

# John Ross, Ph.D., P.E.

## Summary

Consulting electrical engineer specializing in electromagnetics, antennas, microwaves, RF and radar. Deep knowledge and experience in antennas. Involved in everything from research & development, to design, simulation, testing, manufacturing and cost reduction. Antenna applications include man pack and re-configurable antennas for the military, automotive AM/FM and SDARS antennas, AM broadcast antennas, miniature high temperature antennas for use inside jet engines and turbine machinery, ultra wide band antennas for medical products, underwater antennas for breast cancer detection, antennas for microwave ablation therapy, variety of antennas for WiFi and HDTV.

Licensed Professional Engineer with numerous patents, journal, and conference publications. Research in applied and computational electromagnetics, genetic and nature based search & optimization algorithms, smart antennas, automated design software, RF and analog circuits, ultra wide band / short pulse radar, target detection, discrimination and identification algorithms.

Entrepreneur with experience in technology startups, formation, business and technology planning, partnering, market strategy, and capitalization.

## Contact Information

**Address:** 3282 East Vallejo Circle, Moab, Utah 84532  
**Phone:** 801-359-5957 **Fax:** 801-931-2020  
**E-mail:** [johnross@johnross.com](mailto:johnross@johnross.com) **Web:** <http://www.johnross.com>

## Professional Experience

### *1997- present, Owner, John Ross & Associates, LLC, Moab, Utah*

- Consulting engineer in applied electromagnetics, antennas, microwaves, RF and radar.
- Clients include small businesses, multinationals and government agencies in automotive, consumer electronics, medical, defense and aerospace industries.
- Developed teaming relationships with other small business and universities to successfully win SBIR and STTR contracts. Principal investigator on resultant programs.
- Developed unique and proprietary cross-disciplinary design automation tools for solving difficult coupled design problems involving electromagnetic and circuit analysis.
- Developed proprietary signal processing software to perform spectral and temporal signal analysis and filtering.
- Applied in-house, government & commercial solvers to analyze & design wide range of antennas, microstrip devices, and novel traveling wave tube devices.
- Conducted R&D, design & analysis of smart antennas, re-configurable antennas for military vehicles, broadband high efficiency monopole antennas for military man packs, conformal AM/FM antennas and satellite radio antennas for automobiles, HDTV & WiFi antennas, UWB antennas for wireless ultrasound unit, underwater antennas for breast cancer detection, antennas for ablation therapy, high temperature antennas for use in jet engines and turbine machinery.
- Inventor of Clearstream series of HDTV antennas manufactured and sold by Antennas Direct and available nationwide in Best Buy stores.

**2011 – present, Owner & Manager, Security Beacon, LLC, Moab, Utah**

- Manager and prime contributor to web blog focused on computer, network and digital security issues facing small business and home users.
- Applied research in computer and network security issues.
- IT services and security consulting for small businesses.

**2004 to 2008 - Founder & VP R&D, 2008 – present, President, Viamorph, Inc., Moab, Utah**

- Lead entrepreneurial effort to create startup-company focused on development and commercialization of new smart antenna technology.
- Forged teaming relationships between large Fortune 100 companies, universities and small businesses.
- Interfaced with top-level corporate and military customers, angel investors and venture capitalists.
- Created business plans and technology strategy to attract Seed Round investment.
- Developed expertise in all aspects of startup operation including company formation, capitalization, intellectual property, licensing, negotiations, employee and investor relations.
- Managed small team of engineering professionals to successfully execute on various development projects.

**2006 – 2010, Board of Advisors, Somark Innovations, Inc.**

- Advisor on technical strategy, sensors, system design etc.

**1996 – 1997, Visiting Assistant Professor, Department of Electrical Engineering, University of Idaho**

- Taught undergraduate courses in Electromagnetic Theory and Microwave Engineering.
- Conducted research in computational electromagnetics and design automation for analog circuits.

**1994 – 1996, Staff Fellow, Electrical and Electronics Engineering Department, General Motors R&D Center, Warren, Michigan**

- Developed custom suite of software tools to analyze and design vehicular antennas.
- Developed custom software to automate data acquisition in antenna test chamber.

