

Report of the United States of America National Committee to the XIII General Assembly of the International Scientific Radio Union, London, England, September 5 to 15, 1960.

Foreword

The U.S.A. National Committee Report for the period 1957-1960 represents a departure from previous reports in scope and form. The Committee decided that a concerted effort should be made by the Commissions to review the work in their fields more critically than was done heretofore. The evaluation of progress rather than a bibliographical summary and a résumé that places the status of the field in its proper perspective were set as major objectives. The members of the Commissions responded enthusiastically to the call for contributions and the objectives have been met in a large measure. We hope that the National Committee Report will itself furnish a basis for discussions at the General Assembly and it represents a step forward in the activity of the National Committee.

The National Bureau of Standards has given inestimable aid to the preparation of the report for presentation to the General Assembly. An editorial group under Mr. Bradford Bean undertook the enormous task of uniformizing the method of referencing and of checking the references and preparing the manuscript for final printing. Time was too limited to allow for extensive editing of the manuscripts and in some cases the reports are more than coverages of the period 1957-1960. However, such deviations and expansions are not without value in a first presentation of this type.

U.S.A. National Committee

Table of Contents

	Page
Commission 1. Radio Measurement Methods and Standards:	
Review of developments	591
1. Frequency and time interval	E. A. Gerber 592
1.1. Quartz crystal standards	592
1.2. Atomic frequency and time standards	592
1.3. Frequency and time measurement and comparison	593
1.4. References	594
2. RF and microwave power measurements	G. F. Engen 596
References	596
3. Impedance measurements and standards	G. S. Deschamps 598
References	598
4. Development in attenuation measurements and standards	Bruno O. Weinschel 599
4.1. Definition of attenuation	599
4.2. Techniques for insertion loss or attenuation measurements	599
4.3. Self-calibrating techniques	600
References	600
5. Noise measurements and standards	B. M. Oliver 601
References	601
6. Field strength measurements	M. C. Selby 603
References	603
7. Measurements of physical quantities by radio techniques	M. C. Thompson, Jr. 605
References	605
Commission 2. Tropospheric Radio Propagation:	
National Committee Report	607
1. Physical characteristics of the troposphere	607
1.1. Synoptic scale	607
1.2. Refractive irregularities	608
1.3. Absorption in the troposphere	609
2. Tropospheric propagation (theories)	612
2.1. Ground wave propagation	612
2.2. Back scattering from rough surfaces	612
2.3. Theory of propagation through a stratified atmosphere	613
2.4. Line-of-sight scintillation	613
2.5. Scatter propagation	614
a. Layers	614
b. Blobs	614
3. Experimental results from investigations of tropospheric propagation	615
3.1. Attenuation with distance	615
Data sources for report and chart	615
3.2. Effects of rough terrain	616
a. Forward scattering	616
b. Backscattering	618
3.3. Angular diversity	618
3.4. Frequency diversity	619
3.5. Diversity improvement	619
3.6. Phase stability	620
4. Radio meteorology	621
4.1. Climatic investigations	621
4.2. Refractometer investigations	621
4.3. Refraction	621
4.4. Radar meteorology	621
5. References	622
Commission 3. Ionospheric Radio Propagation:	
Review of U.S.A. activity, 1957-59	629
1. Structure of the upper atmosphere	629
2. Ionizing radiations	630
3. Electron densities	630
4. Satellite beacon studies	630
5. Ionospheric processes	630
6. Ionospheric disturbances	631
7. Sporadic <i>E</i> and spread <i>F</i>	631
8. Studies of the lower ionosphere	631
9. Radar studies of auroral ionization	631
10. Refraction in the ionosphere	632
11. Ionospheric propagation studies—general	632
12. Ionospheric scatter transmission	632
13. Radio reflection from meteor ionization	632
13.1. The reflection properties of individual trails	632
13.2. Computation and measurement of the gross propagation characteristics of ensembles of trails	632
13.3. The study of ionospheric motions through the use of meteor trails as indicators	633
14. Ionospheric propagation research with communication systems applications	633
14.1. Multipath effects	633
14.2. Fading	633
14.3. Arctic propagation	633
14.4. General	634
References	634

