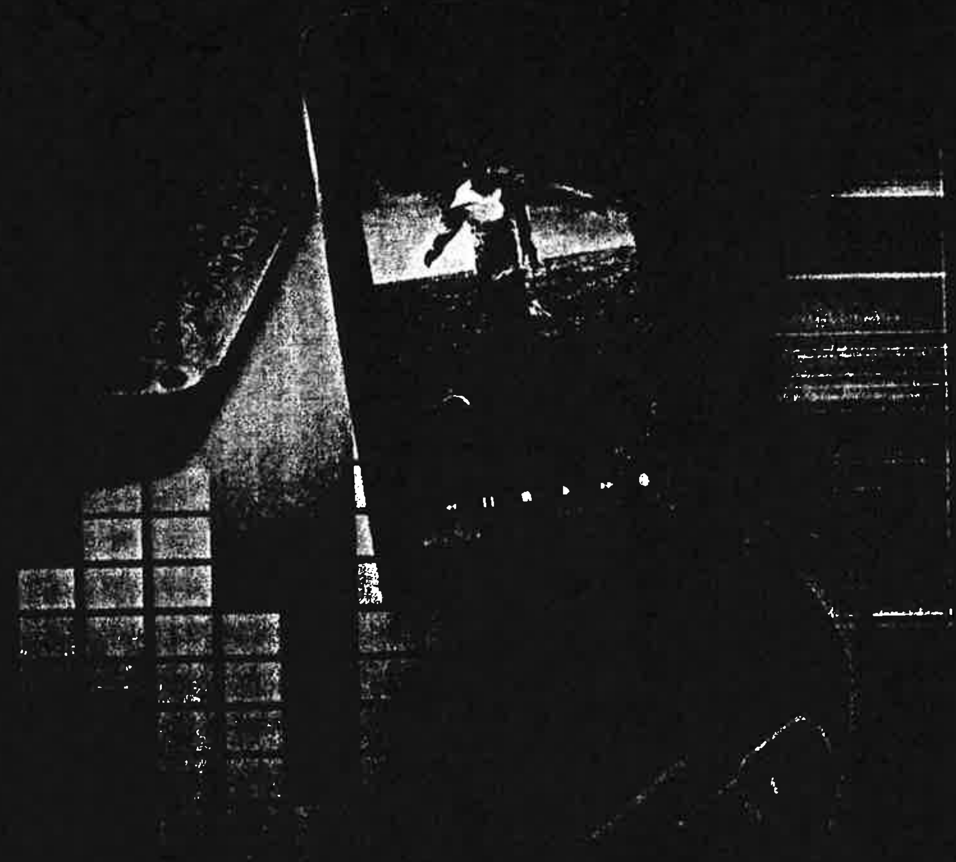

Mobile Handset Design

Sajal Kumar Das

WILEY

MOBILE HANDSET DESIGN

Sajal Kumar Das
Nokia R&D Center, India

John Wiley & Sons (Asia) Pte Ltd

Visit our Home Page on www.wiley.com

Other Wiley Editorial Offices

John Wiley & Sons, Ltd, The Atrium, Southern Gate, Chichester, West Sussex, PO19 8SQ, UK

John Wiley & Sons Inc., 111 River Street, Hoboken, NJ 07030, USA

Jossey-Bass, 989 Market Street, San Francisco, CA 94103-1741, USA

Wiley-VCH Verlag GmbH, Boschstrasse 12, D-69469 Weinheim, Germany

John Wiley & Sons Australia Ltd, 42 McDougall Street, Milton, Queensland 4064, Australia

John Wiley & Sons Canada Ltd, 5353 Dundas Street West, Suite 400, Toronto, ONT, M9B 6H8, Canada

Wiley also publishes its books in a variety of electronic formats. Some content that appears in print may not be available in electronic books.