**1992 – 1994, Post Doctoral Fellow, Electromagnetics Laboratory, Michigan State University**

- Conducted experimental and theoretical research on radar target detection and identification using ultra-wide band/short pulse systems.
- Designed antennas for a life detection radar system used for earthquake rescue operations.
- Provided direction to graduate research assistants and assisted professors in proposal writing and report preparation for numerous contracts and grants.

**1989 – 1992, Graduate Research Assistant, Electromagnetics Laboratory, Michigan State University**

- Conducted experimental and theoretical research on transient scattering phenomena related to radar target discrimination.
- Developed free-field transient scattering measurement facility based on vector network analyzer.
- Time domain scattering measurements on ground plane and free-field ranges.
- Significant hands-on experience in transient wave scattering and radiation, instrument control, data acquisition and digital signal processing.

**1990, Graduate Teaching Assistant, Department of Electrical Engineering, Michigan State University**

- Instructor for off campus graduate level Fourier Optics course including holography and spatial filtering

**1987 – 1988, Graduate Research Assistant, Radiation Laboratory, University of Michigan**

- Conducted experimental research in millimeter wave remote sensing, polarimetric calibration techniques, scattering properties of natural targets.
- Operated, tested, repaired, and improved a suite of microwave and millimeter wave remote sensing radars and radiometers.
- Developed, designed and built unique Faraday Rotator controller circuit used to accurately change the polarization state of millimeter wave radar.

**1985-1987, Graduate Teaching Assistant, Department of Electrical Engineering, West Virginia University**

- Taught a junior level digital electronics laboratory, developed new laboratory experiments and projects and assigned final grades.

**1984-1985, Assistant Engineer, Illinois Institute of Technology Research Institute, Annapolis, Maryland**

- Implemented and tested enhancements to the TIEM (Terrain Integrated Rough Earth Model) program for predicting wave propagation over the earth.
- Developed a program called CCPAM (Cylindrical Conformal Phased Array Analysis Model) for use in antenna and EMC studies.
- Used NEC-2 (Numerical Electromagnetics Code) to perform co-site interference study of Marine Tactical Airborne Operation Control unit.

## **Education**

**1988 – 1992, Ph.D. Electrical Engineering, Michigan State University**

- Dissertation: "[Application of Transient Electromagnetic Fields to Radar Target Discrimination](#)"
- Course Emphasis: electromagnetics, plasmas, antennas, semiconductors, RF devices, radar
- Department of Electrical Engineering Fellowship 1988 - 1989

**1987 – 1988, Graduate Study, Electrical Engineering, University of Michigan**

- Emphasis: microwave and millimeter wave remote sensing, lasers, optics.

**1985 – 1987, M.S. Electrical Engineering, West Virginia University**

- Thesis: "[AM Broadcast Antenna Engineering](#)"
- Emphasis: electromagnetics, electrostatics, antennas

**1982 – 1984, B.S. Electrical Engineering, West Virginia University**

- Senior Project: "Optical Density Measurement System"
- Emphasis: RF Engineering and Antennas

- Eta Kappa Nu Electrical Engineering Honorary

**1980-1982, A.A. Engineering, Potomac State College, Keyser, West Virginia**

- Computer Simulation of Mechanical System
- Mathematics Achievement Award

## Registration & Licenses

- Licensed Professional Engineer in Utah #354136-2202
- Licensed General Class Amateur Radio Operator KC7WVD

## Professional Memberships

- [Institute of Electrical and Electronics Engineers](#) - Senior Member
- [Applied Computational Electromagnetics Society](#)
- [National Society of Professional Engineers](#)

## Awards and Scholarships

- Edward S. and Sarah J. Moran Scholarship 1980-1984

## Computer Skills

- FORTRAN and Visual BASIC programming, instrument control using GPIB interface
- Linux, Windows, TCP/IP Networking, hardware configuration and troubleshooting

