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Unabridged List Of Publications

Updated September 28, 2023

FREDERICK H. RAAB, THESES

[1] F. H. Raab, "Binary data compression using characteristic vectors," M.S. Thesis, Iowa State University, Ames, 1970.

[2] F. H. Raab, "Carrier generation using pulsewidth modulation," Ph.D. Dissertation, Iowa State University, Ames, 1972.

FREDERICK H. RAAB, PAPERS

[1] F. H. Raab, "Binary data compression by linear transformation," *Computer Graphics and Image Processing*, vol. 2, no. 1, pp. 12 - 21, Aug. 1973. [TP70-4]

[2] F. H. Raab, "Radio frequency pulsewidth modulation," *IEEE Trans. Commun.*, vol. COM-21, no. 8, pp. 958 - 966, Aug. 1973. [TP72-1]

[3] F. H. Raab, "High efficiency RF power amplifiers," *Ham Radio*, vol. 7, no. 10, pp. 8 - 29, Oct. 1974. [TP73-1]

[4] F. H. Raab, "A simple preprocessor for narrowband omega retransmission," *Proc. Int. Telemetering Conf.*, vol. 10, pp. 252 - 259, Los Angeles, CA, Oct. 15-17, 1974. [TP74-2]

[5] F. H. Raab, "High efficiency amplification techniques," *IEEE Circuits and Syst.* (Newsletter), vol. 7, no. 10, pp. 3 - 11, Dec. 1975. [TP75-6]

[6] F. H. Raab, "VTOL landing aid using low-frequency near-field techniques," *Proc. Inst. Navigation National Aerospace Symp.*, Warminster, PA, pp. 109 - 116, April 27 - 28, 1976. [TP76-2]

[7] F. H. Raab, "FET power amplifier boosts transmitter efficiency," *Electronics*, vol. 49, no. 12, pp. 122 - 126, June 10, 1976. [TP75-1] Russian translation in *Elektronika*, no. 12, pp. 57 – 63, 1976.

[8] F. H. Raab, "The average efficiency of RF power amplifiers...," *Electronic Design*, vol. 24, no. 14, pp. 52 - 54, July 5, 1976. [TP75-5]

[9] F. H. Raab, "High efficiency amplification techniques," *Nikkei Electronics* (Japanese), no. 44, pp. 121 - 146, Aug. 23, 1976. [TP75-6]

[10] C. W. Mosher, M. Abrams, J. C. Murdock, W. L. Polhemus, and F. H. Raab, "Loran-C conceptual analysis," *Proc. Fifth Annual Wild Goose Assoc. Convention*, Washington, D.C., pp. 23 - 32, Oct. 27 - 29, 1976. [TP76-6]

[11] F. H. Raab, G. W. Board, S. D. Arling, J. D. Dobbs, S. C. Smrdel, and J. R. Waechter, "An application of the global positioning system to search and rescue and remote tracking," *Proc. Inst. Navigation National Marine Meeting*, San Diego, CA, pp. 65 - 73, Nov. 4-5, 1976. [TP75-2]

[12] N. O. Sokal and F. H. Raab, "Harmonic output of class E RF power amplifiers and load coupling network design," *IEEE J. Solid State Circuits*, vol. SC-12, no. 1, pp. 86 - 88, Feb. 1977. [TP76-3]

[13] F. H. Raab, "The class BD high-efficiency RF power amplifier," *IEEE J. Solid State Circuits*, vol. SC-12, no. 3, pp. 291 - 298, June 1977. [TP75-8]

[14] F. H. Raab, "Omega ambiguity resolution techniques," Presented at *The Inst. Navigation Annual Meeting*, Costa Mesa, CA, June 22-24, 1977. [TP75-9]

[15] F. H. Raab and J. R. Waechter, "The counting phase detector with VLF atmospheric noise," *IEEE Trans. Aerosp. and Electronic Sys. Mag.*, vol. 13, no. 5, pp. 522 - 532, Sept. 1977. [TP75-7]

[16] F. H. Raab, G. W. Board, S. D. Arling, J. D. Dobbs, S. C. Smrdel, and J. R. Waechter, "An application of the global positioning system to search and rescue and remote tracking," *Navigation*, vol. 24, no. 3, pp. 216 - 228, Fall 1977. [TP77-1]

[17] F. H. Raab, "Search and rescue using navaid retransmission," *Proc. Inst. Navigation National Marine Meeting*, Linthicum Heights, MA, pp. 25 - 34, Oct. 31 - Nov. 1, 1977. [TP76-1]

[18] F. H. Raab, "Idealized operation of the class E tuned power amplifier," *IEEE Trans. Circuits and Syst.*, vol. CAS-24, no. 12, pp. 725 - 735, Dec. 1977. [TP75-3]

[19] F. H. Raab, "Effects of circuit variations on the class E tuned power amplifier," *IEEE J. Solid State Circuits*, vol. SC-13, no. 2, pp. 239 - 247, April 1978. [TP75-4]

[20] F. H. Raab and R. G. Olsen, "Detection of Loran-C anomalies caused by man-made structures," *Proc. Seventh Annual Tech. Symp. of the Wild Goose Assoc.*, New Orleans, LA, pp. 144 - 149, Oct. 18-20, 1978. [TP78-5]

[21] F. H. Raab, "Get broadband, dual-mode operation with this FET power amplifier," *EDN*, vol. 23, no. 19, pp. 117 - 124, Oct. 20, 1978. [TP78-7]

[22] F. H. Raab, "MOSFET power amplifier for operation from 160 through 6 meters," *Ham Radio*, vol. 11, no. 11, pp. 12 - 17, Nov. 1978. [TP78-8]

[23] F. H. Raab and N. O. Sokal, "Transistor power losses in the class E tuned power amplifier," *IEEE J. Solid State Circuits*, vol. SC-13, no. 6, pp. 912 - 914, Dec. 1978. [TP76-5]

[24] F. H. Raab, "Omega ambiguity resolution techniques," *Navigation*, vol. 25, no. 4, pp. 371 - 384, Winter 1978-1979. [TP78-6]

