

TECHNICAL PROGRAM

1969 IEEE G-MTT INTERNATIONAL SYMPOSIUM

MAY 5-7, 1969

MARRIOTT MOTOR HOTEL, DALLAS, TEXAS

INTRODUCTORY SESSION

Monday, May 5

8:30 - 9:00

WELCOMING REMARKS

J. C. Sadler, Co-Chairman, Steering Committee, 1969 IEEE G-MTT
International Symposium

KEYNOTE ADDRESS

Leo Young, Chairman, G-MTT National Administration Committee

SESSION MAM – I

MICROWAVE INTEGRATED CIRCUITS I

Monday, May 5

Chairman: B. T. Vincent
Electro/Data, Incorporated
Dallas, Texas

I-1	WAVE PROPAGATION IN MICROSTRIP-TRANSMISSION LINES,	
9:10	G. I. Zysman and D. Varon, Bell Telephone Laboratories, Whippany, New Jersey	3
I-2	INTERDIGITATED STRIP-LINE QUADRATURE HYBRID,	
9:30	Julius Lange, Texas Instruments, Dallas, Texas	10
I-3	FILTERING, FREQUENCY MULTIPLEXING, AND OTHER	
9:50	MICROWAVE APPLICATIONS WITH INVERTED-COMMON-COLLECTOR TRANSISTOR CIRCUITS, David K. Adams and Raymond Y. C. Ho, Stanford Research Institute, Menlo Park, California	14
10:10	Coffee Break	
I-4	A 3:1 BANDWIDTH LOW-NOISE MICROWAVE MIXER,	
10:40	Ronald E. Blight, Microwave Associates, Inc., Burlington, Massachusetts	21
I-5	A HYBRID INTEGRATED L-BAND DIGITAL PHASE	
11:00	SHIFTER, R. F. Lee and K. F. Sodomsky, Bell Telephone Laboratories, Reading, Pennsylvania	26
I-6	A 4 GHz MULTI-STAGE TRANSISTOR AMPLIFIER,	
11:20	Kazuo Ayaki, Eiichi Igarashi and Yuji Kajiwara, Nippon Electric Company, Kawasaki, Japan	31

SESSION MAM – II PRECISION MEASUREMENTS AND COMPONENTS Monday, May 5

Chairman: R. W. Beatty
National Bureau of Standards
Boulder, Colorado

II-1	MEASUREMENTS ON THE PROPERTIES OF MICROWAVE	
9:10	INTEGRATED CIRCUITS, M. Caulton, B. Hershenov and L. S. Napoli, RCA Laboratories, Princeton, New Jersey, and S. P. Knight, RCA Astro-Electronic Div., Hightstown, New Jersey	38
II-2	DEPENDENCE OF STRIPLINE PERFORMANCE ON DIELECTRIC	
9:30	PROPERTIES AND PACKAGING TECHNIQUES, J. H. Ball, Murray Olyphant, Jr., and L. K. Van Dover, 3M Company, St. Paul, Minnesota.	45
II-3	TECHNIQUES FOR DETERMINING THE MICROWAVE PROPERTIES	
9:50	OF THERMALLY DEGRADED SPACECRAFT HEAT SHIELD MATERIALS, M. C. Gilreath, W. F. Croswell and J. Earl Jones, NASA, Langley Research Center, Hampton, Virginia	53
10:10	Coffee Break	
II-4	THE ROTARY SLOT ATTENUATOR	
10:30	Franklin S. Coale, Electronic Resources, Inc., William L. Wallick, Microwave Division, Systron-Donner	59
II-5	NANOSECOND MEASUREMENT OF MICROWAVE REFLECTION	
10:50	COEFFICIENTS AND PROPERTIES OF MATERIALS, Ronald S. Hawke, Lawrence Radiation Laboratory, University of California, Livermore, California	68
II-6	COMPUTER-AIDED MICROWAVE IMPEDANCE MEASUREMENTS,	
11:10	James E. Dalley, Bell Telephone Laboratories, Reading, Pennsylvania	70