## Journal Publications

1. Richard Schneider and John Ross, "Antennas for the New Airwaves," IEEE Spectrum Magazine, pp. 44-49, February 2009.
2. C.M. Coleman, E.J. Rothwell and J.E. Ross, "Investigation of Simulated Annealing, Ant-Colony Optimization, and Genetic Algorithms for Self-Structuring Antennas," IEEE Transactions on Antennas and Propagation, April 2004.
3. E.J. Rothwell, C.M. Coleman, J.E. Ross and L.L. Nagy, "Self-Structuring Antennas," IEEE Antennas and Propagation Magazine, June 2002.
4. Q. Li, P. Ilavarasan, J.E. Ross, E.J. Rothwell, K.M. Chen and D.P. Nyquist, "Radar Target Identification Using a Combined Early-time/Late-time E-pulse Technique," IEEE Transactions on Antennas and Propagation, Vol. 46, No. 9, September 1998.
5. A. Norman, D. Nyquist, E. Rothwell, K.M. Chen, J. Ross and P. Ilavarasan, "Transient Scattering of a Short Pulse from a Conducting Sinusoidal Surface," The Journal of Electromagnetic Waves and Applications, Vol. 10, No. 4, pp. 461-487, 1996.
6. E.J. Rothwell, K.M. Chen, D.P. Nyquist, J.E. Ross, "Time-domain Imaging of Airborne Targets Using Ultra-Wideband or Short-Pulse Radar," IEEE Transaction on Antennas & Propagation, Vol. 43, No. 3, pp. 327-329, March 1995.
7. J.E. Ross, E.J. Rothwell, D.P. Nyquist and K.M. Chen, "Transient Coupling Analysis Using the Singularity Expansion Method," IEEE Transactions on Electromagnetic Compatibility, Vol. 36, No. 4, pp. 358-364, November 1994.
8. E.J. Rothwell, K.M. Chen, D.P. Nyquist, P. Ilavarasan, J.E. Ross, R. Bebermeyer and Q. Li, "A General E-Pulse Scheme Arising from the Dual Early-Time/Late-Time Behavior of Radar Scatterers," IEEE Transactions on Antennas and Propagation, Vol. 42, No. 9, pp. 1336-1341, September 1994.

9. B. Drachman, J. Ross and D.P. Nyquist, "Approximation of Certain Functions Given by Integrals with Highly Oscillatory Integrands," IEEE Transactions on Antennas Propagation, Vol. 42, No. 9, pp. 1355-1356, September 1994.
10. J.E. Ross, E.J. Rothwell, D.P. Nyquist and K.M. Chen, "Approximate Integral-Operator Methods for Estimating the Natural Frequencies of Coupled Objects," Radio Science, Vol. 29, No. 2, pp. 677-684, July-August 1994.
11. E.J. Rothwell, K.M. Chen, D.P. Nyquist, J.E. Ross and R. Bebermeyer, "A Radar Target Discrimination Scheme Using the Discrete Wavelet Transform for Reduced Data Storage," IEEE Transactions on Antennas and Propagation, Vol. 42, No. 7, pp. 1033-1037, July 1994.
12. P. Ilavarasan, J.E. Ross, E.J. Rothwell, D.P. Nyquist and K.M. Chen, "Performance of An Automated Radar Target Discrimination Scheme Using E-Pulses and S-Pulses," IEEE Transactions on Antennas and Propagation, pp. 582-588, vol. 41, no. 5, May 1993.

## Chapters in Books

1. K.M. Chen, E. Rothwell, D.P. Nyquist, J. Ross, P. Ilavarasan, R. Bebermeyer, Q. Li, C.Y. Tsai and A. Norman, "Radar Identification and detection using ultra-wideband/short-pulse radars," in Lawrence Carin and Leopold B. Felsen (ed.), Ultra-Wideband, Short-Pulse Electromagnetics 2, New York. Plenum, pp. 535-542, 1995.
2. E.J. Rothwell, K.M. Chen, D.P. Nyquist, P. Ilavarasan, J. Ross, R. Bebermeyer, and Q. Li, "Radar Target Identification and Detection Using Short EM Pulses and the E-pulse Technique," in Henry L. Bertoni, Lawrence Carin and Leopold B. Felsen (ed.), Ultra-Wideband, Short-Pulse Electromagnetics, New York. Plenum, pp. 475-482, 1993.