	Page
Commission 4. Radio Noise of Terrestrial Origin:	
Report of U.S. Commission 4, URSI (1957-1960)	637
1. Radiofrequency radiation from lightning discharges	A. Glen Jean 638
2. Properties of atmospheric noise at various receiving locations	William Q. Crichlow 640
3. Summary of research on whistlers and related phenomena	642
3.1. Stanford University	R. A. Helliwell 642
a. Methods of whistler analysis	642
b. IGY-IGC synoptic whistler results	642
c. Whistler sources	643
d. Association between aurorae and VLF hiss observed at Byrd Station, Antarctica	643
e. Duct theory	643
f. Ray path calculations	643
g. Electron density of the outer ionosphere	644
h. Theory of VLF emissions	644
i. Controlled whistler—mode experiments	644
j. Satellite measurements	644
k. Geocyclotron	644
3.2. Dartmouth College	M. G. Morgan 644
a. Whistlers—East	644
(1) Whistlers	645
(2) Ionospherics	645
b. E 4° (Geomagnetic) stations: successor to whistler—East	646
c. Post-IGY results	646
d. E 94° (Geomagnetic) stations	646
e. Angle of arrival measurements	646
f. Acknowledgment	646
4. A summary of VLF and ELF propagation research	James R. Wait 647
4.1. Introduction	647
4.2. Theoretical studies	647
4.3. Experimental studies	648
4.4. Recent applications of VLF propagation	648
5. Hydromagnetic waves and ELF oscillations in the ionosphere	James M. Watts 650
6. The exosphere	James M. Watts 651
6.1. Introduction	651
6.2. Theories of the exosphere	651
a. Magnetic storm effects	651
b. Radiation belt theory	651
c. Composition of the exosphere	651
6.3. Experiments in the exosphere	651
7. References	652
Commission 5. Radio Astronomy:	
Review of developments	655
1. University of Alabama	655
2. Air Force Cambridge Research Center	655
3. U.S. Army Signal Research and Development Laboratory	656
4. California Institute of Technology	656
5. Carnegie Institution of Washington	656
6. Cornell University	657
7. Collins Radio Company	657
8. University of Colorado	658
9. Harvard University	659
10. Hayden Planetarium	659
11. University of Illinois	659
12. U.S. Naval Research Laboratory	660
12.1. Planets:	
Venus	660
Jupiter	661
Mars	661
12.2. Cosmic radio sources	661
12.3. Sun	662
12.4. Moon	663
12.5. Atmospheric attenuation	663
13. The National Aeronautics and Space Administration	663
14. National Bureau of Standards, Boulder Laboratories	664
15. National Radio Astronomy Observatory	664
15.1. The flux density of radiation from Cas A at 1400 Mc/s	664
16. Ohio State University	664
17. Rensselaer Polytechnic Institute	665
18. Stanford University	665
19. Yale University	665
20. University of Michigan	666
20.1. University of Michigan 85-foot radio telescope	666
20.2. Traveling-Wave tube receiver at 8000 Mc/s	666
20.3. Maser radiometer at 8700 Mc/s	666
20.4. Radiometer at 1.8 CM wavelength	666
20.5. Theoretical radio spectrum of Venus	666
References	667

Commission 6. Radio Waves and Circuits:		
Subcommission 6.1. Information Theory:		Page
Part 1. Information theory and coding	P. Elias	671
1. Foundations		671
2. Binary channels		671
3. Sequential decoding		672
4. Conclusions on coding		672
5. Other topics		672
6. References		673
Part 2. Random processes	P. Swerling	674
References		675
Part 3. Pattern recognition	Arthur Gill	676
3.1. Redundancy removal		676
3.2. Recognition programs		676
3.3. Recognition system design		676
References		677
Part 4. Detection theory	Robert Price	678
4.1. Remarks		678
4.2. Papers		678
4.3. Bibliography:		
a. Applications to radar		678
b. Applications to communications		679
c. Sequential decision		679
d. Detection of stochastic signals in noise		679
e. Parameter estimation		679
f. Loss in nonlinear devices		679
g. Attacks on the <i>a priori</i> problem		680
h. Miscellaneous		680
4.4. Books		680
Part 5. Prediction and filtering	L. A. Zadeh	681
5.1. Nonlinear filtering		681
5.2. Filtering and radiation of nonstationary, discrete-time, and mixed processes		683
5.3. Miscellaneous contributions		684
Bibliography		684
Subcommission 6.2. Circuit Theory:		
Circuit theory	Louis Weinberg	687
1. Introduction		687
2. Combinatorial topology or linear graphs		688
2.1. Future research activity and evaluation		689
3. Synthesis by pole-zero techniques		692
3.1. Future research activity		694
4. Realizability conditions and positive real matrices		696
4.1. Future research		696
5. Systems with time-varying and nonlinear reactances		698
6. Active systems		700
6.1. Active RC synthesis		700
6.2. Adaptive systems		701
6.3. Tunnel-diode networks		701
6.4. Future research activity		702
7. Concluding remarks		703
References		704
Subcommission 6.3. Antennas and Waveguides:		
Part 1. Diffraction and scattering	L. B. Felsen and K. M. Siegel	707
1. High-frequency diffraction		707
1.1. Canonical problems		708
1.2. Approximate theories		710
Summary		712
2. Rayleigh scattering		712
3. The resonance region		712
4. Future activities		713
5. References		713
Part 2. On multiple scattering of waves	V. Twersky	715
1. Purpose		715
2. General considerations		715
3. Survey		718
3.1. Fixed configurations of N scatterers		718
3.2. Infinite planar lattices		720
3.3. Planar random distributions		722
a. Sparse distribution (two dimensional "rare gas")		722
b. General statistical distribution		723
3.4. Periodic volume distributions		724
3.5. Random volume distributions		724
References		725
Part 3. Antennas	R. W. Bickmore and R. C. Hansen	731
1. Introduction		731
2. Broadband antennas		731
Bibliography		732