► **SESSION MPM – I FERRITE COMPONENTS Monday, May 5**

Chairman: J. E. Pippin
Electromagnetic Sciences, Inc.
Atlanta, Georgia

I-1	FOUR-PORT YIG FILTER, John C. Hoover, and Robert E. Tokheim,	
1:30	Watkins-Johnson Company, Palo Alto, California	77
I-2	VHF- AND UHF-BAND STACKED-JUNCTION CIRCULATORS,	
1:50	S. Okamura and T. Nagai, Tokyo Shibaura Electric Company, Ltd., Kawasaki, Japan	83
I-3	A LOW-COST LATCHING FERRITE PHASER FABRICATION	
2:10	TECHNIQUE, D. H. Temme, Lincoln Laboratory, Massachusetts Inst. of Technology, Lexington, Massachusetts, and R. L. Hunt, R. G. West and A. C. Blankenship, Trans-Tech, Inc., Gaithersburg, Maryland	88
I-4	REVIEW OF PLANAR FERRITE DEVICES, G. P.	
2:30	Rodrigue, Georgia Institute of Technology, Atlanta, Georgia (Invited)	97

3:00	Coffee Break	
I-5	MEASUREMENT OF SLOT-LINE CHARACTERISTICS,	
3:30	E. Mariani, C. Heinzman, and J. Agrios, U.S. Army Electronics Command, Fort Monmouth, New Jersey, and S. B. Cohn, Consultant, Tarzana, California	99
I-6	APPLICATION OF SLOT LINE TO MINIATURE	
3:50	DEVICES, G. H. Robinson and J. L. Allen, Sperry Rand Corp., Clearwater, Florida	106
I-7	COPLANAR WAVEGUIDE, A SURFACE STRIP	
4:10	TRANSMISSION LINE SUITABLE FOR NONRECIPROCAL GYROMAGNETIC DEVICE APPLICATIONS, Cheng P. Wen, RCA Laboratories, Princeton, New Jersey	110
I-8	A THIN FILM LUMPED ELEMENT CIRCULATOR,	
4:30	R. H. Knerr, Bell Telephone Laboratories Allentown, Pennsylvania	116
I-9	AN INVESTIGATION OF SIX-PORT PHASE-TYPE	
4:50	CIRCULATORS AND SWITCHES, A. I. Gherm, Yu. P. Kasianov, N. V. Slavin, Radio Industry Ministry of the USSR, Moscow, U. S. S. R.	122

SESSION MPM – II SOLID-STATE CIRCUITS AND DEVICES Monday, May 5

Chairman: F. K. Clark
Continental Electronics Mfg. Co., LTV
Dallas, Texas

II-1	A NEW TECHNIQUE FOR DESIGNING HIGHLY	
1:30	STABLE HIGH EFFICIENCY VARACTOR MULTIPLIER CHAINS, A. I. Grayzel and R. Minkoff, NASA, Electronics Research Center, Cambridge, Massachusetts	131
II-2	THE DESIGN OF BROADBAND FREQUENCY DOUBLERS	
1:50	USING CHARGE-STORAGE DIODES, K. L. Kotzebue and G. L. Matthaei, University of California, Santa Barbara, California	136
II-3	A STUDY OF HIGH POWER PULSED LSA GaAs DEVICES,	
2:10	Bert I. Jeppsson, Cayuga Associates, Inc., Ithaca, New York	143
2:30	Coffee Break	
II-4	AN ALL-TRANSISTOR, 1-KILOWATT, HIGH-GAIN	
3:00	UHF POWER AMPLIFIER, R. L. Bailey, W. P. Bennett, L. F. Heckman, and I. E. Martin, RCA, Lancaster, Pennsylvania	149
II-5	A TEN MEGAWATT RADAR DUPLEXER, J. J. Wormser,	
3:20	Continental Electronics Company, LTV, Dallas, Texas	154