## Conference Papers

1. [John Ross, "Design of Receive Antennas for DTV", Society of Broadcast Engineers, 37th Annual SBE Chapter 22 Expo, Pittsburgh, PA, October 22, 2008.](#)
2. [A.M. Patel, E.J. Rothwell, L.C. Kempel, and J.E. Ross, "Electromagnetic Interference Reduction Study using Self-Structuring Antenna," URSI North American Radio Science Meeting, Ottawa, July 26, 2007.](#)
3. [B.T. Perry, E.J. Rothwell, L.L. Nagy and J.E. Ross, "Self-Structuring Antenna Concept for FM-band Automotive Backlight Antenna design", 2005 AP-S/URSI Symposium, Washington, DC.](#)
4. [J.E. Ross, E.J. Rothwell and S. Preschutti, "A Complementary Self-Structuring Antenna for Use in a Vehicle Environment," 2004 AP-S/URSI Symposium, Monterey, CA, June 23, 2004.](#)
5. [B.T. Perry, E.J. Rothwell, J.E. Ross and L.L. Nagy, "Simplicity Study for a Self-Structuring Antenna in an Automobile Environment," 2004 AP-S/URSI Symposium, Monterey, CA, June 21, 2004.](#)
6. [B.T. Perry, E.J. Rothwell, L.C. Kempel, J.E. Ross and L.L. Nagy, "Simulation of a FM Band Self-Structuring Antenna in an Automobile Environment," 2003 URSI National Radio Science Meeting, Columbus, OH, June 2003.](#)
7. [B.T. Perry, J.A. Nanzer, E.J. Rothwell, L.C. Kempel, J.E. Ross and L.L. Nagy, "A Comparison of Several Self-Structuring Antenna Templates," 2003 URSI National Radio Science Meeting, Columbus, OH, June 2003.](#)
8. [B.T. Perry, C.M. Coleman, E.J. Rothwell, L.C. Kempel, J.E. Ross and L.L. Nagy, "Effect of Switch Failure on the Performance of a Self-Structuring Antenna," 2002 URSI National Radio Science Meeting, San Antonio, TX, June 2002.](#)
9. [C.M. Coleman, B.T. Perry, E.J. Rothwell, J.E. Ross and L.L. Nagy, "A Study of Simple Self-Structuring Antenna Templates," 2002 URSI National Radio Science Meeting, San Antonio, TX, June 2002.](#)
10. [C.M. Coleman, E.J. Rothwell and J.E. Ross, "Application of Two-Level Evolutionary Algorithms to Self-Structuring Antennas," 2001 URSI National Radio Science Meeting, Boston, MA, July 2001.](#)