	Page
3. Dynamic antennas.....	733
Bibliography.....	735
4. Large aperture antennas.....	735
References.....	738
5. Small aperture antennas.....	739
References.....	741
A bibliography on coherence theory.....	G. B. Parrent, Jr. 742
Text.....	742
References.....	742
A bibliography of automatic antenna data processing.....	C. J. Drane 743
Text.....	743
References.....	745
Surface and leaky wave antennas.....	F. J. Zucker 746
1. Surface wave antennas.....	746
2. Leaky wave antennas.....	747
3. Assessment and predictions.....	748
References.....	748
Commission 7. Radio Electronics:	
1. Parametric amplifiers.....	P. K. Tien and H. Heffner 751
1.1. General theory and historical development.....	751
1.2. Ferromagnetic amplifier—theory and experiment.....	751
1.3. Diode amplifiers and noise figure measurements.....	752
1.4. Electron beam parametric amplifier—space-charge wave parametric amplifier and Adler's tube.....	753
References.....	753
2. Microwave properties of ferrites.....	P. K. Tien and B. Lax 755
2.1. Finite waveguide components, frequency doubler and mixer, and ferromag- netic amplifiers.....	755
2.2. Linewidth of single crystal yttrium-iron garnet surface imperfections and rare earth impurities.....	755
2.3. Instabilities and magnetostatic modes.....	756
References.....	756
3. Progress in solid-state masers.....	A. Siegman 758
3.1. Cavity-type solid-state masers: experimental results.....	758
3.2. Applications of solid-state masers.....	758
3.3. Solid-state masers: theory and analysis.....	758
3.4. Maser materials.....	759
3.5. Pulsed and two-level masers.....	759
3.6. Traveling-wave masers.....	759
3.7. Noise in masers.....	759
3.8. Infrared and optical masers.....	760
References.....	760
4. Low-noise beam-type microwave tubes.....	L. Smullin 763
4.1. Progress during the past three years.....	763
a. Design of solid-beam, low-noise guns.....	763
b. Theory of noise on beams and low-noise amplifications.....	763
c. Hollow beam low-noise guns.....	763
d. Theory of noise in multiveLOCITY electron beams.....	764
e. Fundamental noise measurements.....	764
f. Electron beam parametric amplifiers.....	764
g. Low-noise klystrons.....	764
References.....	764
5. Interaction between plasmas and electromagnetic fields.....	L. Smullin 766
5.1. Introduction.....	766
5.2. Propagation of electromagnetic waves in unbounded plasmas—small signal theory.....	766
5.3. Plasma waveguides.....	766
5.4. Electron stimulated plasma oscillations.....	766
5.5. Large signal oscillations.....	767
References.....	767
Publications of the staff of the National Bureau of Standards.....	769
Index to volume 64D. Radio Propagation, Jan.—Dec. 1960.....	773

Figures

Commission 2, Tropospheric Radio Propagation	
Figure 1. Attenuation due at one atmosphere.....	610
Figure 2. Water vapor attenuation for 7.5 g/cm.....	611
Figure 3. Beyond horizon transmission.....	616
Figure 4. Theoretical smooth earth curves.....	617
Commission 6, Radio Waves and Circuits	
Subcommission 6.2, Circuit Theory	
Figure 1. Chain of five 1-ohm resistances realizing the given impedance matrix.....	692
Figure 2. Idealized parametric amplifier.....	699
Figure 3. Possible form for realization of any active transfer function.....	700
Figure 4. Representation of an active driving-point function.....	700
Figure 5. Signal-flow diagram of the classical method of active RC network design.....	700
Figure 6. Network realizing the given RC voltage ratio (values in ohms and farads).....	702