PANEL DISCUSSIONS

SESSION MEV — I	MICROWAVE ENERGY APPLICATIONS, NON-COMMUNICATION	Monday, May 5
Organizer:	M. C. Horton Bendix Research Laboratories Southfield, Michigan	
Chairman:	W. A. Geoffrey Voss University of Alberta Alberta, Canada	160
SESSION MEV — II	TECHNIQUES FOR FABRICATION AND PRODUCTION OF MICROWAVE INTEGRATED CIRCUITS	Monday, May 5
Organizer:	B. T. Vincent Electro/Data Dallas, Texas	
Chairman:	J. B. LaGrange Air Force Avionics Laboratory Wright-Patterson AFB, Dayton, Ohio	160
SESSION MEV — III	NOISE IN SOLID-STATE DEVICES AND SYSTEMS	Monday, May 5
Organizer:	K. E. Gsteiger Sperry Rand Corporation Clearwater, Florida	
Chairman:	J. R. Ashley University of Colorado Colorado Springs, Colorado	161
SESSION TAM — I	GUNN EFFECT DEVICES	Tuesday, May 6
	Chairman: R. D. Hall Hewlett-Packard Company Palo Alto, California	
I-1 8:30	A REVIEW OF THE STATE-OF-THE-ART ON GUNN AND LSA DEVICES, L. F. Eastman, Cornell University, Ithaca, New York (Invited)	163
I-2 9:00	THEORETICAL AND EXPERIMENTAL STUDY OF THE QUENCHED-DOMAIN MODE GUNN-EFFECT OSCILLATOR, D. D. Khandelwal and W. R. Curtice, The University of Michigan, Ann Arbor, Michigan	170
I-3 9:20	THE YIG-TUNED GUNN OSCILLATOR, ITS POTENTIALS AND PROBLEMS, Masahiro Omori, Varian Associates, Palo Alto, California	176

I-4	THE EFFECT OF TEMPERATURE ON LSA OSCILLATIONS	
9:40	BETWEEN 26-40 GHz, S. E. Gibbs, Royal Radar Establishment, Malvern, Worcs, England	182
10:00	Coffee Break	
I-5	CW GUNN DIODES IN COMPOSITE STRUCTURE,	
10:30	Shigeru Mitsui and Akihiro Kondo, Mitsubishi Electric Corporation, Itami-City, Japan	191
I-6	X-BAND DISTRIBUTED ARRAY GUNN EFFECT	
10:50	TRANSMITTER, M. S. Stringfellow, G. Bednar, F. J. Rosenbaum and K. L. Horn, Emerson Electric Co., St. Louis, Missouri	196
I-7	AMPLITUDE AND FREQUENCY MODULATION OF	
11:10	CW GUNN OSCILLATORS, W. C. Tsai and F. J. Rosenbaum, Washington University, St. Louis, Missouri	203

SESSION TAM – II

MILLIMETER WAVE COMPONENTS

Tuesday, May 6

Chairman: D. D. King
North American Philips Co., Inc.
Briarcliff Manor, New York

II-1	DETECTION OF MILLIMETER-TO-INFRARED RADIATION,	
8:30	F. R. Arams, Airborne Instruments Laboratory, Melville, New York (Invited)	210
II-2	HIGH FREQUENCY LIGHT MODULATORS,	
9:00	Ivan P. Kaminow, Bell Telephone Laboratories, Holmdel, New Jersey (Invited)	211
II-3	INFRARED PARAMETRIC AMPLIFICATION USING	
9:30	A QUASI-MICROWAVE APPROACH TO PHASE- MATCHING, D. B. Anderson and J. D. McMullen, Autonetics, Anaheim, California	212
II-4	MILLIMETER- AND SUBMILLIMETER-WAVE	
9:50	DETECTION BY PARAMAGNETIC MATERIALS, C. F. Krumm and G. I. Haddad, The University of Michigan, Ann Arbor, Michigan	217
10:10	Coffee Break	
II-5	RECENT DEVELOPMENTS IN MILLIMETER WAVE	
10:30	COMPONENTS, M. Cohn, L. E. Dickens, Westinghouse Electric Corporation Baltimore, Maryland, and J. W. Dozier, ADTEC Laboratories of Beckman Instruments, Inc., Timonium, Maryland	225
II-6	A NEW MILLIMETER-WAVE BAND-SPLITTING FILTER	
10:50	USING FIGURE-8 HYBRIDS, Sadakuni Shimada, Nobuo Suzuki and Isao Ootomo, Nippon Telegraph and Telephone Public Corporation, Tokyo, Japan	232