11. [B.T. Perry, C.M. Coleman, E.J. Rothwell, B.F. Basch and J.E. Ross, "Self-Structuring Antenna for Television Reception," 2001 IEEE International Symposium on Antennas and Propagation, Boston, MA, July 2001.](#)
12. [Kenneth V. Noren and John E. Ross, "Analog Circuit Design Using Genetic Algorithms," Second Online Symposium for Electronics Engineers, Summer 2001.](#)
13. [E.J. Rothwell, C.M. Coleman and J.E. Ross, "Self-Structuring Antennas," IEEE International Symposium on Antennas and Propagation, Salt Lake City, UT, July 16-21, 2000.](#)
14. [J.E. Ross, E.J. Rothwell, C.M. Coleman and L.L. Nagy, "Numerical Simulation of Self-Structuring Antennas Based on a Genetic Algorithm Optimization Scheme," USNC/URSI National Radio Science Meeting, Salt Lake City, UT, July 16-21, 2000.](#)
15. [John E. Ross, Louis L. Nagy, Jaroslaw Szostka, "CAD Tools for Vehicular Antennas," 1999 IX National Symposium of Radio Science, Poznan, Poland, March 16-17, 1999.](#)
16. [E.J. Rothwell, K.M. Chen, D.P. Nyquist, J. Ross and R. Bebermeyer, "Measurement and processing of scattered ultra wide-band/short-pulse signals", 1995 SPIE Meeting, San Diego, CA, July 9-14, 1995.](#)
17. [J.E. Ross, R. Bebermeyer, E.J. Rothwell, K.M. Chen, D.P. Nyquist, "Aspect Angle Sensitivity of Ultrawide Band Target Scattering Data," The 1994 URSI Radio Science Meeting, Seattle, WA.](#)
18. [Q. Li, E.J. Rothwell, K.M. Chen, D.P. Nyquist, J. Ross and R. Bebermeyer, "Data Storage Techniques for use in Correlation-Based Early-Time Radar Target Discrimination," The 1994 URSI Radio Science Meeting, Seattle, WA.](#)
19. [Q. Li, E.J. Rothwell, K.M. Chen, D.P. Nyquist, J. Ross and R. Bebermeyer, "Determination of Radar Target Scattering Center Transfer Functions from Measured Data," The 1994 IEEE APS Symposium, Seattle, WA.](#)
20. [D. Infante, J. Ross and D.P. Nyquist, "Time Domain Method for Materials Characterization using Microstrip Field Applicators," The 1994 URSI Radio Science Meeting, Seattle, WA.](#)
21. [R. Bebermeyer, J. Ross, E. Rothwell, K-M Chen and D. Nyquist, "Polarization Diversity for Reduction of Scattering from Spatially Periodic Perfectly Conducting Surfaces," The 1994 IEEE APS Symposium, Seattle, WA.](#)
22. [A. Norman, J. Song, D.P. Nyquist, J. Ross, P. Ilavarasan, M. Seneski, K.M. Chen, E.J. Rothwell, "Scattering of transient radiation from an imperfectly-conducting infinite periodic sea surface," The 1994 AP-S International Symposium and URSI Radio Science Meeting, Seattle, WA.](#)
23. [K.M. Chen, E. Rothwell, D.P. Nyquist, P. Ilavarasan, J. Ross, Q. Li, C.Y. Tsai, R. Bebermeyer and A. Norman, "Target Detection and Identification using Ultra-Wideband/Short-Pulse Radars," International Conference on Ultra-Wideband Short-Pulse Electromagnetics, Brooklyn, NY, April 1994.](#)
24. [J. Song, A. Norman, D. Nyquist, J. Ross, P. Ilavarasan, M. Seneski, K. Chen and E. Rothwell, "Scattering of Pulsed Radiation from an Imperfectly Conducting Infinite Periodic Sea Surface," The 1994 National Radio Science Meeting, Boulder, CO.](#)
25. [J. Ross, P. Ilavarasan, E. Rothwell, R. Bebermeyer, K.M. Chen, D. Nyquist and Q. Li, "Radar Target Discrimination using E-pulses with the Early Time and Late-Time Responses," The 1993 URSI Radio Science Meeting, Ann Arbor, Michigan, June 27-July 2, 1993.](#)
26. [P. Ilavarasan, J. Ross, R. Bebermeyer, E. Rothwell, K.M. Chen and D. Nyquist, "Radar Detection of Targets in a Sea Clutter Environment using E-pulse Technique," The 1993 URSI Radio Science Meeting, Ann Arbor, Michigan, June 27-July 2, 1993.](#)
27. [D. Infante, D.P. Nyquist, J. Ross and M. Havrilla, "Calibration of Microstrip & Stripline Field Applicators using Time Domain Techniques," The 1993 URSI Radio Science Meeting, Ann Arbor, Michigan, June 27-July 2, 1993.](#)
28. [K.M. Chen, E. Rothwell, D.P. Nyquist, P. Ilavarasan and J. Ross, "Radar Target Identification and Detection Using Short EM Pulses and the E-Pulse Technique," The International Conference on Ultra-Wideband Short-Pulse Electromagnetics, Brooklyn, NY, October 1992.](#)
29. [J. Ross, E. Rothwell, K.M. Chen, D.P. Nyquist and J. Nathan, "Investigation of the Early-Time Behavior of Radar Targets Excited in the Resonance Region," The 1992 URSI Radio Science](#)

- [Meeting, Chicago, Illinois, July 18-25, 1992.](#)
30. [K.M. Chen, D.P. Nyquist, E. Rothwell, P. Ilavarasan and J. Ross, "Transient Radar for Target Identification and Detection," The 1992 URSI Radio Science Meeting, Chicago, Illinois, July 18-25, 1992.](#)
  31. [J. Ross, E. Rothwell, D. Nyquist, K.M. Chen and J. Nathan, "Transient Scattering Measurements," The National Radio Science Meeting, Boulder, CO, January 7-11, 1992.](#)
  32. [P. Ilavarasan, E. Rothwell, J. Ross, D. Nyquist and K.M. Chen, "Time Domain Radar Target Discrimination Using S-Pulse Waveforms," PIERS 1991, Cambridge, MA, July 1-5, 1991.](#)
  33. [J. Ross, E. Rothwell, D. Nyquist and K.M. Chen, "Transient Response of Radar Targets Using Wide-Band Stepped-Frequency Measurements," The 1991 North American Radio Science Meeting, London, Ontario, Canada, June 22-25, 1991.](#)
  34. [P. Ilavarasan, E. Rothwell, J. Ross, D. Nyquist and K.M. Chen, "Radar Target Discrimination Using S-Pulse Waveforms," The 1991 North American Radio Science Meeting, London, Ontario, Canada, June 22-25, 1991.](#)
  35. [J.E. Ross, E.J. Rothwell, D.P. Nyquist and K.M. Chen, "Multiple Target Discrimination using E-Pulse Techniques," The 1990 IEEE/AP-S Symposium, Dallas, TX, May 7-11, 1990.](#)
  36. [P. Ilavarasan, E. Rothwell, D. Nyquist, K.M. Chen and J. Ross, "Radar Target Discrimination of Nearly Identical Targets Using Free-Field Measurements," The 1990 North American Radio Science Meeting, Dallas, TX, May 7-11, 1990.](#)

