

PETER WILLIAM SHACKLE
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Education

9/62-5/65 Bachelor's degree in Physics from University of Birmingham, UK. Recipient of simultaneous state scholarship and University open entrance scholarship. Graduated top student in University class.

9/65- 5/69 Ph.D. in Physics from Trinity College, Cambridge, UK. Researched at the Royal Society Mond Laboratory, an élite subsection of the Cavendish Physics laboratory including Nobel Prize winner Brian Josephson. Thesis described a new technique for measuring the Hall effect in liquid metals.

1982 Passed the Master of Business Administration exam for the University of Florida after studying an MBA course in conjunction with Harris Corporation.

Work Experience

1/2012 – present President and Founder of Photalume, a consulting company in the field of lighting electronics products, particularly LED drive circuits and electronic ballast circuits.

1/2011-12/2011 Director of Power Supply Products, Light Based Technologies. Operated a three person laboratory in Torrance, CA developing LED drive application circuits for the LBT microprocessor chip.

1/2008 – 12/2010 Chief Technologist at Lightech Electronics North America, Inc., Torrance, CA. Responsible for operating a three person laboratory in Torrance, CA developing advanced LED drives for this international company. During this time developed phase control dimming LED drives capable of dimming to 0.1% using TRIAC dimmers. Put eight such products through UL and into Chinese manufacturing, and three more European products through ENEC approval and into Chinese manufacturing. Developed a dramatically new technology for dimmable constant current LED drives with efficiency of 90%, capable of working at either 120V or 277V. Side responsibilities involved managing the patent portfolio of Lightech internationally. Two patent applications filed during this time.

8/2004-12/2007 V. P. Advanced Technology at Fulham Co., Inc., Hawthorne, CA. Responsible for the technology direction of this fast growing company. Responsibilities included creation of new technologies and development of new products involving innovative technology. Achievements at Fulham included the creation of the Racehorse family of high performance products that are the subject of a Fulham patent application, and the creation of a new charge pump technology for cost effective instant start T8 ballasts, subject of an issued patent. Nine products transferred to Chinese manufacture during this time. Managed design of a 4 channel LED driver which was transferred to China for manufacture

5/2002-8/2004 Director of Engineering and later V.P. of Advanced Technology at Universal Lighting Technologies, Inc., Huntsville, AL. Worked on the latest analog and digital technology for electronic ballasts. Product focus was on low cost IC based products and on sophisticated microprocessor based products for more complex applications such as dimming and instant start T5. Ran an operation of 30 people and directly organized a group of nine, including 3 Ph.D. level staff. Achievements in this position included a line of microprocessor based instant start T5 ballasts. Five patents resulted.

10/2000 – 5/2002 V.P. Engineering at Robertson Worldwide, Blue Island, IL. Managed both electronic and magnetic ballast new product development. Invented a new low cost electronic ballast architecture that still has all the specified features, marketed as the "World Series" ballasts. Trained engineering staff for modern electronic ballast development and assembled state of the art ballast characterization facilities.

4/93-10/2000 Engineering Manager and Chief Technologist at Energy Savings, Inc. Schaumburg, IL. Worked on fundamental issues making possible the development of low cost, low profile electronic ballasts. Personally designed and put into manufacture 60 ballasts in first five years. Later managed team of designers and technicians producing ballast designs while personally prototyping the more difficult designs. ESI ballasts combined high performance with low cost & small size with capability for extremely fast product development. Authored multiple inventions involving microprocessor controlled digital ballasts. Responsibilities in this company included all fundamental technology issues and patent related activities. Developed new low cost dimming technology. Personally designed the logical flow charts for microprocessor ballast software. Shipments rate increased to \$40M/yr. from zero in 7 years.

8/91-4/93 Manager of Ballast integrated Circuit Design at Motorola Lighting Inc., Buffalo Grove, IL. Worked on novel ballast circuits suitable for integration in silicon. Put three conventional ballast circuits into production.

4/87-8/91 Research Department head at Philips Research, Briarcliff, NY. Worked on the application of Power IC technology to all products in the Philips family of companies. Worked on analysis of customer needs and specification of Power IC products to meet those needs. Ran a department of 20 producing power IC designs, including chips for Fluorescent Lighting ballasts.