II-7	QUASI-OPTICAL LOW-PASS FILTERS WHICH ATTENUATE	
11:10	BY ABSORPTION, G. L. Matthaei and D. A. Leedom, University of California, Santa Barbara, California	238
II-8	A PERTURBATION THEORY FOR DIELECTRIC AND	
11:30	OPTICAL WAVEGUIDES WITH APPLICATION TO THE LAUNCHING OF SURFACE MODES, Allan W. Snyder, University College London, London, England	243

SESSION TPM – I

AVALANCHE DIODES

Tuesday, May 6

Chairman: G. I. Haddad
University of Michigan
Ann Arbor, Michigan

I-1	CIRCUITS FOR HIGH EFFICIENCY AVALANCHE	
1:30	DIODE OSCILLATORS, W. J. Evans, Bell Telephone Laboratories, Murray Hill, New Jersey (Invited)	250
I-2	HIGH-EFFICIENCY AVALANCHE RESONANCE	
2:00	PUMPED AMPLIFICATION, B. Hoefflinger, C. P. Snapp and L. A. Stark, Cornell University, Ithaca, New York	255
I-3	MICROSTRIP HIGH-POWER L-BAND AVALANCHE-DIODE	
2:20	OSCILLATOR, S. G. Liu, RCA Laboratories, Princeton, New Jersey	261
I-4	A ONE WATT CW AVALANCHE DIODE SOURCE	
2:40	OR POWER AMPLIFIER, John J. Sie and William J. Crowe, Micro State Electronics Operation of Raytheon Company, Murray Hill, New Jersey	266
3:00	Coffee Break	
I-5	COMPUTER-AIDED SMALL-SIGNAL CHARACTERIZATION	
3:30	OF IMPATT DIODES, C. N. Dunn and J. E. Dalley, Bell Telephone Laboratories, Reading, Pennsylvania	273
I-6	X-BAND SOLID STATE OSCILLATOR AND MIXER,	
3:50	W. B. Day and W. M. Jones, Sperry Rand Corporation, Clearwater, Florida	278
I-7	BROADBAND NEGATIVE RESISTANCE OSCILLATOR	
4:10	CIRCUITS, K. Kurokawa, J. P. Beccone and N. D. Kenyon, Bell Telephone Laboratories, Murray Hill, New Jersey	281

SESSION TPM – II

PASSIVE COMPONENTS

Tuesday, May 6

Chairman: S. B. Cohn, Consultant
Tarzana, California

II-1	SYNTHESIS OF HIGH-POWER REJECTION WAVEGUIDE	
1:30	FILTERS, R. Levy, Microwave Development Laboratories, Needham Heights, Massachusetts	286

II-2 1:50	PREDISTORTED WAVEGUIDE FILTERS FOR USE IN COMMUNICATIONS SYSTEMS, Robert Livingston, Collins Radio Company, Dallas, Texas	291
II-3 2:10	NARROW BANDWIDTH ELLIPTIC-FUNCTION FILTERS, I. Rubinstein, R. L. Slevin and A. F. Hinte, Airborne Instruments Laboratory, Deer Park, New York	298
II-4 2:30	THE STEPPED CAVITY COUPLED ELLIPTIC FILTER, J. D. Rhodes, Microwave Development Laboratories, Inc., Needham Heights, Massachusetts	304
2:50	Coffee Break	
II-5 3 20	DESIGN OF COMMENSURATE TRANSMISSION LINE CIRCUITS, William Steenaart and R. Jay Murphy, Rensselaer Polytechnic Institute, Troy, New York	310
II-6 3:40	SOME MAGIC TEES WITH 2 TO 3 OCTAVES BANDWIDTH, Allen F. Podell, Adams-Russell Company, Inc., Waltham, Massachusetts	317
II-7 4:00	AN ASYMMETRIC NON-MONOTONIC STRIPLINE MAGIC-T, Earl W. Carpenter, Radiation Systems, Inc., McLean, Virginia	320
II-8 4:20	THE EVEN AND ODD MODE CAPACITANCE PARAMETERS FOR COUPLED LINES IN SUSPENDED SUBSTRATE, J. I. Smith, Bell Telephone Laboratories, Whippany, New Jersey	324
II-9 4:40	COUPLED TRANSMISSION LINE NETWORKS IN AN INHOMOGENEOUS DIELECTRIC MEDIUM, A. K. Johnson and G. I. Zysman, Bell Telephone Laboratories, Whippany, New Jersey	329

SYMPOSIUM BANQUET

Tuesday Evening, May 6

7:00 - 10:00 p.m.