## Dissertation and Thesis

- [John E. Ross, III, "Application of Transient Electromagnetic Fields to Radar Target Discrimination", Doctoral Dissertation, Michigan State University, 1992.](#)
- [John E. Ross, III, "AM Broadcast Antenna Engineering," MS Problem Report, West Virginia University, Morgantown, West Virginia, 1987.](#)

## White Papers

- John Ross, "Design Automation for Vehicle Electronic Systems," March 2000.
- [J.E. Ross and E.J. Rothwell, "A White Paper on Self-Structuring Antenna Technology," March 2004.](#)

## Non-Proprietary Project Reports

1. K.M. Chen, D.P. Nyquist, E.J. Rothwell, J.E. Ross, "Radar Target Detection Using Short EM Pulses and the E-Pulse Technique," Final Technical Report prepared for Naval Command, Control and Ocean Surveillance Center, RDT&E Division, San Diego, CA, December, 1993.
2. John Ross, Edward Rothwell and Kun-Mu Chen, "Non-Cooperative Target Recognition Using Ultra-Wide Band Radars," Final Technical Report prepared for ThermoTrex Corporation, San Diego, CA, September, 1992.
3. John E. Ross, Edward J. Rothwell, Kun-Mu Chen and Dennis P. Nyquist, "Application of Transient Electromagnetic Fields to Radar Target Discrimination," Final Technical Report prepared for Naval Command, Control and Ocean Surveillance Center, RDT&E Division, San Diego, CA, September 1992.
4. Kun-Mu Chen, Dennis P. Nyquist, Edward J. Rothwell, John E. Ross and Ponniah Ilavarasan, "Target Detection using Transient Electromagnetic Pulses," Final Technical Report prepared for Naval Command, Control and Ocean Surveillance Center, RDT&E Division, San Diego, CA, September 1992.
5. J.E. Ross and P.E. Hussar, "A Cylindrical, Conformal Phased-Array Analysis Model," ECAC-TN-85-005, 1985.

## Issued Patents

1. R.E. Schneider and J.E. Ross, "Antenna element," [US D604,276](#), November 17, 2009.
2. R.E. Schneider and J.E. Ross, "Tapered loop antenna element," [US D598,433](#), August 18, 2009.
3. R.E. Schneider and J.E. Ross, "Double tapered loop antenna element," [US D598,434](#), August 18, 2009.
4. R.E. Schneider and J.E. Ross, "Antenna assemblies with antenna elements and reflectors", [US 7,609,222](#), October 27, 2009.
5. R.E. Schneider, J.E. Ross, C. Feit, D. Picolet, and C. Stuemke, "Antenna assemblies with tapered loop antenna elements and reflectors", [US 7,839,347](#), November 23, 2010.
6. R.E. Schneider, J.E. Ross, C. Feit, D. Picolet, "Antenna", [US D666,178](#), August 28, 2012.
7. R.E. Schneider, J.E. Ross "Antenna assemblies with antenna elements and reflectors", [US 8368607](#), February 5, 2013.
8. R.E. Schneider, J.E. Ross, D.E. Young, and D.P. Koller, "Smart Antenna Systems Suitable for Reception of Digital Television Signals," [US 8648770](#), February 11, 2014.
9. R.E. Schneider, J.E. Ross, C. Feit, "Antenna assembled including antenna elements with dielectric for forming closed bow tie shapes," [US 8674897](#), March 18, 2014.

## Patent Applications

1. J.E. Ross and E.J. Rothwell, [Complementary Self-Structuring Antenna](#), Filed January 2005. Abandoned.