[25] F. H. Raab, E. B. Blood, T. O. Steiner, and H. R. Jones, "Magnetic position and orientation tracking system," *IEEE Trans. Aerosp. and Electronic Sys.*, vol. AES-15, no. 5, pp. 709 - 718, Sept. 1979. [TP77-5]

[26] F. H. Raab, "Squarewave correlation phase detector with VLF atmospheric noise," *IEEE Trans. Aerosp. and Electronic Sys.*, vol. AES-15, no. 5, pp. 726 - 732, Sept. 1979. [TP78-9]

[27] J. Kroenert and F. H. Raab, "Comments on squarewave correlation phase detector with atmospheric noise," *IEEE Trans. Aerosp. and Electronics Sys.*, vol. AES-16, no. 6, pp. 855 - 858, Nov. 1980. [TP80-2]

[28] F. H. Raab, "Low-frequency correlation phase detectors using hard limiting," *IEEE Trans. Aerosp. and Electronics Sys.*, vol. AES-7, no. 2, pp. 305 - 311, March 1981. [TP79-5]

[29] F. H. Raab, "A ciphering technique," *Creative Computing*, vol. 7, no. 4, pp. 116 - 124, April 1981. [TP79-1]

[30] J. T. Scully, Jr., P. K. Hansen, and F. H. Raab, "Demonstration of the SPA-SYN-COM communication and control aid concept," *Proc. Fourth Int. Conf. on Rehabilitation Engineering*, Washington, D.C., pp. 125 - 127, Aug. 30 - Sept. 3, 1981. [TP81-1]

[31] F. H. Raab, "Quasi-static magnetic-field technique for determining position and orientation," *IEEE Trans. Geoscience and Remote Sensing*, vol. GE-19, no. 4, pp. 235 - 243, Oct. 1981. [TP78-10]

[32] F. H. Raab and P. K. Hansen, "Electromagnetic system for subsurface position measurement," *Proc. IEEE Industry Appl. Soc. Annual Meeting*, Philadelphia, PA, pp. 111 - 118, Oct. 5 - 9, 1981. [TP80-3]

[33] F. H. Raab, "Spread-spectrum Loran (Loran-E)," *Proc. Eleventh Annual Tech. Symp. of the Wild Goose Assoc.*, Washington, DC, pp. 7 - 14, Oct. 13 - 15, 1982. [TP82-1]

[34] F. H. Raab, "Bandwidth conversion of ELF noise parameters," *IEEE Trans. Commun.*, vol. COM-32, no. 2, pp. 209 - 211, Feb. 1984. [TP82-2]

[35] F. H. Raab, "Signal processing for through-the-earth electromagnetic systems," *Proc. IEEE APS / URSI Symp.*, Boston, MA, pp. 125 - 128, June 25 - 29, 1984. [TP83-2]

[36] F. H. Raab, "Signal processing for through-the-earth electromagnetic systems," *Proc. IEEE IAS Annual Meeting*, Chicago, IL, pp. 86 - 89, Sept. 1984. (Second-Prize-Paper Award, Mining Industry Committee, March, 1986.) [TP84-1]

[37] F. H. Raab, "Alternative power-line proximity-warning techniques," *Proc. IEEE IAS Annual Meeting*, Chicago, IL, pp. 96 - 99, Sept. 1984. [TP81-2]

[38] F. H. Raab, "Class-D power-amplifier load impedance for maximum efficiency," *Proc. RF Technology Expo*, Anaheim, CA, pp. 287 - 295, Jan. 23 - 25, 1985. [TP80-5]

[39] F. H. Raab, "Efficiency of outphasing power-amplifier systems," *IEEE Trans. Commun.*, vol. COM-33, no. 10, pp. 1094 - 1099, Oct. 1985. [TP84-2]

[40] F. H. Raab, "Average efficiency of power amplifiers," *Proc. RF Technology Expo '86*, Anaheim, CA, pp. 474 - 486, Jan. 30 - Feb. 1, 1986. [TP85-1]

[41] F. H. Raab, "Average efficiency of Class-G power amplifiers," *IEEE Trans. Consumer Electronics*, vol. CE-32, no. 2, pp. 145 - 150, May 1986. [TP85-2]

[42] F. H. Raab and C. C. Brewster, "Software package for predicting the performance of VLF-navigation systems," *Proc. Forty-second Annual Meeting ION*, Seattle, WA, pp. 32 - 40, June 24 - 26, 1986. [TP85-6]

[43] F. H. Raab and C. C. Brewster, "Coverage predictions and radiated-power requirements for new Canadian VLF-navigation transmitters," *Proc. Eleventh Annual Meeting of the Int. OMEGA Assoc.*, Quebec City, Canada, pp. 6-1 - 6-8, Aug. 5 - 8, 1986. [TP85-7]

[44] S. W. Kershner, V. I. Weihe, F. H. Reder, and F. H. Raab, "VLF-navigation system to supplement OMEGA coverage in Canada," *Proc. Eleventh Annual Meeting of the Int. OMEGA Assoc.*, Quebec City, Canada, pp. 5-1 - 5-4, Aug. 5 - 8, 1986. [TP85-8]

[45] F. H. Raab, "Efficiency of envelope-tracking RF power-amplifier systems," *Proc. RF Expo East '86*, Boston, MA, pp. 303 - 311, Nov. 10 - 12, 1986. [TP85-3]

[46] F. H. Raab, "Efficiency of Doherty RF-power amplifier systems," *IEEE Trans. Broadcasting*, vol. BC-33, no. 3, pp. 77 - 83, Sept. 1987. [TP85-4]

[47] F. H. Raab, "Envelope-elimination-and-restoration system concepts," *Proc. RF Expo East '87*, Boston, MA, pp. 167 - 177, Nov. 11 - 13, 1987. [TP86-1]

[48] F. H. Raab, "Envelope-elimination-and-restoration system requirements," *Proc. RF Technology Expo '88*, Anaheim, CA, pp. 499 - 512, Feb. 10 - 12,1988. [TP87-4]