**Master of Ceremonies: Dr. Irvin H. Solt, Jr.,
Fairchild Microwave Products
Mountain View, California**

**1968 IEEE G-MTT Microwave Prize
Dr. William F. Gabriel, Delex Systems
Incorporated, McLean, Virginia**

Banquet Speaker

**B. F. "Sandy" Coggan, North American Rockwell Corporation,
E. Segundo, California**

"APOLLO AND BEYOND"

Chairman: G. P. Rodrigue
Georgia Institute of Technology
Atlanta, Georgia

I-1	ACOUSTIC WAVE ANALYSIS USING MICROWAVE	
8:30	CONCEPTS, B. A. Auld, Stanford University, Stanford, California (Invited)	339
I-2	A REVIEW OF THE STATE-OF-THE-ART ON SURFACE	
8:55	ACOUSTIC WAVE TECHNOLOGY, Ernest Stern, Lincoln Laboratory, MIT, Lexington, Massachusetts (Invited)	347
I-3	ACOUSTIC SURFACE WAVES AND RAYLEIGH-	
9:20	TYPE SPIN WAVES AT MICROWAVE FREQUENCIES, P. H. Carr, A. J. Slobodnik, Jr., and J. C. Sethares, Office of Aerospace Research, L. G. Hanscom Field, Bedford, Massachusetts	354
9:40	Coffee Break	
I-4	ROOM TEMPERATURE ELECTRON PARAMAGNETIC	
10:10	RESONANCE (EPR) SIGNAL STORAGE, D. A. Bozanic, D. C. Buck, F. H. Harris, R. E. Huber, D. Mergerian, R. W. Minarik, Westinghouse Electric Corporation, Baltimore, Maryland	359
I-5	ACTIVE IMPEDANCE MATCHING FOR MICROWAVE	
10:30	ACOUSTIC DELAY LINES, R. Y. C. Ho and A. J. Bahr, Stanford Research Institute, Menlo Park, California	366
I-6	LASER-ACOUSTIC MICROWAVE SIGNAL	
10:55	PROCESSING, H. A. Heynau and M. J. Brienza, United Aircraft Research Laboratories, East Hartford, Connecticut	371
I-7	PROPAGATING MAGNETIC WAVES IN EPITAXIAL	
11:15	YIG, W. L. Bongianni, J. H. Collins, F. A. Pizzarello, Autonetics, Anaheim, California	376

SESSION WAM – II COMPUTER-ORIENTED MICROWAVE TECHNIQUES Wednesday, May 7

Chairman: W. J. Getsinger
Lincoln Laboratories, MIT
Lexington, Massachusetts

II-1	OPTIMIZATION OF MICROWAVE NETWORKS BY	
8:30	RAZOR SEARCH, J. W. Bandler and P. A. Macdonald, University of Manitoba, Winnipeg, Canada	382
II-2	DOMINANT POLE SYNTHESIS OF TRANSMISSION	
8:50	LINE NETWORKS, Solaimanul Mahdi and Alan B. Macnee, The University of Michigan, Ann Arbor, Michigan	388