Library of Congress Cataloging-in-Publication Data

Das, Sajal K.
Mobile handset design / Sajal Kumar Das.
p. cm.
ISBN 978-0-470-82467-2 (cloth)
1. Mobile communication systems. 2. Wireless communication systems. 3. Cellular telephones. I. Title.
TK6570.M6D35 2009
621.3845'6–dc22

2009018214

ISBN 978-0-470-82467-2 (HB)

Typeset in 9/11pt Times by Thomson Digital, Noida, India.
Printed and bound in Singapore by Markono Print Media Pte Ltd, Singapore.
This book is printed on acid-free paper responsibly manufactured from sustainable forestry in which at least two trees are planted for each one used for paper production.

power P_t is spread over the surface of a sphere whose radius is r, so the power density will be $P_t/4\pi r^2$. Taking this energy, the flux lines will move away from the transmitting antenna. Now, as they move away from the antenna, the size of the sphereincreases, r increases but the same power (P_t) is contained within it. Thus the power density $P_t/4\pi \cdot r^2$ decreases as it travels far from the transmitting antenna (for example, increase in r), and the problem of transmission of electrical energy via air/free-space is solved.

How is Energy Received on the Other Side? – Again, the antenna helps to solve this problem too. It transforms the received EM wave into an electrical signal. When the transmitted wave arrives at the receiving end, it tries to penetrate via another the metallic antenna. We know that the EM wave consists of an electric field and a magnetic field and that these are perpendicular to each other, and also that they are perpendicular to the direction of propagation. Thus when the EM wave touches the metallic antenna (from Maxwell's third equation) the magnetic field (H) will generate a surface current on the metallic antenna, which will try to penetrate via the metal (as it is a good conductor). However, it will die down after traveling a thickness of the skin depth, and, the EM wave will generate an electrical current in the metal body of the antenna. Similarly (from Maxwell's fourth equation), the electric field will generate an electric voltage in the antenna, as shown in Figure 1.19.

This phenomenon can be experienced by placing a radio inside a closed metallic chamber and finding that it does not play, as the EM wave can not penetrate via the thick metallic wall. However, it can penetrate through a concrete wall. For the same reason, a mobile telephone call disconnects inside an enclosed metallic lift due to the degradation of the signal strength.

Thus we have converted the transmitted energy (which was transmitted using the carrier of the EM waves) back into the electrical signal through the help of another antenna. So the antenna helped in transmitting and receiving the information through the air. As the user wants to send and receive the information, ideally the user should have both transmitting and receiving antennas. However, in general, in a mobile device, the same antenna is used for transmission as well as receiving purposes (refer to Chapter 4).

Thus we now know how to transmit and receive the information via the air (for example, via a wireless medium) using antenna. However, the problem at this stage is whether the baseband signal is transmitted directly, as its frequency is low (~KHz), and so it can not be sent directly via the air due to the following problems:

1. A larger antenna length ($\sim\lambda/4$) is required.
2. Much less BW is available at the lower frequency region.

The solution to this is to up-convert the baseband signal to a high frequency RF signal at the transmitter and then similarly down-convert at the receiver for example, which requires RF conversion techniques. How is the baseband signal up-converted/down-converted? The solution for up-conversion is the use of analog or digital modulation and mixing techniques (on a transmitter block) and the solution for down-conversion is the use of demodulation mixing techniques (on a receiver block). These will be discussed in more detail in Chapter 4. Next we will establish what else, apart from the antenna, is required inside the transmitter and receiver to transmit or receive the information.

1.2.3 Basic Building Blocks of a Wireless Transmitter and Receiver

We know that a digital system is more immune to noise, and that in addition to this there are many such advantages of digital systems over the old analog systems. So, from the second generation onwards wireless systems have been designed with digital technology. However, there is a problem, in that voice and video signals are inherently analog in nature. So how can these signals be interfaced with a digital system? These signals have to be brought into the digital domain for processing using an analog-to-digital converter (ADC) and then again reverted back into an analog signal using a digital-to-analog converter (DAC) and then sent via an antenna. A typical transmitter block diagram of a wireless system is shown in the Figure 1.20.