[49] F. H. Raab, "Signal processing for through-the-earth electromagnetic systems," *IEEE Trans. Industry Appl.*, vol. 24, no. 2, pp. 212 - 216, March/April 1988. [TP87-3]

[50] F. H. Raab, "Effects of VSWR upon the class-E RF-power amplifier," *Proc. RF Expo East '88*, Philadelphia, PA, pp. 299 - 309, Oct. 25 - 27, 1988. [TP88-1]

[51] F. H. Raab, "Suboptimum operation of class-E RF power amplifiers," *Proc. RF Technology Expo '89*, Santa Clara, CA, pp. 85 - 98, Feb. 14 - 16, 1989. [TP88-5]

[52] F. H. Raab, "Radio transmitter," in *McGraw-Hill Yearbook of Science & Technology 1990* by S. B. Parker, ed. New York: McGraw-Hill, 1989. [TP88-4]

[53] F. H. Raab, "Radio transmitters," *Encyclopedia of Science and Technology*, Seventh Edition, by S. B. Parker, ed. New York: McGraw-Hill, 1992. [TP89-1]

[54] F. H. Raab and D. J. Rupp, "Quasi-complementary class-D HF power amplifier," *RF Design*, vol. 15. no. 9, pp. 103 - 110, Sept. 1992. [TP92-1]

[55] F. H. Raab and D. J. Rupp, "Quasi-complementary class-D HF power amplifier," *Proc. RF Expo East '92*, Tampa, FL, pp. 403 - 412, Sept. 22 - 24, 1992. [TP92-3]

[56] F. H. Raab, "Extraction of VLF-noise parameters," *Proc. MILCOM'92*, San Diego, CA, vol. 3, pp. 1040 - 1045, Oct. 11 - 14, 1992. [TP85-5]

[57] F. H. Raab and D. J. Rupp, "HF power amplifier operates in both class B and class D," *Proc. RF Expo West '93*, San Jose, CA, pp. 114 - 124, March 17 - 19, 1993. [TP92-7]

[58] F. H. Raab, "Receiver for through-the-earth communication at VLF," *Proc. Second Int. Symp. on Commun. Theory and Applications*, Ambleside, Lake District, UK, pp. 307 - 311, July 11 - 16, 1993. [TP92-5]

[59] F. H. Raab, "Signal-processing receiver for through-the-earth communication," *Proc. MILCOM'93*, pp. 619 - 623, Boston, MA, Oct. 11 - 14, 1993. [TP92-4]

[60] F. H. Raab and D. J. Rupp, "Class-S high-efficiency amplitude modulator," *RF Design*, vol. 17, no. 5, pp. 70 - 74, May 1994. [TP93-1]

[61] F. H. Raab and D. J. Rupp, "High-efficiency single-sideband HF/VHF transmitter based upon envelope elimination and restoration," *Proc. Sixth Int. Conf. HF Radio Systems and Techniques (HF'94)* (IEE CP 392), York, UK, pp. 21 - 25, July 4 - 7, 1994. [TP94-1]

[62] F. H. Raab and D. J. Rupp, "High-efficiency multimode HF/VHF transmitter for communication and jamming," *Proc. MILCOM'94*, Ft. Monmouth, NJ, pp. 880 - 884, Oct. 2 - 5, 1994. [TP94-3]

[63] F. H. Raab and D. J. Rupp, "High-efficiency amplitude modulator," *Proc. RF Expo East '94*, Orlando, FL, pp. 1 - 9, Nov. 15 - 17, 1994. [TP94-7]

[64] K. Dierberger, L. Max, and F. H. Raab, "Low-cost, high-efficiency 13.56-MHz power amplifier," Presented at RF Expo East '94, Orlando, FL, Nov. 15 - 17, 1994. [TP94-9] Available as Application Note APT9403, Advanced Power Technology, Bend, OR, Nov. 1994. [H-1457]

[65] F. H. Raab, "Receiver for through-the-earth communication at VLF," in *Communications Theory and Applications II* by B. Honary, M. Darnell, and P. Farrell, eds., pp. 317 - 327. Lancaster, UK: HW Communications, 1994. [TP93-4]

[66] K. Dierberger, F. H. Raab, B. McDonald, and L. Max, "High-efficiency power amplifiers for 13.56 ISM and HF communication," *R. F. Design*, vol. 18, no. 5, pp. 28 - 36, May 1995. [TP95-6]

[67] F. H. Raab, "Noise model for low-frequency through-the-earth communication," *Proc. Third Int. Symp. on Commun. Theory and Applications*, Ambleside, Lake District, UK, pp. 411 - 414, July 10 - 14, 1995. [TP95-3]

[68] F. H. Raab and I. R. Joughin, "Signal processing for through-the-earth radio communication," *IEEE Trans. Commun.*, vol. 43, no. 12, pp. 2995 - 3003, Dec. 1995. [TP95-2]

[69] F. H. Raab, "Simple and inexpensive high-efficiency power amplifier for 160 - 40 meters," *Communications Quarterly*, vol. 6, no. 1, pp. 57 - 63, Winter 1996. [TP96-1]

[70] F. H. Raab, "An introduction to class-F power amplifiers," *RF Design*, vol. 19, no. 5, pp. 79 - 84, May 1996; vol. 19, no. 7, p. 14, July 1996. [TP96-2]

[71] F. H. Raab, "Intermodulation distortion in Kahn-technique transmitters," *IEEE Trans. Microwave Theory Tech.*, vol. 44, no. 12, part 1, pp. 2273 - 2278, Dec. 1996. [TP96-3]

[72] F. H. Raab, "Switching transients in class-D RF power amplifiers," *Proc. Seventh Int. Conf. HF Radio Syst. and Techniques (HF'97)*, Nottingham, UK, pp. 190 - 194, July 7 - 10, 1997. [TP97-1]

[73] F. H. Raab, "Class-F power amplifiers with maximally flat waveforms," *IEEE Trans. Microwave Theory Tech.*, vol. 45, no. 11, pp. 2007 - 2012, Nov. 1997. [TP97-2]

[74] F. H. Raab, "Noise model for low-frequency through-the-earth communication," in *Communications Coding and Signal Processing* by B. Honary, M. Darnell, and P. Farrell, eds., pp. 287 - 298. Lancaster, UK: HW Communications, 1996.