II-3	COMPUTER-AIDED DESIGN OF BROADBAND AND LOW NOISE MICROWAVE AMPLIFIERS, T. W. Houston and L. W. Read, Texas Instruments, Dallas, Texas	392
II-4	COMPUTER-AIDED DESIGN OF 3-PORT WAVEGUIDE JUNCTION CIRCULATORS, J. B. Castillo and L. E. Davis, Rice University, Houston, Texas	397
9:50	Coffee Break	
II-5	NEW DIRECTIONS IN COMPUTER FIELD ANALYSIS, A. Wexler, University of Manitoba, Winnipeg, Canada (Invited)	402
II-6	A COMPARISON OF TWO NUMERICAL COMPUTER METHODS FOR SOLVING TEM FIELD PROBLEMS, E. G. Cristal, Stanford Research Institute, Menlo Park, California	403
II-7	INTERMODAL COUPLING AT THE JUNCTION BETWEEN A STRAIGHT AND A CONTINUOUSLY CURVED WAVEGUIDE OF RECTANGULAR CROSS SECTION, C. P. Bates, Bell Telephone Laboratories, Whippany, New Jersey	406
II-8	COMPUTER-AIDED SOLUTION OF VECTOR FIELD BOUNDARY VALUE PROBLEMS IN THREE DIMENSIONS, G. K. Cambrell, Monash University, Australia	411

SESSION WPM – I MICROWAVE INTEGRATED CIRCUITS II Wednesday, May 7

Chairman: Harold Sobol
Radio Corporation of America
Somerville, New Jersey

I-1	INTEGRATED S-BAND PARAMETRIC AMPLIFIER, Robert S. Forman, American Electronic Laboratories, Inc., Colmar, Pennsylvania	419
I-2	INTEGRATED PARAMETRIC AMPLIFIERS WITH IMPATT DIODE PUMPING, P. Bura, S. Yuan, W. Y. Pan, RCA, Princeton, New Jersey	426
I-3	A 1.8 TO 4.2 GHz YIG TUNED TRANSISTOR OSCILLATOR WITH A WIDEBAND BUFFER AMPLIFIER, John J. Dupre, Hewlett-Packard Company, Palo Alto, California	432
2:30	Coffee Break	
I-4	A HYBRID INTEGRATED TRANSISTOR AMPLIFIER FOR HIGH-VOLUME PRODUCTION, M. M. Hower and K. F. Sodomsy, Bell Telephone Laboratories, Reading, Pennsylvania	439

I-5	200 WATT SOLID STATE UHF AMPLIFIER,	
3:20	David Staiman and Maurice Breese, Radio Corporation of America, Moorestown, New Jersey	445
I-6	A HYBRID INTEGRATED CIRCUIT MICROWAVE	
3:40	TELEMETRY TRANSMITTER AND COMMAND RECEIVER, J. C. Pinac and B. S. Skinner, Jr., Texas Instruments, Dallas, Texas	450

SESSION WPM – II	MILLIMETER WAVE SYSTEMS	Wednesday, May 7
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Chairman: J. C. Wiltse
Martin Marietta Corporation
Orlando, Florida

II-1	COMPARISON OF THEORETICAL AND EXPERIMENTAL	
2:30	VALUES OF PHASE CONSTANT FOR DIPOLE MODE SURFACE WAVE PROPAGATION IN OPEN GYRO-MAGNETIC FERRITE ROD, F. R. Seyfried and J. S. Lee, The George Washington University, Washington, D. C.	459
II-2	OPTICAL DISPLAY OF MILLIMETER-WAVELENGTH	
1:50	RADIOMETRIC MAPS WITH GOOD SPATIAL, TEMPORAL, AND TEMPERATURE RESOLUTIONS, F. I. Shimabukuro, Aerospace Corporation, El Segundo, California	467
II-3	NEAR EARTH MILLIMETER WAVE RADAR AND	
2:10	RADIOMETRY, Kenneth A. Richer, U. S. Army Ballistic Research Laboratories, Aberdeen Proving Ground, Maryland	470
2:30	Coffee Break	
II-4	A 94-GHz RADAR FOR SPACE OBJECT IDENTIFICATION,	
3:00	L. A. Hoffman, H. J. Wintroub, K. H. Hurlbut, and D. E. Kind, The Aerospace Corporation, El Segundo, California	475
II-5	MILLIMETER-WAVE SYSTEMS APPLICATIONS,	
3:20	W. O. Copeland, J. R. Ashwell, G. P. Kefalas, and J. C. Wiltse, Martin Marietta Corp., Orlando, Florida	485
II-6	MILLIMETER WAVE RADAR INVESTIGATIONS,	
3:40	Marvin J. Foral, NADC, Johnsville, Warminster, Pennsylvania	489