11/83-4/87 V.P. of Engineering for Telmos, Inc. in Sunnyvale, CA. Developed the first 500V CMOS technology and put numerous high voltage IC chips into production. 1986 Chaired the Electrochemical society symposium on high voltage and Smart Power Devices, which has since morphed into the conference series now known as ISPSD. These developments were the subject of a cover page article in Powertechnics magazine.

6/80-11/83 Manager of high voltage integrated circuit products at Harris Semiconductor in Melbourne, Florida developing high voltage ac line powered integrated circuits. This work was the subject of a cover page article in Electronics Design magazine.

6/70 – 6/80 Member of technical staff at ATT Bell Laboratories, Murray Hill, NJ doing research on solid state devices in general and high voltage integrated circuits in particular. Invented the first 500V IC, for which work a prize was awarded at the 1981 International Solid State Circuits Conference. Became group supervisor in 1979.

5/69 – 6/70 Member of technical staff at the GEC Hirst Research Center in Wembley, UK, doing research on circuits and structures for microwave avalanche diodes.

Issued Patents and Pending Patent Applications

61 issued patents from the United States Patent and Trademark Office

1. F. A. D'Altroy, A. R. Hartman, R. M. Jacobs, R. L. Pritchett, P. W. Shackle, "Integrated circuit switching network using low substrate leakage current

- thyristor construction,” U.S. Patent No. 4,130,827, issued on December 19, 1978.
2. A. R. Hartman, J. C. North, G. W. Reutlinger, P. W. Shackle, “High Voltage Semiconductor Devices,” U.S. Patent No. 4,131,910, issued on December 26, 1978.
 3. R. S. D’Angelo, A. R. Hartman, P. W. Shackle, “High Voltage Monolithic Transistor Circuit,” U.S. Patent No. 4,167,748, issued on September 11, 1979.
 4. A. R. Hartman, T. J. Riley, P. W. Shackle, “Dielectrically-Isolated Integrated Circuit Complementary Transistors for High Voltage Use,” U.S. Patent No. 4,232,328, issued on November 4, 1980
 5. J. E. Berthold, A. R. Hartman, P. W. Shackle, “Dielectrically Isolated High Voltage Semiconductor Devices,” U.S. Patent No. 4,242,697, issued on December 30, 1980.
 6. J. A. Davis, W. F. MacPherson, P. W. Shackle, “Control Circuitry Using a Pull-Down Transistor for High Voltage Field Terminated Diode Solid-State Switches,” U.S. Patent No. 4,250,409, issued on February 10, 1981.
 7. A. R. Hartman, R. S. Scott, P. W. Shackle, “Solid-State Projector Circuitry Using Gated Diode Switch,” U.S. Patent No. 4,271,445, issued on June 2, 1981.
 8. W. F. MacPherson, R. S. Scott, P. W. Shackle, “Integral Turn-On High Voltage Switch,” U.S. Patent No. 4,309,715, issued on January 5, 1982.
 9. A. R. Hartman, R. S. Scott, P. W. Shackle, “Solid-State Projector Circuitry Using Gated Diode Switch,” U.S. Patent No. 4,323,942, issued on February 11, 1981.
 10. J. A. Davis, W. F. MacPherson, H. E. Mussman, P. W. Shackle, “Control Circuitry for High Voltage Solid-State Switches,” U.S. Patent No. 4,345,163, issued on August 17, 1982.
 11. A. R. Hartman, P. W. Shackle, “Control Circuitry Using a Pull-Down Transistor for High Voltage Field Terminated Diode Solid-State Switches,” U.S. Patent No. 4,349,751, issued on September 14, 1982.
 12. P. W. Shackle, R. S. Pospisil, “Phase-to-Voltage Converter,” U.S. Patent No. 4,480,219, issued on October 30, 1984.
 13. P. Shackle W. “Control Circuitry for High Voltage Solid-State Switches,” U.S. Patent No. 4,516,037, issued on May 7, 1985.
 14. P. W. Shackle, R. S. Pospisil, “Integrated Circuit Switch Using Stacked SCRs,” U.S. Patent No. 4,528,461, issued on July 9, 1985.
 15. P. W. Shackle, R. S. Pospisil, “Integrated Circuit Switch Using Stacked SCRs,” U.S. Patent No. 4,528,462, issued on July 9, 1985.