[75] F. H. Raab, B. E. Sigmon, R. G. Myers, and R. M. Jackson, "High-efficiency L-band Kahn-technique transmitter," *Int. Microwave Symp. Digest*, vol. 2, Baltimore, MD, pp. 585 - 588, June 7 - 12, 1998. [TP98-1]

[76] F. H. Raab, "Low-cost high-efficiency HF power amplifiers," *Proc. Nordic Shortwave Conf. (HF 98)*, Fårö, Sweden, pp. 2.2.1 - 2.2.10, Aug. 11 - 13, 1998. [TP98-2]

[77] T. Roberts and F. H. Raab, "Class-E power amplifier and digital driver for 160 meters," *Communications Quarterly*, vol. 8, no. 4, pp. 9 - 19, Fall 1998. [TP98-3]

[78] F. H. Raab, "Class-F power amplifiers with reduced conduction angles," *IEEE Trans. Broadcasting*, vol. 44, no. 4, pp. 455 - 459, Dec. 1998. [TP98-4]

[79] F. H. Raab, B. E. Sigmon, R. G. Myers, and R. M. Jackson, "L-band transmitter using Kahn EER technique," *IEEE Trans. Microwave Theory Tech.*, pt. 2, vol. 46, no. 12, pp. 2220 - 2225, Dec. 1998. [TP98-5]

[80] F. H. Raab, "Drive modulation in Kahn-technique transmitters," *Int. Microwave Symp. Digest*, Anaheim, CA, vol. 2, pp. 811 - 814, June 14 - 17, 1999. [TP99-1]

[81] F. H. Raab, "Transmitter technology for the second century of wireless," *Technical Digest, 1999 IEEE Topical Workshop on Power Amplifiers for Wireless Communications*, paper no. 1.1, San Diego, CA, Sept. 13 - 14, 1999. [TP99-2]

[82] F. H. Raab, "Electronically tunable class-E power amplifier," *Int. Microwave Symp. Digest*, Phoenix, AZ, vol. 3, pp. 1513 - 1516, May 20 - 25, 2001. [TP01-1]

[83] F. H. Raab, "Maximum efficiency and output of class-F power amplifiers," *IEEE Trans. Microwave Theory Tech.*, vol. 49, no. 6, pp. 1162 - 1166, June 2001. [TP01-2]

[84] M. D. Weiss, F. H. Raab, and Z. B. Popovic, "Linearity of X-band class-F power amplifiers in high-efficiency transmitters," *IEEE Trans. Microwave Theory Tech.*, vol. 49, no. 6, pp. 1174 - 1179, June 2001. [TP01-3]

[85] F. H. Raab, "Class-E, -C, and -F power amplifiers based upon a finite number of harmonics," *IEEE Trans. Microwave Theory Tech.*, vol. 49, no. 8, pp. 1462 - 1468, Aug. 2001. [TP01-4]

[86] F. H. Raab, "Class-E power amplifier with electronic tuning and modulation," *Proc. Nordic Shortwave Conf. (HF 01)*, Fårö, Sweden, pp. 2.3.1 - 2.3.8, Aug. 14 - 16, 2001. [TP01-5]

[87] F. H. Raab, P. Asbeck, S. Cripps, P. B. Kenington, Z. B. Popovic, N. Pothecary, J. F. Sevic, and N. O. Sokal, "Power amplifiers and transmitters for RF and microwave," *IEEE Trans. Microwave Theory Tech.*, vol. 50, no. 3, pp. 814 - 826, March 2002. [TP02-1]

[88] F. H. Raab, R. Caverly, R. Campbell, M. Eron, J. B. Hecht, A. Mediano, D. P. Myer, and J. L. B. Walker, "HF, VHF, and UHF systems and technology," *IEEE Trans. Microwave Theory Tech.*, vol. 50, no. 3, pp. 888 - 899, March 2002. [TP02-2]

[89] F. H. Raab, "High-efficiency linear amplification by dynamic load modulation," *Int. Microwave Symp. Digest*, vol. 3, pp. 1717 - 1720, Philadelphia, PA, June 8 - 13, 2003. [TP03-1]

[90] F. H. Raab and D. Ruppe, "Frequency-agile class-D power amplifier," *Ninth Int. Conf. on HF Radio Systems and Techniques*, pp. 81 - 85, University of Bath, UK, June 23 - 26, 2003. [TP03-2]

[91] F. H. Raab, P. Asbeck, S. Cripps, P. B. Kenington, Z. B. Popovic, N. Pothecary, J. F. Sevic, and N. O. Sokal, "RF and microwave power amplifier and transmitter technologies - part 1," *High Frequency Electronics*, vol. 2, no. 3, pp. 22 - 36, May 2003. [TP03-3]

[92] F. H. Raab, P. Asbeck, S. Cripps, P. B. Kenington, Z. B. Popovic, N. Pothecary, J. F. Sevic, and N. O. Sokal, "RF and microwave power amplifier and transmitter technologies - part 2," *High Frequency Electronics*, vol. 2, no. 4, pp. 22 - 36, July 2003. [TP03-4]

[93] F. H. Raab, P. Asbeck, S. Cripps, P. B. Kenington, Z. B. Popovic, N. Pothecary, J. F. Sevic, and N. O. Sokal, "RF and microwave power amplifier and transmitter technologies - part 3," *High Frequency Electronics*, vol. 2, no. 5, pp. 34 - 48, Sep. 2003. [TP03-5]

[94] F. H. Raab, P. Asbeck, S. Cripps, P. B. Kenington, Z. B. Popovic, N. Pothecary, J. F. Sevic, and N. O. Sokal, "RF and microwave power amplifier and transmitter technologies - part 4," *High Frequency Electronics*, vol. 2, no. 6, pp. 38 - 49, Nov. 2003. [TP03-6]

