as it impacts many aspects of implementing your system. Frequency and wavelength are discussed in detail in Section 1.1.2.

You probably have experience with radio waves every day, as you make use of radio and television entertainment and cordless telephones. All of these use radio waves to deliver sound or pictures to your car or house (excluding alternate delivery mechanisms such as cable television). Every day, you make use of the ability of radio waves to carry data such as voice,