- 16.A. R. Hartman, B. T. Murphy, T. J. Riley, P. W. Shackle, "High Voltage Junction Solid-State Switch," U.S. Patent No. 4,586,073, issued on April 29, 1986.
- 17.J. E. Berthold, A. R. Hartman, T. J. Riley, P. W. Shackle, "High Voltage Dielectrically Isolated Remote Gate Solid-State Switch," U.S. Patent No. 4,587,545, issued on May 6, 1986.
- 18.A. R. Hartman, T. J. Riley, P. W. Shackle, "High Voltage Solid-State Switch," U.S. Patent No. 4,587,656, issued on May 6, 1986.
- 19.A. R. Hartman, A. U. MacRae, P. W. Shackle, "High Voltage Dielectrically Isolated Dual Gate Solid-State Switch," U.S. Patent No. 4,602,268, issued on July 22, 1986.
- 20.A. R. Hartman, T. J. Riley, P. W. Shackle, "High Voltage Dielectrically Isolated Solid-State Switch," U.S. Patent No. 4,608,590, issued on August 26, 1986.
- 21.J. A. Davis, W. F. MacPherson, H. E. Mussman, P. W. Shackle, "Control Circuitry Using Two Branch Circuits for High Voltage Solid-State Switches," U.S. Patent No. 4,656,366, issued on April 7, 1987.
- 22.E. Arnold, S. L. Merchant, P. W. Shackle, "Integrated Circuit Device Particularly Adapted for High Voltage Applications," U.S. Patent No. 5,113,236, issued on May 12, 1992.
- 23.P. W. Shackle, "Ballast Circuit Equipped with Ground Fault Detector," U.S. Patent No. 5,363,018, issued on November 8, 1994.
- 24.J. G. Konopka, P. W. Shackle, J. R. Wood, "Toggle Brightening Circuit for Powering Gas Discharge Lamps and Method for Operating Gas Discharge Lamps," U.S. Patent No. 5,373,218, issued on December 17, 1994.
- 25.J. G. Konopka, P. W. Shackle, "High-Power Factor Circuit for Energizing Gas Discharge Lamps," U.S. Patent No. 5,374,875, issued on December 20, 1994.
- 26.P. W. Shackle, "Protection Circuit for Electronic Ballasts Which Use Charge Pump Power Factor Correction," U.S. Patent No. 5,396,153, issued on March 7, 1995.
- 27.R. J. Bezdon, K. E. Crouse, R. G. Russell, P. W. Shackle, "Self-Dimming Electronic Ballast," U.S. Patent No. 5,396,155, issued on March 7, 1995.
- 28.J. G. Konopka, P. W. Shackle, "Ballast Circuit for Driving Gas Discharge," U.S. Patent No. 5,399,944, issued on March 21, 1995.
- 29.P. W. Shackle, "Circuit for Powering Gas Discharge Lamp," U.S. Patent No. 5,412,287, issued on May 2, 1995.
- 30.P. W. Shackle, "Electronic Ballast with Two Transistors and Two Transformers," U.S. Patent No. 5,416,388, issued on May 16, 1995.