[95] F. H. Raab, P. Asbeck, S. Cripps, P. B. Kenington, Z. B. Popovic, N. Pothecary, J. F. Sevic, and N. O. Sokal, "RF and microwave power amplifier and transmitter technologies - part 5," *High Frequency Electronics*, vol. 3, no. 1, pp. 46 - 54, Jan. 2004. [TP04-1]

[91-95] F. H. Raab, P. Asbeck, S. Cripps, P. B. Kenington, Z. B. Popovic, N. Pothecary, J. F. Sevic, and N. O. Sokal, "RF and microwave power amplifier and transmitter technologies," *High Frequency Electronics*, five-part series: vol. 2, no. 3, pp. 22 - 36, May 2003; vol. 2, no. 4, pp. 22 - 36, July 2003; vol. 2, no. 5, pp. 34 - 48, Sep. 2003; vol. 2, no. 6, pp. 38 - 49, Nov. 2003; vol. 3, no. 1, pp. 46 - 54, Jan. 2004.

[96] F. H. Raab, "Split-band modulator for Kahn-technique transmitters," *IEEE MTT-S Int. Microwave Symp. Digest*, vol. 2, pp. 887 - 890, Fort Worth, TX, June 6 - 11, 2004. [TP04-3]

[97] F. H. Raab, "HF/VHF 250-W class-E power amplifier," *Proc. Nordic Shortwave Conf. (HF 04)*, Fårö, Sweden, pp. 4.2.1 - 4.2.8, Aug. 10 - 12, 2004. [TP04-4]

[98] F. H. Raab, "Transmitter architectures for high-efficiency amplification," *Power Amplifier Workshop Digest, Radio and Wireless Systems Conf. 2006 (RWS'06)*, San Diego, CA, Jan. 16 - 17, 2006. [TP06-1]

[99] F. H. Raab, M. F. Gladu, and D. J. Rupp, "Complementary class-D power amplifier for LF and MF," *QEX*, no. 235, pp. 9 - 13, March/April 2006. [TP06-3]

[100] F. H. Raab, "Broadband class-E power amplifier for HF and VHF," *IEEE MTT-S Int. Microwave Symp. Digest*, paper WE4C-1, pp. 902 - 905, San Francisco, CA, June 11 - 16, 2006. [TP06-4]

[101] F. H. Raab, "Model for the low-frequency performance of ferrite-loaded balun transformers," *2007 Int. Microwave Symp. Digest*, Session TU3A, Honolulu, HI, June 3 - 8, 2007. [TP07-1]

[102] F. H. Raab, M. C. Poppe III, and D. P. Myer, "High-efficiency transmitter for magnetic-resonance imaging," *Technical Digest, 2009 IEEE Topical Symp. on Power Amplifiers for Wireless Commun.*, paper 1.4, San Diego, CA, Jan. 19 - 20, 2009. [TP09-1]

[103] R. Beltran, F. H. Raab, and A. Velazquez, "HF outphasing transmitter using class-E power amplifiers," *IEEE MTT-S Int. Microwave Symp. Digest*, paper WE4A-1, pp. 757 - 760, Boston, MA, June 7 - 12, 2009. [TP09-2]

[104] F. H. Raab, "Amateur radio exploration of 500 kHz," *Platinum Jubilee Yearbook* (J. Belrose, Ed.), paper T2, Radio Club of America, Nov. 2009. [TP09-3]

[105] R. Beltran, F. H. Raab, and A. Velazquez, "High-efficiency outphasing transmitter using class-E power amplifiers and asymmetric combining," *Microwave and Optical Technology Letters*, vol. 51, no. 12, pp. 2959 - 2963, Dec. 2009. [TP09-4]

[106] F. H. Raab and M. C. Poppe III, "Kahn-technique transmitter for L-band communication/radar," *Digest, 2010 IEEE Radio & Wireless Symp. (RWW 2010)*, paper MO3A-1, pp. 100 - 103, New Orleans, LA, Jan. 10 - 14, 2010. [TP10-1]

[107] R. Beltran and F. H. Raab, "Lumped-element output networks for high-efficiency power amplifiers," *IEEE MTT-S Int. Microwave Symp. Digest*, paper TUPC-1, pp. 324 - 327, Anaheim, CA, May 23 - 28, 2010. [TP10-2]

[108] F. H. Raab, "Class-D power amplifier with RF pulse-width modulation," *IEEE MTT-S Int. Microwave Symp. Digest*, paper WE4E-1, pp. 924 - 927, Anaheim, CA, May 23 - 28, 2010. [TP10-3]

[109] F. H. Raab, "Noise model for low-frequency through-the-earth communication, *Radio Sci*., vol. 45, paper RS6019, Dec. 2010. [TP10-5]

[110] F. H. Raab, "Introduction to RF power amplifiers for MRI," Syllabus 07-10, *Weekend Educational Session, Intl. Soc. Mag. Reson. Med. 19*, Montreal, May 7 - 13, 2011. [TP11-2]

[111] F. H. Raab, M. C. Poppe III, and D. P. Myer, "High-efficiency linear power-amplifier module for magnetic-resonance imaging," Paper 1850, *Proc. Intl. Soc. Mag. Reson. Med. 19*, Paper 1850, Montreal, May 7 - 13, 2011. [TP11-3]

[112] R. Beltran, F. H. Raab, and A. Velazquez, "High-efficiency outphasing transmitter using class-E power amplifiers and asymmetric combining, Part 1," *High Frequency Electronics*, vol. 10, no. 4, pp. 18 - 26, April 2011. [TP11-4]

[113] R. Beltran and F. H. Raab, "An outphasing transmitter using Class-E PAs and asymmetric combining, Part 2," *High Frequency Electronics,* vol. 10, no. 5, pp. 34 - 46, May 2011. [TP11-5]