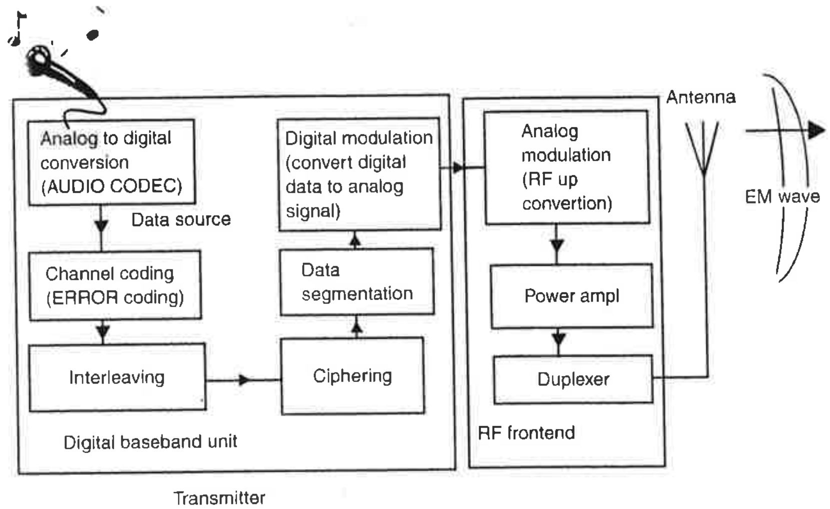

Figure 1.20 Transmitter system block diagram

As shown in the Figure 1.20, on the transmitter side, when the user speaks in front of a microphone, it generates an electrical signal. This signal is sampled and converted into digital data and then fed to the source codec, for example, a speech codec unit (this is discussed in more details in Chapter 8), which removes the redundant data and generates the information bits. These data are then fed into the channel coder unit. When the signal travels via the medium, during this time it can be affected by signal noise, so we need some type of protection against this. The channel coder unit inserts some extra redundant data bits using an algorithm, which helps the receiver to detect and correct the received data (this is discussed in more detail in Chapter 3). Next, it is fed to an interleaving block. When data pass through the channel, this time there may be some type of burst noise in the channel, which can actually corrupt the entire data during this burst period. Although the burst lasts for only a short duration, its amplitude is very high, so it corrupts the data entirely for that duration. In order to protect the data from burst error, we need to randomize the data signal (separate consecutive bits) over the entire data frame, so that data can be recovered, although some part will be corrupted completely. An interleaving block helps in this respect (this is discussed in detail in Chapters 3 and 8). Next, it is passed to a ciphering block, where the data are ciphered using a specific algorithm. This is basically done for data security purposes, so that unauthorized bodies cannot decode the information (ciphering is discussed in Chapters 7 and 9). Then the data are put together in a block and segmented according to the data frame length.

The data processing is now over, and next we have to pass it for transmission. This data signal can not be sent directly using an antenna, because, it will be completely distorted. Also, the frequency and amplitude of the data signal is less, as we know the length of the transmitting antenna should be a minimum of the order of $\lambda/4$. So, the required size of the antenna will have to be very large, which is not feasible. This is why we need to convert it into a high frequency analog signal using modulation techniques. The digital modulator block transfers the digital signal into a low amplitude analog signal. As the frequency of this analog signal may be less, we therefore may need to convert it into a high frequency RF signal, where the wavelength is small and the required antenna length will also be small. The analog modulator block helps to up-convert the analog signal frequency to a high RF carrier frequency (the modulation technique is discussed in Chapter 5). It is then fed into a power amplifier to increase the power of the signal, and after that it is passed to duplexer unit. We know that our telephone acts as a transmitter as well as a receiver, so it

DOCKET ALARM

Explore Litigation Insights

Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

Real-Time Litigation Alerts

Keep your litigation team up-to-date with **real-time alerts** and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

Advanced Docket Research

With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

Analytics At Your Fingertips

Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

LAW FIRMS

Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

FINANCIAL INSTITUTIONS

Litigation and bankruptcy checks for companies and debtors.

E-DISCOVERY AND LEGAL VENDORS

Sync your system to PACER to automate legal marketing.