- 31.K. E. Crouse, R. G. Russell, P. W. Shackle, "Booster Driven Inverter Ballast Employing the Output from the Inverter to Trigger the Booster," U.S. Patent No. 5,461,287, issued on October 24, 1995.
- 32.R. J. Bezdon, R. G. Russell, P. W. Shackle, "Lamp Protective, Electronic Ballast," U.S. Patent No. 5,493,180, issued on February 20, 1996.
- 33.K. E. Crouse, R. G. Russell, P. W. Shackle, "Capacitive Lamp Out Detector," U.S. Patent No. 5,493,181, issued on February 20, 1996.
- 34.R. J. Bezdon, K. E. Crouse, R. G. Russell, P. W. Shackle, "Low Height Ballast for Fluorescent Lamps," U.S. Patent No. 5,500,576, issued on March 19, 1996.
- 35.R. J. Bezdon, K. E. Crouse, R. G. Russell, P. W. Shackle, "Externally Dimmable Electronic Ballast," U.S. Patent No. 5,539,281, issued on July 23, 1996.
- 36.R. J. Bezdon, K. E. Crouse, R. G. Russell, P. W. Shackle, "Electronic Ballast That Monitors Direct Current Through Lamp Filaments," U.S. Patent No. 5,747,941, issued on May 5, 1998.
- 37.M. W. Bandel, R. J. Bezdon, B. Boykov, K. E. Crouse, P. J. Keegan, W. L. Keith, P. W. Shackle, "Microprocessor Controlled Electronic Ballast," U.S. Patent No. 5,925,990, issued on July 20, 1999.
- 38.R. J. Bezdon, K. E. Crouse, P. J. Keegan, W. L. Keith, G. Mirskiy, P. W. Shackle, "Electronic Ballast with Filament Cut-Out," U.S. Patent No. 5,973,455, issued on October 26, 1999.
- 39.R. J. Bezdon, K. E. Crouse, R. G. Russell, P. W. Shackle, "Electronic Ballast Producing Voltage Having Trapezoidal Envelope for Instant Start Lamps," U.S. Patent No. 5,982,113, issued on November 9, 1999.
- 40.R. J. Bezdon, K. E. Crouse, P. J. Keegan, P. W. Shackle, "Electronic Ballast Deriving Auxiliary Power from Lamp Output," U.S. Patent No. 6,023,132, issued on February 8, 2000.
- 41.M. W. Bandel, K. E. Crouse, G. Mirskiy, P. W. Shackle, "Fast Starting, Surge Limited, Electronic Ballast," U.S. Patent No. 6,111,365, issued on August 29, 2000.
- 42.D. G. Huvaere, Jr., P. W. Shackle, M. L. Wu, "Electronic Ballast with Selective Load Control," U.S. Patent No. 6,137,239, issued on October 24, 2000.
- 43.R. J. Bezdon, M. L. Wu, D. G. Huvaere, Jr., P. W. Shackle, "Electric Ballast with Selective Power Dissipation," U.S. Patent No. 6,177,769, issued on January 23, 2001.
- 44.P. W. Shackle, "Fluorescent Lamp Ballast with Integrated Circuit," U.S. Patent No. 6,420,838, issued on July 16, 2002.

- 45.G. L. Grouev, P. W. Shackle, "Electronic Ballast with Cross-Coupled Outputs," U.S. Patent No. 6,437,520, issued on August 20, 2002.
- 46.P. W. Shackle, "Low Pressure Gas Discharge Lamp Ballast with On-Off Indicator," U.S. Patent No. 6,791,275, issued on September 14, 2004.
- 47.P. W. Shackle, "LED Drive for Generating Constant Light Output," U.S. Patent No. 7,019,662, issued on March 28, 2006.
- 48.Q. Yu, C. Radzinski, P. Shackle, J. J. Dernovsek, "Electronic Ballast with Open Circuit Voltage Control and Cable Compensation," U.S. Patent No. 7,098,606, issued on August 29, 2006.
- 49.Q. Yu, C. Radzinski, P. Shackle, J. J. Dernovsek, "Electronic Ballast with Lossless Snubber Capacitor Circuit," U.S. Patent No. 7,098,607, issued on August 29, 2006.
- 50.Q. Yu, C. Radzinski, P. Shackle, J. J. Dernovsek, "Lossless Circuit for Sample of Lamp Voltage," U.S. Patent No. 7,098,608, issued on August 29, 2006.
- 51.P. Shackle, J. J. Dernovsek, B. Drew, Q. Yu, "High Efficiency 4-Lamp Instant Start Ballast," U.S. Patent No. 7,132,803, issued on November 7, 2006.
- 52.C. Radzinski, P. Shackle, Q. Yu, "Power Supply Circuits and Methods for Supplying Stable Power to Control Circuitry in an Electronic Ballast," U.S. Patent No. 7,423,386, issued on September 9, 2008.
- 53.D. A. Blair, P. Shackle, and R. Shi, "IC-Based Low Cost Reliable Electronic Ballast with Multiple Striking Attempts and End of Lamp Life Protection," U.S. Patent No. 7,432,660, issued on October 7, 2008.
- 54.P. W. Shackle, Z. Wu, "Ballast for Fluorescent Lamps," U.S. Patent No. 8,018,173, issued on September 13, 2011.
- 55.P. W. Shackle, Z. Du, "Phase Controlled Dimming LED Driver System and Method Thereof," U.S. Patent No. 8,203,276, issued on June 19, 2012.
- 56.P. W. Shackle, Z. Du, "Electronic ballasts with high-frequency-current blocking component or positive current feedback" U.S. Patent No. 8,736,189 issued May 27th, 2014.
- 57.P.W. Shackle, Denny D. Beasley, "Single phase bridgeless boost converter for LED lighting applications" US Patent No. 8,994,293, issued March 31st, 2015.
- 58.P.W. Shackle, Z. Du, "Phase controlled dimming LED driver system and method thereof" US Patent No. 9,167,641, issued October 20th, 2015.
- 59.P.W. Shackle "AC-powered LED light engine" US Patent 9,491,821, issued November 8th, 2016.
- 60.P.W. Shackle "AC-powered LED light engine" US Patent 9,585,212, issued February 28th, 2017.