[114] R. A. Beltran and F. H. Raab, "VHF Doherty amplifier with GaN FETs and independent drive-signal control," *IEEE MTT-S Int. Microwave Symp. Digest,* paper WEPK-2, Baltimore, MD, June 5 - 10, 2011. [TP11-6]

[115] F. H. Raab, "Electronically tuned UHF power amplifier," *IEEE MTT-S Int. Microwave Symp. Diges*t, paper TH1G-3, Baltimore, MD, June 5 - 10, 2011. [TP11-7]

[116] M. Eron, B. Kim, F. Raab, R. Caverly, and J. Staudinger, "The head of the class", *Supplement to IEEE Microwave Mag*., vol. 12, no. 7, pp. S16 - S33, Dec. 2011. [TP11-8]

[117] R. Caverly, F. Raab, and J. Staudinger, "High efficiency power amplifiers," *Supplement to IEEE Microwave Mag.*, vol. 13, no. 7, pp. S22 - S32, Nov./Dec 2012. [TP12-1]

[118] R. A. Beltran and F. H. Raab, "Simplified analysis and design of outphasing transmitters using Class-E power amplifiers," Paper M02C-1, pp. 16-18, Power Amplifiers for Wireless and Radio Applications, (PAWR'15), San Diego, CA, Jan. 26-27, 2015. [TP15-1]

[119] F. H. Raab, "650-W high-efficiency amplifier for 704 MHz," *IEEE MTT-S Int. Microwave Symp. Digest,* paper WE4E-1, San Francisco, CA, May 22 - 27, 2016. [TP16-1]

[120] F. H. Raab, "High-Efficiency 500-W RF-Power Modules for UHF," *Proc. North American Particle Accelerator Conf. (NAPAC'16)*, paper MOPOB51, pp. 174 – 176, Chicago, IL, Oct. 9 - 14, 2016. [TP16-2]

[121] F. H. Raab, "Recollections of Nathan Sokal," *IEEE MTT-S Int. Microwave Symp. Digest*, paper TH1D-1, Honolulu, HI, June 4 - 9, 2017. [TP17-1]

[122] F. H. Raab, "Recollections of Nathan Sokal," *IEEE Microwave Mag*., vol. 19, no. 5. pp. 16 - 21, July/Aug. 2018. [TP18-3]

[123] A. Grebennikov and F. H. Raab, "A history of switching-mode class-E technique," *IEEE Microwave Mag*., vol. 19, no. 5, pp. 25 - 41, July/Aug. 2018. [TP18-4]

[124] A. Grebennikov and F. H. Raab, "History of class-F and inverse class-F techniques," *IEEE Microwave Mag.*, vol. 19, no. 7. pp. 99 - 115, Nov./Dec. 2018. [TP18-5]

[125] F. H. Raab, "GaN-FET class-E amplifier for 60-MHz radar," Session 58, pp. 1099 - 1102, *Proc. 50th European Microwave Conf.* (EuMC'20), Utrecht, The Netherlands, 12 - 15 Jan. 2021. [TP21-1]

[126] F. H. Raab, "200-W outphasing amplifier system for 650 MHz," *IEEE MTT-S Int. Microwave Symp. Digest* (IMS'22), paper Tu3B-4, pp. 226 - 229, Denver, CO, June 19 - 24, 2022. [TP22-1]

[127] F. H. Raab, "200-W 13.56-MHz class-E PA with gate-driver ICs," *IEEE MTT-S Int. Microwave Symp. Digest (IMS'23)*, paper We4C-4, pp. 705 - 708, San Diego, CA, June 11 - 16, 2023. [TP23-2]

[128] F. H. Raab, "HF Class-E power amplifier with improved efficiency for mismatched loads," *Proc. 53rd European Microwave Conf.*, Paper EuMC19-5, pp. 384 - 387, Berlin, Sep. 19 - 21, 2023. [TP23-3]

FREDERICK H. RAAB, PATENTS

[1] F. H. Raab, "Remote object position locater," U.S. Patent 4,054,881, Oct. 13, 1977. [TP76-7] [Cincinnati Electronics]

[2] F. H. Raab, "Position determining apparatus and method," U. S. Patent 4,114,155, Sept. 12, 1978. [TP76-8] [Polhemus Navigation Sciences]

[3] F. H. Raab, "Remote object position and orientation locater," U.S. Patent 4,314,251, Feb. 2, 1982. [TP78-1] [Polhemus Navigation Sciences]

[4] F. H. Raab, "Remote object position and orientation locator," U.S. Patent 4,346,384, Aug. 24, 1982. [TP78-2] [Polhemus Navigation Sciences]

[5] R. G. Myers, B. E. Sigmon, and F. H. Raab, "Method and apparatus for delay matching in a power amplifier," U. S. Patent 5,831,475, Nov. 3, 1998. [H-1600] [Motorola]

[6] R. G. Myers, K. V. Buer, and F. H. Raab, "Method and apparatus for high efficiency high dynamic range power amplification," U.S. Patent 5,929,702, July 27, 1999. [H-1622] [Motorola]

[7] B. E. Sigmon, F. H. Raab, and J. R. Clark II, "Method and apparatus for high efficiency wideband power amplification," U.S. Patent 6,084,468, July 4, 2000. [H-1772] [Motorola]

[8] B. E. Sigmon, F. H. Raab, and J. R. Clark II, "Method and apparatus for high efficiency wideband power amplification," U.S. Patent 6,175,273, Jan. 16, 2001. [H-1773] [Motorola]

[9] F. H. Raab, "Technique for wideband operation of power amplifiers," U.S. Patent 6,252,461, June 26, 2001. [H-1762] [GMRR]

[10] F. H. Raab, "Power-conserving drive-modulation method for envelope-elimination-and-restoration (EER) transmitters," U.S. Patent 6,256,482, July 3, 2001. [H-1763] [GMRR]

[11] F. H. Raab, "Wideband, minimum-rating filters and multicouplers for power amplifiers," U.S. Patent 6,552,634, April 22, 2003. [E-164] [GMRR]

