

PREFACE TO SECOND EDITION

Frequencies below 10 GHz continue to provide a large fraction of satellite service, and new applications, including mobile satellite service and the global positioning system, use frequencies below 10 GHz. As frequency decreases below 10 GHz, attenuation due to precipitation and gases decreases and ionospheric effects increase. Thus the ionosphere, which can be largely neglected above 10 GHz, receives major attention in this handbook. Though attenuation and depolarization due to rain are less severe below 10 GHz than above, they are nevertheless still important and constitute another major topic. Emphasis of this handbook is on propagation effects on satellite communications but material that is pertinent to radionavigation and positioning systems and deep-space telecommunications is included as well.

A handbook on propagation effects in the 10-100 GHz range has been prepared under NASA sponsorship* and the present handbook serves a similar purpose for the 100 MHz to 10 GHz range. Much interest is directed at present to frequencies above 10 GHz. The ACTS (Advanced Communications Technology Satellite) program utilizes frequencies near 30 and 20 GHz.

Descriptive background material concerning the various propagation impairments is given in Chapters 1 through 7, and Chapter 9 is devoted to the estimation or calculation of the magnitudes of these effects for use in system design. Link power budget equations and the role of propagation effects in these equations are the subjects of Chapter 10. The final two chapters include some repetition of material presented earlier so that they can be used independently of the earlier chapters to a considerable extent. To avoid excessive duplication, however, references are made in some cases to figures and tables of the earlier chapters. Chapter 8 deals with the complex subject of interference between space and terrestrial systems. Although it draws upon the previous chapters and is pertinent to Chapter 10, the material of Chapter 8 constitutes a distinct and interesting subject of its own.

The handbook is based upon the work of the many investigators cited in the lists of references. Research supported by the Communications and Information Systems Division of the Office of Space Science and Applications of NASA has contributed greatly to knowledge of satellite communications, including the propagation aspects considered here, and is well represented in the reference lists.

I would like to express my appreciation for support and cooperation in the preparation of this handbook to Dr. Ernest K. Smith, RTOP manager at the Jet Propulsion Laboratory while this volume was in preparation, and to Mr. John Kiebler and Dr. Louis J. Ippolito, present and former managers at NASA Headquarters respectively. Also I appreciate the assistance of Dr. Faramaz Davarian, present RTOP manager, Dr. Vahraz Jamnejad, Dr. Arvydas J. Kliore, Mr. Tomas A. Komarek, Mr. Paul Robbins, Dr. Stephen D. Slobin, and Dr. William J. Weber, all with the Jet Propulsion Laboratory, and Mr. Alfred M. Goldman, Jr., formerly with the Laboratory.

In this second edition, updating of the frequency allocations of Chapter 1 has been carried out using information provided by Paul Robbins. Chapter 2 on ionospheric effects received updating but has changed the least. Chapter 3 includes new material on excess range delay and water-vapor radiometers. The subject of modeling of rain attenuation in Chapters 4 and 9 has been updated to include the latest revisions of the CCIR model, and Chu's treatment of depolarization has been featured. The treatment of Rayleigh scattering of Chapter 5 has been reorganized. The material on land-mobile satellite systems in Chapters 6 and 9 has been expanded considerably, and the global positioning system (GPS) is also treated more fully in Chapter 6. Antimultipath techniques and shadowing by trees receive attention in Chapter 6. Noise of terrestrial origin is now treated more adequately in Chapter 7. Chapter 8 on interference has been updated to conform to the latest CCIR treatment. Single sideband systems and spread spectrum systems are topics which have been added to Chapter 10.

*NASA Communications Division, NASA Headquarters, A Propagation Effects Handbook for Satellite Systems Design, A Summary of Propagation Impairments on 10-100 GHz Satellite Links, with Techniques for System Design, Third Edition, June 1983, NASA Reference Publication 1082 (03) by L. J. Ippolito, R.D. Kaul, and R.G. Wallace.