61.P.W. Shackle “AC-powered LED light engine” US Patent 9,723,671 issued August 1st, 2017.

Publications

Eight publications in refereed journals, plus eleven other publications.

1. P. W. Shackle, “Measurement of the Hall Coefficient of Liquid Metals by the Corbino Method,” *Phil. Mag.* 21.173, 987-1002 (1970).
2. P. W. Shackle, “A High-Efficiency, Self-Pulsed IMPATT Oscillator Circuit,” *Electronics Lett.*, Aug. 1969, P.395.
3. P. W. Shackle, “A New Technique for the Characterization of Microwave Avalanche Diodes,” *IEEE Trans. on Microwave Theory and Techniques* 18. 11, pp. 995-998 (1970).
4. P. W. Shackle and R. S. Payne, “The Fabrication of Bipolar Transistors Using Electron Lithography, Ion Implantation and Nickel-Masked Gold Metallization,” *J. of Vacuum Sci. and Tech.* 10.6, 1090-93 (1973).
5. P. W. Shackle, “An Experimental Study of Distributed Effects in a Microwave Bipolar Transistor,” *IEEE Trans. on Electron Devices*, 21.1, 32-39 (1974).
6. P. W. Shackle, A. R. Hartman, J. M. Adrian, and R. L. Pritchett, “A Low Substrate Leakage Junction Isolated P-N-P-N Crosspoint Array,” *IEEE J. Solid State Circuits*, 13.2, 210-18 (1978).
7. P. W. Shackle, A. R. Hartman, T. J. Riley, J. C. North, J. E. Berthold, and J. A. Davis, “A 500V Monolithic Bidirectional 2X2 Crosspoint Array,” *IEEE Int’l Solid State Circuits Conf.*, San Francisco, February 1980 (Outstanding paper award).
8. P. W. Shackle, A. R. Hartman, B. T. Murphy, R. S. Scott, R. A. Lieberman, and M. Robinson, “A New Bidirectional Solid-State Switch for Telephone Loop Plant Applications,” *Proc. IEEE* 69.3, 292-99 (1981) (Cover Page Article).
9. P. W. Shackle and R. S. Pospisil, “A Line Powered Induction Motor Energy Saver,” *IEEE Custom Integrated Circuits Conference*, 1983, 412-16 (1983).
- 10.P. W. Shackle, “IC Increases Efficiency of Single-Phase Induction Motors,” *Electronic Design* 31.10 (Cover page article).
- 11.P. W. Shackle, “High Voltage ICs Are Here,” *Integrated Circuits Mag.* 2.2, 19-25 (1984) (Cover Page article).
- 12.P. W. Shackle, “Custom High Voltage Integrations for Industry,” Presentation in Professional program at ELECTRO/85, New York, April 1985.