[12] F. H. Raab, "Electronically tuned power amplifier," U.S. Patent 7,202,734, April 10, 2007. [E-431] [GMRR]

FREDERICK H. RAAB, BOOKS

[1] H. L. Krauss, C. W. Bostian, and F. H. Raab, *Solid State Radio Engineering*. New York: Wiley, 1980. [TP76-4] [31,627 copies sold]

[1] H. L. Krauss, C. W. Bostian, and F. H. Raab, *Solid State Radio Engineering*. New York: Wiley, 1980. Spanish edition - *Estado Solido en Ingenieria de Radiocomunicacion*. Balderas, D.F., Mexico: Editorial Limusa, S.A., 1984. Bulgarian edition - Полупроводникова Радиотехника (*Poluprovodnikova Radiotechnika*). Sofia, Bulgaria: Izdatelscvo Technika, 1985. [TP76-4]

[1] H. L. Krauss, C. W. Bostian, and F. H. Raab, *Estado Solido en Ingenieria de Radiocomunicacion*. Balderas, D.F., Mexico: Editorial Limusa, 1984. [TP76-4] (Spanish translation of *SSRE*)

[1] H. L. Krauss, C. W. Bostian, and F. H. Raab,Полупроводникова Радиотехника (*Poluprovodnikova Radiotechnika*). Sofia, Bulgaria: Izdatelscvo Technika, 1985. [TP76-4] (Bulgarian translation of *SSRE*)

[2] F. H. Raab, P. Asbeck, S. Cripps, P. B. Kenington, Z. B. Popovic, N. Pothecary, J. F. Sevic, and N. O. Sokal, "Power Amplifier Design," Chapter 5 in A. Hussain, *Advanced RF Engineering for Wireless Systems and Networks*. Hoboken, NJ: John Wiley & Sons, 2005. [TP05-3] [666 copies sold 04/12.]

[3] J. L. B. Walker, D. P. Myer, F. H. Raab, and C. Trask, *Classic Works in RF Engineering: Combiners, Couplers, Transformers, and Magnetic Materials*. Boston, MA: Artech House, 2006. [TP06-2] [554 copies sold.]

GMRR REPORTS

[1] F. H. Raab, "Adaptive-noise-cancellation techniques for through-the-earth electromagnetics, Volume I," Report TR82-1, Green Mountain Radio Research Company, Winooski, VT, Jan. 1982.

[2] F. H. Raab, "Alternative power-line proximity-warning techniques," Report TR82-2, Green Mountain Radio Research Company, Winooski, VT, Jan. 1982.

[3] F. H. Raab, "Algorithms for position and orientation determination in magnetic-helmet-mounted-sight systems," Report TR82-3 (AFAMRL-TR-82-45), Green Mountain Radio Research Company, Winooski, VT, July 1982.

[4] F. H. Raab, "Communication and navigation systems for aircraft-to-aircraft operation of helmet-mounted sight and display systems," Report TR82-4 (AFAMRL-TR-83-085), Green Mountain Radio Research Company, Winooski, VT, Nov. 1983.

[5] F. H. Raab, "Adaptive-noise-cancellation techniques for through-the-earth electromagnetics, Volume II," Report TR83-1, Green Mountain Radio Research Company, Winooski, VT, Sept. 1983.

[6] F. H. Raab, "Polarized interferometer feasibility study," Report TR83-2, (NASA-CR-170979) Green Mountain Radio Research Company, Winooski, VT, July 1983.

[7] F. H. Raab, "Adaptive-noise-cancellation techniques for through-the-earth electromagnetics, Volume III, Report TR84-1, Green Mountain Radio Research Company, Winooski, VT, Feb. 1984.

[8] F. H. Raab, C. C. Brewster, and A. P. Robinson, "Signal processing for through-the-earth communication," Final Report GMRR TR85-1 (BMO TR-85-48), Green Mountain Radio Research Company, Winooski, VT, Sept. 1985.

[9] F. H. Raab and C. C. Brewster, "Magnetic-multipole technique for moveable-scatterer compensation," Final Report TR85-2 (AAMRL-TR-88-054), Green Mountain Radio Research Company, Winooski, VT, Nov. 1988.

[10] F. H. Raab and I. R. Joughin, "Signal-processing experiments for through-the-earth communication," Interim Report TR87-1, Green Mountain Radio Research Company, Winooski, VT, Jan. 1987. [BMO2]

[11] F. H. Raab, "Adaptive-jammer power-amplifier system feasibility study," Final Report TR87-2, Green Mountain Radio Research Company, Winooski, VT, May 1987. [SWL1]

[12] F. H. Raab and I. R. Joughin, "Signal-processing experiments for through-the-earth communication," Interim Report TR87-3, Green Mountain Radio Research Company, Winooski, VT, Aug. 1987. [BMO2]

[13] F. H. Raab and I. R. Joughin, "Signal-processing equipment for through-the-earth communication," Final Report TR87-4 (BMO-TR-88-50, DTIC AD-B127 892L), Green Mountain Radio Research Company, Winooski, VT, Dec. 1987. [BMO2]

[14] F. H. Raab and I. R. Joughin, "Signal-processing experiments for through-the-earth communication," Final Report TR87-5 (BMO-TR-88-67, DTIC AD-B127 893L), Green Mountain Radio Research Company, Winooski, VT, Dec. 1987. [BMO2]

[15] F. H. Raab and W. E. Lenius, "Feasibility study for integrated antenna/amplifier system," Report TR90-1 (Rev. -), Green Mountain Radio Research Company, Colchester, VT, May 1990. [SWL3]

[16] F. H. Raab and W. E. Lenius, "Antennas for mobile systems," Report TR90-2 (Rev. -) (BMO-TR-90-84), Green Mountain Radio Research Company, Colchester, VT, June 1990. [BMO3]

[17] F. H. Raab and W. E. Lenius, "Communications for mobile systems," Report TR90-3 (Rev. -) (BMO-TR-90-83), Green Mountain Radio Research Company, Winooski, VT, June 1990. [BMO3]