- 13.P. W. Shackle, "Standard Cells Step In to Ease The Design of High-Voltage Chips," *Electronic Design*, 21, 149-54 (1985).
- 14.P. W. Shackle, "The High Voltage IC Revolution," *Powertechnics Mag.*, Sept. 1985.
- 15.P. W. Shackle, "High Voltage and Smartpower ICs - The last Semiconductor Frontier," invited paper at the Fifth Australian and Pacific region Microelectronics Conference. May 1986.
- 16.P. W. Shackle, "High Voltage and Smartpower ICs," (book edited by P. W. Shackle, 1987), Proceedings of a symposium held at the Electrochemical Society meeting in May 1987.
- 17.P. W. Shackle and I. Wacyk, "An ASIC approach to PICs," *Proc. of the 2nd Semiconductor Devices and ICs*, 7-12 (1990) (invited keynote address).
- 18.P. W. Shackle: "Selecting or Specifying a driver for your LED array" June 2013." LEDS magazine white paper (now available at Engineers Online)
- 19.P. W. Shackle "New Driverless LED Light Engines Have Up to 93% Efficiency and No Perceptible Flicker" LEDS magazine, September 2014, page 73.
- 20.P.W. Shackle "A New Approach to the Design of Driverless AC LED Light engines" LED Professional magazine Feb 2015 P49
- 21.P.W. Shackle: "Driverless AC LED light Engines Deliver Improved Flicker Performance" LEDs magazine, March 2016, P67.
- 22.P.W. Shackle: "Progress in AC LED Light Engines" Presentation at Strategies in Light, 2016.
- 23.Peter Erwin and Peter Shackle "Understanding a New Flicker Metric and its application to AC-LED light engines" LEDs Magazine, April 2017, pages 55-62.

Honors and Achievements

- Received a prize from the International Solid State Circuits Conference in February 1980 for paper describing the first 500V solid state crosspoint
- 1987 Chairman of First Symposium on High Voltage and Smart Power devices, which subsequently became the ISPSD conference series
- Elected a Senior Life Member of IEEE in 2010.
- Published the science fiction novel *A Disruptive Invention* in 2010, available electronically through multiple on-line channels.

Litigation Related Experience

I have provided deposition testimony or testified at trial in the following matters:

- *Jam Strait, Inc. v. Osram Sylvania, Inc.*, Case No. 2:13-cv-02495 (E.D. La.) (on behalf of Defendant Osram Sylvania, Inc.). Complaint filed Oct. 10, 2012.
- *Richmond v. Jiawei North America, Inc. et al.*, Case No. 3:13-cv-01953 (D.N.J.) (on behalf of Defendant Jiawei North America, Inc. et al.). Complaint filed Mar. 27, 2013.
- *Koninklijke Philips N.V. v. iGuzzini Lighting USA, Ltd., et al.*, Case No. 1:15-cv-03979 (S.D.N.Y.) (on behalf of iGuzzini Lighting USA, Ltd. et al.). Complaint filed May 22, 2015.
- *In the Matter of Certain LED Lighting Devices, LED Power Supplies, and Components Thereof*. ITC No. 337-TA-1081 (on behalf of respondent Feit et al.). Complaint filed Sep. 21, 2017.
- *Jiawei Tech. (USA) Ltd. v. Richmond*, IPR2014-00935 (on behalf of Petitioner Jiawei Tech. (USA) Ltd.). Petition filed Jun. 11, 2014.
- *Jiawei Tech. (USA) Ltd. v. Richmond*, IPR2014-00936 (on behalf of Petitioner Jiawei Tech. (USA) Ltd.). Petition filed Jun. 11, 2014.
- *Jiawei Tech. (USA) Ltd. v. Richmond*, IPR2014-00938 (on behalf of Petitioner Jiawei Tech. (USA) Ltd.). Petition filed Jun. 11, 2014
- *FEIT Electric Co., Inc. v. Philips Lighting Holding B.V.*, IPR2018-00921 (on behalf of Petitioner FEIT Electric Co., Inc.). Petition filed Apr. 16, 2018.
- *Satco Products, Inc. v. Seoul Viosys Co., Ltd.* IPR2020-00750. Petition filed April 1st, 2020
- Certain Light-Emitting Diode Products, Fixtures, and Components Thereof ITC 337-TA-1213, and United States District Court for the Southern District of New York, Ideal Industries Lighting LLC d/b/a Cree Lighting v. RAB Lighting Inc., Civil Action No. 1:20-cv-05424. October 2020.