[18] F. H. Raab, "Techniques for nondeniable communication," Report TR90-4 (Rev. -) (BMO-TR-90-114), Green Mountain Radio Research Company, Colchester, VT, Dec. 1990. [BMO4]

[19] F. H. Raab, C. C. Brewster, F. L. Stone, and W. F. Mackin, "Algorithms for magnetic helmet-mounted sight," Report TR90-5 (Rev. -) (AL/CF-TR-1993-0077), Green

Mountain Radio Research Company, Colchester, VT, Jan. 1991. [SRL9, SRL10, SRL11, SRL12, SRLI13]

[20] F. H. Raab, "Efficiency of RF-power-combining techniques," Report TR91-1, Green Mountain Radio Research Company, Colchester, Vermont, Sept. 1991. [SWL4]

[21] F. H. Raab and R. F. Calderwood, "Feasibility study for RF transmitter/locator," Report TR93-1, Green Mountain Radio Research Company, Colchester, VT, Sept. 1993. [WES1]

[22] F. H. Raab, "Experimental Adaptive Jammer Power-Amplifier system," Report TR94-1, Green Mountain Radio Research Company, Colchester, VT, June 1995. [SWL2]

[23] F. H. Raab, "Antennas for Integrated Antenna/Amplifier System," Report TR95-1, Green Mountain Radio Research Company, Colchester, VT, May 1995. [SWL5]

[24] F. H. Raab, "Filter/matching networks for Integrated Antenna/Amplifier System," Report TR97-1, Green Mountain Radio Research Company, Colchester, VT, June 1997. [SWL5]

[25] F. H. Raab and K. Shenai, "High-power electronic tuning," Report TR98-1, Green Mountain Radio Research Company, Colchester, VT, April 1998. [SWL6]

[26] F. H. Raab, "Feasibility study for high-efficiency Ka-band MMIC power amplifier," Report TR99-1, Green Mountain Radio Research Company, Colchester, VT, Dec. 1999. [JPL1]

[27] F. H. Raab, Z. B. Popovic, and M. D. Weiss, "Wideband high-efficiency power amplifiers," Technical Report TR00-1 (AFRL-VS-TR-2000-1046), Green Mountain Radio Research Company, Colchester, VT, April, 2000.

[28] F. H. Raab and K. Shenai, "Compact, high-power amplifiers and matching networks for sonar," Report TR01-1, Green Mountain Radio Research Company, Colchester, VT, Oct. 2001. [ONR1 Tasks 1 - 7]

[29] F. H. Raab, "Low-cost, high-efficiency power amplifiers for magnetic-resonance imaging," Report TR02-1, Green Mountain Radio Research Company, Colchester, VT, Feb. 2002. [NSF1]

[30] F. H. Raab, "Compact, high-power amplifiers and matching networks for sonar, Volume II," Report TR02-2, Green Mountain Radio Research Company, Colchester, VT, May 2002. [ONR1 Tasks 8 - 9]

[31] F. H. Raab and K. Shenai, "High-power electronic tuning, Phase II," Report TR02-3, Green Mountain Radio Research Company, Colchester, VT, Sept. 2002. [SWL7]

[32] F. H. Raab, "High-efficiency power amplifier for space-based radar," Report TR03-1, Green Mountain Radio Research Company, Colchester, VT, Feb. 2003. [AFR2]

[33] F. H. Raab and D. P. Myer, "High-efficiency power amplifiers for particle accelerator," Report TR03-2, Green Mountain Radio Research Company, Colchester, VT, Aug. 5, 2003. [DOE1] (DoE ID 812752)

[34] F. H. Raab and S. I. Long, "Wideband high-efficiency power amplifier," Report TR03-3, Green Mountain Radio Research Company, Colchester, VT, Oct. 2003. [SWL8-7]

[35] F. H. Raab and M. C. Poppe III, "High-efficiency power amplifiers for multi-purpose radio," Report TR04-1, Green Mountain Radio Research Company, Colchester, VT, June 2004. [NSW1-7]

[36] F. H. Raab and D. P. Myer, "High-efficiency radar transmit module," Report TR06-3 (Rev. A), Green Mountain Radio Research Company, Colchester, VT, Dec. 2006. [NAV1]

[37] F. H. Raab, "Low-cost, high-efficiency power amplifiers for magnetic-resonance imaging," Report TR07-1 (Rev. -), Green Mountain Radio Research Company, Colchester, VT, Apr. 14 2007. [NSF2]

[38] F. H. Raab, M. C. Poppe, S. I. Long, and T. Mujahed, "High-efficiency power amplifier for space-based radar," Report TR08-1 (AFRL-RY-HS-TR-2008-0014), Green Mountain Radio Research Company, Colchester, VT, June 2008. [AFR3]

[39] F. H. Raab, "Electronically tuned high-efficiency power amplifiers", Report TR08-2, Green Mountain Radio Research Company, Colchester, VT, December 2008. [SWL9]

[40] F. H. Raab, "Phase-I investigation of high-efficiency power-amplifiers for 704 MHz," GMRR Report TR10-1/TR10-4 (DoE Technical Report DOE/SC0002548-1), Green Mountain Radio Research Company, Colchester, VT, Aug. 10, 2010. [Long/short versions.]

[41] F. H. Raab, "Phase-I investigation of high-efficiency power-amplifiers for 50 - 350 MHz," GMRR Report TR10-2/TR10-5(DoE Technical Report DOE/SC0001469-1), Green Mountain Radio Research Company, Colchester, VT, Aug. 10, 2010. [Long/short versions.]

[42] F. H. Raab, "Phase-I investigation of high-efficiency power-amplifiers for 350 - 500 MHz," GMRR Report TR10-3/TR10-6 (DoE Technical Report SC0002103-1), Green Mountain Radio Research Company, Colchester, VT, Aug. 10, 2010. [Long/short versions.]

SEMINAR NOTEBOOKS

[1] F. H. Raab, *High-Efficiency Power Amplifiers* (Seminar Notebook). Colchester, VT: Green Mountain Radio Research Company, 1999. [NB-9]